YNYSLAS HULKS, YNYSLAS, CEREDIGION: ARCHAEOLOGICAL INVESTIGATIONS 2015 - 2016 INTERIM REPORT

Prepared by Dyfed Archaeological Trust
For Cadw

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SUMMARY

Three hulks, all designated Scheduled Ancient Monuments, lie close to the canalised, tidal channel of the Afon Leri at Ynyslas, Ceredigion. One of the hulks, Wreck 3 the main subject of the works undertaken in 2015 and 2016, protrudes into the channel, and, due to changes in the river, is actively eroding.

According to a 2011 RCAHMW report, the three hulks were probably locally-built slate-carrying vessels operating out of quays on the Leri. By the early 1860s the construction of a railway to the west of Machynlleth effectively killed off the trade and shipbuilding on the Leri. It would seem that in 1868 the three hulks were placed on the west bank of the canalised course of the Leri to mark the approach channel. They are marked as wrecks on an 1892 Admiralty chart. There is a possibility the three vessels may have also been used as ferries between Ynyslas and Aberdyfi prior to them being scuppered.

Works at the site were undertaken with grant aid from Cadw, with the 2015 to 2016 works concentrating on preparing a detailed record of the timber elements of the wreck to assist with our understanding of its construction and use, and assist with monitoring changes and erosion of the wreck in the future. Ian Cundy of MADU assisted with the recording work in June 2015 and also provided a number of very useful talks and information sessions on ships and boat building.

Additionally in 2015 a photogrammetric survey of the wreck was undertaken by Adam Stanford of Aerial-Cam. A coastal engineer was also commissioned to prepare a report on erosion of the wreck and changes in the channel of the Afon Leri in the last 50 years.

The work undertaken in 2014 enabled strategies for the recording works undertaken in 2015 and 2016, which are considered to have been successful. No further excavation was carried out due to potential impacts on the erosion of the wreck and changes to the river channel up and downstream. No reconstruction of the wreck has been possible to date, due to the lack of surviving information and the fact that accessible parts of the wreck are also those areas which have collapsed in the past and do not provide accurate cross sections through the vessel. A very simplified attempt has been made within this document, the accuracy of which is questionable.

At the start of the year ordnance awareness training was provided by Qinetiq to all members of staff at DAT who would be involved in the project, as well as to members of MADU and Cadw. Luckily during the works undertaken in 2015 and 2016 no ordnance was identified at Ynyslas.

INTRODUCTION

The sites of three wrecks lie on the bank of the Afon Leri on the southern side of the Dyfi Estuary at Ynyslas, Ceredigion (Figure 1). It is thought that the wrecks were locally built slate hulks and possibly part of the Derwenlas slate-carrying fleet. Following work undertaken by RCAHMW (2011), the wrecks were highlighted as being of national significance and they were designated as a Scheduled Ancient Monument in 2012 (SAM CD282) (Figure 1).

According to the 2011 RCAHMW report, by the early 1860s the construction of a railway to the west of Machynlleth effectively killed off the slate-carrying trade and shipbuilding on the Leri. In 1868 the three hulks were apparently placed on the west bank of the canalised section of the Afon Leri to mark the approach channel and are marked as wrecks on an 1892 Admiralty chart.

The work from 2014 was reported on in a previous interim report (Meek 2014), which had been designed to determine the scope of future works at the site. The report included the project design for the 2015 – 2016 works, to include timber recording (Phase 1) and some excavation of the upper surface of Wreck 3 (Phase 2). The Phase 1 works were undertaken in conjunction with Ian Cundy of MADU who provided invaluable assistance on-site as well as morning presentations on boat building/terminology. The works carried out by MADU have been reported upon in their report from 2015 (Cundy 2015).

Following the Phase 1 works in June 2015, it was determined that it would be necessary to have a coastal engineer's report to ascertain what effects the excavation of the surface of the wreck could have on the river channel, before implementing a scheme of excavation. The scope of the Phase 2 works was altered to further timber recording and monitoring of changes in the wreck since the Phase 1 works. A photogrammetric survey of the wreck was also implemented, undertaken by Adam Stanford of Aerial-Cam.

In November 2015 a coastal engineer from Royal HaskoningDHV was commissioned to undertake a study of the wreck site and erosion patterns in the Afon Leri around it.

Although there have been no significant storm events, in comparison to the winter of 2013/2014, the recording work at the wreck has indicated continuing erosion and significant changes to Wreck 3. The upper part of the Afon Leri channel edge seems to be retreating quite quickly over the wreck and to the north and south. This has been identified as a slight meander in the course of the canalised river.

No works were undertaken on Wrecks 1 or 2, other than general monitoring of their condition.

Figure 1: Location plan of the three slate hulks on the banks of the Afon Leri, in relation to Ynyslas Nature Reserve Centre and Searivers Caravan Park – with Ordnance Survey grid overlaid

METHODOLOGY

A series of written scheme of investigation (WSI) for the proposed work were prepared by DAT (Meek 2015, DAT 2015a and DAT 2015b). The initial WSI was submitted with the interim report from last year (Meek 2015); this was updated before the Phase 1 works in June (2015b) and prior to the Phase 2 works in September (DAT 2015b; Appendix 1).

Permissions, Consents and Agreements

The site area lies on Crown Estate land managed by Natural Resources Wales. The site lies in a number of areas with environmental designations, namely:

- Dyfi Estuary/Aber Dyfi Special Protection Area
- Pen Lyn a'r Sarnau/Llyen Pen Special Area of Conservation
- Dyfi Biosphere
- Dyfi Site of Special Scientific Interest
- Cors Fochno & Dyfi RAMSAR and
- Dyfi National Nature Reserve

The investigations were carried out following the granting of all relevant permissions and consents in respect of the above designations from Natural Resources Wales (NRW) and Scheduled Monument Consent from Cadw. It was confirmed with NRW that a Marine Licence was not be required for the works. It was also confirmed that a Flood Defence Consent was not needed. A licence from Crown Estates was also granted via NRW. The Receiver of Wrecks was contacted at the start of the works and subsequently to inform of finds from the site using the 'Report of Wreck and Salvage Form'.

The procedures agreed with Milford Haven coastguard were again carried out before the Phase 1 and Phase 2 works: the coastguard was contacted at the start and end of works and a yellow 'hazard' marker buoy was anchored at the wreck site.

Following the discovery of ordnance at the during the 2014 works, an ordnance awareness training course was organised for staff to be involved on the project with Tony Clark an ordnance expert from QinetiQ at MOD Pendine (staff attending included Alice Day, James Meek, Fran Murphy, Felicity Sage and Hubert Wilson. Ian Cundy and Bill Turner of Malvern Archaeological Diving Unit and Polly Groom of Cadw also attended the training session. Mr Clark also assisted with the development of a specific UXO risk assessment (as included in last year's report, Meek 2015). The training session enabled a much greater understanding of the potential type of ordnance that could be present at Ynyslas and the procedures that should be followed in the event of finding anything suspicious. As for the 2014 works, in the event that any potential ordnance was observed the site area would be cleared and the local coastguard initially informed. They would then determine if there was a hazard, and if so call in the Royal Navy Bomb Disposal

Unit to deal with the object. No such objects were observed during the 2015-2016 works.

Archaeological recording

No excavations were undertaken on the wreck during 2015 – 2016 as it was determined that the results of a coastal engineers report would be needed to determine what impacts excavation could have on the wreck site in the future and also other parts of the Afon Leri channel.

The Phase 1 works were undertaken between 30th May and 6th June and involved a programme of cleaning, timber labelling and detailed timber recording (through written, photographic and survey records (Figure 2)). An attempt was made to undertake a photogrammetric survey of the wreck during the Phase 1 works which proved only partially successful.

The Phase 2 works were carried out between 28th and 30th September which involved initial cleaning of the wreck, additional timber recording, drawing profiles of the frames where possible and a full photogrammetric survey of the wreck and aerial photographs by Aerial-Cam Ltd.

Additional monitoring visits were made to the wreck in April and November 2015 and March 2016.

Coastal Engineers Survey

The coastal engineer, Gregor Guthrie of Royal HaskoningDHV, undertook a site survey in November 2015, which was supplemented with analysis of historic aerial photographs and other tidal information. Gregor has undertaken a considerable amount of work in the Dovey Estuary and so already knew the area very well.

SUMMARY OF RESULTS

Two phases of investigation were undertaken at Ynyslas, the first between 30th May and 6th June 2015; the second between 28th and 30h September 2015.

Phase 1 Works

For the first phase of works the low tides occurred in the early to late afternoon, with the lower of the tides at the tail end of the week. This worked well as on the first two days a scheme of cleaning algae, seaweed and silt off the wreck was undertaken which did not require access to the very lower parts of the vessel. On the Monday severe gales and heavy rain meant that site work was abandoned for safety reasons. Windy weather persisted for most of the week, but in general the weather was clear and sunny.

Date	Low Tide	Height
Saturday 30/05/2015	1340	1.3m
Sunday 31/05/2015	1420	1.4m
Monday 01/06/2015	1457	1.0m
Tuesday 02/06/2015	1534	0.9m
Wednesday 03/06/2015	1611	0.8m
Thursday 04/06/2015	1651	0.8m
Friday 05/06/2015	1733	0.8m
Saturday 06/06/2015	1819	0.9m

Phase 2 Works

Date	Low Tide	Height
Monday 28/09/2015	1557	0.3m
Tuesday 29/09/2015	1639	0.2m
Wednesday 30/09/2015	1719	0.3m

The Phase 1 works concentrated on timber recording using the timber recording sheets designed during last year's programme of work. The works started off with an initial clean of the wreck removing seaweed and algae, as well as the thin layer of silt covering the timbers themselves (Photos 1, 2 & 3). This cleaning phase was also repeated at the start of the Phase 2 works.

In the vast majority of cases it was not possible to record the full dimensions of timbers as they were partially hidden within the silts or projected into inaccessible areas of the vessel's structure.

Where possible, individual photographs of each timber were taken with a photographic board showing the number (Photo 4). In some cases it was not possible to use a photo board due to the inaccessible location of the timber, but the timber numbers were noted on site records. In other cases groups of timbers were included in the same photo (for example decking planks in the hold and collapsed outer planking).

The 2015 works commenced a programme of individually numbering and recording each timber of the wreck, including written, measured, surveyed and photographic record (where possible). Timbers were allocated individual numbers for ease of identification and recording. For ease of recording when on-site timbers, on the starboard side were numbered in the range 0001 to 0099; timbers on the port side within the range 0100 to 0199 and those on the surface of the wreck numbered in the range of 0200 to 0299. Circular metal labels with impressed numbers were tacked on to the timbers.

An attempt was made to draw profiles of the timber frames on the starboard side of the wreck during the Phase 2 works, although due to the very soft ground conditions this proved relatively difficult (the upright poles, even when supported on matting and with a tripod, were apt to move as profiles were being drawn). Accessible frames were also of little use as they had been subject to partial collapse or movement previously and so the angles of the timber were not correct. A profile was drawn across the end frame that projected on both the port and starboard sides of the vessel, enabling the locations of inner planking to be recorded also. Unfortunately not enough information could be obtained to be able to draw or project a full series of profiles across the wreck for an accurate reconstruction. A very simplified attempt is made below.

Photo 1: Removal of seaweed, algae and silts from the wreck prior to recording (June 2015)

Photo 2: View of port side of stern following clean (June 2015)

Photo 3: View of starboard side of the wreck following clean (June 2015)

Photo 4: Example of single timber photograph. This is one of the collapsed futtocks on the starboard side of the vessel (June 2015)

Photo 5: View of deck planking in the hold, numbers 224, 225, 226, 227 and 228 left to right, near to the stern on the port side of the vessel (June 2015)

Photo 6: Timber group photograph showing the outer planking timbers 052, 053 and 054, left to right on the starboard side of the vessel, underlying collapsed futtocks (June 2015)

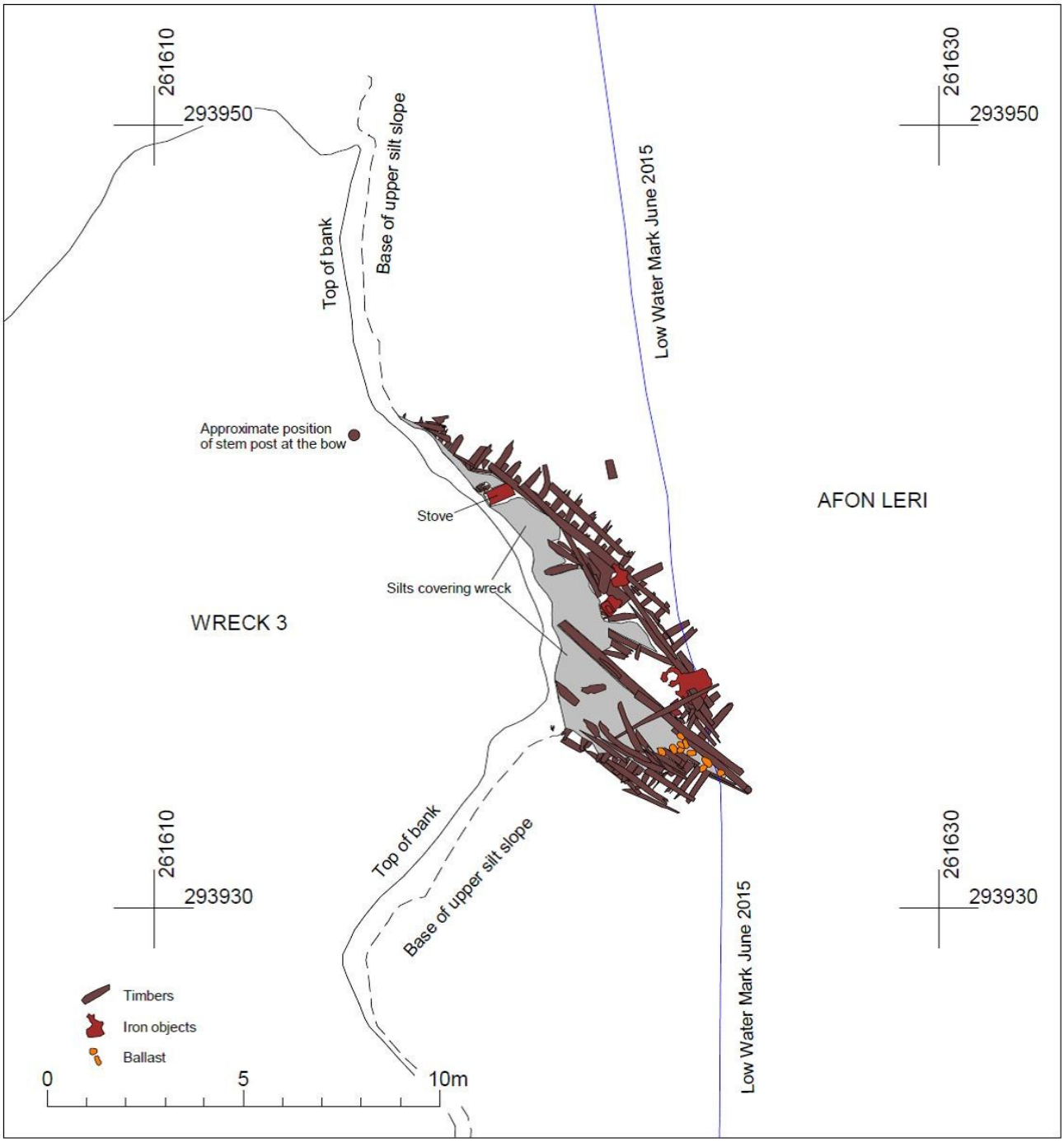

Figure 2: Overall plan of Wreck 3 from topographic survey June 2015

MAIN SHIP TIMBERS

The following section discusses the main structural elements of the vessel's construction. A series of photographs are used with timber numbers added (Photos 7, 8, 9, 10 and 11). A schematic plan of the surviving frames is also included (Figure 4) for ease of identification as to what elements they represent.

It is evident that the majority of the upper parts of the wreck had long since gone, the vessel now surviving at hold level. Potentially a little more of the vessel survives towards the bow, but this still remains covered in silt. No timbers are visible through the silts above the Afon Leri channel.

Starboard Side

Almost the complete length of the starboard side of the vessel is exposed to some degree (Photo 7). The stern is almost completely exposed, with the wreck becoming more submerged in the silts as you head towards the edge of the river channel. The cant frames towards the bow of the wreck can be seen to curve quite sharply inward in their layout, to produce the blunt nose as the vessel would have originally had (Photo 8).

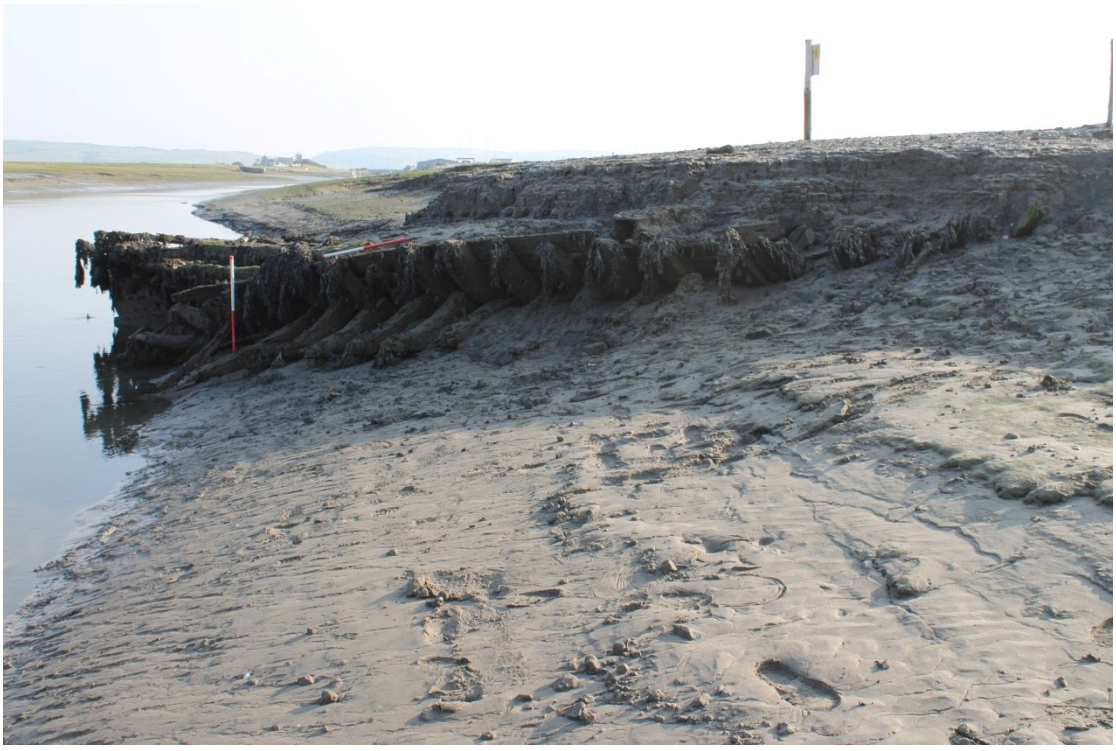

Photo 7: Full view of the exposed part of the starboard side of the vessel (September 2014)

It is evident from photographs taken of the wreck since 2010 that the central part of the starboard side had partially collapsed outwards perhaps during its silting up process. Up until 2013 the majority of outer planking survived along this side (except at the stern). In 2013 the outer planking collapsed taking a number of elements of the frames with them. These appear to be the 1st futtocks attached

to the floor frames. Filler frames between are still presently roughly in-situ, being held against the inner planking and the bases of the frames still held in the silt, although it will not be long before these too collapse outwards. At this point much of the upper part of the wreck and the objects on top are likely to fall also. This will include the possible oven recorded in 2014. A number of loose timbers and iron work had moved to the edge of the wreck as noted during a visit in March 2016.

Photo 8: Bow end of the starboard side, with cant frames highlighted curving in towards bow stempost as revealed in 2014 excavation (March 2016)

Photo 9 shows the main timber elements of the starboard side of the stern. The stern post, 026 is clearly visible with deadwood fillers between it and the first of the floor frames, 028. The first frame lies on top of a deadwood piece, 212. The next frame, 035, is also located on top of this piece of deadwood, although it has been located into a rebate half way through the timber. The next frames, 066, 065 and 064 would appear to lie directly on the underlying keel which was not visible (other than its upper surface) due to being buried in the silts. The two end floor frames were both attached to two additional filler pieces (029 & 030; 034 & 033) evidently being used to create the shape of the stern of the vessel to which outer planking was formerly attached. Only the lowest outer plank was survived at the stern, 032. This was partially attached to a further shaping filler piece attached to 212, which was an elongated wedge.

Photos 10 and 11 show the majority of the remainder of the starboard side. Although the ends of floor frames could be identified along the rest of the starboard side, it was not possible to see these attached to the keel which was hidden below silt and other timbers. Collapsed 1st futtocks could be seen, many still attached by treenails to underlying outer planking. Simple scarf joints had been used to join these to the floor frames. Filler frames remained in-situ.

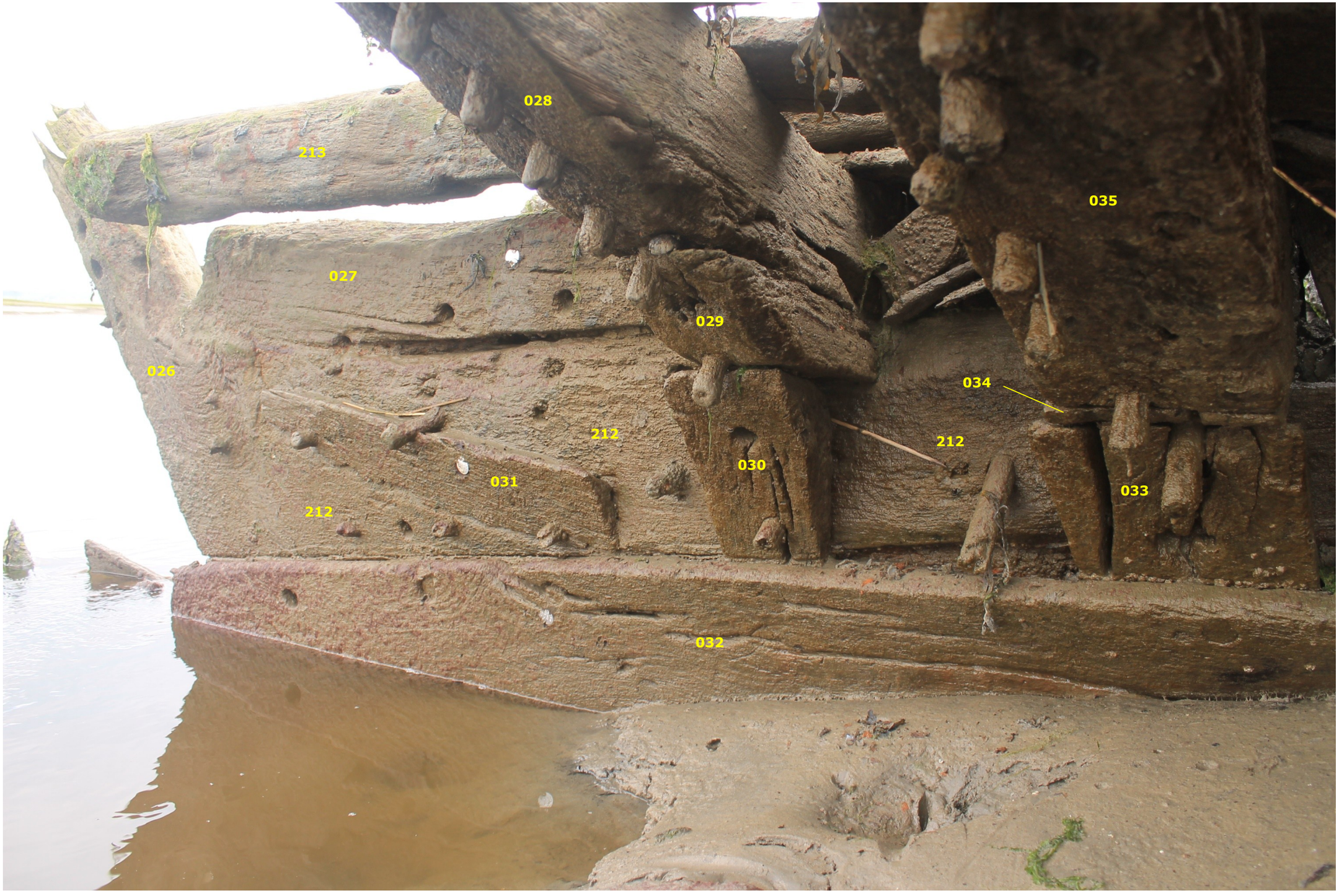

Photo 9: Timbers forming the stern on the starboard side (June 2015)

Photo 10: Frames on the starboard side (between Photo 11 and stern, Photo 9)
(merged photographs from June 2015)

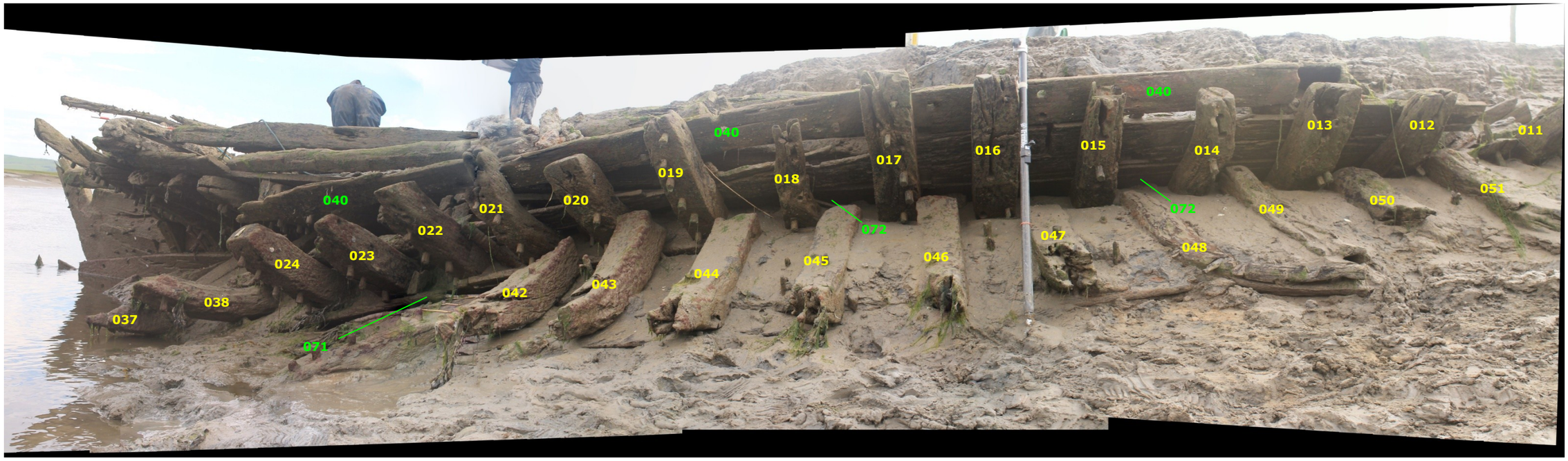

Photo 11: Collapsed frames along the starboard side; Frames (yellow) and inner planking (green)
(merged photographs from June 2015)

Port Side

The surviving part of the port side of the wreck still remains mostly buried in the silts of the river edge (Photo 12). It has certainly become more exposed since it was first recorded in 2010, but only the stern of the vessel is exposed to a significant depth. Some outer planking survives in situ, with the uppermost surviving planks towards the stern having collapsed outwards. A number of the frames towards the centre of the vessel project almost vertically out of the silts towards the present river channel edge (Photo 13). The exposed ends of the frames were almost all very badly eroded and decayed.

Photo 12: Full view of the exposed part of the port side of the vessel (June 2015)

Labelled timbers are shown on photo 15. The end three frames, 116, 115 and 114, are still roughly in-situ, being attached to both the inner planking of the hold and the outer planking, four of which still remain attached to the vessel (217, 218, 219 and 220). These planks have evidently been shaped to fit the vessel to create a streamlined stern as can be seen in Photo 14. Collapsed outer planking is also present, which has become detached from the frames, but is still trapped in the silts to the northwest.

The first floor frame 113 is the same timber as 028 on the starboard side, and 113 is the same as 035. Although the whole of the floor frames could not be seen, 109 would correspond with 066; 107 with 065; 105 with 064; 102 with 063 and 100 with 062.

Photo 13: View along the port side of the wreck from the stern, showing the longer surviving frames still roughly in situ towards the river edge

Photo 14: View of stern showing shaped outer planking on port side

Photo 15: Port side of wreck showing frames and outer planking towards the stern
(merged photographs from June 2015)

Upper Surface of Wreck 3

Numerous timbers, iron objects and ballast lie on the upper surface of the wreck. Many of the timbers do not seem to form part of the surviving structure, although the majority are likely to have formerly been elements of the wreck, now collapsed. At the stern end of the vessel inner planking for the hold and elements of the keel (possible keelson and deadwood) could be seen and are shown on Photo 16.

This photo also includes loose timber elements such as 213, which could possibly be a former boom from its shape. It has been seen lying almost directly on top of and parallel with elements of the keel (deadwood 212) since 2010, but has become looser with more and more erosion. It was still in-situ during the work in 2014 and 2015, but could be seen to move slightly as the water rose back into the Afon Leri channel and its movement was exacerbated when boats using the channel passed and their wake hit the wreck. In March 2016 timber 213 had moved and now lies at an angle over the starboard side with its end sticking into the silts of the river channel. It is possible that the timber was deliberately moved rather than it being caused by tidal movement of wakes from motor boats.

Inner planking of the hold includes timbers 225, 226, 227 and 228 on the starboard side and timbers 235, 236, 237 and 238 on the port side. Timbers 214, 215 and 216 appear to be collapsed elements from the former structure above. A number of large rounded pebbles remain in the hold and represent ballast. A large coil of corroded iron chain is still present on the starboard side. Within the corrosion of the chain are fragments of broken roofing slate, presumably former cargo, and also smaller pieces of timber which may include the lid a small wooden box, part of which was recovered in 2014. A number of small copper or brass pipes are also present the function of which is uncertain. These were visible in September 2014 when the Royal Navy Bomb Disposal Squad looked over the wreck to check for ordnance, so it is assumed they are associated with the wreck (although have not been removed).

Towards the bow end of the vessel on its starboard side lies the possible iron stove with the ceramic vessel inside, as recorded in 2014. This has not been recovered from the wreck, corrosion being extensive and fused to the timber structure. It has become more exposed than in 2014, with the feet of the object now clearly visible. Other iron objects representing other coils of chain and various boat fittings are also still present on the exposed starboard side of the wreck. A number of these objects do appear to have shifted further towards the edge of the wreck, which may have moved through the tidal activity shifting timbers. It was also noted that a number of loose timber elements had also moved to the starboard edge of the vessel. Within the central part of the wreck a number of large timbers did not appear to form part of the wreck structure. These included an angled timber, 206, which retained bark and knots from former branches. It looked like it could have been a knee for the structure of the wreck, but its untreated surface suggests it was either driftwood or part of a timber cargo. A long timber, 207, lay beneath this, which was tangentially sawn on its upper surface, but retained the bark and original curved timber profile beneath. This may have been an unfinished timber forming part of the last cargo of the vessel, although this is not certain. It was certainly not driftwood.

Photo 16: Stern end of exposed hold showing inner planking and other main surface timbers (September 2015)

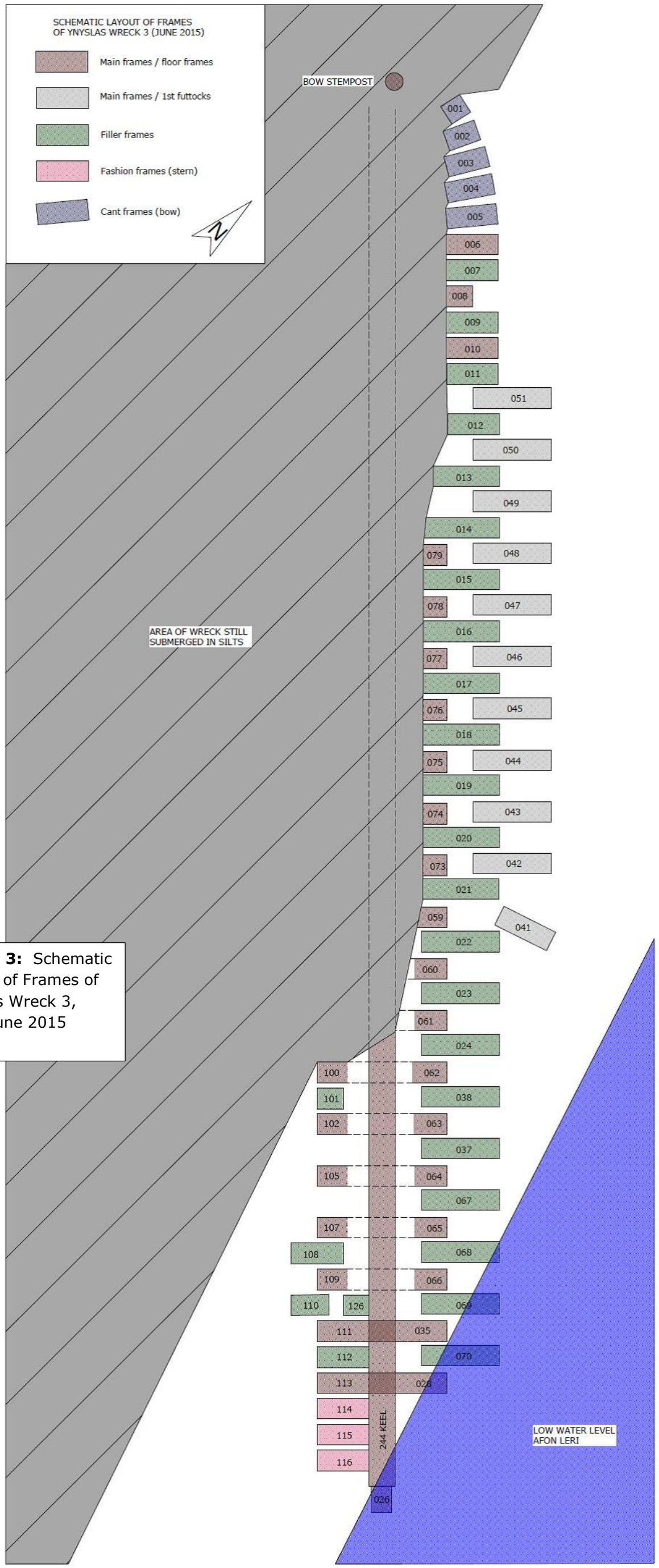

Figure 3: Schematic Layout of Frames of Ynyslas Wreck 3, from June 2015 survey

The Stern

The stern post juts out into the Afon Leri channel and would appear to be exposed almost to the base of the wreck. During the low tide in September 2015 following the removal of detritus which had stuck to the base of the stern, it was possible to see an additional timber projecting into the channel beyond the stern post with a rectangular hole within it, surrounded by an iron deposit (Photo 17). This is likely to represent the keel, which was not visible within the remainder of the wreck, lying mostly buried in silts or hidden by other timbers. The hole could possibly be either a mortice for a lost timber or possibly part of a rudder hinge. If the hole is for a former timber, this may have been for a former stern post which has since become detached and washed away, with the remaining upright, 026, representing an inner sternpost.

Photo 17: Stern of vessel on port side, showing lower timber projecting below the waterline with hole within it (September 2015)

3D PHOTOGRAMMETRY SURVEY

As noted above, an attempt to undertake a photogrammetry survey was undertaken in June 2015, although the results were only partially successful (due to inexperience, limitations of software available and the necessary computer processing power for such a complicated subject). As no excavation was to be undertaken in Phase 2 it was agreed with Cadw that Adam Stanford of Aerial-Cam would be commissioned to undertake the survey. This was undertaken on 29th September 2015.

The photo survey was undertaken using a mix of aerial drone, hand held and pole mounted photography. The drone allowed both aerial shots of the wreck (Photos 18 and 19) and a video of its location within the Dovey estuary to be made. The resulting photogrammetric survey has been uploaded to the Sketchfab website which is publically accessible. It has been promoted on social media and has presently had over 1100 views. The image can be seen at https://skfb.ly/HAQW (Photo 20). 3D screen captures

Photo 18: Overall aerial shot of the wreck during recording in September 2015 (Aerial-Cam image)

Photo 19: Detailed aerial shot of the stern end of the wreck during recording in September 2015 (Aerial-Cam image)

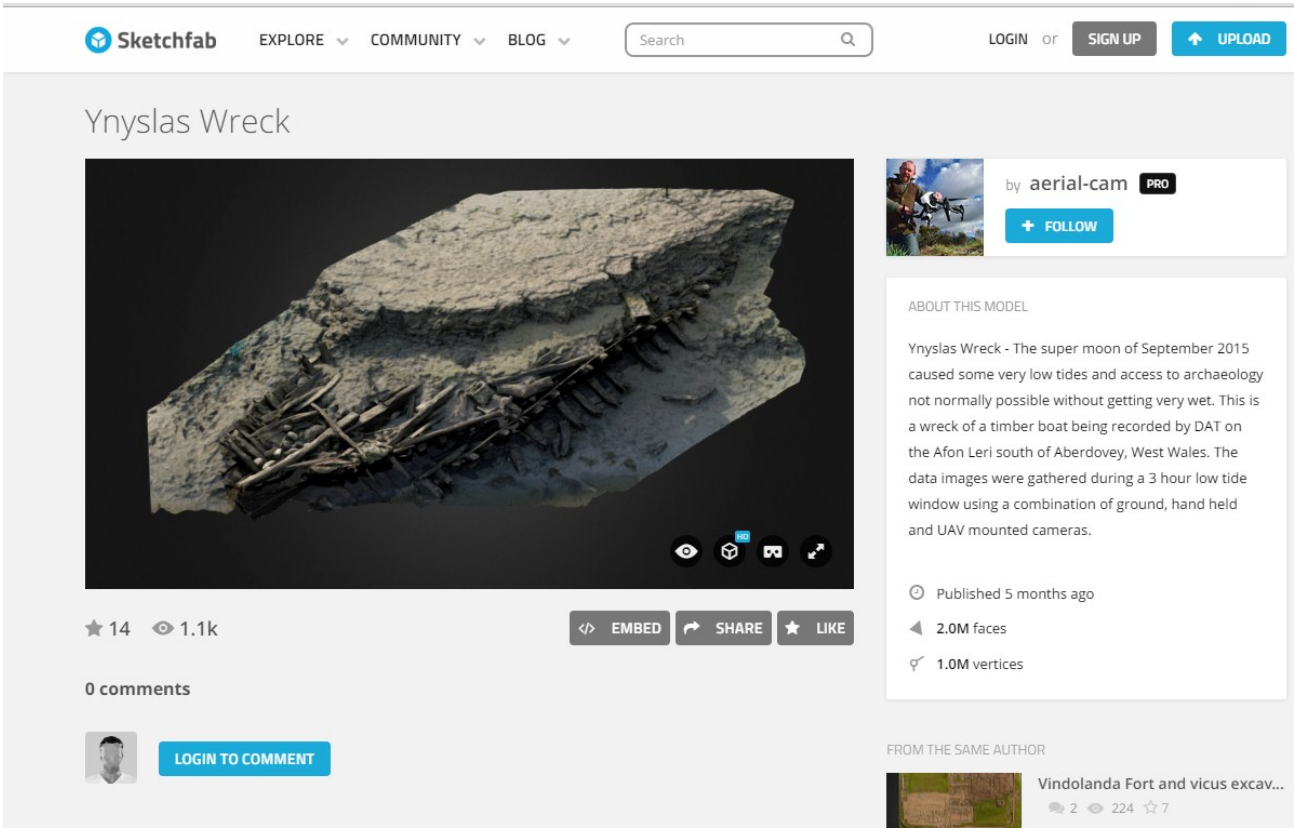

Photo 20: Screen capture of the Sketchfab webpage showing the 3D image by Aerial-Cam of Wreck 3 which can be manipulated via the website (https://skfb.ly/HAQW)

COASTAL ENGINEER SURVEY (November 2015)

The work of the coastal engineer (Appendix 2) has demonstrated that the wreck became exposed due to a slight meander in the channel of the Afon Leri, and since the stern became exposed, this has acted as an obstruction in the channel causing scouring both up and downstream of the wreck. This is speeding up the erosion of the river bank and exposure of the wreck, most notably on the upstream, side of the wreck which has the greatest flow rate.

To excavate the surface of the wreck would increase the speed of erosion. To protect the wreck through sandbagging or other forms of protection would only be temporary, but would need to be extensive to avoid causing erosion up and downstream of the wreck. This could potentially effect Wrecks 1 and 2, which are presently quite well protected by the hard estuary deposit on the western side of the mouth of the Leri.

CONCLUSIONS

The continuing recording of Ynyslas Wreck 3 has enabled a more detailed survey of the vessel to be made, with timber recording allowing structural elements of the vessel to be identified and their positions recorded. This has already allowed us to be able to see changes in the wreck over a short period of time, and identify elements of the wreck which are likely to be lost in the short term. The recording has also allowed us to identify the main surviving timber elements of the vessel. Due to previous loss and collapse, it has also been determined that only a very conjectural reconstruction of the wreck could be made from the surviving elements.

Erosion

As stated in the 2015 report 'The wreck contains a significant number of timbers, a number of which are loose or collapsing …. A number of loose pieces are present on the exposed hold. These are under threat of being lost through further erosion and tidal movement.' This still remains true, but in mitigation a record has been made of the timbers to provide a 'present state' record of the vessel (based on the June 2015 survey). Changes were visible by the Phase 2 works undertaken in September, as an example timber 043, a fallen 1st futtock, was attached to the collapsed outer planking (by treenails) in June (Photo 21) but had become detached and moved by September (Photo 22). The timber had not moved much more by March 2016 having been embedded in silts.

Changes had also occurred to the upper surface of the wreck where objects were quite well embedded in silts during the survey in June 2015 (Photo 23), but by September much of the silt had been washed away and the objects looser and under far greater threat of being lost through tidal movement (Photo 24).

Photo 21: Fallen 1st futtock attached to collapsed outer planking in June 2015

Photo 22: Fallen 1st futtock detached from collapsed outer planking and moved by September 2015

Photo 23: Showing the starboard side of the upper part of the wreck, the hold, showing silts below the photo board (loose timbers 235 and 239 recorded)

Photo 24: Same part of the surface of the hold of the wreck in September 2015 showing that the silts have been washed away and numerous small objects had become exposed and under threat of being washed away

As was noted above, the possible boom 213 that was formerly located on the keelson at the stern of the wreck had moved by March 2016 and also a number of loose timbers and iron on the surface had slipped down the side of the wreck (Photo 25).

Photo 25: Alterations to the wreck by March 2016, showing possible boom 213 over the stern of the wreck in the top left of the photo and loose timber 206 and adjacent lump of corroded iron chain slumped further down on the starboard side

Conjectured reconstruction of the vessel

It was hoped that the information gained from the recording in 2015 would allow for a reconstruction of the vessel to be made. In September 2015 profiles of a number of the frames were drawn, although it was only possible to draw one frame in-situ – the floor frame 028/113 at the stern end. All other frames were those that had partially collapsed on the starboard side of the wreck. The profiles of the timbers were also incomplete due to them being partially buried in the silts. These were not good enough to be able to project the shape of the vessel through the mid-ships. Other frames could not be drawn due to difficulties of access, either due to other timbers being in the way or due to soft silts or the Afon Leri itself.

It has been possible to use floor frame 028/113 to provide very simplified conjectural reconstructions of the profile of the wreck (Figure 4). As we have the length of the vessel from recording undertaken in 2015 (12.86m) a simplified side view of the wreck has also been attempted (Figure 5) using similar examples of contemporary ships to provide a potential outline of the wreck. These could indicate that the original length of the wreck at deck height would have been around 16m.The height of the hold and shape is based on similar sized examples of contemporary vessels recorded in a number of sources. These indicate that the height of the hold mid-ships would have been between 6 to 7 foot (*c.*1.8m to 2.1m) and that the width would have been around 15ft (4.6m). The resultant profiles demonstrate how much of the vessel has probably already been lost and what might still survive buried in the silts.

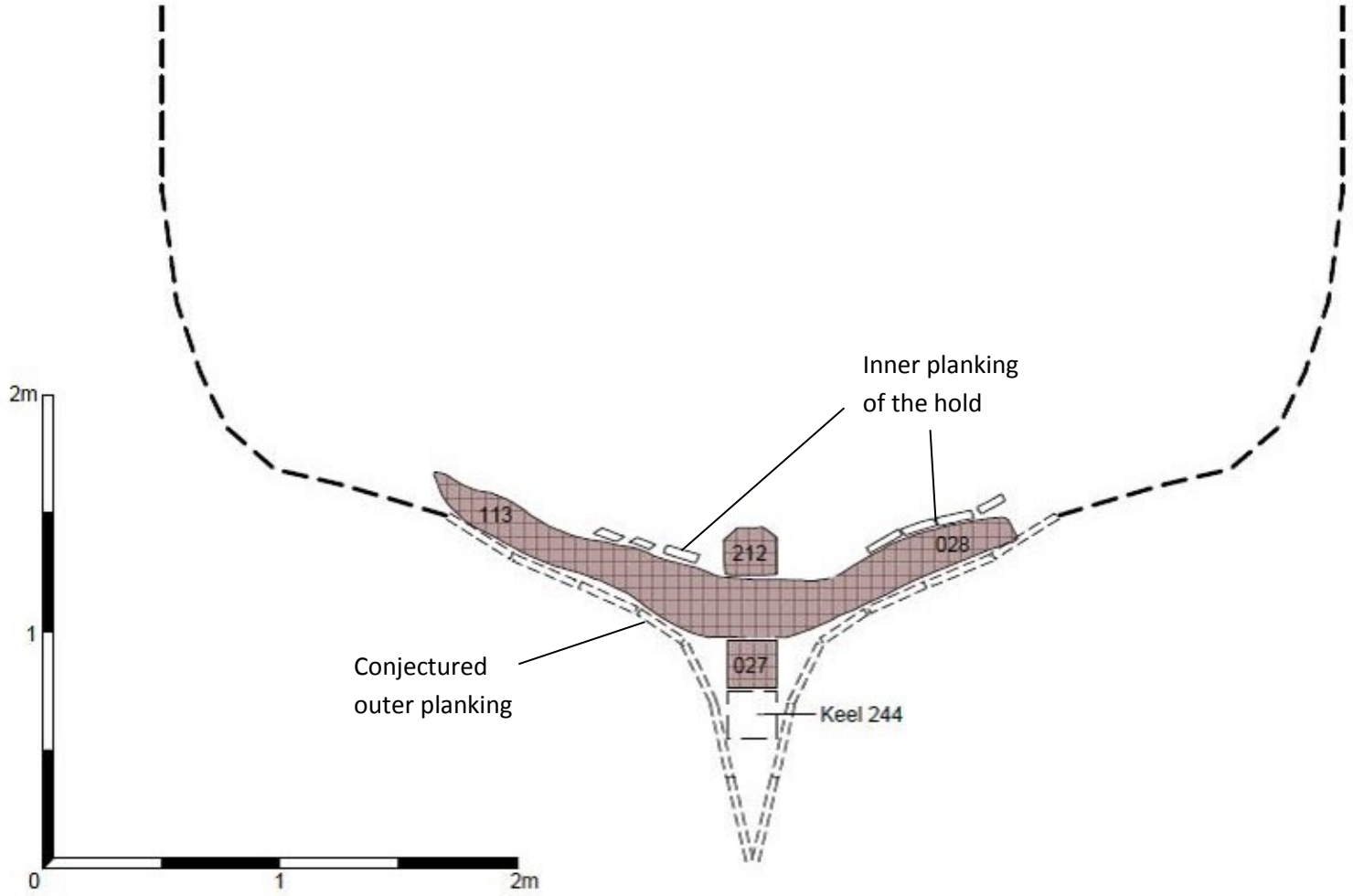

Figure 4: Conjectured profile through the wreck based on floor frame 113/028 and similar contemporary examples

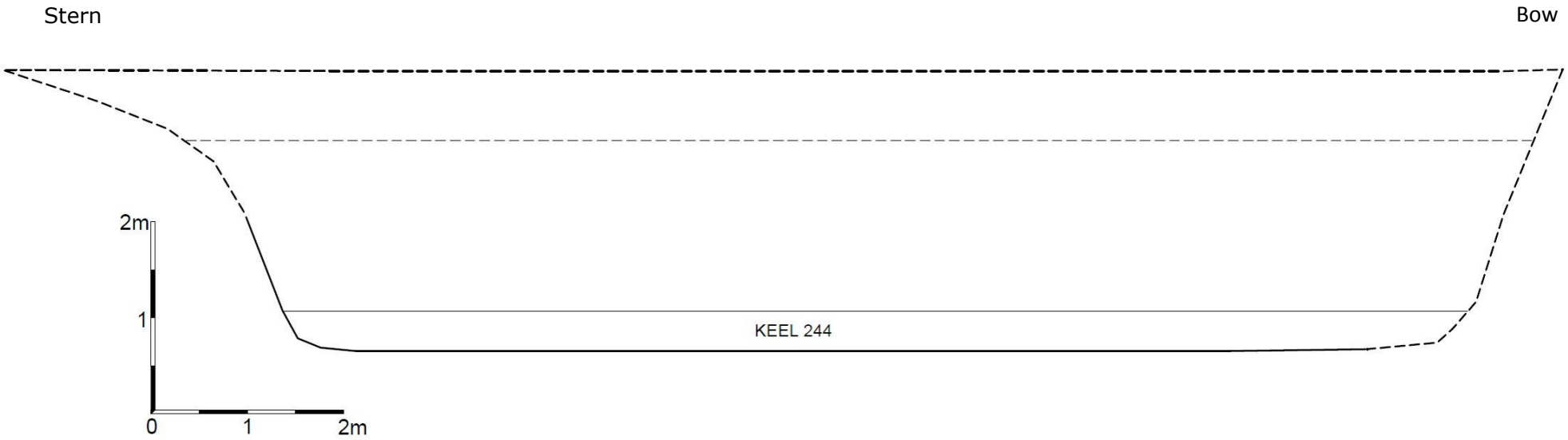

Figure 5: Conjectured profile of potential longitudinal shape of the wreck based on its known length and similar contemporary examples
The solid line represents the known length of the wreck from what is visible and the possible positon of the bow is taken from the excavations undertaken in September 2014

Wreck 3 measurements – 12.86m x 4.6m in width based on what survives. (42’ 2 ” by 15’ 1”).
The depth of the surviving elements of the wreck from top of stern post to visible depth is around 1m (3’ 3”)

From work undertaken in 2014 on Wreck 2 (measured probing and survey) it is considered likely that the majority of this vessel survives below the silts, including its deck. This would indicate that it is the best surviving of the three. Although it was also identified in 2014 that the three wrecks are of different sizes and not identical, it is still likely that this retains the best amount of information on the former slate hulks, which could enable an accurate reconstruction to be drawn. As noted by the coastal engineer, this wreck is not any immediate threat of erosion, but with climate change and changes in the tide and course of the Leri, how long it will remain protected is unknown.

Further Works

During 2015/2016 contact has been made with Crown Estates to see if they would be willing to fund further work at the wreck site. A project proposal for 2016 – 2017 has also been submitted to Cadw for further monitoring and recording of the wreck. The changes in the wreck throughout 2015 – 2016 further indicate that continued monitoring is essential in the future before it is completely lost. More timbers will be exposed, and more lost. Further information on its construction presently lies buried within the silts which will eventually become exposed and lost without further recording. It is recommended that four visits are made throughout the year, two day visits during very low spring tides, probably in late Spring and late Autumn, with shorter monitoring carried out in early and late winter or after significant storm events. It is hoped that further recording would continue to be undertaken in conjunction with Ian Cundy of MADU.

The Crown Estate application for funding including additional funds to assist with detailed recording of changes in the wreck; additional photogrammetry survey to make a visual record of changes; conservation of items recovered from the wreck and the ability to deal with more objects; and also a museum display for Ceredigion Museum who are very keen to have information on the wreck and shipping in Ceredigion in general. This request for funds covers a conventional display to include text and images with conserved objects also included in the display; it also suggests an interactive touchscreen display to include more information on the slate trade, a timeline for the wreck from construction, through use, its scuppering on the edge of the Leri and eventual rediscovery and erosion. Funds for a website possibly based on the interactive display has also been considered. We have not heard back from Crown Estates as yet.

In February 2016 Jane Lloyd Francis, a representative of an art group working on the Hydrocitizenship project contacted the author to discuss the wreck and potential art projects that could result from it. One of those presently being developed follows the Afon Leri from its source to the Dovey estuary, referencing the use of the river (woollen mills, fishing, boat building etc) and the people who use it, and the wreck is a fitting end point for it. Contact and a site visit was also made with Alison Lochhead, a sculptor who is also very keen to some artwork develop from the wreck. It is hoped that the wreck will inspire artwork that will be displayed enabling a wider audience to learn more about the site.

The wreck continues to attract interest from members of the public, as noted by the number of views of the Sketchfab model. A number of talks have been given

about the site, including to the Welsh Group of the Royal Society of Antiquaries; at the 2015 MOROL conference in Aberystwyth; and at the Ceredigion Archaeology Day School (carried out in conjunction with Ian Cundy of MADU).

ACKNOWLEDGEMENTS

The investigations were directed by J Meek with support from Alice Day, Fran Murphy, Felicity Sage and Hubert Wilson of Dyfed Archaeological Trust and Ian Cundy of the Malvern Archaeological Diving Unit. The coastal engineer's report ws prepared by Gregor Guthrie of Royal HaskoningDHV.

The report and illustrations were prepared by J Meek.

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APPENDIX 1:
YNYSLAS HULKS, YNYSLAS, CEREDIGION; WRITTEN SCHEME OF INVESTIGATION FOR ARCHAEOLOGICAL RECORDING AND EXCAVATION - VERSION 3 – AMENDED SEPTEMBER 2015

1 INTRODUCTION

1.1 This written scheme of investigation presents a proposed detailed methodology for further archaeological recording and partial excavation of the eroding hulk on the bank of the Afon Leri, at Ynyslas, Ceredigion (Photo 1). The hulk is one of three located at the junction of the Afon Leri and the Afon Dovey. The hulk to be investigated is eroding from the western bank of the Leri located at NGR SN 61594 93942. The wreck is suffering from significant and constant erosion, exacerbated by the winter storms of 2013-2014.

Photo 1: Showing the hulk eroding into the Afon Leri, viewing south

1.2 The importance of the site of the three wrecks has been recognised by them becoming a Scheduled Ancient Monument in 2012 (SAM CD282).

1.3 In September 2014 an evaluative investigation was carried out to trial methodologies for recording and excavation of the vessel, and determine the best strategy for future monitoring and recording of the hulks. This WSI is appended to the interim report on the results of the 2014 works.

1.4 The works were undertaken by Dyfed Archaeological Trust with assistance from the Nautical Archaeology Society and RCAHMW.

1.5 The site lies in a number of areas with environmental designations, namely:

- Dyfi Estuary/Aber Dyfi Special Protection Area
- Pen Lyn a'r Sarnau/Llyen Pen Special Area of Conservation
- Dyfi Biosphere
- Dyfi Site of Special Scientific Interest

- Cors Fochno & Dyfi RAMSAR and
- Dyfi National Nature Reserve

1.6 Permission for the works was arranged and consented /licenced through Natural Resources Wales (NRW), Cadw, Crown Estates, The Receiver of Wrecks and the coastguard.

1.7 It was confirmed with NRW that neither a Marine Licence nor Flood Defence Consent was required for the works.

1.8 A small display was prepared for visitors and exhibited in the Ynyslas National Nature Reserve Centre, so that they were informed of the works. A web dig diary and social media postings were also produced during the excavation.

1.9 The specification is in accordance with the relevant Chartered Institute for Archaeologists Standard and Guidance (Chartered Institute for Archaeologists (CIfA), 2014). This version (2) of the WSI addresses comments and suggestions provided by Cadw, MADU, NAS and RCAHMW.

1.10 The Trust always operates to best professional practice. DAT Archaeological Services has its own Health and Safety Policy, and all works are covered by appropriate Employer's Liability and Public Liability Insurances. Copies of all are available on request.

2 WAYS IN WHICH THE PROJECT WILL CONTRIBUTE TO WELSH GOVERNMENT PRIORITIES

Programme for Government (2011)

- Widen access to our culture and heritage

Conservation Principles (2011)

- Manage historic assets to sustain their value
- Understand the significance of historic assets
- Assist in promoting the historic environment as a shared resource
- Enable everyone to participate in sustaining the historic environment
- Document and learn from decisions on the historic environment

Historic Environment Strategy for Wales (2013)

- Heritage protection and sustainable development
- Skills and opportunities
- Public participation, understanding and enjoyment
- Partnership and delivery

Cadw Community Archaeological Framework

The following criteria set out in the framework document apply to this project:

- The asset is under a management threat
- The project has a clear research focus and is linked to objectives in the Wales Archaeological Research Framework
- The project will endeavour to engage with young people and those that feel socially excluded
- The project will support the development of skills
- The project will maximise opportunities to learn about and care for local heritage

Pan-Wales Heritage Interpretation Plan (2012)

- Enhance local and national pride in our heritage assets
- Make connections between people and places
- Provide opportunities for people to learn something new
- Increase appreciation of the historic environment and so contribute towards its conservation

Figure 1: Site location plan on 1:50000 Ordnance Survey map – Grid reference – SN 61594 93942

3. AIM AND OBJECTIVES OF THE PROJECT

3.1 This document provides a scheme of works for:

The implementation of programme of timber recording and excavation on the eroding hulk on the western bank of the Afon Leri at Ynyslas, Ceredigion. The works will involve participation with the Nautical Archaeological Society and Royal Commission on the Ancient and Historical Monuments of Wales. A report on the results and archive will be prepared which will inform further management plans for the site in the future.

3.2 The following tasks will be completed:

- Provision of a written scheme of investigation to outline the methodology by which DAT Archaeological Services will undertake the archaeological excavation (this document);
- To establish the character, extent and date of the eroding hulk;
- To appropriately investigate and record any archaeological deposits within the excavation area;
- To produce an archive and report on any results to be used to inform a management plan for the constantly eroding Scheduled site.

4. ARCHAEOLOGICAL RECORDING METHODOLOGY

4.1 Archaeological Timber Recording

4.1.1 It is proposed that a continuation of the timber recording exercise undertaken in early June 2015 will be continued to provide as much detailed evidence about the timber components of the wreck before further erosion takes place. Not all of the timbers could be recorded in June due to the height of the tides, but it is hoped that a with the lower tides in either late September or mid-October more of the stern timbers will be visible. The information may be used to assist with the construction of a model of an interpretation of how the vessel originally looked.

4.1.2 In terms of timber recording the following information would again be needed:

a) Individual numbering of the timbers, with timber recording sheets completed for each one;

b) Dimensions of exposed areas of timbers;

c) Section drawing of the shape of the surviving frames of the vessel, which mostly lie on the northern side of the wreck;

d) Photographs of the timbers, including individual timbers and groups of timbers;

e) Identification of the function/technical name of the timber elements;

f) Timber species identification;

4.1.3 The timbers of the vessel will be allocated individual numbers for ease of identification and recording, continuing on from those given in June. These will be allocated using a simple index system. Once numbered, timbers will be tagged using impressed metal labels with the individual numbers on, tacked on to the timbers (where feasible). Using impressed metal labels will withstand erosion from tidal movement and silt for identification in the future. DAT Archaeological Services timber recording sheets will be used to record the timbers.

4.1.4 The dimensions of the exposed areas of the timbers will be recorded as best as possible within the confines of the wreck. Although some small scale silt removal may be undertaken on some timbers to ascertain extents, this will be limited to prevent increased erosion. No *in-situ* structural timbers of the wreck should be moved during this process.

4.1.5 In order to obtain enough information to potentially have reconstructions of the vessel built in the future, it is proposed to draw profiles/sections across the *in-situ* frames where possible. These are mostly visible and accessible on the northern side of the vessel. As it is very likely the frames on the north side of the boat would have been symmetrical with those to the south, it is assumed that the information from each recorded frame can be extrapolated to show that on the opposite side of the vessel, thereby giving a near complete profile across the boat in several places. This will only be able to be undertaken for a short window when the tide is at its lowest exposing the Afon Leri bank and the underside of the vessel. A vertical rule or pole will be inserted to the north of the wreck in front of each frame. This will be made true vertical and a measure attached. A spirit level or similar will be used to measure horizontally across from this line to the timber, and a number of measurements will be made to record the profile of the timber frames. The collapsed cant frames will also be recorded where possible. In most cases the width of the timber frames should be possible to record, and the face of the inner planking behind. Profiles across the top of the vessel in line with the frames will also be possible using measured probing techniques to obtain as best a profile across the top of the boat to ascertain its width. It was not possible to do this in June due to time constraints, but it is hoped that this can be attempted during this second phase of recording.

4.1.6 Although individual photos of timbers would be ideal, due to the nature of the wreck and the proximity and important juxtaposition of timbers, photos of groups of timbers may be taken as well. This will be done using digital photographs with an ongoing photographic index maintained throughout. It is also proposed that photographs of the vessel are also taken around its perimeter, with at least a 60% overlap of each photo, in order that they can be utilised using to create 3D models using various forms photographic manipulation software. This will be carried out by an experienced photogrammetric expert (Adam Stanford of Aerial-Cam) using hand held photography and a heli-drone to obtain photographs from the stern side of the vessel, over the Afon Leri.

4.2 **Excavation Methodology**

4.2.1 Following the work undertaken in June 2015 it has been decided that no excavation works will take place this year. It is recommended that until a detailed coastal engineer's report is obtained for the wreck and the affected bank of the Afon Leri no excavation should take place. This has been agreed with Cadw.

4.3 General Recording Methodology

4.3.1 The site area has been surveyed by DAT staff using a Trimble Total Station. Information has been registered to the Ordnance Survey National Grid. Existing survey points used during the earlier surveys carried out by MADU and DAT are still present and can be used for additional surveys of the site if needed.

4.3.2 Recording of all archaeological deposits will conform to best current professional practice and be carried out in accordance with the Recording Manual[1]

[1] Dyfed Archaeological Trust Field Services have adopted the new Recording Manual developed by English Heritage Centre for Archaeology. A copy will be available on-site for inspection if required.

used by Dyfed Archaeological Trust. A new timber recording sheet (based on those by MOLAS /English Heritage /ULAS will be used – see Appendix 1).

4.3.3 The hulk will be photographed throughout both phases of works using high resolution digital format and possible black and white colour print if the remains are of significant quality. Digital photographs will be taken in RAW format and converted to lower resolution Jpeg and high resolution TIFF images, and stored on the Dyfed Archaeological Trust photographic server.

4.3.4 Sections through deposits and profiles across the wreck will be hand drawn. Datum lines will be tied in to Ordnance datum. Hand drawn plans and sections will be drawn at scales of 1:10 or 1:20. Plans will also be combined with those recorded by NAS.

4.3.5 The relevant standards and guidance as laid down by the Chartered Institute for Archaeologists (CIfA) will be used followed during the excavations. The guidelines laid out in 'Waterlogged Wood – Guidelines on the recording, conservation and curation of waterlogged wood', English Heritage 2010, will be used.

5. POST-FIELDWORK REPORTING AND ARCHIVING

5.1 All data recovered during the fieldwork will be collated into a site archive structured in accordance with the specifications in *Archaeological Archives: a guide to best practice in creation, compilation, transfer and curation* (Brown 2007), and the procedures recommended by the National Monuments Record, Aberystwyth. The *National Standards for Wales for Collecting and Depositing Archaeological Archives* produced by the Federation of Museums and Art Galleries of Wales will also be adhered to.

5.2 The results of the fieldwork will be assessed in local, regional and wider contexts.

5.3 The report for the 2015 works will be an interim report, awaiting more a more detailed report in 2016-2017. The interim report will include a summary desk-based assessment element and the some of the results already obtained from other elements of the previous work undertaken by DAT, MADU/NAS and RCAHMW. The report will be based on standard DAT report structure generally including the following sections: Summary; Introduction; Project Commission and Scope; Site location; Archaeological and Historical Background; Methodology; Results; Discussion; Conclusions; Sources; Figures; Photographs.

5.4 The project archive, including all significant artefacts and ecofacts (excepting those which may be deemed to be Treasure) will be deposited with an appropriate body following agreement with the landowner and Receiver of Wrecks. Ceredigion Museum at Aberystwyth will be approached to house all finds and the archive following approval from the Receiver of Wrecks, and conservation of the artefacts.

5.5 A summary of the project results may be prepared for wider dissemination (e.g. Archaeology in Wales and special interest or period-specific journals).

5.6 A report on the results will be prepared in accordance with the relevant CIfA *Standards and Guidance*.

5.7 Bound copies of the reports will produced for the funding bodies of the excavation. Digital copies in pdf format will also be supplied if required. Bound copies of the reports will also be produced for the Dyfed Archaeological Trust Historic Environment Record.

5.8 The report will be made available online through the DAT website.

6 TIMETABLE

6.1 The second phase of recording is anticipated to be undertaken during the Spring Tides at the end of September (28th to 30th) or in October (26th to 28th).

6.2 Post excavation work will commence as soon as possible after the fieldwork, for completion within three months depending on other commitments.

7 STAFFING

7.1 The second phase of timber recording works will be carried out by two members of DAT, a supervisor (James Meek) and an additional archaeologist (tbc). It is intended that Ian Cundy of NAS will be invited to assist if he is available, although for the second phase of recording this may not be necessary.

7.2 DAT staff would be required to undertake reporting and illustration.

7.3 The project will be managed by J Meek CMIfA, Head of DAT Archaeological Services.

8. MONITORING

8.1 Cadw, NRW and representatives of DAT Heritage Management will be afforded reasonable access to the site at all times for the purposes of monitoring. Such visits will ensure that the works being undertaken are to the correct standard.

9. HEALTH AND SAFETY

9.1 All permanent members of DAT Archaeological Services staff are CSCS[2] registered.

9.2 DAT Archaeological Services will carry out a health and safety risk assessment to ensure that all potential risks are minimised (a separate document).

9.3 All relevant health and safety regulations must be followed. These will be made clear to all volunteers at the site, who will be given H&S inductions and will need to sign the site risk assessment to indicate that they have understood and will follow any procedures identified.

9.4 DAT Archaeological Services are not aware of any existing services running through the area.

9.5 Following the works undertaken in 2014 it will be essential for site staff to be equipped with some or all of the following waders, waterproofs, wellingtons, gloves and a hi-vis vest or coat. There is no need for hard hats. Life-rings and ropes will be taken to site in the event of falling in the river. Lifejackets will be available, and should be worn where working near the water's edge.

9.6 The site area lies at the edge of a tidal salt marsh, adjacent to the Afon Leri channel. All site staff will be responsible for ensuring that they are aware of safe areas to walk and access and will watch to check that no other party is walking into dangerous areas. Existing knowledge of the area indicates that the route to the site, from the southern side of the beach at Ynyslas is safe heading east adjacent to the upright timber boundary posts before the salt marsh, and then heading in a direct line to the site area at the end of these posts. Only a

[2] Construction Skills Certification Scheme (Health and Safety Tested)

single stream channel needs to be crossed using this route and the ground is mostly firm underfoot. The area is slippery and all site staff will be made know of the slip hazards. The risks from ordnance whilst accessing the site are considered very low, although in the event that any possible ordnance is identified, then the standard procedures will be followed.

9.7 It is likely that most of the work undertaken during the timber recording will be carried out on the lower banks of the Afon Leri. These areas are covered in slippery, fairly soft and deep estuarine silts. Site staff will not work in this area alone and will ensure that they are very aware of the state of the tides. Ropes will be used to attach site staff to posts on the upper ground level to both assist with access into the site area and also to prevent being blown into the water or slipping and being swept away by the river.

9.8 Working times will be chosen to access the site as the tide goes out and the vessel is uncovered and to complete works prior to the tide reaching the top of the Leri channel, leaving plenty of time to pack up equipment and leave safely and unhurriedly from the site area.

9.9 The Milford Haven coastguard will need to be contacted at the start of works and end of works every day to inform them of when we are on and off site in order that it can be made known to users of the waterway.

9.10 The site area has a high potential for Ordnance to be present. A unexploded ordnance session has been provided by Anthony Clark, an expert on Explosives Ordnance Disposal (EOD), from Qinetiq in Pendine which has made staff aware of the issues and correct procedures to follow in the event that any ordnance is observed.

9.11 In the event that potential ordnance is identified, the site area will be evacuated and all personnel will return to the car park leaving the object where it lies. The coastguard will then be called and the object reported. The coastguard will come and assess the object and determine whether they think it is safe or if they need the services of the Royal Navy Bomb Disposal team from Plymouth. No more will be done at the site until the object has been dealt with, even if this causes delays to the works program. This is unlikely to be an issue during the timber recording phase as the Royal Navy Bomb Disposal team did look over the exposed area of the wreck and removed a suspect item during the works in 2014.

TIMBER RECORDING SHEET TO BE USED DURING FURTHER WORKS AT YNYSLAS (see over)

TIMBER RECORDING FORM

DAT Archaeological Services

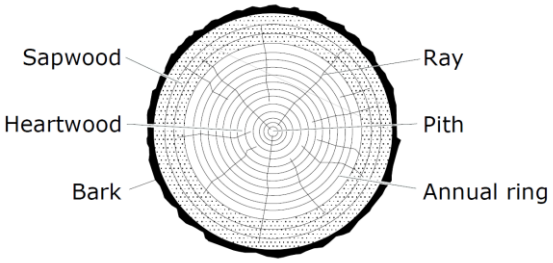
Site Name	Project Code/Year	Timber No
Simple Name / form	**Species**	**Area**

Co-ordinates	E	N	E	N
Length	Width		Thickness	Diameter

Condition

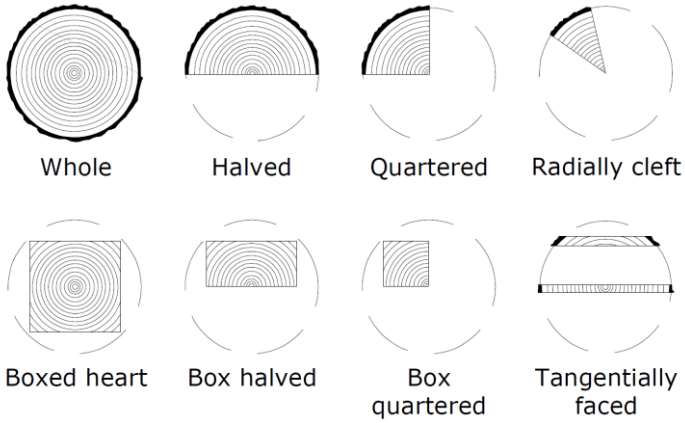
Ancient or recent damage? **Reused?** Yes No Unsure

Timber Elements



Bark	Yes	No
Sapwood	Yes	No
Knotty	Yes	No
Straight grained	Yes	No

Timber Conversion Identification



Conversion (see above)

Woodworking technology

Tool marks

Joints

Fixings and Fittings

Intentional Marks

Surface Treatment

Other

Structural element / timber name

EXCAVATION DETAILS

Recorded by/date	Checked by/date
Drawing Nos	
Photo Nos	

Site Name	Project Code	Context No

PHYSICAL RELATIONSHIPS	
Jointed to	
Joint type	
Cut by	
Butted by	
Butts	
Bonded with	

INTERPRETATION	
Preliminary Phase	Preliminary Date
Associated Contexts	
Part of	
Interpretation / Comments	

SKETCH Plan/elevation/section/profile with annotation (circle as appropriate)

APPENDIX 2: COASTAL ENGINEERS REPORT

By Greg Guthrie, Royal HaskoningDHV

REPORT

Ynyslas Hulks

Erosion Study

Client: Dyfed Archaeological Trust Ltd

Reference: PB4575 R1

Revision: 01/Draft

Date: 16 January 2016

Open

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Document short title: Ynyslas Hulks
Reference: PB4575 R1
Revision: 01/Draft
Date: 16 January 2016
Project name: Ynyslas Hulks erosion study
Project number: pb4575
Author(s): Gregor Guthrie

Drafted by: JGL Guthrie

Checked by: David Potts

Date / initials: 01/02/2016

Approved by:

Date / initials:

Classification
Open

Table of Contents

Introduction

Three historically important hulks have been identified situated on the western bank of the Leri Cut on the southern side of the Dyfi estuary (Figure 1.1). It is thought that the wrecks were beached around 1868, apparently to mark the approach channel.

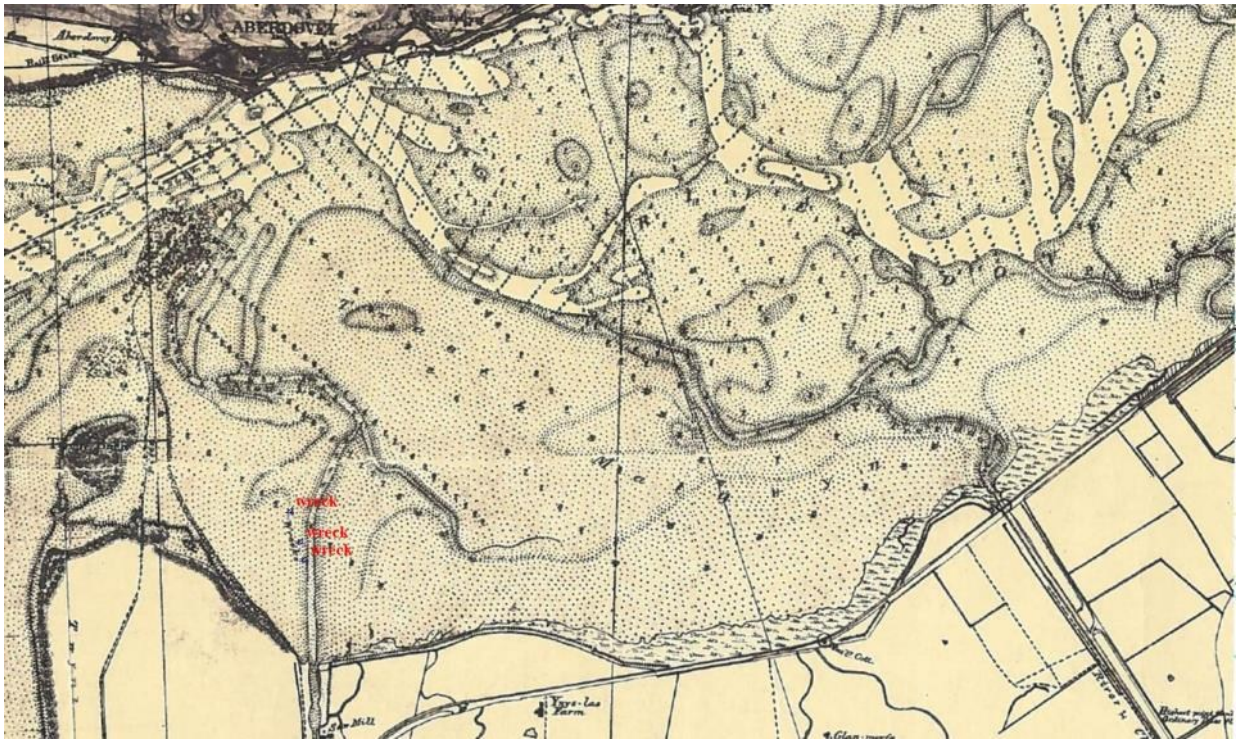


Figure 1.1. Position of wrecks shown on chart 1892.

The Leri had previously flowed through to the open coast to the south of Ynyslas and was straightened and cut through to the Dyfi Estuary around the time when the railway line was constructed along the southern flank of the estuary.

The position of the wrecks has been resurveyed *(Archaeological Investigations 2014, interim report - Dyfed Archaeological Trust)*. These positions are shown in Figure 1.2.

Over the last decade the wrecks have become increasingly exposed. As can be seen in Figure 1.2, as the channel has swung to the west, Wreck 3 is now increasingly at risk from erosion at the edge of the channel. Wrecks 1 and 2 have also become more exposed, although their

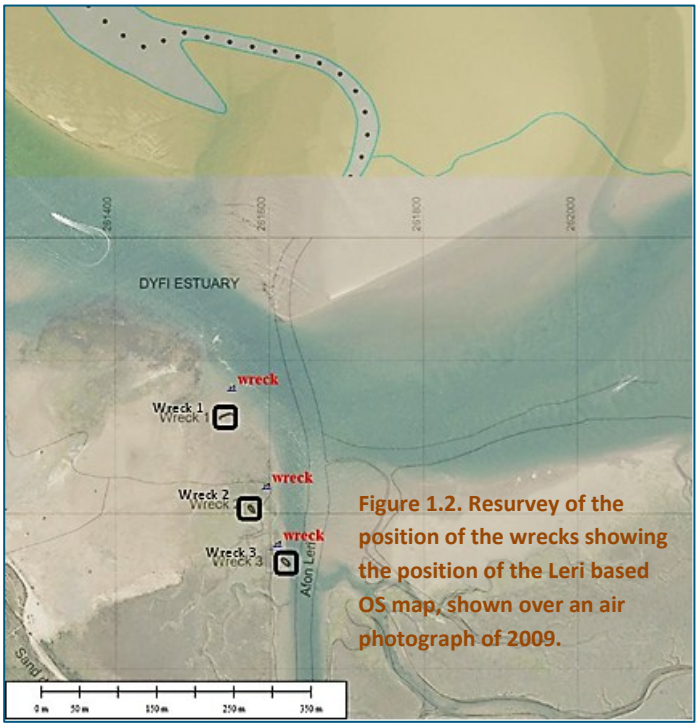


Figure 1.2. Resurvey of the position of the wrecks showing the position of the Leri based OS map, shown over an air photograph of 2009.

position is not seen as being quite so critical.

Dyfed Archaeological Trust Ltd has commissioned RHDHV to undertake a brief review of these issues, looking at this continuing threat.

As indicated in Figure 1.2, the erosion has occurred as a result of the change in the alignment of the Leri. There have been changes at the local scale, impacting directly on Wreck 3 (Plate 1.1) but these local changes are also influenced by, or even driven by, more significant changes that have occurred in relation to the broader scale estuary shape.


Plate 1.1

This study, therefore, starts by providing a general review of the broader scale change, based on readily available charts and air photographs of area. The study then discusses the local scale impact in the context of this larger scale change. Based on this discussion, an assessment is made of future behaviours relating this to the likelihood of continued erosion pressure on the wrecks.

Acknowledgements.

In addition to information held by RHDHV, we would acknowledge the assistance provided by Gwynedd Council in providing air photographs and access to previous reports examining the behaviour of the Dyfi Estuary. We would also acknowledge the valuable information provided by the Dyfed Archaeological Trust.

BROAD SCALE ESTUARY BEHAVIOUR.

General

One of the key difficulties in assessing the long term behaviour of the estuary is the aggregation of specific details over time on individual historical charts and indeed present day maps. Figure 2.1 shows, as the main image, the air photograph from 1971. Included within the figure is the 1892 chart comparing this with a chart with updates to 1951 but actually dated 1971.

At the mouth of the estuary there is clearly significant change identified between the charts (reflecting the detail shown in the main air photograph).However, within the estuary itself, examining the charts in detail, it can be seen that soundings recorded on the 1951/71 chart are identical to soundings shown on the earlier chart.

Therefore, care, and a degree of judgement, has to be applied in assessing and interpreting recorded information over time. There is obviously greater confidence when comparing air photographs, although even here it is recognised that, to a degree, air photographs provide only a snap shot of conditions existing within this dynamic estuary. Care has to be taken in assessing trend of change between specific times, recognising that quasi cyclic changes may have occurred over the period of time between photographs. However, it is still possible to draw certain conclusions from the interpretation of coastal and estuarial processes, linking these changes together to develop an understanding of the impact on the course of Leri.

Figure 2.1 is also used to highlight certain key features of the estuary which are used in this report to describe how change has occurred.

More detailed information is available on levels within the estuary taken from LIDAR surveys. This has been analysed, comparing changes influencing the site. As above, some care is needed in relating old chart data (referenced to local datums) to the more detailed information now available from LIDAR.

Change within the main channel system.

Available records have been rectified to a common projection to allow comparison. (Rectification has been based on the detailed rectification of the 2009 air photograph using common features. This rectification is recognised to be relatively crude based on three identifiable points for each set of images.) From this, for each time step, the interpreted positions of the various main channels have been traced, along with the shape and alignment of the Leri channel.

Comparative images for 1892. 1971, 1982, 1990, 1996, 2006, and 2009 are shown in Figure 2.2, alongside more local images of the Leri from air photographs for 1971, 1990 and 2009.

Discussion of channel positions

A key feature noted in other studies (*BMT - Jan 1998 and CCW – Sept 2009*) is the relatively fixed position of the mouth, between Aberdyfi and Cerrig y penrhyn (Figure 2.1). The CCW report suggests that the southerly constraint is as a result of dumped ship's ballast on the southern side of the estuary. While this constrained mouth fixes the position of the mouth, it may be seen that this functions more as a hinge within the system allowing variation in alignment of the main channel. This variation changes the outer orientation of the entrance channels and to a degree, the way in which channels develop upstream (within the estuary) of the constrained mouth.


Figure 2.1
Aberdyfi
North Bank
North entrance channel
Main entrance channel
Cerrig y penrhyn
Ebb Bar
South Bank
South entrance channel
Twyni Bach
Ynyslas Spit
Ynyslas saltings
Leri Channel
Ynyslas
Leri
1971
0 m 250 m 750 m 1250 m 1750 m
Bryneithyn
Northern inner channel
Inner north bank
Inner cross channels
Central bank
Southern inner channel
Malgwyn Pil
Traeth Malgwyn saltings
1892
1971(?)

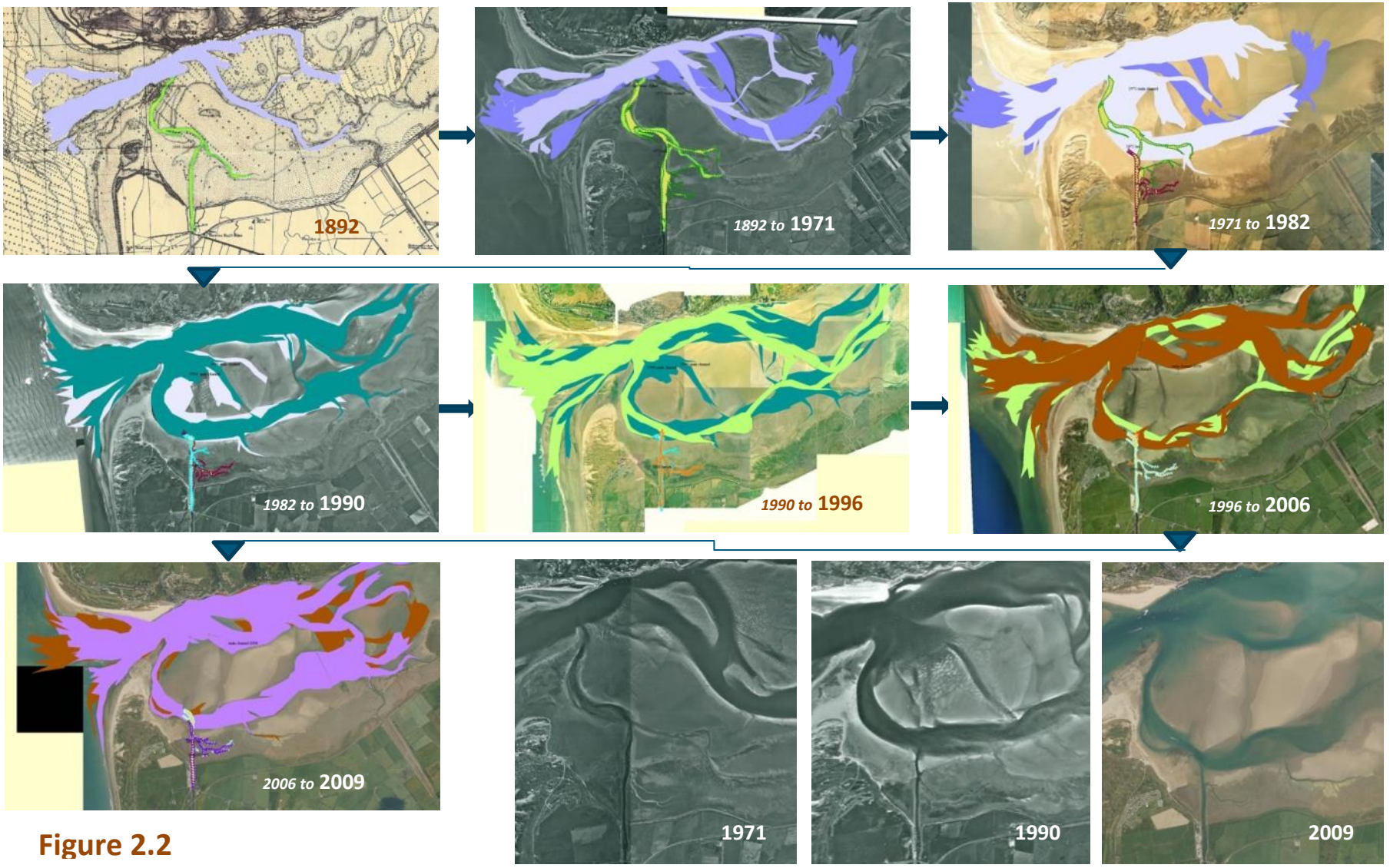

1892
1892 to 1971
1971 to 1982
1982 to 1990
1990 to 1996
1996 to 2006
2006 to 2009
1971
1990
2009

Figure 2.2

On the coastal side, it may be seen that typically there can be a south and/ or north channel, which tends to form in addition to the main entrance channel. There is little to suggest a true cyclic behaviour of these channels. It is suggested that movement and dominance of channels may be related more to wave driven sediment transport along the nearshore zone and across the estuary entrance than to movement and change of channel positions within the estuary. The shape of the offshore entrance seems likely, however, to influence the position and change just within the mouth of the estuary.

The report by BMT Ltd (1998) undertook flow measurements which highlighted that, on the flood, the strong constrained flow through the mouth of the estuary then spreads within the inner estuary. Part of the flow tends to drive against the Aberdyfi shoreline tending to reinforce a channel past the harbour and further along the northern side of the estuary. However, there is also a significant flow filling the estuary towards the southeast across the central bank (the Traeth Malgwyn bank). It appears that on the flood, sediment brought in by the strong flows, is likely to be deposited as a broad flood delta forming the inner north bank and central bank.

Clearly channels cut naturally through this inner bank system forming the inner northern channel and the series of inner cross channels linking through to the southern inner channel.

The BMT report suggested that further within the estuary, the arrangement of channels can be significantly influenced by fluvial flows within the Dyfi, influencing the way in which the channels within the estuary develop particularly on the ebb. This balance of flood and ebb flows, and the different strengths of tidal flow and fluvial flow creates a highly dynamic area within the inner estuary varying the position of banks and channels in this interactive zone. This change is clearly shown in the comparisons presented in Figure 2.2.

Notwithstanding the recognition that channels and banks can change over a tide, there does appear to have been a relatively fundamental change in the balance of the overall shape of the estuary over possibly the last 40 years. In the plot (Figure 2.2) comparing the 1892 to 1971, in may be seen that by 1971 the inner southern channel appears to take on more significance. Figure 2.3, overlaying part of an air photograph from 1948 over the 1971 image, highlights that possibly this was not a sudden change (“flip”) within the system but that the position of the cross channels had varied, exploring a more westerly position over earlier periods.

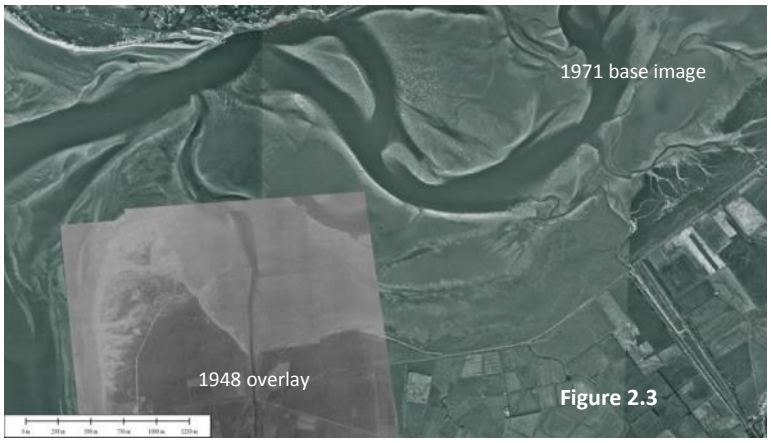


Figure 2.3

This process, in developing the southern inner channel does appear to have continued from 1971, such that by 1982 the southern channel has developed further behind the Ynyslas Spit, linking through and capturing the seaward part of the Leri channel. This has progressively altered the shape and behaviour of the Leri channel and the area around the wrecks.

This local system around the Leri has continued to develop. Initially (between 1982 and 1990) the southern channel appears to work almost independently of the northern channel within the estuary, forming a strong sweep cutting across the back of Ynyslas. Over more recent times this channel appears to have weakened. In 2006 the inner northern channel appears to have cut through, capturing at least part

of the flow of the upper section of the southern inner channel. Even though the general width of the section of the southern inner channel is possibly wider in the 2009 image, there is a strong indication that the form of this channel from 2006 through to 2009 has become less dominant (figure 2.4).

Figure 2.4. Air photographs 2006 and 2009.

There is an indication that, as this seaward section of the southern inner channel has become less dominant in terms of the overall flows within the estuary, this has allowed movement in the central bank, squeezing and locally strengthening the local flows around the Leri.

The shape of the channels interacts with the change in the banks and the tidal prism of the estuary as a whole. This is considered below.

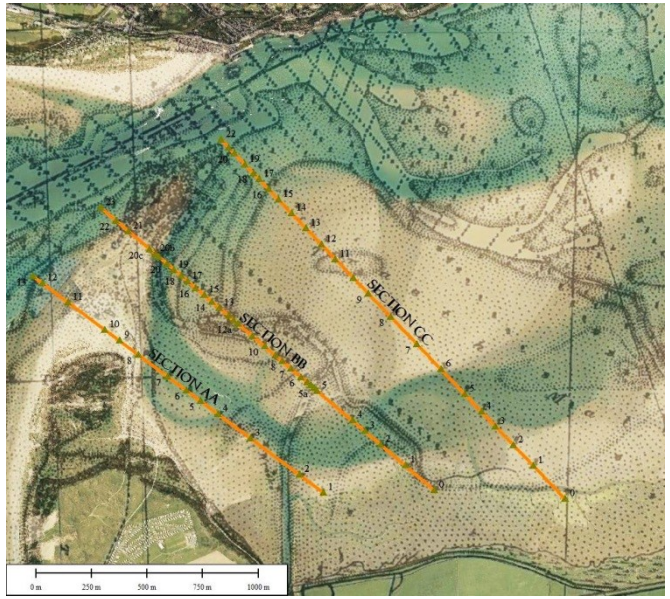
Change in bed levels.

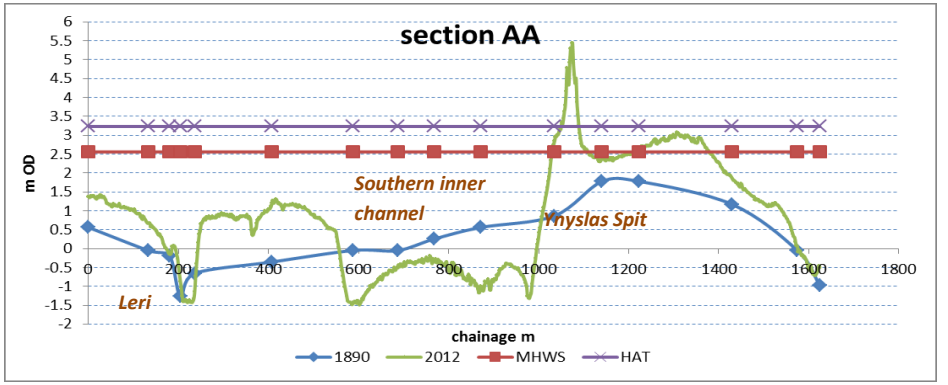
An analysis has been undertaken comparing historic change in bed levels, comparing soundings recorded on the 1892 chart (actually surveyed in1890) with LIDAR data. Three profiles have been considered as shown in Figure 2.5.

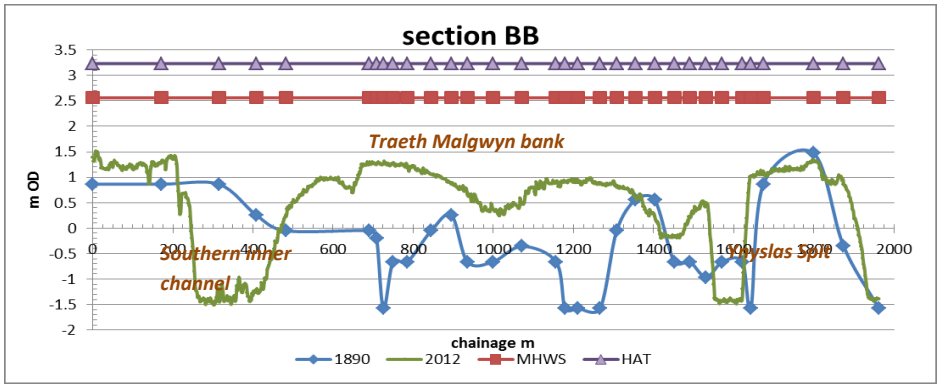
Section AA runs across the Leri channel through to the extension of the Ynyslas Spit. It is significant that soundings were actually made across the Ynyslas spit between Twyny Bach and Cerrig y penrhyn in 1890, demonstrating (as shown in the section) that this area was intertidal on spring tides at this time. The 2012 LIDAR shows the closure of this area and the growth of the spit and dunes stopping tidal flow across the spit.

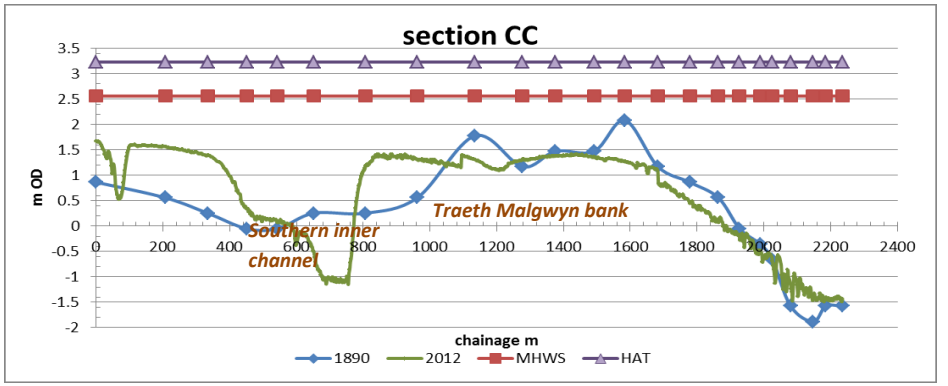
The influence of the southern inner channel is quite evident on the present day survey, cutting below the level shown in 1890. Further back along the profile, the growth of the Ynyslas saltings is shown, with present day levels some 1m higher in the area of the wrecks than the historical levels, which might have characterised the area around the time that the wrecks were beached.

With the growth of the Ynyslas saltings and the growth (again in the order of 1m) of the saltings along Traeth Malgwyn (to east of the Leri), it can be seen that the Leri channel cuts deeper relative to the surrounding bed levels. A more detailed cross section, based on section AA across the Leri, is shown on the left of Figure 2.5. While recognising the inherent difficulty of rectifying the old chart soundings to present day, there is still a clear indication that the eastern bank of the Leri channel has moved westward, potentially by some 10m to 20m. The actual depth of the channel may also have deepened but the LIDAR only captures data on land above water levels. The difference in levels between the western bank is consistent with the position or level of the wrecks, assuming that they were beached at a level of the old bed.


SECTION AA
SECTION BB
SECTION CC


section AA
Leri
Southern inner channel
Ynyslas Spit
m OD
chainage m
1890
2012
MHWS
HAT


section BB
Traeth Malgwyn bank
Southern inner channel
Ynyslas Spit
m OD
chainage m
1890
2012
MHWS
HAT


section CC
Traeth Malgwyn bank
Southern inner channel
m OD
chainage m
1890
2012
MHWS
HAT

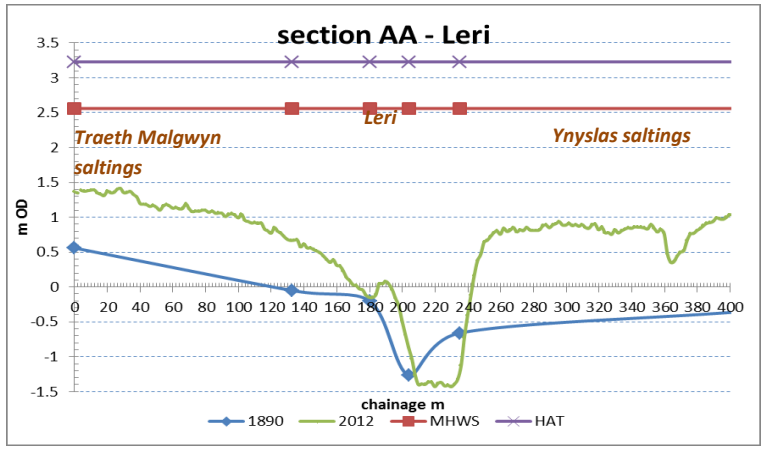

section AA - Leri
Traeth Malgwyn saltings
Leri
Ynyslas saltings
m OD
chainage m
1890
2012
MHWS
HAT

Figure 2.5

Section BB shows the growth of the Traeth Malgwyn saltings at the landward end of the profile. The old chart soundings start at the start of the profile but it is reasonable to assume that, further shoreward, the saltings have also increased in level. Indeed, comparison with spot levels further within the estuary, along the southern shoreline, strongly indicate that the saltings all the way along this frontage have increased in level by around 1m. This would suggest that the estuary, certainly on the southern side, has been infilling. Further within the estuary, this growth on the southern side may have influenced the upper course of the southern channel.

Section BB also shows a significant growth of the central bank across the centre of the estuary. The profile also shows how the southern inner channel has cut in behind Ynyslas. At the seaward end of the profile, where the profile cuts just to the south of Cerrig y penrhyn, the present day and past levels remain remarkably consistent.

Slightly further within the estuary, section CC shows less change with respect to the basic level of the central bank, although there appears to have been some movement of the bank towards the south before reducing in level where the southern inner channel now cuts between the central bank and the Traeth Malgwyn saltings. The very steep southern face of the central bank in relation to the channel is consistent with the idea discussed earlier, that the movement of the central bank is pushing into and is being constrained by the flows within the southern channel.

Summary

In summary, it can be seen the inner estuary is and has been highly dynamic, with significant and on-going changes occurring with respect to the banks and channels. Notwithstanding this variation, there does appear to have been some longer term trends that have a significant influence on the way in which the area around the Leri has changed, most notably in that:

- The southern inner channel pushed further and closer towards the back of Ynyslas over the last 40 years, eventually capturing the seaward end of the Leri.
- Initially, the strength of the southern inner channel was such that it merely captured the seaward end of the Leri channel, without imposing significant change in the alignment of the Leri channel.
- Since the 1990's, however, the southern inner channel appears to have weakened allowing the southerly movement of the central bank to force the southern inner channel to press against the southern shoreline.
- This has resulted in the seaward end of the Leri swinging further towards the west, creating a more distinct curve in the alignment of the mouth of the Leri, tending to introduce a shallow meander in the course of the Leri as it runs through to the Leri Cut.

Alongside these changes there has been significant growth of the saltings to either side of the Leri channel, potentially restricting and channelling flows within the Leri, tending to increase flow rates and increasing the flow within the creek to the east of the Wreck 3 site.

The following section (Section 3) discusses these more local effects in the context of the larger scale changes described above.

Discussion of Local Impacts on the Wreck Sites.

Discussion of local area

Figure 3.1 shows the local area of the wrecks. The image to the left shows the image of the 2009 air photograph, the image to the right shows the same area but taken as the LIDAR image understood to be from 2012. On the LIDAR image areas shown as blue are below typical mid tide level, with areas shown as yellow being areas between 0m OD and 1m OD. The green areas are progressively less exposed to normal tidal levels and typically less exposed to strong tidal flow.

A key feature of the area is the area of packed stone slightly to the west of the Leri. The large creek to the east of the Leri is also highlighted.

As the larger scale processes discussed earlier have developed, particularly as the balance between the dominance of the southern inner channel and the movement of the central bank has occurred, so the southern channel has attempted to move south (as indicated schematically by the arrows shown over the LIDAR). This general movement of the channel appears to have been constrained by the area packed stone. This idea is supported on the LIDAR image by the very sharp northern bank of the main channel and the subsequent stepping southward of the central bank to the east of this constraint point. Clearly this is a simplification of the complex local processes at work but provides a useful explanation of the subsequent development within the Leri channel and particularly at the mouth of the Leri. The schematic southern edge of the southern inner channel is shown as a dotted light blue line.

The general alignment of the Leri is also shown as red lines, emphasising the slight meander that has developed in the channel and also highlighting how the mouth of the Leri has tended to widen at its seaward end. Critically, the western curve of the mouth seems to be controlled again by the area of packed stone.

With respect to the vulnerability of the wrecks, it appears that:

- Wreck 1 gains significant protection from the area of packed stone. While the bed levels around the site of the wreck are lower than both the stone area and the area further south, this may be explained as a result of general turbulence due to flow over the deposited area of stone. If as suggested by the interpretation of the general process the southern edge of the southern channel pushes south, it still seems likely that the wreck itself will remain set back from the main channel edge.
- Wreck 2 seems to be similarly set back sufficiently back from the edge of the Leri channel. Substantially greater change would need to occur in the alignment of the main southern channel for this area to be significantly influenced by erosion.
- Wreck 3, however, is located at a critical inflection point of Leri Channel. Even relatively small changes within this local system have the potential to either increase or, in fact, reduce pressure on the wreck site. A further feature of the system is the deep creek on the eastern side of the Leri channel. Flow from this channel (as shown as a dotted red arrow on Figure 3.1) may also add to the erosion pressure at Wreck 3.

Management and Conclusions

It is recognised that the above discussion is based on information dating back some 4 years and that there have been subsequent developments in the area. Ideally, as further air photography and LIDAR imaging becomes available the interpretation should be reviewed, developing on the basic concepts set out above.

However, critically, the analysis highlights that the processes at work are at a relatively broad scale rather than being a local scale, even though the impact particular on Wreck 3 is clearly locally severe.

It would of course be possible to address the local erosion to Wreck 3, typically by introducing sand bagging or constructing a rock berm around the vulnerable section of the wreck. However, such works would be substantial extending to a significant extent within the flow regime of the Leri channel. It is highly probable that any such intervention would result in significant change elsewhere along the alignment of the Leri, potentially instigating change that could impact on the other wreck sites.

Over, potentially, the last 30 to 40 years, the western edge of the Leri channel at Wreck 3 has moved westward by around 15m (nominally around 0.5m per year). While this is not inconsistent with the erosion of 0.75m recorded over the last few years, this in no way suggests that the rates of erosion are uniform. Indeed at Wreck 2 the long term change seen over the last 30 to 40 years has been in the order of 30m. Almost certainly, this change has been a result of a step change in the larger system and as discussed above further movement at this point will be far less.

Furthermore, the change at Wreck 3 and recent erosion at this location is due to the local turbulence introduced by the exposure of the wreck. It is not possible, therefore, to define rates of erosion. It is however, concluded that as Wreck 3 becomes further exposed, initially there may be more rapid erosion locally to either side of the wreck. However, if the exposed wreck is not actually lost, it may be likely that the exposed section of the wreck structure will start to limit further erosion, acting to a degree as a groyne. If the end of the wreck is lost then it seems probable that the whole face of the bank will cut back further exposing more of the wreck.

It does seem likely that Wreck 3 will be fully exposed and possibly lost over the next ten years, subject to more extreme conditions.

It seems probable that Wrecks 1 and 2 will be less affected. It would, however, be recommended that this is reassessed against further survey data as this becomes available.

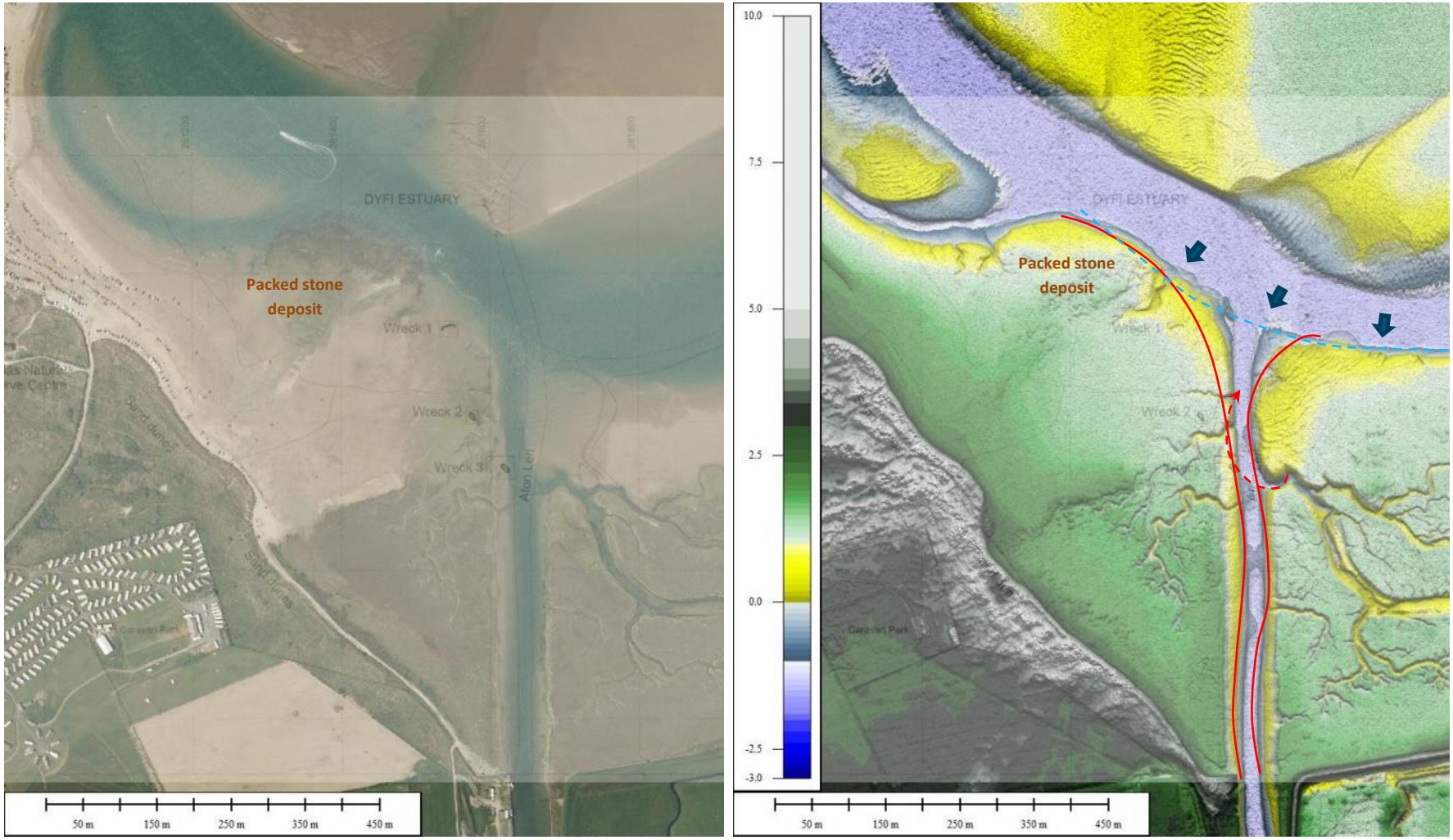

DYFI ESTUARY
Packed stone deposit
Wreck 1
Wreck 2
Wreck 3
Afon Leri
Sand dunes
Sand flats
Caravan Park
50 m
150 m
250 m
350 m
450 m
10.0
7.5
5.0
2.5
0.0
-2.5
-3.0
DYFI ESTUARY
Packed stone deposit
Wreck 1
Wreck 2
Wreck 3
Caravan Park
50 m
150 m
250 m
350 m
450 m

Figure 3.1

YNYSLAS HULKS, YNYSLAS, CEREDIGION: ARCHAEOLOGICAL INVESTIGATIONS 2015 - 2016:

RHIF YR ADRODDIAD / REPORT NO. 2016/15
RHIF Y DIGWYLLIAD / PROJECT RECORD NO. 107509
Cadw Project No. DAT 135

Mawrth 2016
March 2016

Paratowyd yr adroddiad hwn gan / This report has been prepared by J Meek

Swydd / Position: Head of Field Services

Llofnod / Signature ....  .... Dyddiad / Date 31 March 2016

Mae'r adroddiad hwn wedi ei gael yn gywir a derbyn sêl bendith
This report has been checked and approved by K Murphy

ar ran Ymddiriedolaeth Archaeolegol Dyfed Cyf.
on behalf of Dyfed Archaeological Trust Ltd.

Swydd / Position: Trust Director

Llofnod / Signature  Dyddiad / Date 31 March 2016

Yn unol â'n nôd i roddi gwasanaeth o ansawdd uchel, croesawn unrhyw sylwadau sydd gennych ar gynnwys neu strwythur yr adroddiad hwn

As part of our desire to provide a quality service we would welcome any comments you may have on the content or presentation of this report

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