EMERGENCY FLOOD RELIEF CULVERT, LOE BAR, HELSTON, CORNWALL

(NGR SW 64325 24280)

Results of Archaeological Investigations

Cornwall Council Planning Reference: PA17/00115 (Condition 5)

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On behalf of:
BAM Nuttall

Report No: ACD1789/3/1

Date: February 2019

AC archaeology

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Appendix 1: Tree ring analysis

Summary

Archaeological investigations associated with the construction of an emergency flood relief culvert at Loe Bar, Helston, Cornwall (SW 64325 24280) were undertaken by AC archaeology between March and June 2018. The work comprised a borehole survey, the description and dendrochronology dating of timbers recovered during groundworks, and a note on stone pieces also recovered during groundworks. Loe Bar Beach is located approximately 3.5km to the southwest of Helston. It comprises a sand and shingle bar that separates Mounts Bay from a natural lake, The Loe or Loe Pool, which comprises a natural creek principally fed by the River Cober.

Despite previously-recorded evidence for a prehistoric submerged forest present at Loe Bar, no evidence for this was encountered during the borehole survey at the depth required for the new flood relief culvert. Two timbers were recovered during the groundworks. These represented fragments of futtocks from a ship; the curving frame timbers or ribs that form the structure of a ship. These were dated by dendrochronology technique as having been felled at the end of the 19th century. Based on the date of the timbers, they may be connected to the Italian cargo vessel named the Tripolitana, which was driven ashore in 1912. A series of large granite boulders and dressed granite blocks were also recovered during the groundworks. These were considered to have come from an earlier phase of flood channel and associated sluice dating from the 19th century.

1. INTRODUCTION

1.1 This report sets out the results of investigations associated with an emergency flood relief culvert at Loe Bar, Helston, Cornwall (SW 64325 24280), which were undertaken by AC archaeology between March and June 2018. The work was required as a condition (5) of planning consent reference PA17/00115 granted by Cornwall Council, following consultation with the Cornwall Council Development Officer (Historic Environment).

1.2 Loe Bar Beach is located approximately 3.5km to the southwest of Helston. It comprises a sand and shingle bar that separates Mounts Bay from a natural lake, The Loe or Loe Pool, which comprises a natural creek principally fed by the River Cober (Fig. 1). The position of the new flood relief culvert extends northeast to southwest across the northwest portion of the beach. It lies at approximately 7m aOD (above Ordnance Datum), with the underlying solid geology comprising sandstone and argillaceous rocks of the Portscatho Formation beneath sand and gravel marine beach deposits (www.bgs.ac.uk).

1.3 These works formed part of a wider proposed flood alleviation scheme for Helston, which when enacted, will be the subject of a subsequent phase of associated archaeological work.

1.4 Results set out in this report include those from a borehole survey, the description and dendrochronology dating of timbers recovered during groundworks, and a note on some worked stone also recovered during groundworks.

2. ARCHAEOLOGICAL BACKGROUND

2.1 The site had been subject to an Historic Environment Assessment as part of the wider proposed Helston Flood Defence Improvements scheme (Thorne 2014). In this it was identified that the principal archaeological interest in the site at Loe Bar Beach was the presence of a prehistoric submerged forest beneath the existing marine beach deposits and lake. In an appendix to their paper on Trevose Head, Nicholas Johnson and Andrew David (1981, 97) list Loe Pool as an example of a former estuary that was submerged and cut off from the sea following sea level rise, probably dating from around the end of the Mesolithic period.

2.2 The presence of the bar as blocking the entrance to the former estuary was first recorded in the early 14th century, however it was during the 16th century that more detailed reference to the freshwater lake was made by poet and antiquary John Leland (Coard 1987). In his itinerary, Leland makes reference to flooding within Helston and the cutting of breaches through the bar to reduce the backed-up water levels (*ibid* 1987). This activity is then documented as having been regularly undertaken culminating in the 19th century when an adit associated with a mine that was established in the Loe Valley, was constructed to regulate the water level within the lake.

2.3 Observations in the 1860s on Loe Bar Beach describing the exposure of an undated stone-built double oven within a small structure was reported in the *Archaeological Journal* (Rogers 1863). This structure, which was recorded as measuring around 3m long and set within the beach deposits, was thought to have been exposed at the southeast end of Loe Bar (Cornwall Council Historic Environment Record reference. MCO26942).

2.4 There are a number of wrecks recorded off Loe Bar, which date from between the 17th and early 20th centuries. The earliest is the protected wreck site of the *President*, an English East Indiaman cargo ship that sank off Loe Bar in 1684 (MCO40566). Later vessels comprise of the *HMS Anson*, a British frigate (MCO61017) and a Prussian cargo ship, the *Hermanest August* (MCO61118) wrecked in 1807 and 1808, respectively. The most recent to be recorded on the Cornwall Council Historic Environment Record is an Italian cargo vessel named the *Tripolitana*. This was driven ashore during a storm in 1912 and subsequently broken up for scrap (MCO60874).

2.5 The Ordnance Survey 25-inch map of 1878 shows the position of the site at the north end of the beach. Here a short channel is shown as extending from the pool. This is annotated as having an Ordnance Survey benchmark, indicating that it comprised a formal structure at this point, which by the 1908 edition, is labeled as having a sluice. This channel, which had subsequently silted up, was replaced by the current culvert works.

3. RESULTS: BOREHOLE SURVEY *by Mike Allen*

3.1 Introduction

The borehole survey was undertaken in advance of construction of the flood relief culvert. It was carried out to assess the palaeoenvironmental potential at the anticipated depth of excavation for the proposed culvert. This was carried out using a Dando Terrier coring rig (Plate 1). The location of the borehole is shown on Fig. 1 and the results are summarised below.

3.2 Results

The borehole was drilled with sleeves to 4m (Plate 2). Recovered sleeves demonstrated that only sand layers were present throughout (see Table 1). The depth of the borehole exceeded the anticipated depth of 3.2m below existing levels for the new culvert.

Table 1: Results of borehole survey

Height aOD	Depth	Unit	Description
5.21m	0-2.75m	Bar sand	Coarse greyish yellow sand and fine grit, and some coarse grits and rare very small rounded pebbles 240-241cm shale stone 258cm ground water 261-272cm shale
2.46m	2.75m-2.95m		Reddish brown coarse sand and fine grit, and some coarse grits and rare very small rounded pebbles
2.25m-1.21m	2.95m-4m+		Reddish brown coarse sand and fine grit – wet with rare small and medium rounded pebbles

4. RESULTS: TIMBERS

4.1 Two timbers (Timbers 1 and 2) were recovered during the groundworks for the flood relief culvert (Plates 3-5). These comprised small sections from futtocks; the curving frame timbers or ribs that form the structure of a ship. The timbers were square-cut, measuring 0.25m across and 2.5m and 1.2m long, respectively. Both had numerous c.40mm perforations representing the position of former rivets for attaching planking. These were largely stained with iron corrosion product (rust), while a small number were stained green with copper corrosion product. This would suggest that the vessel had also been clad with copper.

5. RESULTS: DENDROCHRONOLOGY

5.1 Introduction

The full dendrochronology report of Timbers 1 and 2 is included as Appendix 1 and is summarised below.

5.2 Methodology and results

Initially, radial sections were taken from the cross-sectional slices and slowly dried to allow them to be prepared by sanding and polishing. Once dried, sanded, and polished, the widths of the annual growth rings of the sections were measured. These measured data sets were then compared with each other. This comparative process indicated that the growth-ring sequences of all radial sections from both samples, agree with each other. These provided two sample sequences that cross-match with each other at relative positions.

The data of these measurements was then combined at their indicated off-set positions to form a site chronology with an overall length of 312 rings. This site chronology was then satisfactorily dated by repeated and consistent cross-matching with a number of relevant reference chronologies for pine as spanning the years 1545 to 1856. The results and proposed dates obtained from the two timbers are set out in Table 2 below.

Table 2. Dendrochronology results

Timber No.	Total rings	First measured ring date (AD)	Heartwood/sapwood boundary (AD)	Last measured ring date (AD)
1	305	1545	Estimate 1830	1850
2	275	1582	Estimate 1840	1856

5.3 Discussion

Dendrochronology has successfully provided an indication of likely date for both the pine samples obtained; Timber 1 having a last ring date of 1850; and, Timber 2 having a last ring date of 1856. These last measured ring dates, however, are not necessarily the exact felling dates of the two trees represented, as some allowance needs to be made for any missing sapwood rings. Unlike oak, where the difference between the inner heartwood rings and the outer sapwood rings is clear, the distinction between heartwood and sapwood on pine is not always clear. Furthermore, the number of sapwood rings found on pine trees is much more variable than with oak (95% of which have between a minimum of 15 sapwood rings and a maximum of 40). These two points are important for estimating a likely felling date for pine.

On the two samples dated here, it is estimated that both have some sapwood rings, the heartwood/sapwood boundary on Timber 1 being dated about 1845, and on Timber 2 being dated about 1850. Allowing for a total complement of, approximately 50 sapwood rings (many of these outer rings having been removed by the original carpenters, or having decayed and rotted away whilst the timbers were buried), it is estimated that the timbers were felled perhaps no later than 1895 to1900.

Thus, as suggested above by the use of copper nails for fixing copper sheaving to the bottom of the ship, the timbers probably date to the very end of the nineteenth century.

6. RESULTS: WORKED STONE

6.1 A quantity of worked stone pieces were recovered during the course of the groundworks. These consisted of a number of granite boulders and a small number of roughly dressed broadly rectangular blocks (Plate 6). No clear drill marks were visible on the dressed blocks. The stone is considered to have been derived from the former channel and sluice arrangement depicted on 19th century and later maps.

7. COMMENTS

7.1 Despite the previously-recorded evidence for a prehistoric submerged forest present at Loe Bar, this was not encountered at the depth required for the new flood relief culvert. The borehole that was drilled, which only recorded sand deposits to 4m below existing levels, demonstrated that the route of the culvert was unlikely to have exposed preserved organic material. The large granite boulders and dressed granite blocks recovered from the culvert trench cut through the sand deposits, were probably associated with earlier culverts and sluice constructions dating from the 19th and 20th centuries.

7.2 The two timbers recovered during the groundworks represent fragments of futtocks from a ship. Evidence for copper corrosion, as shown by the staining of the timbers, has suggested that the hull of the vessel from which they were derived may have been clad in copper sheeting; a protective technique used from the 18th century. The results from the dendrochronology provided broadly equivalent late 19th century dates for the timbers, indicating that they probably were part of the same pine-framed vessel. Should these have come from a wreck, then from the various vessels recorded as lost at Loe Bar, they could have been associated with the Italian cargo vessel, the *Tripolitana*, which was built in 1897 and driven ashore in 1912 (Ivey 1960; Larn and Carter 1969; MCO60874). This ship was iron clad and sold for scrap where it lay and was slowly dismantled on the beach and taken away. It is probable that this ship had a metal rather than timber frame, so the futtocks are unlikely to have formed a structural part of the vessel, but they may have been aboard the ship for another purpose. It is equally possible that they relate to a completely different vessel for which no record currently exists.

8. ARCHIVE AND OASIS

8.1 The paper and digital archive is currently held at the offices of AC archaeology Ltd, at 4 Halthaies Workshops, Bradninch, near Exeter, Devon, EX5 4LQ under the unique project code of **ACD1789**. It will be held until the need for any further archaeological work is established and ultimately will be offered to The National Trust.

8.2 An online OASIS entry has been completed, using the unique identifier **341037** which includes a digital copy of this report.

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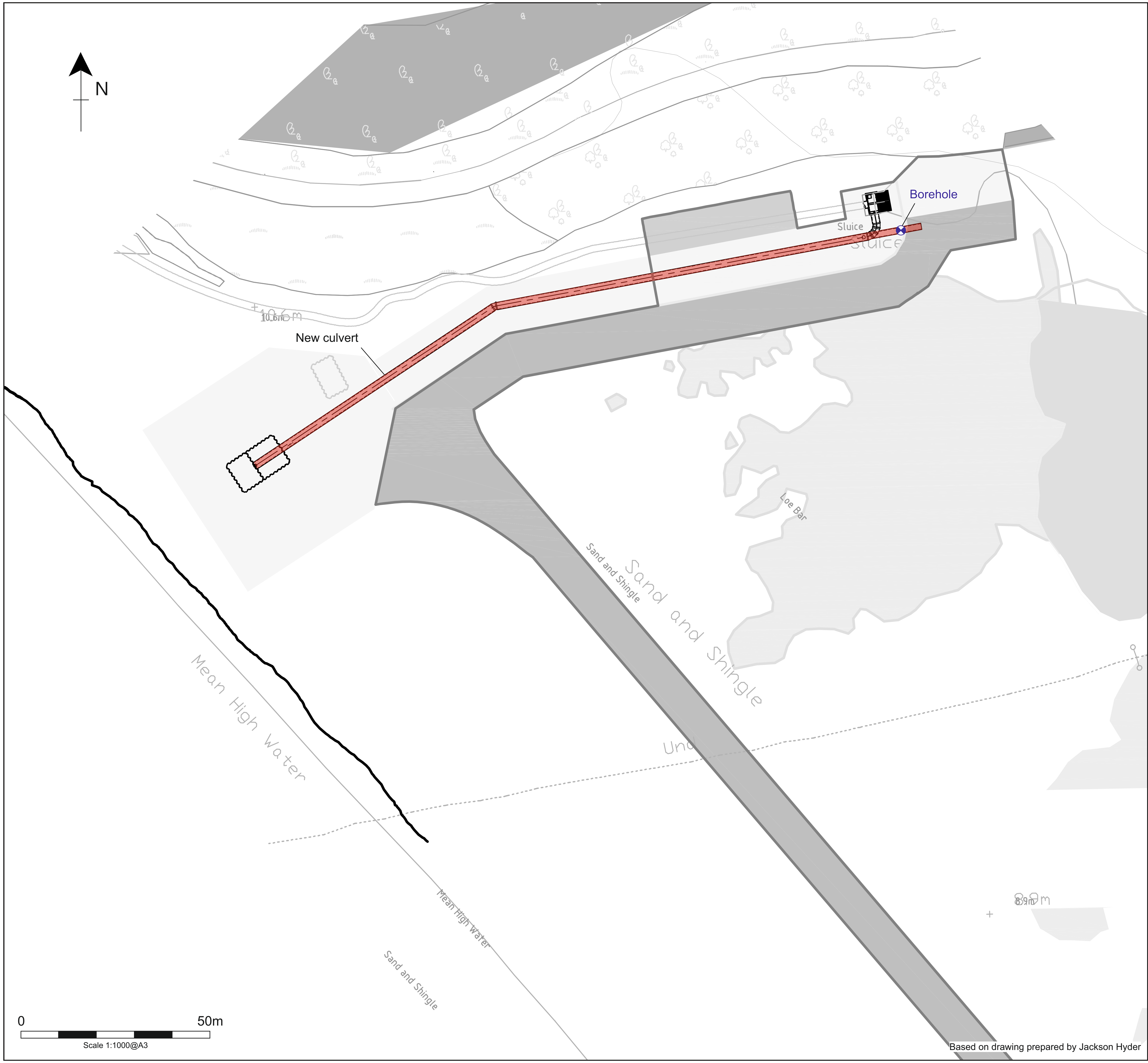

PROJECT
Emergency flood relief culvert, Loe Bar, Helston, Cornwall

TITLE
Fig. 1: Location of site and development plan showing borehole position

AC archaeology

Plate 1: General working view of site during borehole survey. Looking northeast towards Loe Pool

Plate 2: Showing borehole sleeves with recovered sand layer sequence (scale 1m)

Plate 3: Timber 1 (scale 1m)

Plate 4: Timber 1, detailed view with copper stained rivet hole (scale 0.2m)

Plate 5: Timber 2 (scale 0.5m)

Plate 6: Showing recovered stone pieces from groundworks (image provided by BAM Nutall)

Appendix 1
Tree Ring Analysis

TREE-RING ANALYSIS OF SHIP'S TIMBERS EXCAVATED AT LOE BAR HELSTON CORNWALL

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TREE-RING ANALYSIS OF SHIP'S TIMBERS EXCAVATED AT LOE BAR, HELSTON, CORNWALL

ALISON ARNOLD
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SUMMARY

Analysis by dendrochronology was undertaken on samples taken from two different pine timbers which were recovered during flood prevention excavations works at Loe Bar, in Cornwall. This analysis produced a single site chronology comprising both samples and being 312 rings long overall. These 312 rings were dated as spanning the years 1545–1856. Interpretation of the possible sapwood on these samples suggests that the trees used were probably both cut as part of a single programme of felling in the late nineteenth century.

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Introduction

The independent historic environment specialists, AC Archaeology, were involved with an Environment Agency project on National Trust land at Loe Bar, near Helston, on the Lizard in Cornwall (at approximately SW 64325 24280, map Figs 1a/b), this work being to install a series of new pumps near the shore to protect the locality from flooding. During excavations for these works, parts of 2 pine timbers were uncovered from a sand bar behind the bay and moved off-site to a nearby compound for safe storage. Initial examinations of the timbers showed evidence for copper nails which, it was believed, may have fixed copper sheaves to the bottom of a ship.

Sampling

Sampling and analysis by dendrochronology of these two pine timbers were commissioned by AC Archaeology's Andrew Passmore and Simon Hughes on behalf of the Environment Agency and The National trust, both of whom were keen to establish a date for the beams. It was hoped that tree-ring analysis might more accurately and reliably determine the date of the timbers, demonstrate their potential antiquity, and perhaps establish which shipwreck they might represent.

Thus, from the 2 timbers available, a series of full cross-sectional slices were taken using a chainsaw. Each sliced sample was given the tree-ring code LOB-W (for 'Loe Bar Wreck'), and numbered 01 and 02 (see Fig 2). Details of the samples are given in Table 1, including the timber sampled, the total number of rings each sample has, and how many of these, if any, are sapwood rings. The individual date span of each dated sample is also given.

The Nottingham Tree-ring Dating Laboratory would firstly like to very much thank both Andrew Passmore and Simon Hughes for promoting this programme of tree-ring analysis and for their help in arranging access to the timbers. The Laboratory would also like to thank the on-site construction staff present at the time of sampling for their interest, help and cooperation with sampling.

Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principles. Firstly, as is commonly known, trees grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March–September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically influenced pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over a certain number of consecutive years is unique, so too is the growth-ring pattern of the tree. The pattern of a shorter period of growth for pine, 50, 60**,** or even 70 consecutive years, might conceivably be repeated two or even three times in the last one thousand years, and is considered less reliable. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth for pine, that is, anything in excess of 80 years or so. In essence, a short period of growth, anything less than 80 rings for pine, is not reliable, and the longer the period of time under comparison the better.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimetre. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which is known. When the growth-ring sequence of a sample 'cross-matches' repeatedly at the same date span against a series of different reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a '*t*-value'; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phase of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a 'site chronology'. As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any pine site chronology with less than about 70 rings is generally too short for reliable dating.

Having obtained a date for the site chronology as a whole, the date spans of the constituent individual samples can then be found, and from this the felling date of the trees represented may be calculated. Where a sample retains complete sapwood, that is, it has the last or outermost ring produced by the tree before it was cut, the last measured ring date is the felling date of the tree.

Where the sapwood is not complete it is necessary to estimate the likely felling date of the tree. Such an estimate can be made with a high degree of reliability because oak trees generally have between 15 to 40 sapwood rings. For example, if a sample with, say, 12 sapwood rings has a last sapwood ring date of 1400 (and therefore a heartwood/sapwood boundary ring date of 1388), it is 95% certain that the tree represented was felled sometime between 1403 (1400+3 sapwood rings (12+3=15)) and 1428 (1400+28 sapwood rings (12+28=40)). For pine trees, the number of sapwood rings is more variable, but is known to be generally higher.

Analysis

Initially, radial sections were taken from the cross-sectional slices and slowly dried to allow them to be prepared by sanding and polishing. Once dried, sanded, and polished, the widths of the annual growth rings of the sections were measured. These measured data were then compared with each other as described in the notes above. This comparative process indicated that the growth-ring sequences of all radial sections, from both samples, agree with each other, giving two sample sequences which cross-match with each other at relative positions as shown in the bar diagram, Figure 3.

The data of these measurements were then combined at their indicated off-set positions to form LOBWSQ01 a site chronology with an overall length of 312 rings. This site chronology was then satisfactorily dated by repeated and consistent cross-matching with a number of relevant reference chronologies for pine as spanning the years 1545 to 1856. The evidence for this dating is given in the *t*-values of Table 2.

Conclusion

Analysis by dendrochronology has, therefore, dated both the pine samples obtained, sample LOB-W01 having a last ring date of 1850, and sample LOB-W02 having a last ring date of 1856. These last measured ring dates, however, are not necessarily the felling dates of the two trees represented, an allowance needing to be made for any missing sapwood rings. Unlike oak, where the difference between the inner heartwood rings and the outer sapwood rings is clear, the distinction between heartwood and sapwood on pine is not always clear. Further, the number of sapwood rings found on pine trees is much more variable than with oak (95% of which have between a minimum of 15 sapwood rings and a maximum of 40). These two points are important for estimating a likely felling date for pine.

On the two samples dated here, LOB-W01 and W02, it is estimated that both have some sapwood rings, the heartwood/sapwood boundary on sample LOB-W01 being dated about

1845, and on sample LOB-W02 being dated about 1850. Allowing for a total compliment of, say, 50 sapwood rings (many of these outer rings having been removed by the original carpenters, or having decayed and rotted away whilst the timbers were buried), it is estimated that the timbers were felled perhaps no later than, say, 1895–1900.

Thus, as intimated by the use of copper nails for fixing copper sheaving to the bottom of the ship, the timbers probably date to the very end of the nineteenth century.

Woodland sources

As may perhaps be seen from Table 2, although site chronology LOBWSQ01 has been compared with reference chronologies made up of pine timbers from several parts of Europe, there is a distinct tendency for the highest *t*-values (ie, the greatest degrees of similarity) to be found with those made up of material from other sites in Scandinavia (ie, Norway and Sweden). Even where site chronology LOBWSQ01 cross-matches with other sites in Britain, it is believed that the source of timbers in those sites is also Scandinavia. Although of course the exact woodland sources of the trees used at these reference sites are themselves not known, such matching would suggest that the timber washed up on the shore at Loe Bar came from a similar regional source.

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Table 1: Details of tree-ring samples from the timbers recovered from excavations at Loe Bar, Helston, Cornwall

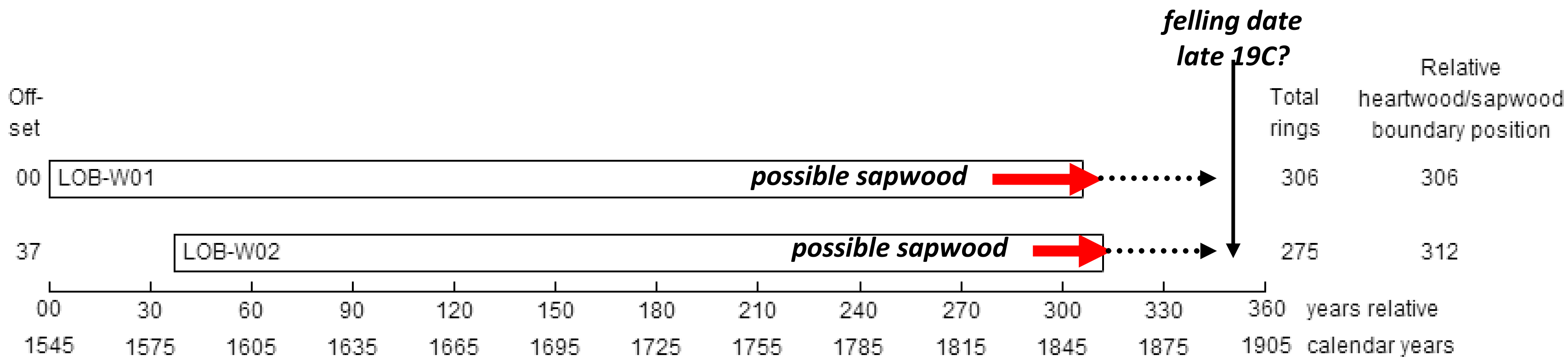
Sample number	Sample location	Total rings	Sapwood rings	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
LOB-W01	Possible ship's timber	305	Possible sap	1545	1830?	1850
LOB-W02	Possible ship's timber	275	Possible sap	1582	1840?	1856

Table 2: Results of the cross-matching of site chronology LOBWSQ01 and the reference chronologies when the first ring date is 1545 and the last ring date is 1856		
Reference chronology	*t*-value	
Berwick upon Tweed, Northumberland	8.3	(Arnold *et al* forthcoming)
Norway Hovden	8.1	(Thun 1987)
GGCP-T6	5.7	(Bartholin pers comm)
Norway Visdalen	5.6	(Briffa *et al* 1986)
Sweden Helsingland	5.6	(Bartholin pers comm)
Sweden Hrjedalen	5.5	(Bartholin pers comm)
Librarian's Loft, Durham Cathedral, Durham	5.4	(Arnold *et al* 2007)
Godolphin House, Cornwall	5.3	(Tyers & Tyers forthcoming a)
Sweden Dalarna	5.2	(Bartholin pers comm)
Clandon House, Surrey	5.0	(Tyers & Tyers forthcoming b)

Site chronology LOBWSQ01 is a composite of the data of the cross-matching samples as seen in the bar diagram, Figure 3, below. This composite data produces an 'average' tree-ring pattern, where the possible erratic variations of any one individual sample are reduced and the overall climatic signal of the group is enhanced. This 'average' site chronology is then compared with a corpus of reference patterns spanning the last thousand years, cross-matching with a number of these only at the date span indicated. It may be noticed from this that the resultant *t*-values are well in excess of the t=3.5 value usually taken as the minimum acceptable level for satisfactory dating.

Maps have been removed

Figure 2: View of the sampled timbers (see Table 1)



blank bars = heartwood rings; shaded arrows = possible extant/missing sapwood rings

Figure 3: Bar diagram of the two pine samples in site chronology LOBWSQ01

The constituent samples of site chronology LOBWSQ01 are shown here in the form of 'bars' at positions where their growth rings cross-match with each other, the similarity being caused by the trees used for the two beams growing at the same time *and place* as each other. The two samples have been combined to form a single site chronology which is then dated by comparison with the pine 'reference' chronologies (see Table 2). Taking into account the possible sapwood element on the samples, and the likely number of sapwood rings these two pine trees may have lost, it is estimated that the two trees represented were felled in the late nineteenth century.

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