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Manor Farm Barn “Bunyan’s Barn” Maydencroft St Ippolyts Hertfordshire

Tree-ring Analysis of Elm and Oak Timbers

Martin Bridge and Cathy Tyers

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Front Cover: Manor Farm Barn “Bunyan’s Barn” Maydencroft, St Ippolyts Hertfordshire.
Photo: Martin Bridge

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SUMMARY
A number of elm timbers were initially assessed as being potentially useful for ring-width dendrochronology, but were subsequently found to contain fewer rings than expected. None of the elm or oak samples taken dated, although two oak series from the west wall plates did cross-match each other.

CONTRIBUTORS
Martin Bridge and Cathy Tyers

ACKNOWLEDGEMENTS
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INTRODUCTION

The investigation of the elm timbers at Bunyan's barn contributes to an on-going research programme, *Developing the dendrochronology of elm in historic buildings*, funded by Historic England through its Heritage Protection Commissions programme, and led by Martin Bridge from the UCL Institute of Archaeology.

Developing the dendrochronology of elm in historic buildings

Ring-width dendrochronology of oak timbers from historic buildings in England is well established, with dating having been obtained on more than 3000 buildings (or parts thereof), with nearly one third of these having been funded by Historic England (and its predecessors). Dendrochronological evidence is a valuable component underpinning the discovery and identification of assets in the historic environment, aiding decisions relating to protection, management, and conservation, and enhancing appreciation and enjoyment of these buildings.

During this work on oak timbers, a significant amount of historic fabric constructed from timbers other than oak, most notably elm, has been identified, but this has previously been rejected as unsuitable for dendrochronological investigation. Elm in buildings has been identified in counties from Cornwall to Kent and up into the Midlands and beyond, but formal records of the presence of elm are scant as such buildings were generally dismissed for dating purposes and thus the presence of elm in the published record is rare. The inability to date historic buildings (or sections of buildings) constructed of elm by ring-width dendrochronology is seen as problematic in some areas of the country which have a comparatively high proportion of such buildings; buildings which nevertheless form a significant part of the historic environment but could not be afforded the same level of understanding in comparison to their oak counterparts.

Prior to the start of this project, only four instances of dating elm by ring-width dendrochronology have been successful (Groves and Hillam 1997; Haddon-Reece *et al* 1989, 1990; Bridge and Miles 2015). Each of these studies involved matching elm with oak from the same site, although the Ashdon, Essex example matched oak chronologies over a wide area (Bridge and Miles 2015). This project aimed to establish whether the use of standard ring-width dendrochronology could be extended to the dating of historic buildings in England where elm (*Ulmus* sp.) is the sole, or predominant species used, rather than oak (*Quercus* sp.). A systematic approach was adopted concentrating on elm in the geographical areas where it is most commonly found. Buildings were thus sought that contained a significant number of elm timbers with sufficient numbers of rings that might be matched against either oak timbers in the same building or oak chronologies from the surrounding area (Fig 1).

An article will summarise the overall outcomes of the project (Bridge and Tyers forthcoming). However, each building sampled for dendrochronology has an associated building survey report or similar publication, whilst the primary archive of the dendrochronological analysis is reported in the Historic England Research Report Series.

Bunyan's Barn

The barn sits in a relatively remote location amongst a complex of farm buildings associated with Maydencroft Manor House in north-west Hertfordshire (Fig 2).

This Grade II* listed, 5-bay barn (LEN 1295380) is said to be late sixteenth or early seventeenth century in date, with brick infill dating to c AD 1700. This assessment of date is based on the short tenons on the edge-halved scarf joints and the mean wind-bracing. There is a documented phase of upgrade to the manor house, following the death of an owner in AD 1608, and the barn may relate to this building phase. It does however show a number of older characteristics, with passing braces from the wall face notched to the tiebeam on the aisled west side (see VAG 2017; Fig 3–5). It is not known why this old tradition may have been used so much later than expected.

The timber frame sits on a flint sill repaired in red brick with tile pinnings. The exposed frame is infilled with narrow red brick, incorporating staggered soldier courses with gaps for ventilation. It has step-jowled posts, unjowled mid-bay posts, straight tension braces above the rail, and long curved braces to the tiebeams. The trusses have a collar at mid-height with two inclined queen-struts to the collar, which supports heavy convex curved inclined queen posts, the enlarged heads of which clasp the upper purlin. There are long straight wind-braces in the middle and end bays. The rafters are jointed into the lower butt-purlin. John Bunyan is said to have preached in the barn (RCHM 1910, 130).

METHODOLOGY

Fieldwork for the present study was carried out in June 2017, following an initial assessment of the potential of the elm timbers for dendrochronology some weeks beforehand. In the initial assessment, based on the general criteria used for oak timbers, accessible elm timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences may be sampled if little other material is available. Those timbers judged to be potentially useful were cored using a 16mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis. Additional oak timbers with complete sapwood were also sampled to provide same-site comparative material to increase the chances of producing dating evidence. It was hoped that this would refine the dating for this site, currently based on typological evidence from the carpentry techniques employed in its construction.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one oak sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual oak samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation. Threshold values for elm samples are as yet unknown, but are likely to be of similar value.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring, ie if it has only the spring vessels or early wood formed, or the latewood or summer growth, a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. In oak, the number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic oak timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997). The equivalent values for elm are as yet unknown, but the results of this project suggest that the range of the number of sapwood rings in elm timbers is likely to be much lower. One problem that has been encountered in considering elm is that it has often proved very difficult to determine the position of the heartwood/sapwood boundary, even when it is known that the complete sapwood is present on a timber. It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

RESULTS AND DISCUSSION

Basic information about the core samples is given in Table 1, the sampling locations being indicated in Figures 3–5. Trusses have been numbered from the north. Many of the elm sequences were shorter than had been expected from an external assessment of the timbers and, as in several other sites examined, the outer rings were found to be narrow but the inner rings wide on a number of samples. Several samples, including one oak, were not therefore measured. The ring-width measurements for nine measured samples are given in the Appendix.

Six elm samples had more than 30 rings, but the outer few on buny02 could not be reliably measured. None of these six series cross-matched each other, and neither did the individual series give any acceptable consistent cross-matches against either the oak sequences from the site or the extensive database of oak reference chronologies.

Two oak samples matched each other, bunyO01 *v* bunyO02, t = 5.0 with 47 years overlap, and these were combined into a single sequence, bunyO21m (Fig 6), for further analysis. Neither this series, nor the remaining individual oak series, bunyO03, gave acceptable and consistent cross-matches against the database of oak reference chronologies. It is of note that both bunyO01 and bunyO02 had complete sapwood, but that their respective felling dates are several years apart.

The lack of cross-matching and cross-dating of the ring-series obtained from this site is unsurprising given the limited number of growth-rings in both the elm and oak timbers.

REFERENCES

Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7–14

Bridge, M C, and Miles, D, 2015 Tree-Ring Date Lists, *Vernacular Architect*, **46**, 102–7

Bridge, M C, and Tyers, C, forthcoming Elm in vernacular buildings and its potential for dating*, Vernacular Architect*

Groves, C, and Hillam, J, 1997 Tree-ring analysis and dating of timbers, in *Multiperiod Saltmaking at Droitwich, Hereford & Worcester - excavations at Upwich,1983-4* (ed J D Hurst), CBA Res Rep, **107**, 74–88

Haddon-Reece, D, Miles, D H, and Munby, J T, 1989 List 32 - Tree-ring dates, *Vernacular Architect*, **20**, 46–9

Haddon-Reece, D, Miles, D H, and Munby, J T, 1990 List 38 - Tree-ring dates, *Vernacular Architect*, **21**, 46–50

Miles, D H, 1997 The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, **28**, 40–56

RCHM, 1910 *An inventory of the historical monuments in Hertfordshire,* London (HMSO)

Tyers, I, 2004 *Dendro for Windows Program Guide 3rd edn*, ARCUS Report, **500b**

VAG 2017, *Spring Conference booklet, Hertfordshire*, Appleby-in-Westmoreland (Vernacular Architecture Group)

TABLES

Table 1: Details of the samples taken from Manor Farm barn (Bunyan's Barn), Maydencroft, St Ippolyts (trusses numbered from the north)

Sample number	Timber and position	No of ring s	Mean ring width (mm)	Sapwood rings	Mean Sens
Elm samples					
buny01	Arcade post, T2	31	3.24	?h/s	0.21
buny02	Arcade post, T3	29	4.52	h/s +5NM	0.31
buny03	Arcade post, T4	<30	NM	-	-
buny04	Arcade post, T5	70	2.47	25C	0.26
buny05	Tiebeam, T4	55	2.44	12C	0.32
buny06	South brace, arcade post to plate, T3	<30	NM	-	-
buny07	West brace, arcade post to tiebeam, T4	38	3.22	-	0.19
buny08	West brace, arcade post to tiebeam, T3	<30	NM	-	-
buny09	South brace, arcade post to plate, T2	38	2.68	C	0.23
Oak samples					
bunyO01	West wall plate, bay 2-3	54	2.30	7C	0.27
bunyO02	West wall plate, bay 5-6	56	1.88	19¼C	0.17
bunyO03	East intermediate storey post, bay 5-6	46	2.02	13	0.25
bunyO04	East intermediate storey post, bay 4-5	<30	NM	16C	-

Key: Mean Sens = mean sensitivity; NM = not measured; C = complete sapwood, winter felled; ¼C = complete sapwood, felled the following spring

FIGURES

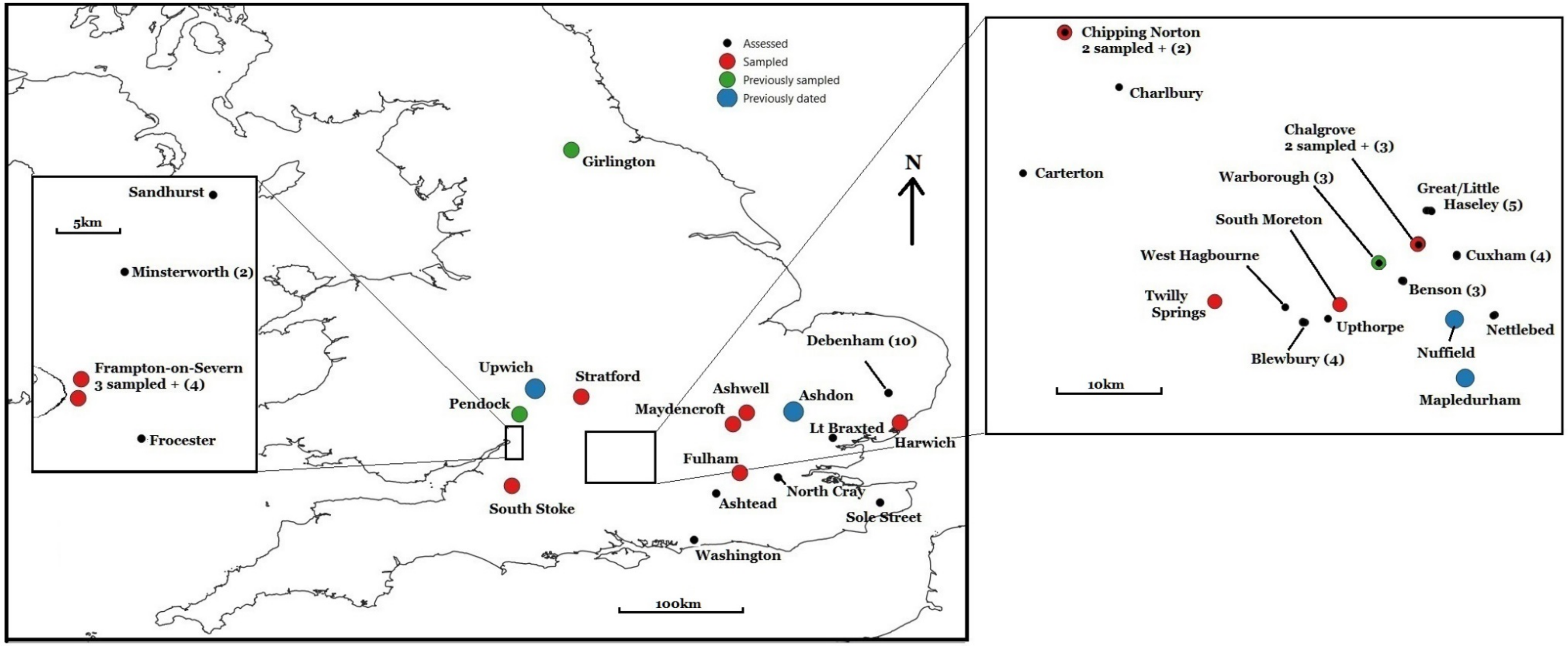


Figure 1: Map showing the distribution of sites sampled, some of which were dated, prior to the start of this project, and sites assessed and sampled properties for this project. Numbers in brackets after a place name represent the number of properties assessed in that location

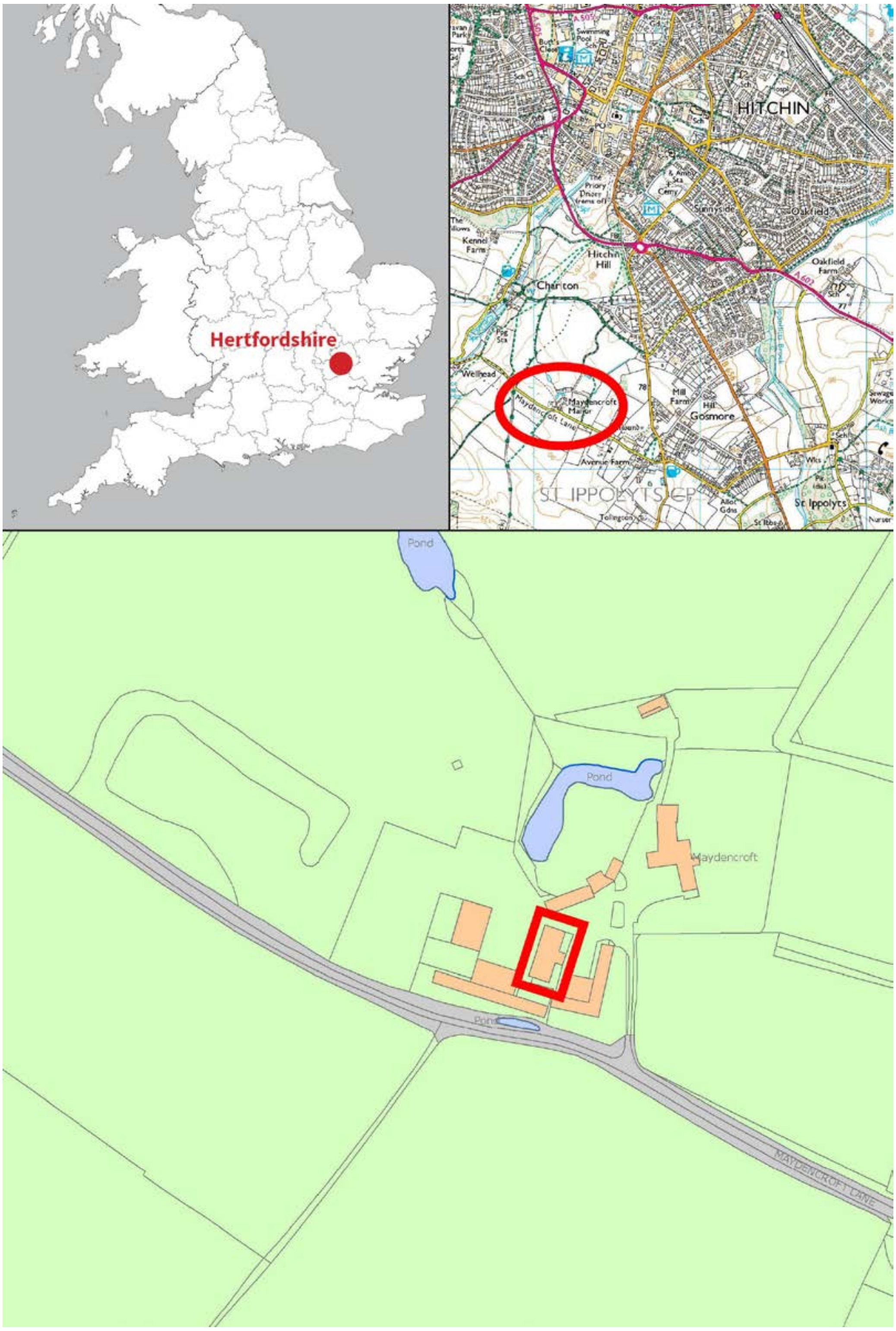


Figure 2: Maps to show the location of Manor Farm Barn, "Bunyan's Barn", St Ippolyts, Hertfordshire, marked in red. Scale: top right 1:30000; bottom 1:2000. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England

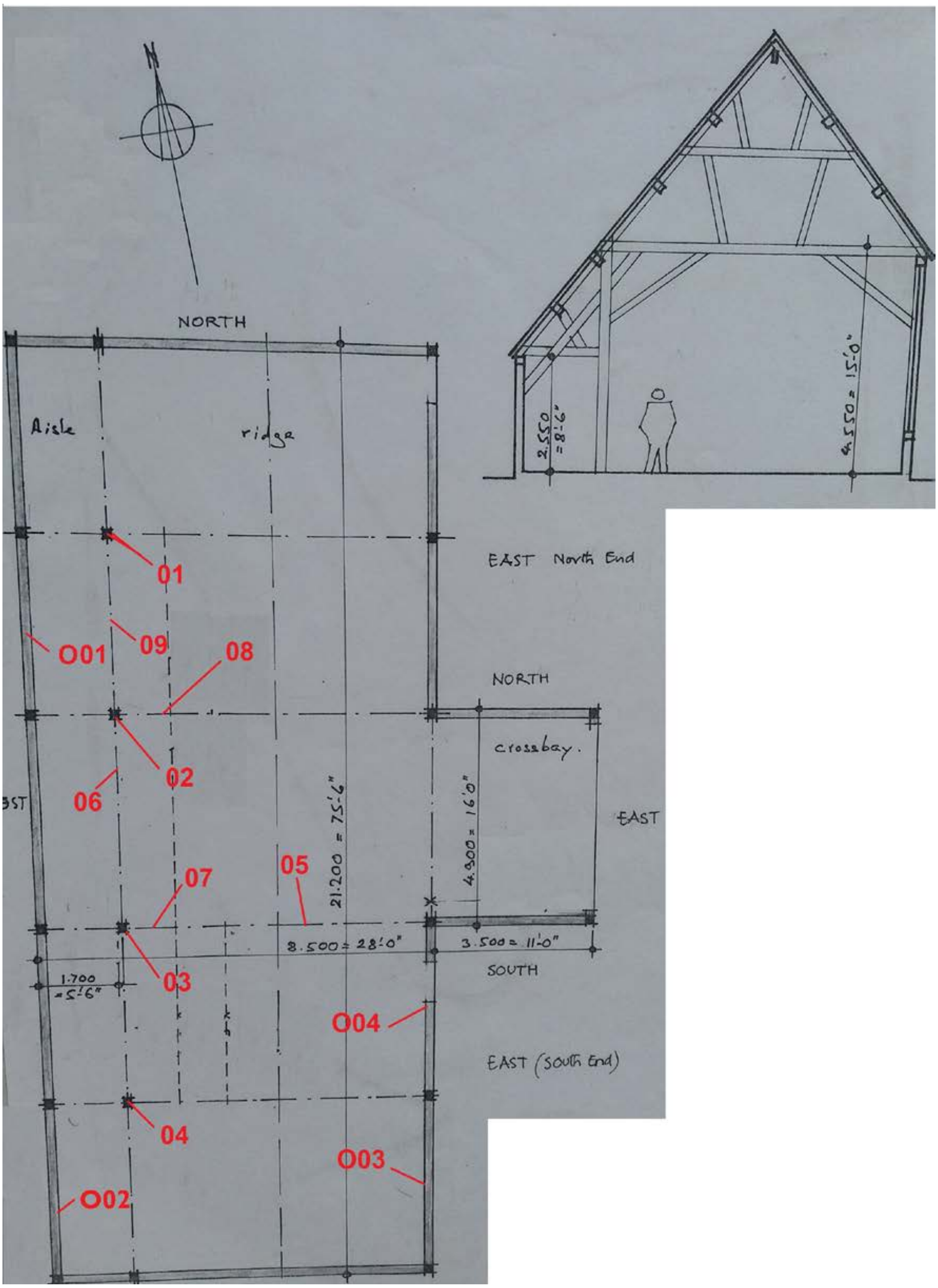


Figure 3: Plan and section of 'Bunyan's Barn', showing the locations of the samples taken for dendrochronology (after Priestman Bennett Partners 1987)

Figure 4: Interior of barn, looking approximately south-west, showing approximate positions of most of the samples taken (photograph: Martin Bridge)

Figure 5: Interior of the barn showing the south-east corner with the location of sample bunyO03, from the intermediate storey post in the southern bay (photograph: Martin Bridge)

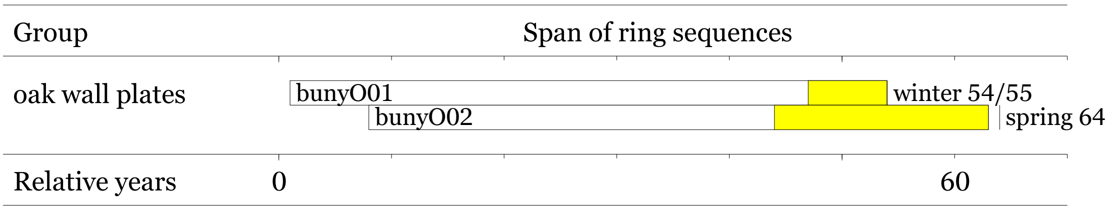


Figure 6: Bar diagram showing the relative positions of overlap of the two matched oak samples and the relative felling dates. White bars represent heartwood rings, yellow bars represent sapwood rings

APPENDIX

Ring width values (0.01mm) for the sequences measured

Elm

buny01

165	250	214	163	300	315	378	358	230	447
372	317	318	353	541	507	436	347	223	268
375	360	257	292	245	306	256	333	350	377
377									

buny02

299	205	284	517	649	751	649	797	797	592
499	375	459	431	131	91	233	294	367	484
552	644	280	468	579	396	512	362	401	

buny04

375	210	160	125	116	232	300	305	240	283
245	270	360	370	399	239	164	382	352	189
221	130	226	251	213	285	345	328	222	179
194	189	233	366	283	401	400	400	587	416
395	357	242	360	468	209	137	136	184	197
226	227	261	152	173	258	344	148	63	69
83	97	108	110	157	173	164	225	211	155

buny05

275	231	156	135	148	86	53	45	37	30
20	42	52	36	54	50	70	149	127	168
391	314	414	421	330	229	407	413	342	194
268	292	196	345	473	358	281	306	318	827
678	384	377	630	809	101	80	86	80	151
165	151	208	172	241					

buny07

255	235	198	201	204	252	307	198	317	374
433	537	494	457	403	375	485	478	365	279
298	235	227	277	327	245	250	348	384	200
234	216	280	184	272	419	477	525		

buny09

480	395	344	333	412	597	529	634	702	706
689	556	338	233	282	386	261	396	116	95
66	80	82	87	72	123	149	154	178	98
79	85	96	72	57	74	74	89		

Oak

bunyO01

212	80	110	96	115	129	167	166	130	441
356	218	305	355	245	247	208	281	385	226
189	208	287	345	321	294	400	351	164	154

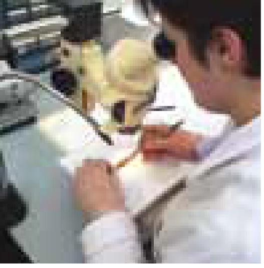
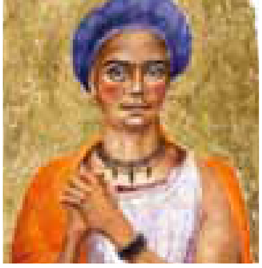
192	228	338	270	413	276	330	202	159	187
150	155	186	144	222	209	189	221	311	151
166	231	173	141						

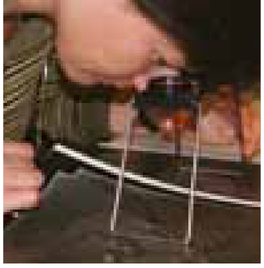
bunyO02

185	179	397	284	245	223	264	233	226	204
203	282	195	172	160	232	391	342	260	278
325	177	198	243	221	210	230	270	275	221
178	198	168	138	183	156	137	147	143	153
143	120	103	115	116	90	98	75	66	72
74	84	94	139	120	99				

bunyO03

233	196	248	242	234	254	360	216	183	231
294	314	332	260	193	230	156	142	226	192
230	264	348	232	280	236	186	217	183	197
188	102	175	271	223	196	140	93	141	91
89	105	82	148	72	86				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