Ancient Monuments Laboratory
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TREE-RING ANALYSIS OF TIMBERS FROM HURSTWOOD GREAT BARN, LANCASHIRE

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Summary

The aisled barn known as the Great Barn at Hurstwood, is a grade II* listed building and a building-at-risk. Although, it has undergone a number of repairs and alterations to its fabric, particularly to the outer faces on its stone walls, it still retains much of its original timber framing. Dendrochronological analysis of oak timbers from these trusses is consistent with primary construction in the period AD 1563-87.

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from Hurstwood Great Barn, near Burnley, Lancashire (NGR SD882314). This is a grade II* listed building which is also on the buildings-at-risk register (English Heritage 1998a). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the building, elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the building. The conclusions may therefore have to be modified in the light of subsequent work.

The primary construction of the building has been dated to the late-sixteenth century (1580-90) on stylistic grounds (Smith 1996), and comprises a double-aisled barn of six bays. The timber framing of the barn appears to remain largely intact (Figs 1-6) and comprises five north-south aligned trusses.

Dendrochronological dating of the primary phase of construction was requested by Jane Harding from English Heritage primarily to provide a precise date for the original barn and hence inform the forthcoming programme of repairs and conversion for this building-at-risk (English Heritage 1998a).

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998b). The methodology used for this building was as follows.

A brief survey identified those oak timbers with the most suitable ring sequences for analysis. Those with more than 50 annual rings and some survival of the original sapwood and bark-edge were sought. The dendrochronological sampling programme attempted to obtain cores from as broad a range of timbers, in terms of structural element types, scantling sizes, and carpentry features, as was possible within the terms of the request.

The most promising timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were left open. The ring sequences in the cores were revealed by sanding.

The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1997a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These and any remaining unmatched ring sequences were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Hillam *et al* 1987). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

All the timbers in the roof, plates, and posts associated with the primary phase of construction are of oak (*Quercus* spp.).

The sapwood frequently disintegrated upon coring, especially at the boundary between the sapwood and heartwood.

A total of 13 timbers were selected as most suitable for sampling (Tables 1 and 2; Figs 1-6). The samples were numbered **01-13** inclusive. The samples can be grouped into five types according to the structural element represented:

All 13 samples were examined in the laboratory and all samples contained sufficient rings for reliable analysis (Table 1). Samples **07** and **10** came from the southern aisle posts of trusses 3 and 4, timbers which, on the basis of morphological features observed during sampling, were considered to derive from the same parent tree. A *t*-value of 9.4 between the measured samples supports this view. Similarly, a *t*-value of 10.8 between the tree-ring curves from samples **01** and **09** suggest that the southern and northern aisle posts of truss 5 were derived from the same parent tree. In each instance, these pairs of tree-ring curves were combined to give mean tree-ring sequences for each parent tree.

The resultant eleven series were initially compared with each other. Four sequences, from five original samples, were found that matched together to form an internally consistent group (Fig 7; Table 3). An 143-year site mean chronology was calculated, named HURSTWOOD (Fig 7; Table 4). The site mean was then compared with dated reference chronologies from throughout the British Isles. Table 5 shows the correlation of the mean sequence at the dating position identified for the sequence, AD 1402-1544 inclusive.

The seven unmatched samples were compared with dated reference chronologies from throughout the British Isles and northern Europe, without any consistent and reliable matching being obtained. These samples are thus undated.

Interpretation

The 143-year chronology HURSTWOOD is dated AD 1402-1544 inclusive. The five samples that made up this mean retained partial sapwood. In many cases whilst the timbers retained complete sapwood and bark edge, it had not proved possible to sample these intact with the sapwood either disintegrating completely, or becoming detached, with concomitant loss of sapwood rings, usually close to the heartwood sapwood boundary. Where detached sapwood was recovered, the number of rings was noted and has been included in Table 1. Where such samples have dated, inclusion of these detached sapwood rings has refined the indicated felling date ranges for their parent timbers (Fig 7). The dated samples have heartwood/sapwood boundaries dated to AD 1533, AD 1540, AD 1534?, AD 1540?, and AD 1532. The tight clustering of these dates suggest a single phase is represented by these samples. Assuming this to be the case and using the 10-55 sapwood estimate (Hillam *et al* 1987) indicates felling occurred between AD 1550 and AD 1587. This range can be further refined since in two cases large numbers of detached sapwood rings were obtained which could not be reliably included in the measured sequence, but which can be counted and used in the interpretation. Adding these produces a date of the latest obtained ring for sample **02** of AD 1563, whilst for sample **12** the latest ring is AD 1559. These indicate a combined felling date range of AD 1563 to AD 1587 for the primary structural timbers in the barn. Assuming the material was used green, as appears normal practise (Rackham 1980), this would indicate construction of the barn occurred at this time.

The dated samples derive from aisle posts in trusses 1, 3, and 4, an aisle-tie from truss 2, and a lower purlin from bay 6 between truss 5 the eastern gable wall.

Conclusion

The objectives of the sampling programme were restricted to determining the date of the primary phase of construction of the barn at Hurstwood. Samples were taken only from timbers that appeared to have remained in their original location and showed no signs of reuse. Many of the timbers examined retained carpenter's marks consistent with the majority of the timber framing being unmodified by later repair or alteration. Certain structural elements such as king posts could not be sampled due to limited access, whilst others exhibited redundant joints indicative of reuse. In two cases, examination of the timbers during sampling and subsequent analysis indicated that halves of the same parent trees were used for at least some of the aisle posts.

The dendrochronological analysis of timbers from Hurstwood Great Barn indicates the original construction of the aisled barn dates to between AD 1563 and AD 1587. Hence the barn could be contemporary with Hurstwood Hall which has a date stone of AD 1579 (Smith 1996) or pre- or post-date it by approximately a decade.

Acknowledgements

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Figure 1 Roof plan of Hurstwood Great Barn (after Borland pers comm) showing the location of surviving trusses, the truss numbers used in this report, and indicating sample locations

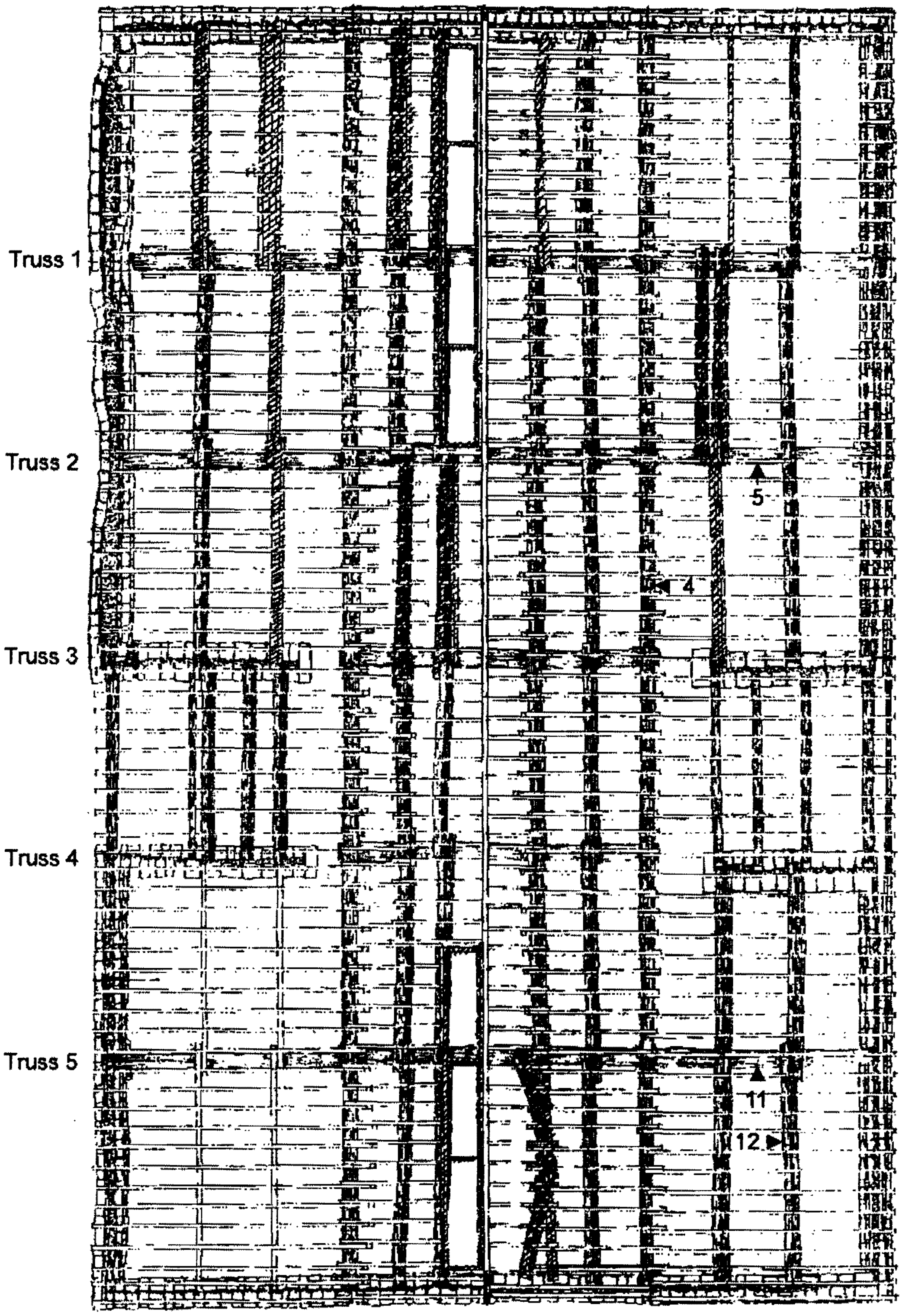

Figure 2 East-facing, elevation of truss 1 indicating sample locations (after Borland pers comm)

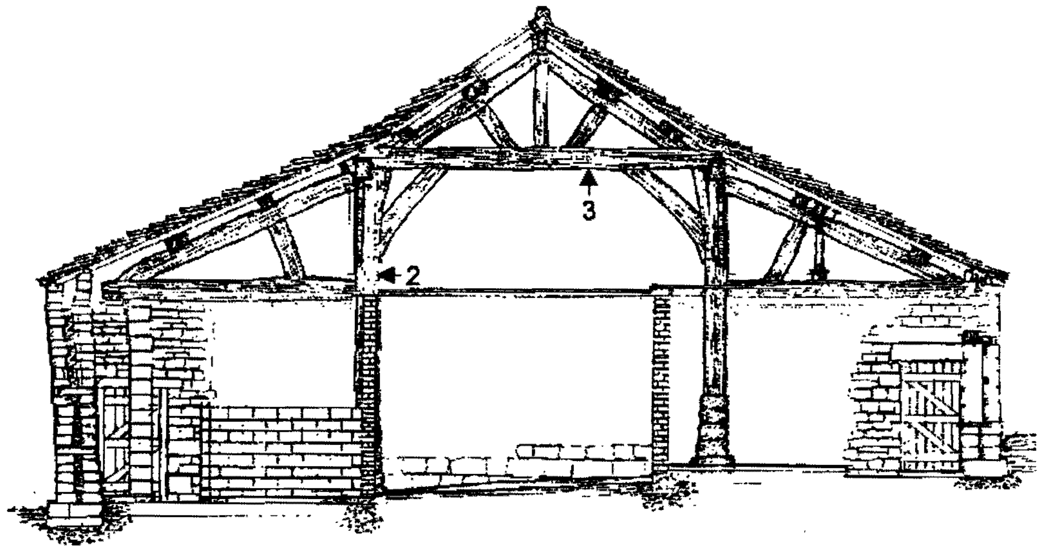

Figure 3 East-facing, elevation of truss 2 indicating sample locations (after Borland pers comm)

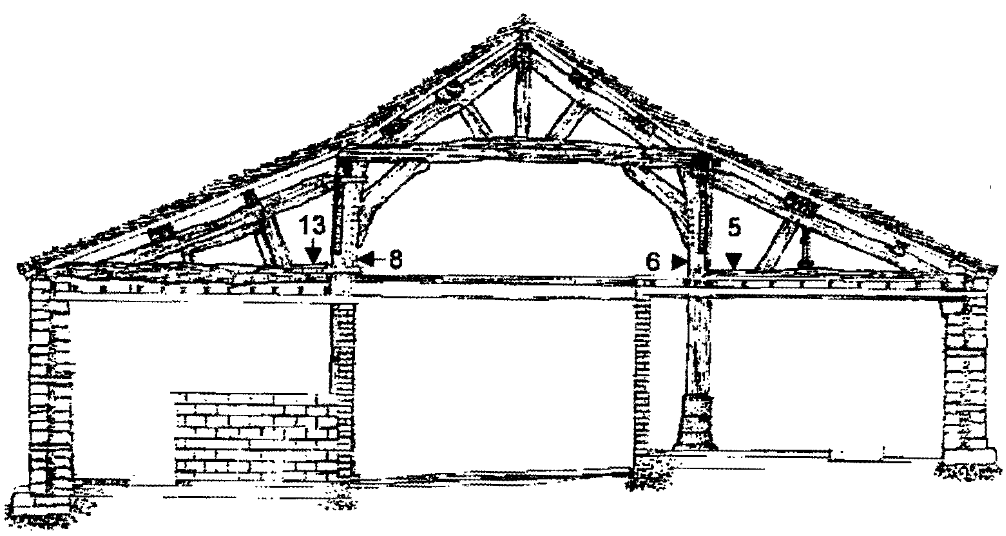

Figure 4 East-facing, elevation of truss 3 indicating sample locations (after Borland pers comm)

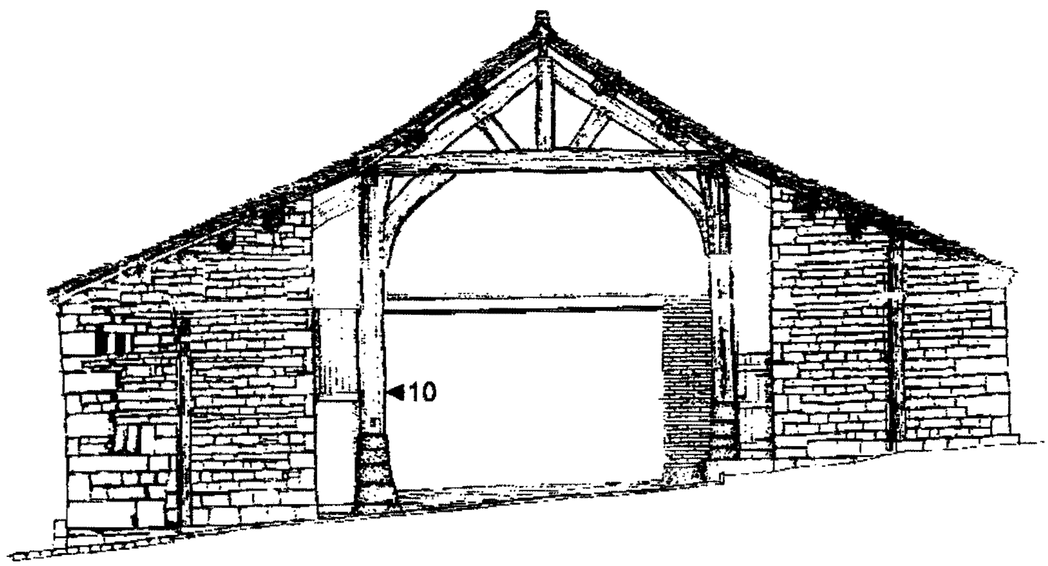

Figure 5 West-facing, elevation of truss 4 indicating sample locations (after Borland pers comm)

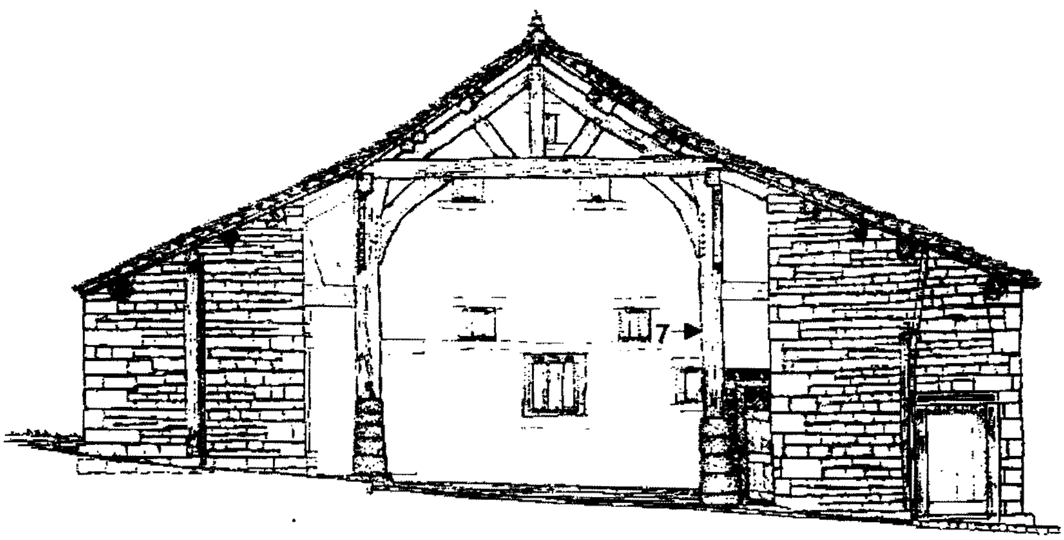

Figure 6 West-facing, elevation of truss 5 indicating sample locations (after Borland pers comm)

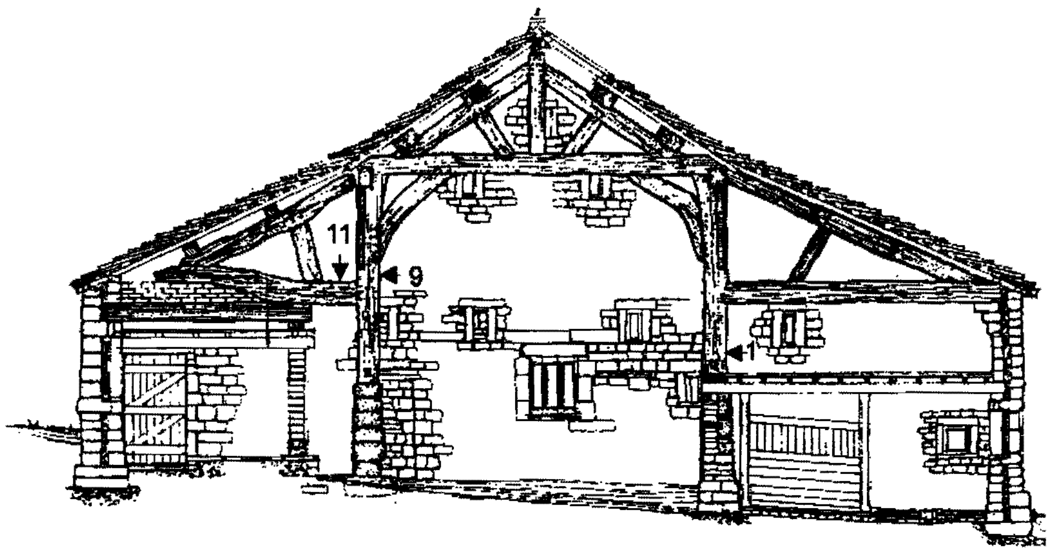

Figure 7. Bar diagram showing the chronological positions of the five dated timbers. The felling period for each sequence is also shown

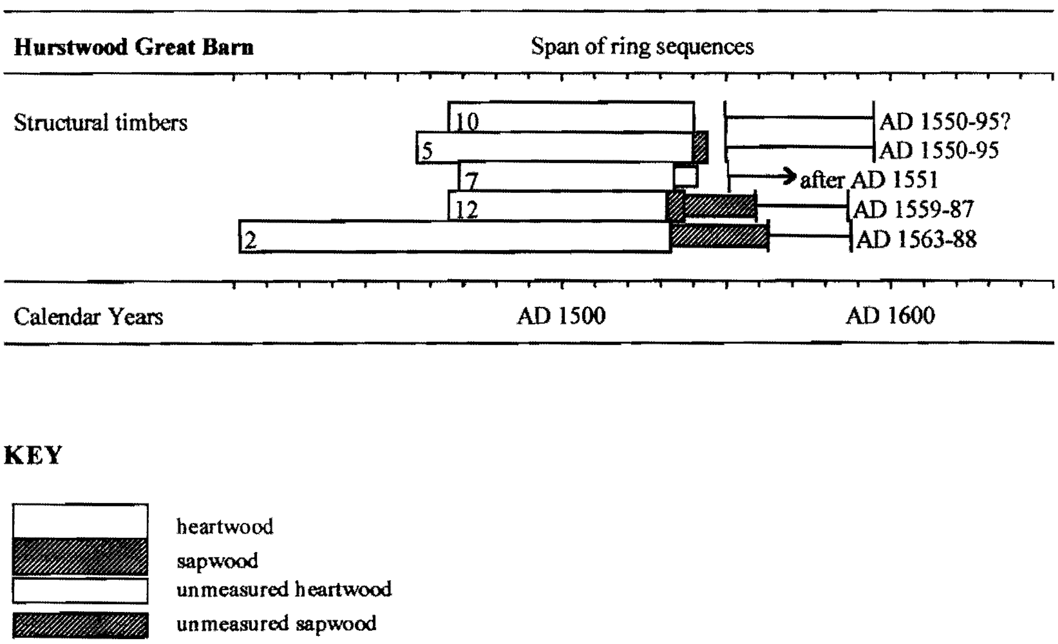

Table 1

List of samples

Core No	Origin of core	Cross-section size (mm)	Cross-section of tree	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	Truss 5: south aisle post	335 x 195	Half	61+24	23 +bs	2.75	undated	
02	Truss 1: south aisle post	330 x 295	Whole	132+30	30+b?	1.07	AD 1402-1533	AD 1563-88
03	Truss 1: tiebeam	385 x 270	Whole	94	6	2.65	undated	
04	Bay 3: north arcade plate	285 x 240	Whole	70+16	3+16+bs	2.02	undated	
05	Truss 2: south aisle tie	270 x 270?	Whole	89	4	1.49	AD 1456-1544	AD 1550-95
06	Truss 2: north aisle post	295 x 285	Whole	120	16	1.17	undated	
07	Truss 4: south aisle post	360 x 185	Half	66	h/s?	2.60	AD 1469-1534	AD 1544-89?
08	Truss 2: south aisle post	260 x 2260	Whole	76	h/s	1.99	undated	
09	Truss 5: north aisle post	345 x 180	Half	71+8	10+7+bs	2.75	undated	
10	Truss 3: south aisle post	380 x 210	Half	75	?h/s	2.21	AD 1466-1540	AD 1550-95?
11	Truss 5: north aisle tie	390 x 160	Half	46+6	6	3.81	undated	
12	Bay 6: lower purlin in north aisle	155 x 125	Whole	72+22	5+22+b	1.59	AD 1466-1537	AD 1559-87
13	Truss 2: south aisle post	280 x 230	Whole	63	18+bw	2.87	undated	

Total rings = all measured rings, +value means additional rings were only counted, the felling period column is calculated using these additional rings.
sapwood rings: h/s heartwood/sapwood boundary, ?h/s possible heartwood/sapwood boundary, +bw = bark-edge winter felled, +bs = unmeasured spring growth also present, +b = bark-edge season indeterminate, +b? = possible bark-edge,
ARW = average ring width of the measured rings

Table 2

Summary showing the structural function of the sampled timbers

Structural element	Sample numbers	Description
Truss tiebeams	**03**	Tiebeam from Truss 1 (Fig 2)
Arcade Plate	**04**	Northern arcade plate in Bay 3 (Fig 1)
Aisle Tie	**05** and **11**	Aisle ties from Trusses 2 and 5 (Figs 1, 3, and 6)
Aisle Posts	**01**, **02**, **06-10**, **13**	Aisle posts from Trusses 1, 2, 3, 4, and 5 (Figs 2-6)
Purlin	**12**	Lower purlin in north aisle, bay 6 (Fig 1)

Table 3

t-value matrix for the timbers forming the chronology HURSTWOOD, - = *t*-value less than 3.0

	5	**7+10**	**12**
2	-	-	3.44
5		5.57	4.17
7+10			6.26

Table 4

Ring-width data from site master HURSTWOOD, dated AD 1402-1544 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1402		155	177	192	205	134	159	146	285	201		1	1	1	1	1	1	1	1	1
	158	169	123	143	144	125	138	102	109	229	1	1	1	1	1	1	1	1	1	1
	173	140	246	176	200	182	182	217	214	165	1	1	1	1	1	1	1	1	1	1
	216	238	179	200	152	152	144	138	124	117	1	1	1	1	1	1	1	1	1	1
	98	79	163	216	148	111	136	118	129	115	1	1	1	1	1	1	1	1	1	1
AD 1451	130	148	135	109	120	141	100	137	101	126	1	1	1	1	1	2	2	2	2	2
	95	98	96	84	106	239	267	244	207	185	2	2	2	2	2	4	4	4	4	4
	137	171	188	252	254	191	198	206	213	188	4	4	4	4	4	4	4	4	4	4
	219	165	161	168	201	184	208	167	154	175	4	4	4	4	4	4	4	4	4	4
	149	117	102	142	155	186	156	155	185	198	4	4	4	4	4	4	4	4	4	4
AD 1501	120	129	130	151	153	182	161	160	184	147	4	4	4	4	4	4	4	4	4	4
	145	161	140	106	98	97	122	137	143	97	4	4	4	4	4	4	4	4	4	4
	121	119	87	113	100	111	107	109	96	82	4	4	4	4	4	4	4	4	4	4
	91	93	90	112	119	109	143	139	186	202	4	4	4	3	3	3	3	2	2	2
	139	179	188	195							1	1	1	1						

Table 5

Dating the mean sequence HURSTWOOD, dated AD 1402-1544 inclusive. *t*-values with independent reference chronologies

Area	Reference chronology	HURSTWOOD
Cheshire	Risley Bridge (Nayling 1998)	4.61
Cheshire	Risley Phase 2 (Nayling 1998)	6.70
Derbyshire	Kent House Ridgeway (Groves and Hillam pers comm)	5.07
East Midlands	East Midlands (Laxton and Litton 1988)	6.11
Gloucestershire	Gloucester Mercer's Hall (Howard *et al* 1996)	6.43
Gtr Manchester	Deardon Fold Farm (Nayling and Tyers forthcoming)	3.28
Gtr Manchester	Peel Hall I (Leggett 1980)	5.45
Gtr Manchester	Peel Hall; II (Leggett 1980	4.80
Gtr Manchester	Stayley Hall (Leggett 1980)	6.98
Lancashire	Clayton Hall (Leggett 1980)	4.95
Lancashire	Lightshaw Hall (Groves forthcoming)	5.49
Shropshire	Langley Gatehouse (Hillam and Groves 1993)	4.19
Staffordshire	Sinai Park (Tyers 1997b)	5.52