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Tree-Ring Analysis of Timbers from the Barn at St Leonard's Grange, Beaulieu, Hampshire

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Summary

The current barn is built within the ruins of an earlier medieval barn, which was thought to have been the largest medieval barn in England. It was thought that the present barn may have been built using materials from the original barn, which was destroyed at the time of the Dissolution. No dendrochronological evidence was found to support this hypothesis. Several repairs and alterations are evident in the present structure. A total of seventeen timbers was sampled from various elements. Two groups of cross-matching timbers were identified, one thought to represent the original construction of the present barn, containing four timbers, with a likely felling date range in the period AD 1557-89, the second group representing a period of repair to the present roof, having a likely felling date range of AD 1734-66, including a single timber retaining complete sapwood, which was felled in spring AD 1739.

Keywords

Dendrochronology
Standing Building

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Introduction

The barn at St Leonard's Grange, Beaulieu (NGR SZ 406 981; Fig 1) is a late medieval barn set within the remains of a much larger medieval barn (Fig 2), thought to have been the largest medieval barn in England (Horn and Born 1965). This larger barn was destroyed in the Dissolution in AD 1538. The existing barn is thought to have been built some time later in the sixteenth century, partly using materials from the original building, including, it is thought, some of the timbers. Several truss forms are to be found today (Fig 3), and it is clear that there have been various alterations through time. The collar to truss 8 (trusses numbered from west to east) was made from softwood, and the purlins to this truss, running from truss 9, had all dropped, and the south principal rafter had split extensively. There were no windbraces present between trusses 9 and 11, and these three trusses were all of king-post construction, with the tie being made from two sections scarfed together.

Dendrochronological dating of the major timbers of the barn was requested to aid the understanding of the constructional development, and significance of the existing structure. The work was commissioned by English Heritage.

Methodology

The site was visited in December 2004 and January 2005. On the first occasion an assessment of the whole roof was made and some samples were taken from more accessible timbers in the loft area at the east end of the barn. With wallplate level about 3.9m above ground level, on the second visit a hydraulic platform was used to gain access to further timbers. Much of the floor area of the barn was covered with stored goods, restricting access with the platform (Fig 3). In the initial assessment, accessible oak timbers with more than 50 rings and traces of sapwood were sought. Those building timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The approximate locations of the samples are shown on the plan in Figure 4, and more details of the sampling sites are given in the subsequent figures (Figs 5–13). The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were prepared for measuring by sanding, using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm 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 (1999). Cross-matching and dating was accomplished 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 to allow visual comparisons to be made between sequences on a light table. This method provides a measure of quality control in identifying any errors in the measurements when the samples cross-match.

Figure 1: Map showing the location of the barn at St Leonard's Grange, Beaulieu.

In comparing one sequence or site sequence against another, *t*-values over 3.5 are considered significant, although in reality it is common to find *t*-values of 4 and 5 which are demonstrably spurious because more than one matching position is indicated. For this reason, it is necessary to obtain some *t*-values of 5, 6, and higher, and for these to be well replicated from different, independent chronologies and with local and regional chronologies well represented, unless the timber is imported. Where two individual sequences match with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they most likely came from the same parent tree.

When cross-matching between samples is found, their ring-width sequences are averaged to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established. This is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the measured rings in each sample. These dates require interpretation for the construction date of the phase under investigation to be determined. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. The sapwood estimates used here are based on those proposed for this area by Miles (1997), in which 95% of oaks contain 9–41 rings. Where complete sapwood or bark is present, the exact date of tree felling may be determined.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Figure 2: View of the south wall of the barn, looking east, showing its position within the remains of a once much larger barn, photograph M Bridge

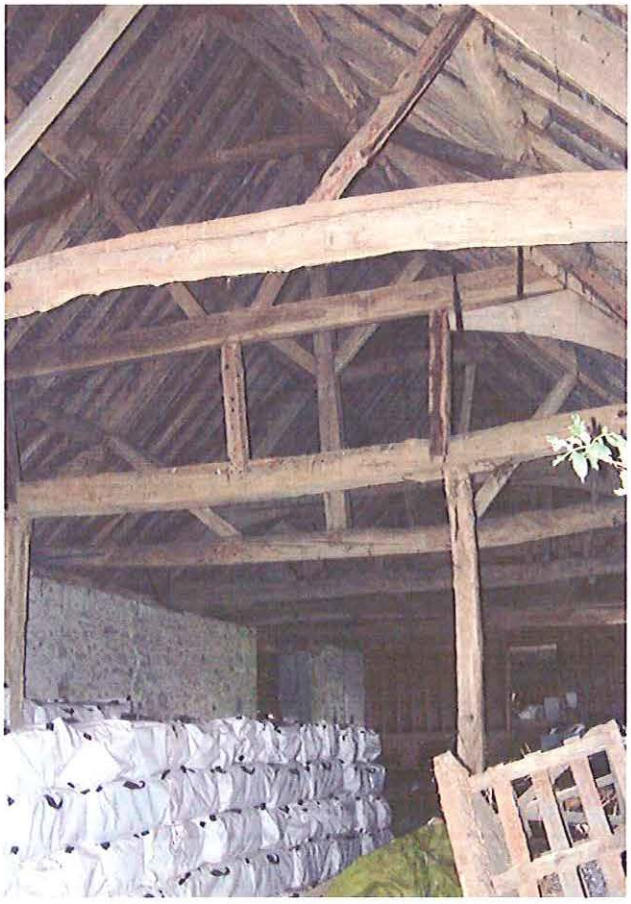

Figure 3: Interior of the barn showing access restrictions and different truss forms, photograph A Grieve

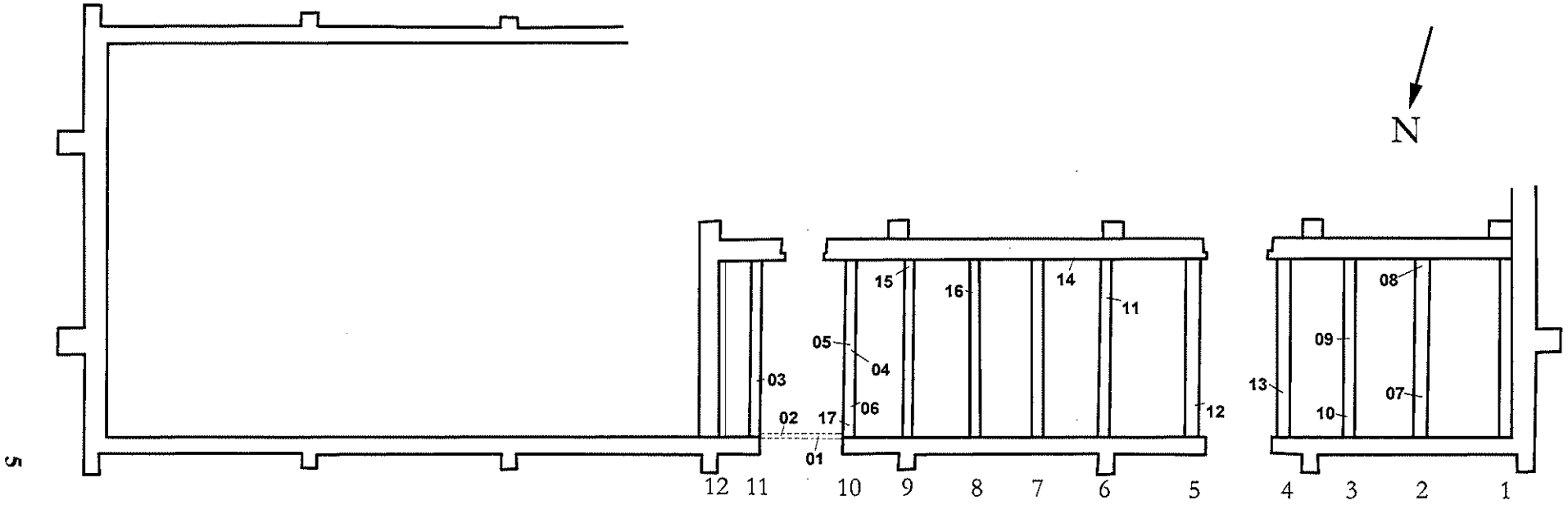

Figure 4: Plan of the barn showing its position within the remains of the original barn, the truss positions numbered from the west end, and the approximate locations of samples taken for dendrochronology

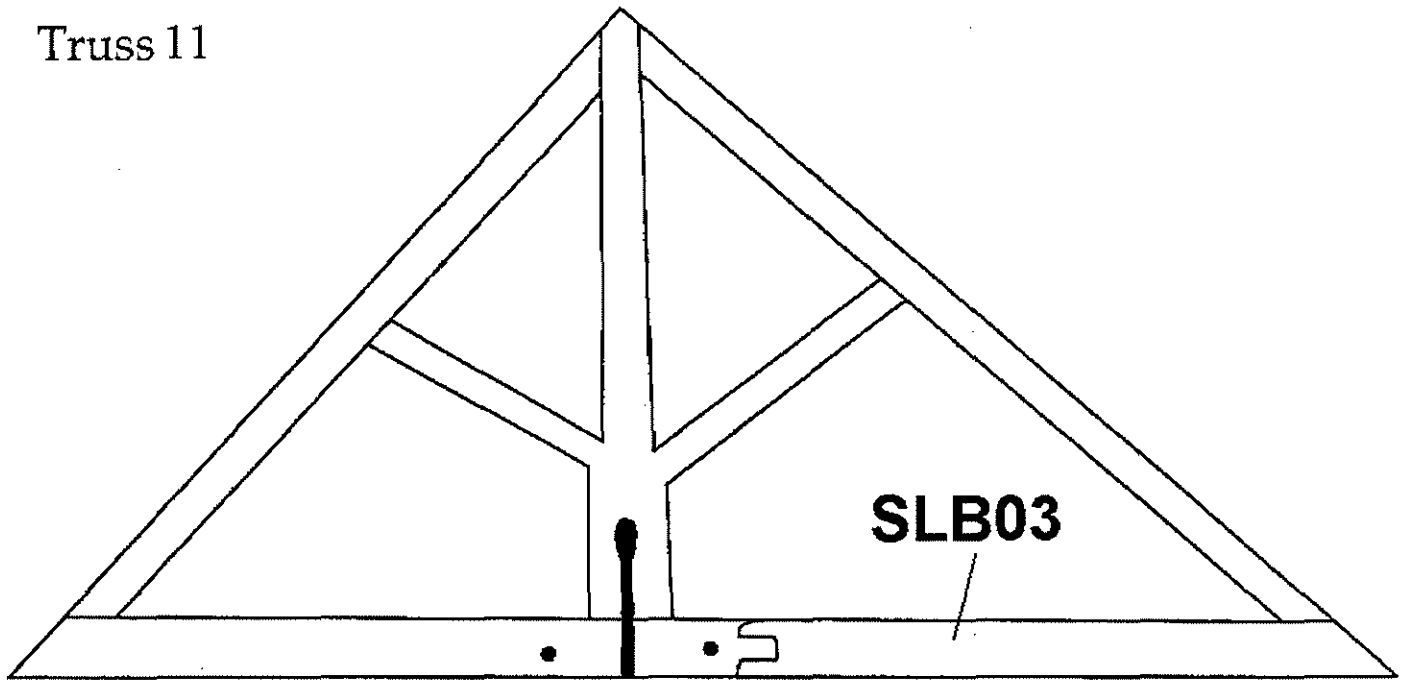

Figure 5: Truss 11, showing the approximate position of the sample taken for dendrochronology

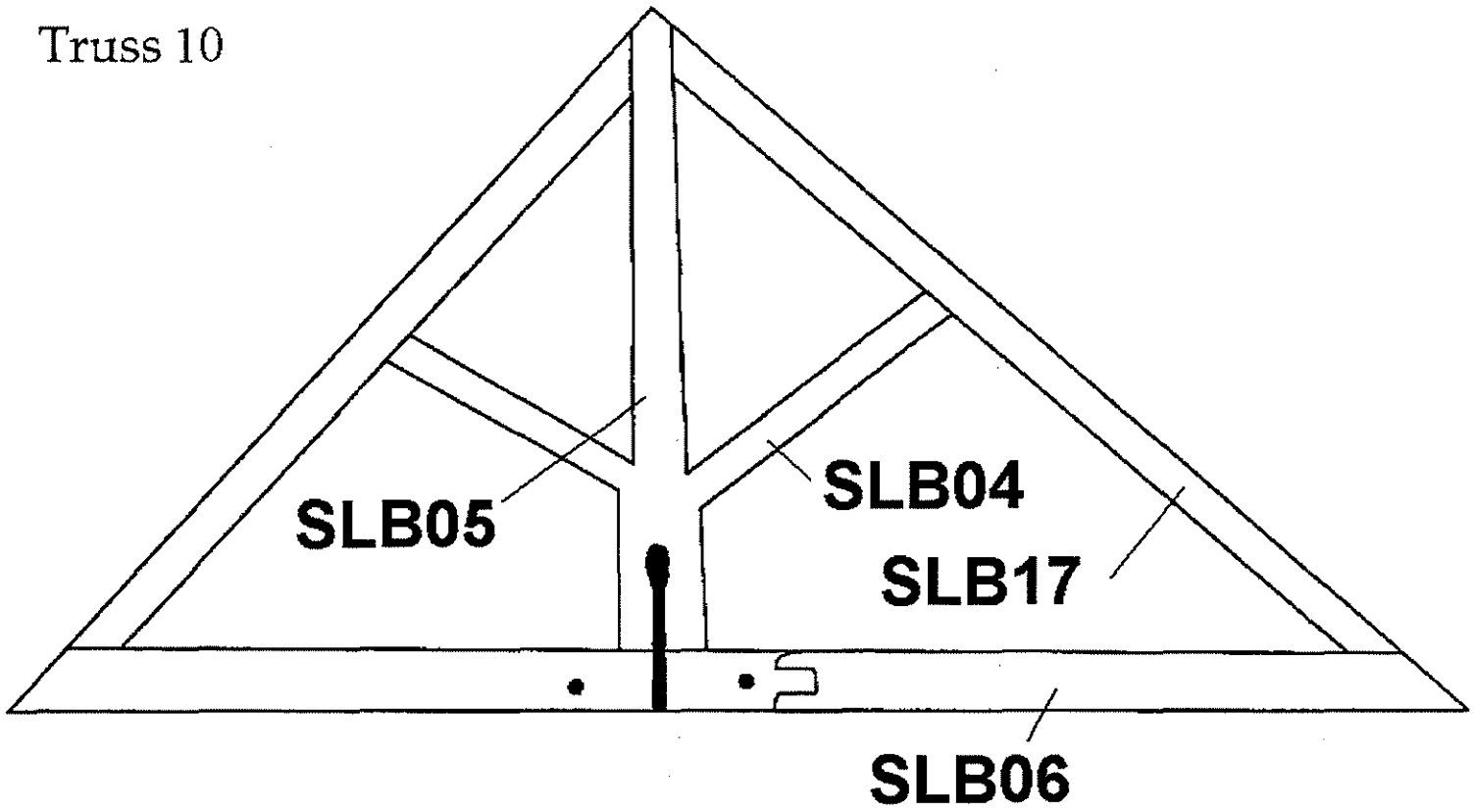

Figure 6: Truss 10, showing the approximate locations of the samples taken for dendrochronology

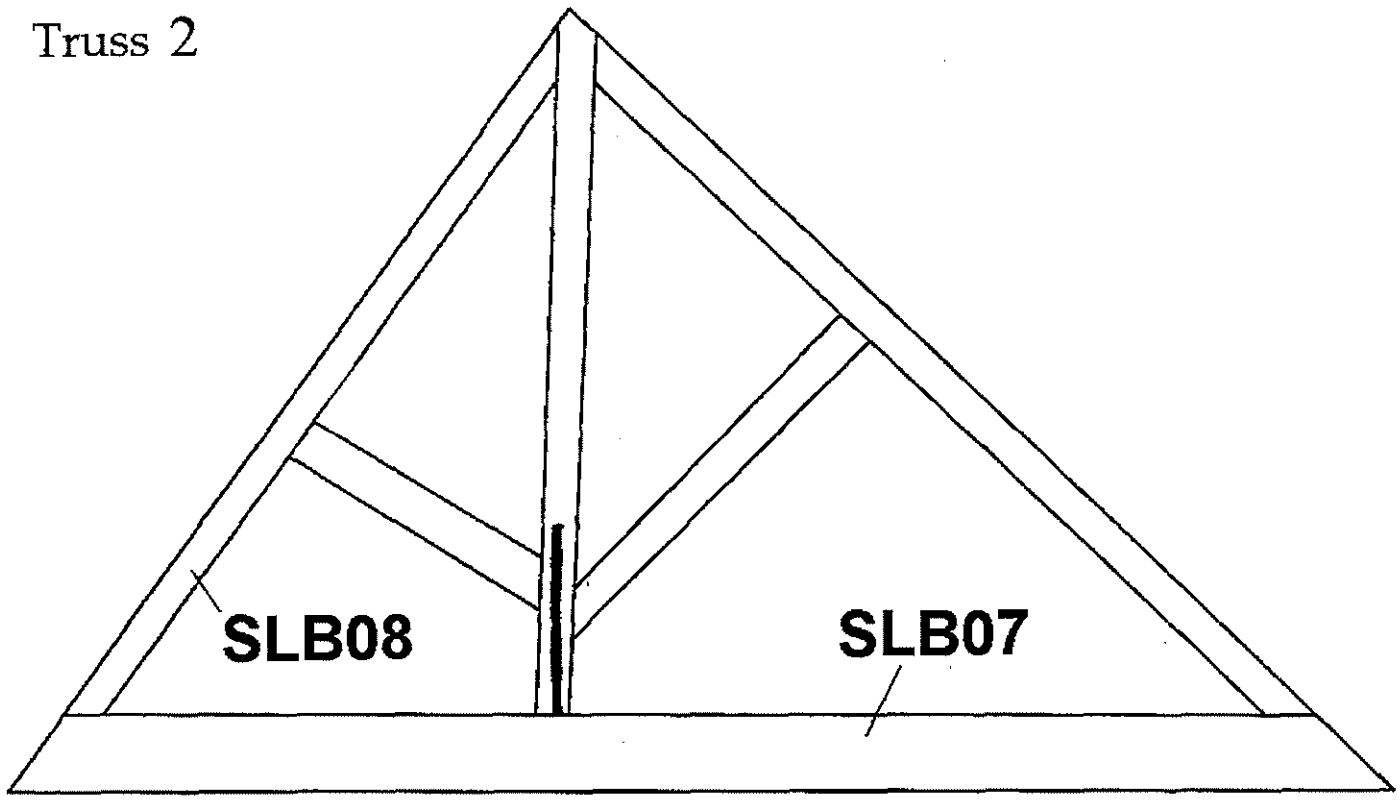

Figure 7: Truss 2, showing the approximate locations of the samples taken for dendrochronology

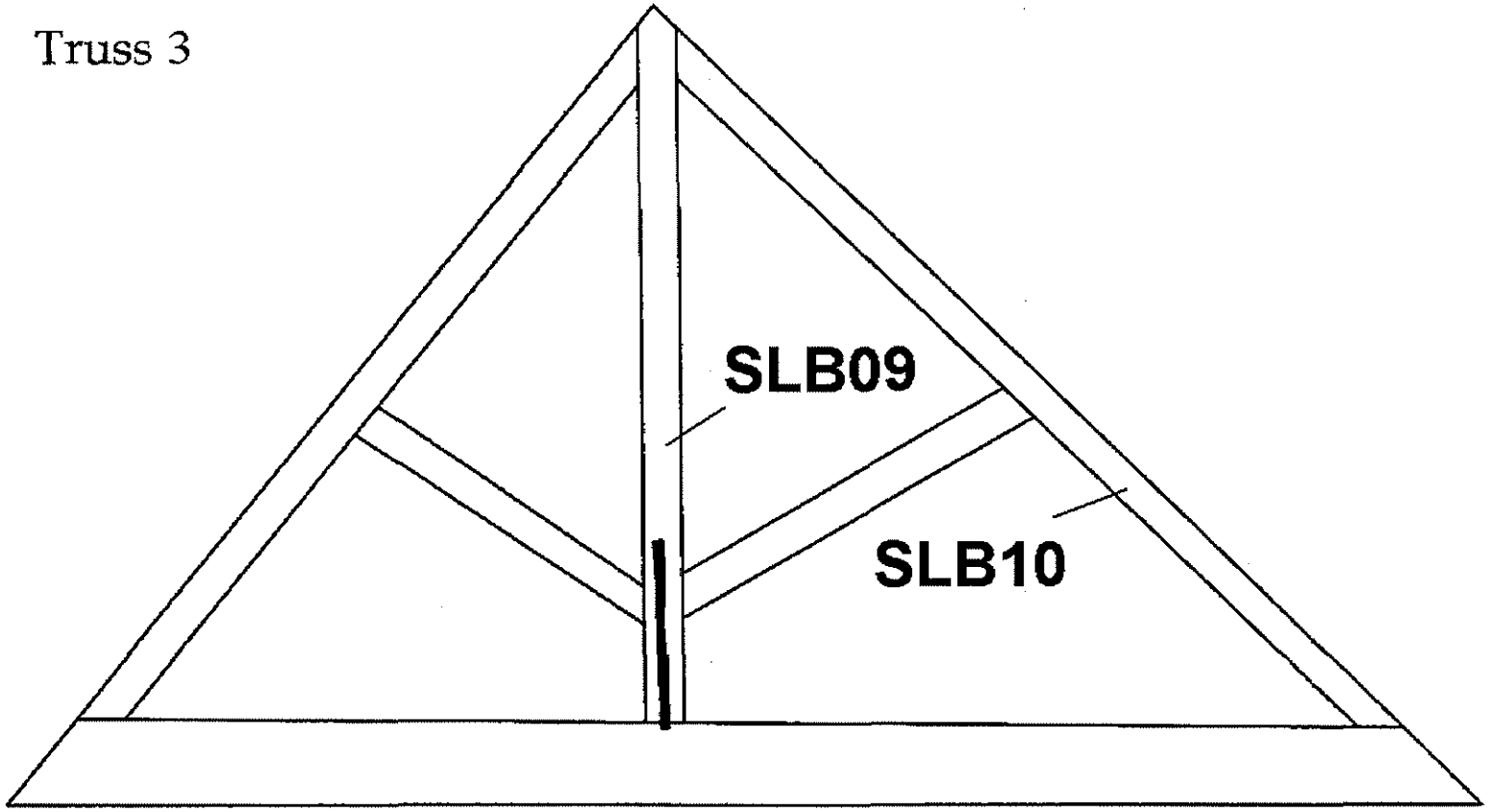

Figure 8: Truss 3, showing the approximate locations of the samples taken for dendrochronology

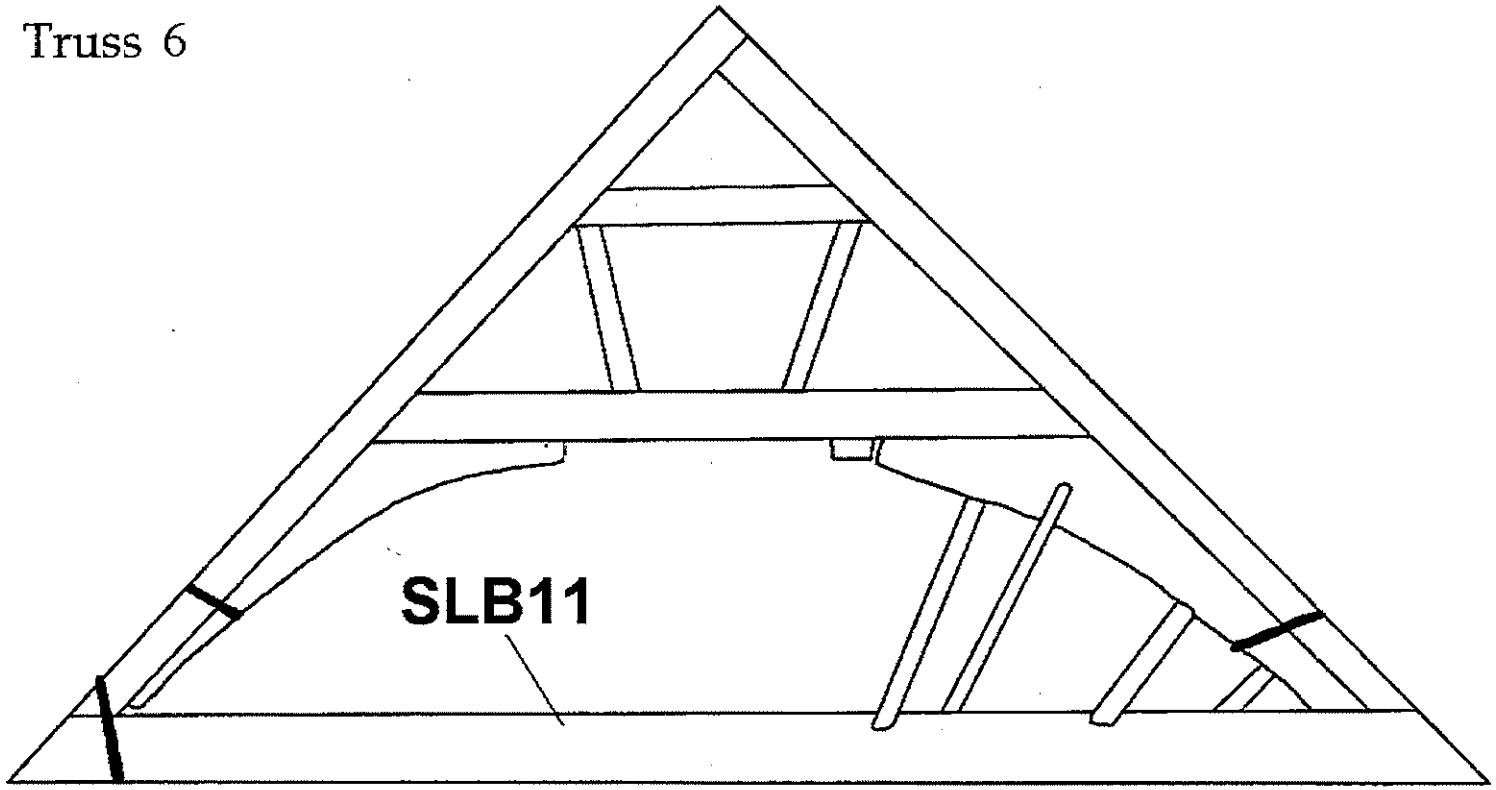

Figure 9: Truss 6, showing the approximate location of the sample taken for dendrochronology

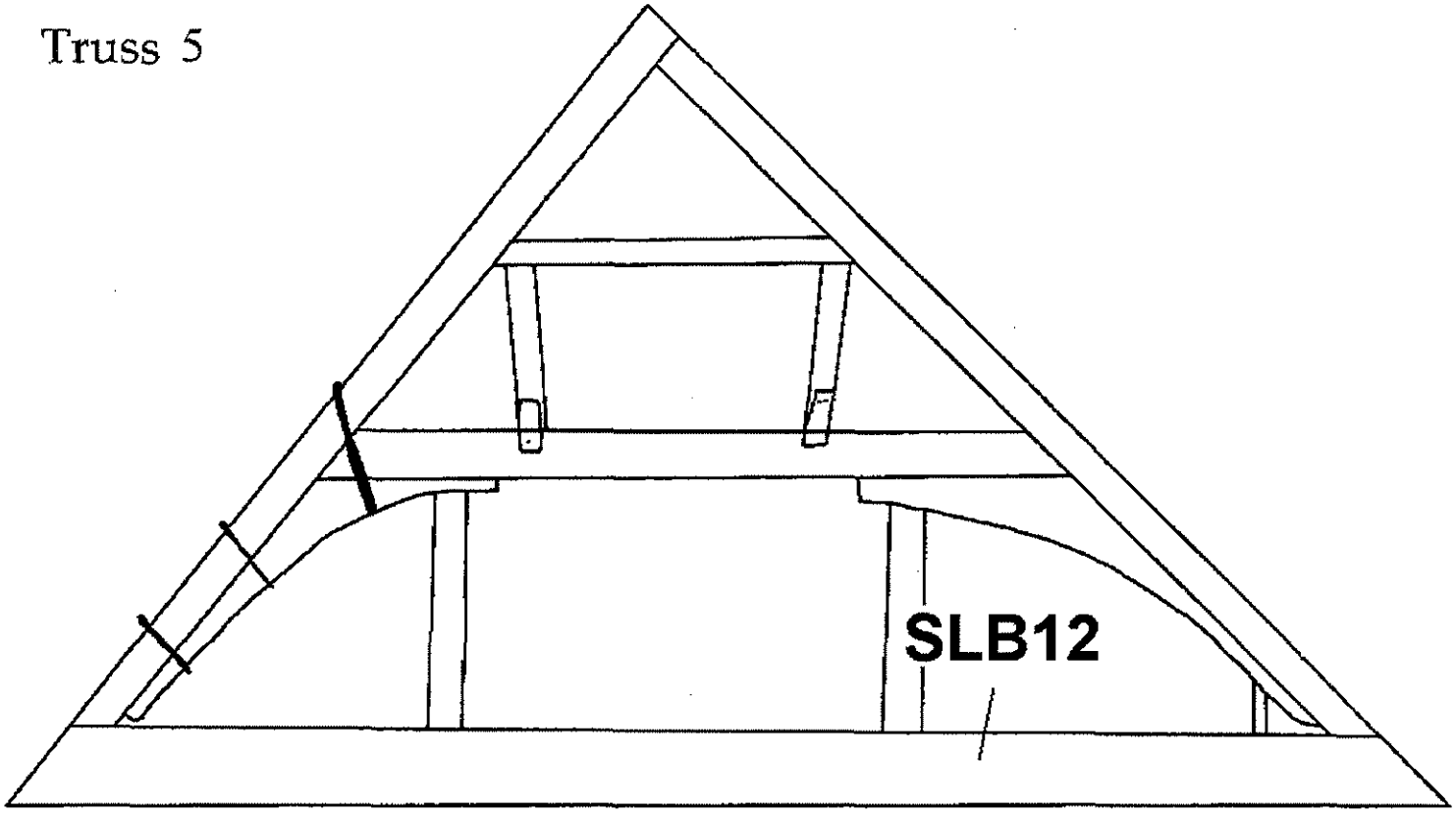

Figure 10: Truss 5, showing the approximate location of the sample taken for dendrochronology

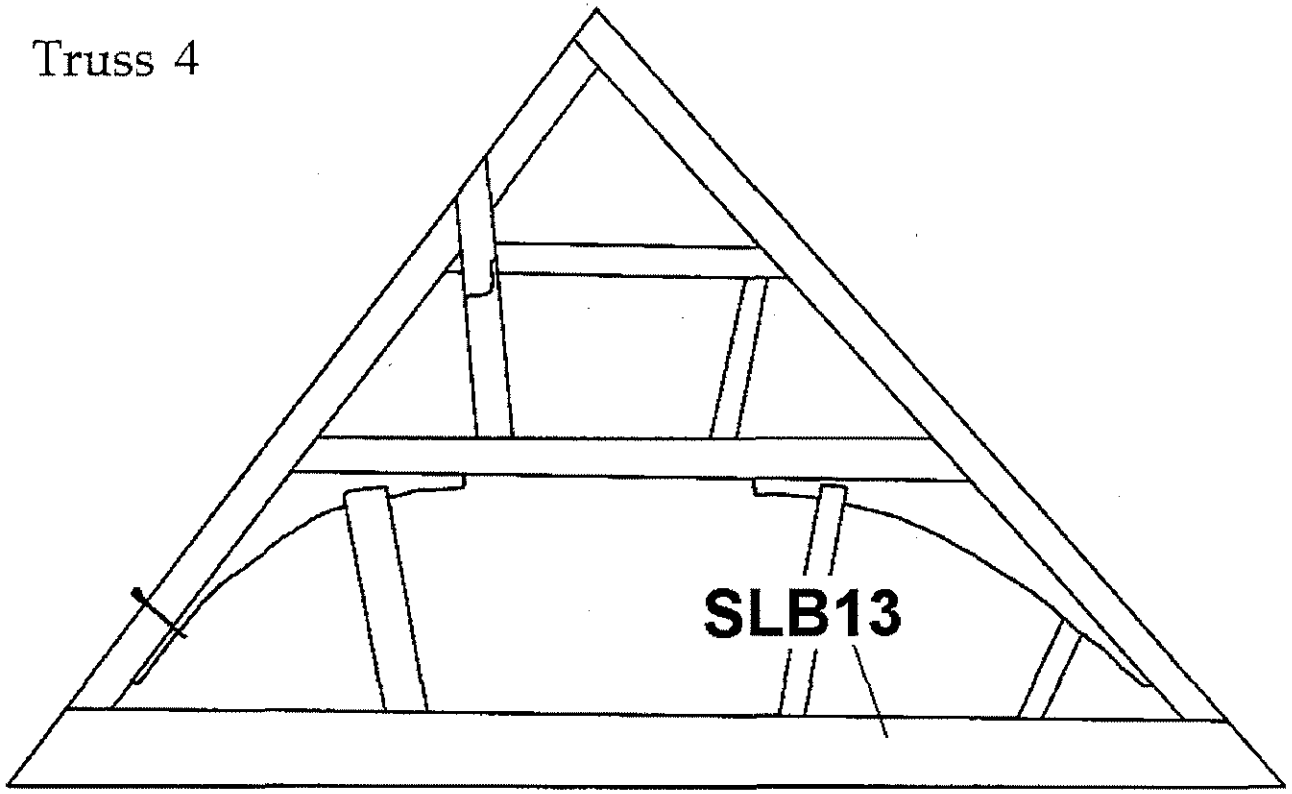

Figure 11: Truss 4, showing the approximate location of the sample taken for dendrochronology

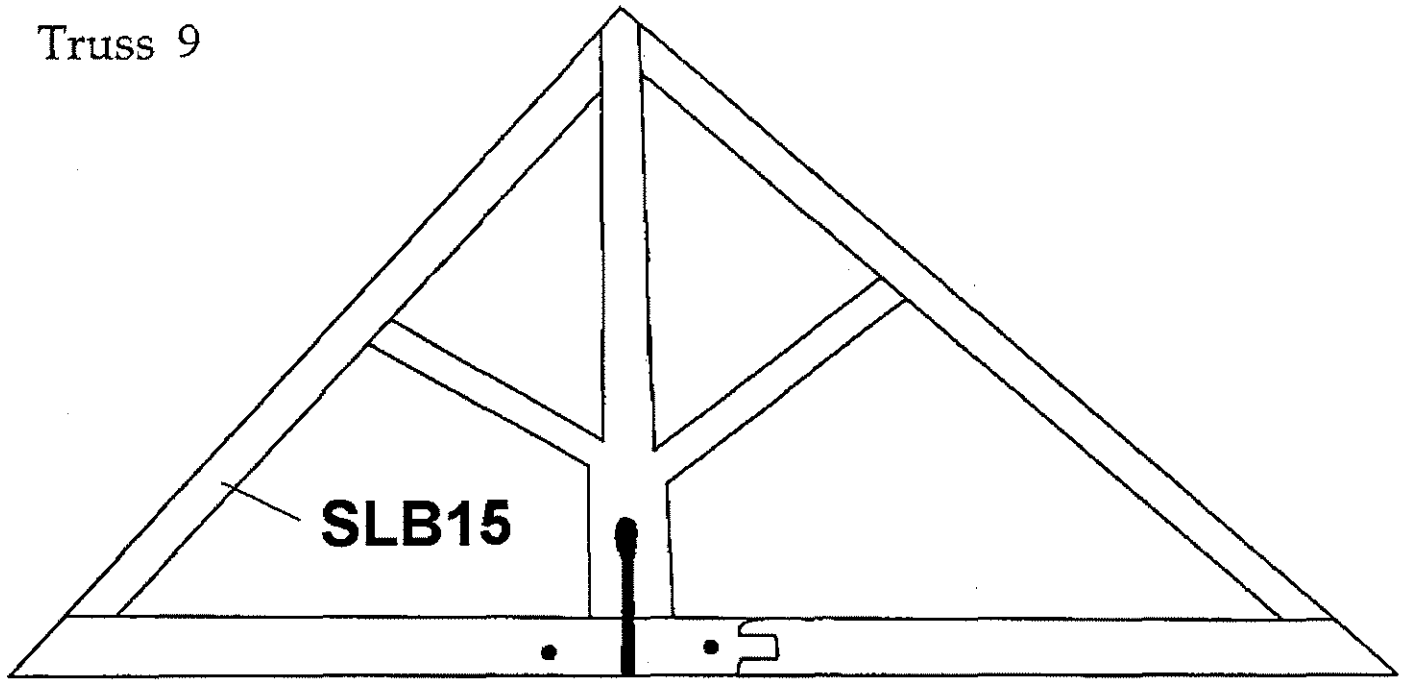

Figure 12: Truss 9, showing the approximate location of the sample taken for dendrochronology

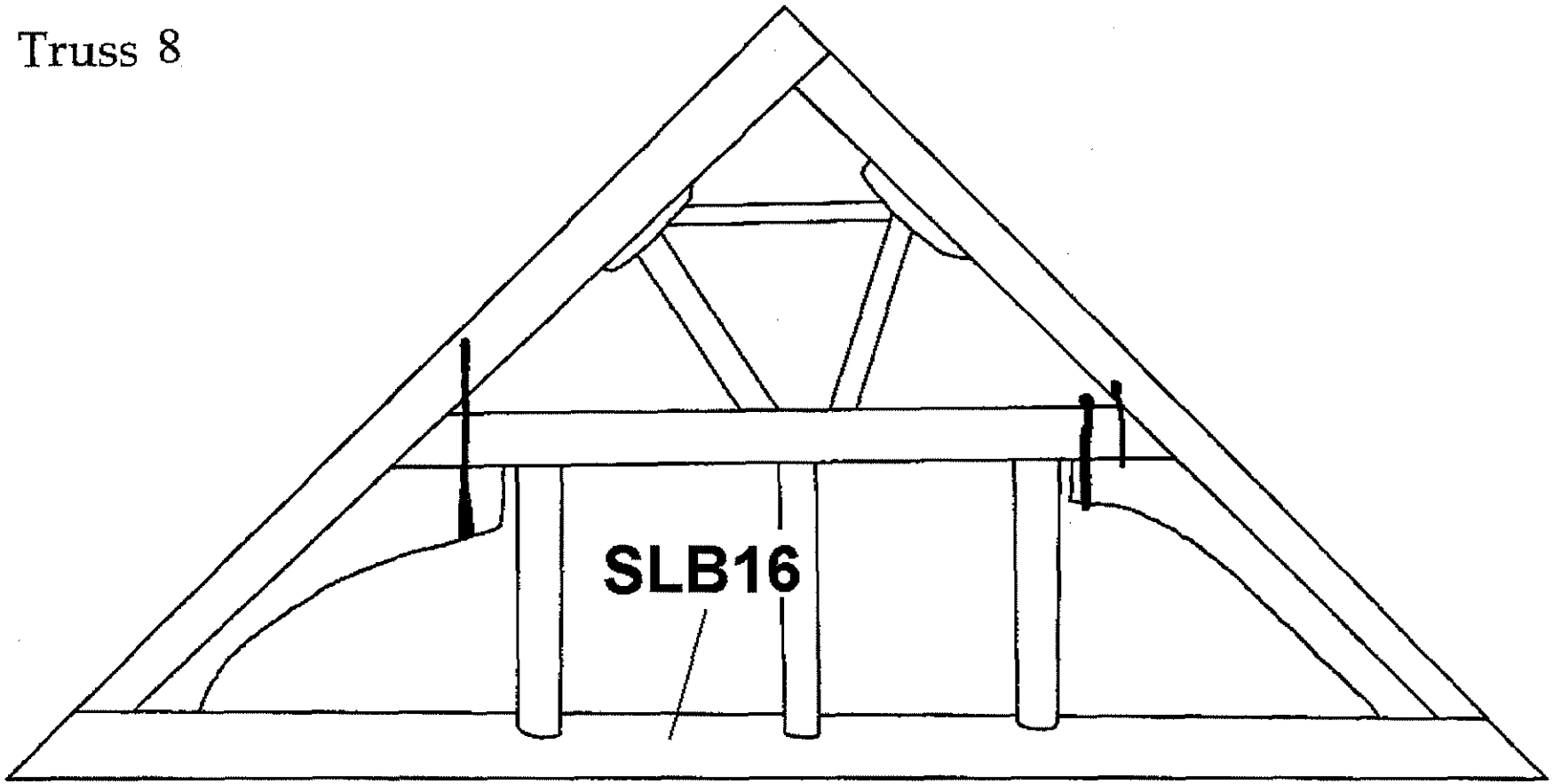

Figure 13: Truss 8, showing the approximate location of the sample taken for dendrochronology

Results

All of the samples taken were of oak (*Quercus* spp.). Details of the samples are given in Table 1, with the trusses being numbered from the west end. Sampling was limited by difficulties of access, with good access at either end of the barn, from the floor and from a hydraulic lift, but limited to tie beams in the middle section of the barn. There was no evidence of re-used timbers except for a door lintel on the south side of the barn. This was not sampled, however.

Cross-matching was found amongst two groups of timbers (Tables 2 and 3) and as a result the series in each group were combined to form two site chronologies, **STLENBL1** and **STLENBL2**. None of the remaining ring series matched these site chronologies or the dated reference chronologies with consistent acceptable matches, and they remain undated. Chronology **STLENBL1** was found to date to the period AD 1433–1550, the best results for this date being given in Table 4, and chronology **STLENBL2** was found to date to the period AD 1639–1738, with the best results supporting this date being given in Table 5. The data for these two series are given in Tables 6 and 7.

The relative positions of overlap of the series forming the two site chronologies are shown, along with information concerning their sapwood complements and interpreted felling dates, in Figure 14.

Table 1: Details of oak (*Quercus* spp.) timbers sampled from the barn at St Leonard's Grange, Beaulieu, Hampshire

Sample Number	Timber and position	No of rings	Mean width (mm)	Mean sens (mm)	Dates AD Spanning	H/S bdry AD	Sapwood complement	Felling seasons and dates/date ranges (AD)
SLB01	Common rafter, bay 10–11	<40	NM	-	-	-	-	unknown
SLB02	Lower north purlin, bay 10–11	51	2.57	0.24	1672–1722	1722	H/S	1731–63
SLB03	Tie 11, east end of barn	54	3.03	0.19	undated	-	H/S	unknown
SLB04	North brace, truss 10	78	1.55	0.19	1661–1738	1727	11½C	Spring 1739
SLB05	King post, truss 10	61	2.10	0.22	1663–1723	1723	H/S	1732–64
SLB06	Tie 10	57	2.58	0.26	1669–1725	1725	H/S (+12NM)	1737–66
SLB07	Tie 2	84 (+6NM)	2.06	0.21	1459–1542	-	-	after 1557
SLB08	South principal rafter, truss 2	42	3.46	0.25	undated	-	H/S	unknown
SLB09	King post, truss 3	<40	NM	-	-	-	-	unknown
SLB10	North principal rafter, truss 3	54	2.20	0.31	undated	-	-	unknown
SLB11a		*84*	*1.26*	*0.19*	*1465–1548*	-	-	
SLB11b		*96*	*1.48*	*0.23*	*1455–1550*	*1550*	*H/S*	
SLB11	Tie 6	96	1.36	0.22	1455–1550	1550	H/S	1559–91
SLB12a		*47*	*0.96*	*0.17*	*undated*	-	*8*	
SLB12b		*68*	*0.97*	*0.23*	*undated*	-	*6 (+12NM)*	
SLB12	Tie 5	70	0.98	0.22	undated	-	8 (+12NM)	unknown
SLB13	Tie 4	69 (+39NM)*	1.44	0.22	1481–1549	1549	H/S	1558–90
SLB14	Wallplate, bay 6-7 south	116	1.50	0.27	undated	-	H/S	unknown
SLB15	South principal rafter, truss 9	68	2.21	0.26	1658–1725	1725	H/S	1734–66
SLB16	Tie 8	111	2.09	0.19	1433–1543	1543	H/S	1552–84
SLB17	North principal rafter, truss 10	96	2.39	0.21	1639–1734	1730	4	1739–71

Key: h/s bdry = heartwood/sapwood boundary - last heartwood ring date; NM = not measured; * = unmeasured rings at the start of the core; mean sens = mean sensitivity; ½C = complete sapwood with partial ring of the next year, summer felled. Sapwood estimate of 9–41 used (Miles 1997)

Table 2: Cross-matching between dated samples forming the site chronology **STLENBL1**

	t - values		
Sample	**SLB11**	**SLB13**	**SLB16**
SLB07	6.2	4.3	4.0
SLB11		7.3	7.4
SLB13			5.1

Table 3: Cross-matching between dated samples forming the site chronology **STLENBL2**

	t - values				
Sample	**SLB04**	**SLB05**	**SLB06**	**SLB15**	**SLB17**
SLB02	7.0	5.7	5.4	5.5	4.2
SLB04		4.5	4.8	5.7	7.1
SLB05			4.4	4.8	3.8
SLB06				4.7	3.8
SLB15					4.1

Table 4: Dating evidence for the site chronology **STLENBL1**, AD 1433–1550
(regional multi-site chronologies have the file name in **bold**)

County or region	*Chronology name*	*Short publication reference*	*File name*	*Spanning (yrs AD)*	*Overlap (yrs)*	*t-value*
Southern England	Southern England Master	(Bridge 1998)	**SENG98**	944–1790	118	8.4
London	London Master Chronology	(Tyers pers comm)	**LONDON**	413–1728	118	8.0
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	118	7.9
Shropshire	Old Hall Farm, All Stretton	(Miles and Haddon-Reece 1996)	OLDHLLFM	1379–1630	118	7.6
Kent	Cowfold	(Tyers 1990)	COWFOLD	1377–1535	103	7.5
Hampshire ‡	Exton Barn	(Miles and Haddon-Reece 1995)	EXTON	1376–1546	114	7.4
Oxfordshire	Greys Court, Rotherfield Greys	(Miles *et al* 2004)	GREYSCT2	1417–1587	118	7.4
Wiltshire	Wilbury House, Newton Tony	(Miles and Worthington 1999)	WILBURY1	1449–1579	102	7.1

‡ component of **HANTS02**

Table 5: Dating evidence for the site chronology **STLENBL2**, AD 1639–1738
(regional multi-site chronologies have the file name in **bold**)

County or region	*Chronology name*	*Short publication reference*	*File name*	*Spanning (yrs AD)*	*Overlap (yrs)*	*t-value*
Kent	Cobham Hall	(Arnold *et al* 2003a)	COBHSQ02	1656–1774	83	7.6
Hampshire ‡	Yew Tree Farm, Chew Stoke	(Miles and Haddon-Reece 1996)	chw11	1666–1772	73	5.8
Derbyshire	Bolsover Castle	(Arnold *et al* 2003b)	BLSBSQ01	1532–1749	100	5.7
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	100	5.4
Oxfordshire Φ	New Farm, Mapledurham	(Miles and Haddon-Reece 1995)	MDM15	1684–1758	55	5.3
Oxfordshire Φ	Oriel College Tennis Court	(Miles and Haddon-Reece 1994)	ORIEL1	1534–1776	100	5.3
Oxfordshire Φ	Park Farm, Mapledurham	(Miles and Haddon-Reece 1995)	MDM13	1650–1722	73	5.2
Oxfordshire	Oxfordshire Master Chronology	(Haddon-Reece *et al* 1993)	**OXON93**	632–1987	100	5.0
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	100	5.0

‡ component of **HANTS02**; Φ component of **OXON93**

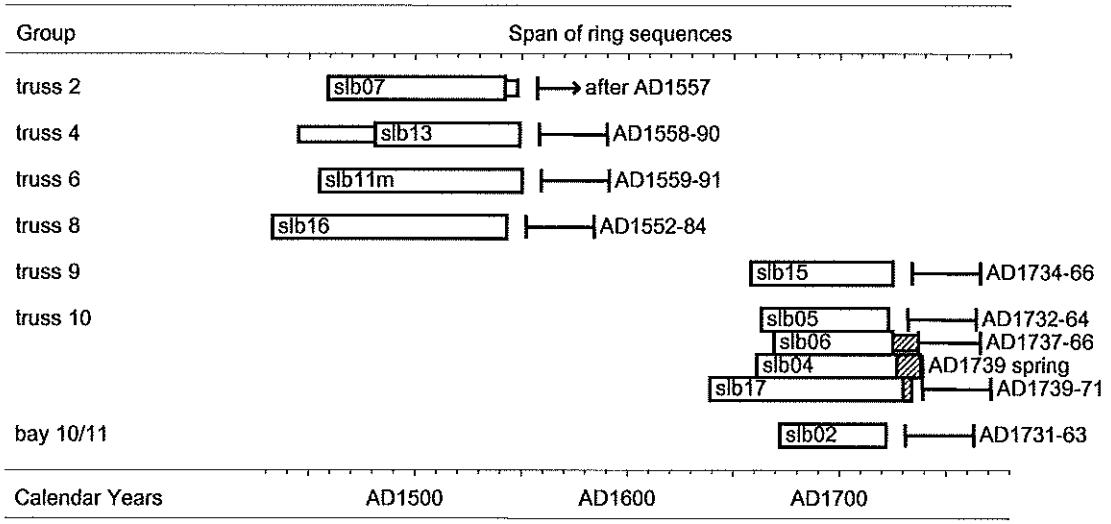

Figure 14: Bar diagram showing the relative positions of overlap of the dated timbers in chronologies **STLENBL1** and **STLENBL2** ordered in relation to their position within the building, along with their interpreted felling dates. Narrow bars represent unmeasured sections of the cores, and hatched areas represent sapwood rings

Interpretation and Discussion

The mean heartwood-sapwood boundary date for the three series with positive dates in site chronology **STLENBL1** is AD 1547. This may be modified to AD 1548 taking into account the additional evidence from sample SLB07, which has a break near the outside of the core. The heartwood/sapwood boundary for this timber cannot predate AD 1549. The most likely felling date range for this group of timbers (all tie beams from trusses 2–8) is therefore AD 1557–89, indicating that the barn was rebuilt about a generation after the Dissolution in AD 1538, using newly-felled timbers. No other elements in this area have been dated. No evidence was found for the re-use of timbers from the original large medieval barn known to have stood on the site, with the possible exception of a door lintel on the south side of the barn, which was not sampled.

The mean heartwood-sapwood boundary date for the timbers in site chronology **STLENBL2** is AD 1725, giving a likely felling date range in the period AD 1734–66. One timber retained complete sapwood and was felled in the spring of AD 1739, and it seems likely that the other timbers in this group, which match each other well, would have been felled in that year, or within one or two years of that date, giving a most likely repair date of AD 1739, or shortly thereafter.

The spatial distribution of the two dated groups is significant. It appears that there must have been some problem towards the eastern end of the barn a couple of centuries after the original build, and that much of the roof around trusses 9–11 was renewed. Should the roof between trusses 1 and 9 become readily accessible above tie beam level, it might be advantageous to sample more extensively to determine the full extent of this repair phase.

Acknowledgements

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Table 6: Ring width data for the site chronology **STLENBL1**, AD 1433–1550

Ring widths (0.01mm)										no of trees									
377	580	563	400	354	323	404	355	445	250	1	1	1	1	1	1	1	1	1	1
459	414	376	308	325	369	353	327	391	264	1	1	1	1	1	1	1	1	1	1
229	268	151	184	142	176	176	199	175	170	1	1	2	2	2	2	3	3	3	3
257	135	193	238	202	164	201	207	163	176	3	3	3	3	3	3	3	3	3	3
161	123	148	139	144	134	198	185	269	206	3	3	3	3	3	3	3	3	4	4
196	224	198	229	256	252	239	247	176	142	4	4	4	4	4	4	4	4	4	4
178	267	208	281	198	132	147	137	150	183	4	4	4	4	4	4	4	4	4	4
176	138	117	140	144	142	181	166	168	181	4	4	4	4	4	4	4	4	4	4
158	147	142	109	138	130	165	89	99	161	4	4	4	4	4	4	4	4	4	4
133	126	113	142	152	172	150	118	137	97	4	4	4	4	4	4	4	4	4	4
113	113	141	133	160	161	167	163	156	90	4	4	4	4	4	4	4	4	4	4
96	78	90	81	104	99	148	177			3	2	2	2	2	2	2	1		

Table 7: Ring width data for the site chronology **STLENBL2**, AD 1639–1738

Ring widths (0.01mm)										no of trees									
445	226	226	269	202	200	256	290	242	195	1	1	1	1	1	1	1	1	1	1
201	191	155	120	188	149	342	420	236	328	1	1	1	1	1	1	1	1	1	2
272	279	235	365	380	239	264	258	278	329	2	2	3	3	4	4	4	4	4	4
248	247	263	219	303	207	252	235	295	360	5	5	5	6	6	6	6	6	6	6
422	356	257	306	205	159	224	276	260	263	6	6	6	6	6	6	6	6	6	6
276	243	252	199	312	338	254	299	241	227	6	6	6	6	6	6	6	6	6	6
185	218	181	173	238	230	159	208	200	222	6	6	6	6	6	6	6	6	6	6
204	113	106	157	140	105	155	186	182	175	6	6	6	6	6	6	6	6	6	6
152	114	133	162	131	156	108	95	112	97	6	6	6	6	5	4	4	2	2	2
119	121	87	77	80	95	46	39	40	43	2	2	2	2	2	2	1	1	1	1