Research Department Report 051-2006

Dendrochronological Analysis of Oak Timbers from Leigh Court Barn, Leigh, Worcestershire

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Summary

A tree-ring dating programme was commissioned on timbers from Leigh Court Barn, Leigh, Worcestershire, by English Heritage in AD 2006. The results, for what is thought to be the largest cruck building in England, identify that timbers in the structure were felled in the spring of AD 1344.

Keywords

Dendrochronology

Standing Building

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from Leigh Court Barn, Leigh, Worcestershire (NGR SO 7835 5351). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. 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.

Leigh is *c* 8km west of Worcester and *c* 12km east of Bromyard (Fig 1). The barn is just to the south of the river Teme, standing adjacent to the church and manor house (Fig 2). In administrative terms the site is in Worcestershire and part of the parish of Leigh. The manor was originally owned by Pershore Abbey. Leigh is according to local usage pronounced 'lie' not 'lee'.

Leigh Court Barn is reputed to be the largest cruck building in England, and may be the world's largest cruck-framed structure. The building was only 'discovered' for modern scholarship in the 1960s by Freddie Charles, who with Walter Horn produced an admirable description of the building (Charles and Horn 1973). Charles and Horn also got Rainer Berger from UCLA to undertake some radiocarbon sampling (Berger 1973), and Veronika Giertz-Siebenlist from Munich to undertake an unsuccessful attempt at dendrochronological analysis (both the earlier dating attempts are further discussed below). The barn was taken into guardianship, and in 1988 English Heritage funded extensive repair work which included underpinning of the plinth, the insertion of strengthening rods into the bottoms of the cruck blades, and the replacement of some of the structural timbers.

The barn is aligned approximately east-west, laying on a level bank to the south of the floodplain of the Teme. The barn has two porches to the south, thought to be original (Fig 3), and two simpler double door entrances opposite these on the north. It has overall dimensions of *c* 42.9m length, *c* 10.7m width, and *c* 11m height. The two porches are of differing width. The western porch is *c* 7.5m wide whilst the eastern porch is *c* 6.8m wide, each is *c* 4.7m long and *c* 7.5m high. The barn had ten bays of the same length, with nine almost identical large cruck trusses (Fig 4), and two end trusses of somewhat different form because of the hipped roof ends. The porches consist of a pair of smaller cruck trusses, each of the same basic design as the main barn trusses. In all cases the cruck blades sit on a low red sandstone plinth varying from *c* 0.5 to *c* 0.9m in height to produce a level platform. The cruck blades, *c* 10.5 to 11m in length, are whole trees, each carefully trimmed with saws and adzes or axes, to create the illusion of similar curvature. The trees are used randomly either their natural way up and upside down. Most show signs of being derived from heavily branched trees and some were clearly cut from strongly forked stems. The wastage in this process must have been immense, unless these trees also produced the curving arch braces and the shorter blades of the porch and end trusses. The trusses are arranged with their upper faces to the west, except for the east wall truss which faces east. Original marking out lines scribed for joints survive throughout the structure, and there are a few visible carpenter's numbers, which use short struck chisel marks rather than scribed lines. Several of these are only visible where joints have opened, so it appears likely that the carpenter's marks were originally in locations not visible from the ground. The careful trimming of the lower parts of the cruck blades and the selection of symmetrical halved curving arch braces to the collars creates the effect of a single arch the length of the barn. Above the collars there is less symmetry with the saddles at varying heights and the short king-posts from these to the diamond set ridge of varying lengths. The two rows of purlins, the wall plates, and the rafters utilise straight whole trees, perhaps from a quite different source than the curving material. There are tabled and bridled scarf joints in the purlins and wall plates at alternate trusses. Halved curving wind braces support both rows of purlins.

The building is a Scheduled Ancient Monument and Grade I listed. Tree-ring analysis of timbers throughout the structure was commissioned by Nick Molyneux, the EH regional Team Leader, to inform future management decisions and aid the interpretation of this important guardianship site. Class 6 Scheduled Monument Consent was granted for the collection of up to 25 samples from the structure.

<u>Methodology</u>

The general methodology used at the Sheffield Dendrochronology Laboratory is described in English Heritage (1998). The methodology used for this building was as follows.

The building was initially visited in March 2006 in the company of Nick Molyneux, and an assessment of the dendrochronological potential of timbers throughout the structure was undertaken. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in any part of the structure. This assessment concluded that the timbers in the building were surprisingly young, considering their size. However, despite this, there appeared to be a great deal of suitable material, principally in the cluck blades, and also in some of the principal rafters and cruck spurs. Most of the smaller elements were considered entirely unsuitable. Access to timbers above the collars was considered impractical because of Health and Safety issues, whilst timbers in the walls were generally unsuitable. The survival of bark-edge and sapwood was extensive.

The timbers were sampled during a subsequent two-day visit, also in March 2006. The timbers selected for analysis 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. In sixteen cases the sampling locations were targeted at surviving bark-edge, the remainder were targeted at the longer lived trees. The sapwood in this building had a curious tendency to laminate under coring more than normal. Depth measurements were taken of the lost sections of the cores to assist with the interpretation of the results. The core holes were filled with oak plugs as requested by the EH regional Team Leader. The ring sequences in the cores were revealed by sanding.

The complete sequences of growth rings in the usable cores were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was 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.

The sequences obtained from the suitable cores were compared with each other and any found to cross-match were combined to form a site master curve. This, 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 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 46 annual rings, where these figures indicate the 95% confidence limits of the range (Tyers 1998a). These figures are applicable to oaks from England and Wales. 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 reuse of timbers, seasoning, 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

Twenty three timbers were selected for sampling from the structure. These samples were numbered **1–23** (Table 1; Figs 3–5). All of these timbers are oak (*Quercus* spp.).

Seven of the samples were found to be unsuitable for analysis, either because of fragmentation or because they contained series of irresolvable bands of narrow rings. The tree-ring series from the remaining 16 timbers were measured and the resultant series were then compared with each other. Nine of the samples were found to match together to form a single group (Table 3). A mean chronology was calculated from these at their synchronised positions. This chronology and the unmatched series were then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well-correlated position was identified for the composite sequence. Table 4 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample of this sequence by this process and their interpretation. Figure 6 shows the chronological position identified for each component sample, with standard interpretations based on maximum and minimum likely sapwood vaules. Appendix 1 lists the individual sample series. The remaining individual series failed to match reference data and remain undated by the analysis reported here.

Interpretation and discussion

The 114-year chronology LCB_T9 is dated AD 1230 to AD 1343 inclusive. It was created from nine of the sampled timbers. Three of these are complete to the original bark surface, each of these has a complete ring for AD 1343, and the initial vessels for the spring growth of AD 1344. The other six each retain either some sapwood, or are complete to the heartwood/sapwood boundary. Adding the minimum and maximum expected number of sapwood rings to the date of the heartwood/sapwood boundary on these samples, and assuming that they are contemporaneous, suggests they were felled between AD 1343 and AD 1369 (Fig 6; Table 1). Calculations based on estimating the number of rings lost in the measured lengths of fragmented sapwood can be applied to four of the dated but incomplete cores (Table 2). These calculations, assuming the material is precisely contemporaneous, supports the conclusion that the entire group was felled AD 1343–45, and hence like the others they were most likely felled in early AD 1344. The dated timbers comprise eight cruck blades and one principal rafter. The material complete to bark edge represents three cruck blades, two from the main trusses of the barn and one from a truss from the eastern porch. Assuming the timbers were felled for immediate usage, which was normal practice in this period (Charles and Charles 1995), then this barn dates from early AD 1344.

No samples were taken from the collars, purlins, rafters, or walling of either the barn or the porches but, given the integrated design, it seems likely that the structure is principally composed of material felled in AD 1344. A 660-year old building will have been repaired, re-roofed and modified a number of times. There are obviously timbers inserted during the 1988 restoration programme, and inspection suggests that timbers associated with the doors and walls include material from a number of dates. For example, all the main trusses have a possibly eighteenth-century metal bracket linking the southern end of the collar with the southern arch brace, and several have a possibly contemporaneous timber inserted below the saddle (examples of both are visible in Fig 3). None of this material was targeted for dating, and most of it is unsuitable for dendrochronological analysis.

The sampled cruck timbers in the Leigh Court Barn are surprisingly short-lived and fast-grown for their size. These are both characteristics which tend to produce highly localised sequences, so it is somewhat surprising how strongly the sequence is cross-matched with other contemporaneous material (Table 4). It is particularly noticeable that the sequence is matching most strongly south and eastwards from the site, perhaps indicating the material is from the floodplains of Worcestershire, rather than the adjacent hills of Herefordshire. The cores exhibited numerous bands of narrow rings, making some samples unmeasurable and presumably adversely affecting the overall success rate. These bands of narrow rings were probably caused by cultural modification, perhaps as the incidental results of timber harvesting activities. These bands are not particularly synchronous within the material, and hence the internal cross-matching is relatively poor. This may imply the cruck blade timbers were sourced over a wide area, or that they were derived from a smaller area but one where only some trees were harvested in most years. It is conceivable that this material was being exploited for winter fodder by shredding.

A *c* 15mm diameter hole following the radius of the tree was observed in the southern cruck blades of both Trusses 2 and 3. These holes are likely to be Veronika Giertz-Siebenlist's core holes from her 1969 attempt to tree-ring date the structure. Charles and Horn (1973, 13) noted that Giertz-Siebenlist considered the material unsuitable for dating, being derived from young and fast grown material, and with patterns that varied greatly between individuals. The new sampling confirms Giertz-Siebenlist's observations but by recovering a much greater number of samples than would have been taken in the 1960s or 1970s an internally strong sequence has been constructed, which has been found to date readily to currently available reference material (it has statistically significant matches to about 200 English site chronologies). If Giertz-Siebenlist had recovered the same number of cores during the first tree-ring dating attempt and the same data series had been measured, it is likely that her attempt would have been successful, either then or shortly afterwards, since the present chronology matches her own German reference chronology (Huber and Giertz-Siebenlist 1969), the relatively local Bredon Barn series (Fletcher and Tapper 1982) and her Great Coxwell Barn series (Siebenlist-Kerner *et al* 1978). On the other hand, it is unlikely to have been successful given that much smaller number of samples were typically recovered from such early projects, and the measurement series taken from them would have been of lower precision. Neither of the two timbers apparently selected for coring earlier have been dated during this analysis. One yielded an unmeasurable core, and the other was not considered appropriate for sampling.

An appendix by Rainer Berger (1973) was published with the Charles and Horn article. This discussed the radiocarbon results from two samples of cruck timbers from Leigh Court Barn. These results are interpreted in the Charles and Horn article (1973, 13) as indicating a date of 'around AD 1325'. The descriptions of the sampling locations in this appendix are not entirely clear and do not tally with obvious signs of interventions on the present trusses. The published information for the second date unfortunately misses off its error term, and quotes as 'in press' a UCLA radiocarbon date list that was never published (Berger 1973, fn 4). It is impossible to recalculate this second date using modern calibration data since it has an unknown error term and it is not possible to now clarify from how far inside the tree the sample was derived. Berger (1973, 29) suggests the radiocarbon results date the barn to the beginning of the fourteenth century. The new dendrochronological date supersedes the earlier radiocarbon date, but confirms that this original work was of high quality. As is usual the issue with the earlier radiocarbon results was not that they were wrong but the tendency to gloss over the date ranges when they are used in discussions. It is possible that one of the two radiocarbon dated timbers (assuming the truss numbering given is the same as Charles and Horns) has been successfully tree-ring dated during this analysis, but unfortunately it is not stated whether this sample (UCLA-1487) is from the north or south blade of Truss 7. The northern blade yielded a dated core, and the southern was not considered appropriate for sampling. The other radiocarbon sample (UCLA-1342) was from the north blade of Truss 2 which was not considered appropriate for sampling.

Acknowledgements

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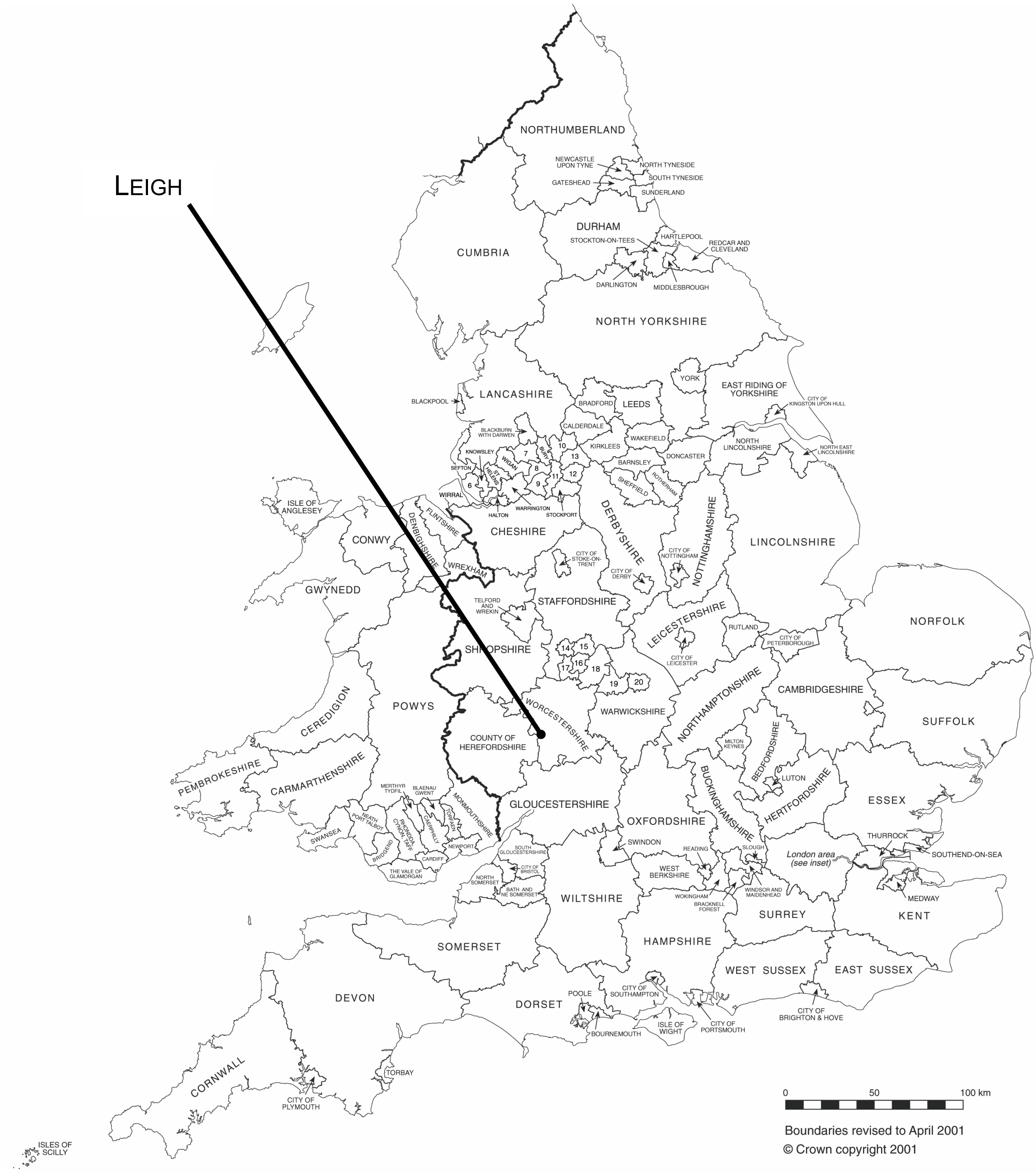

Figure 1 Location of Leigh, Worcestershire, within England and Wales.

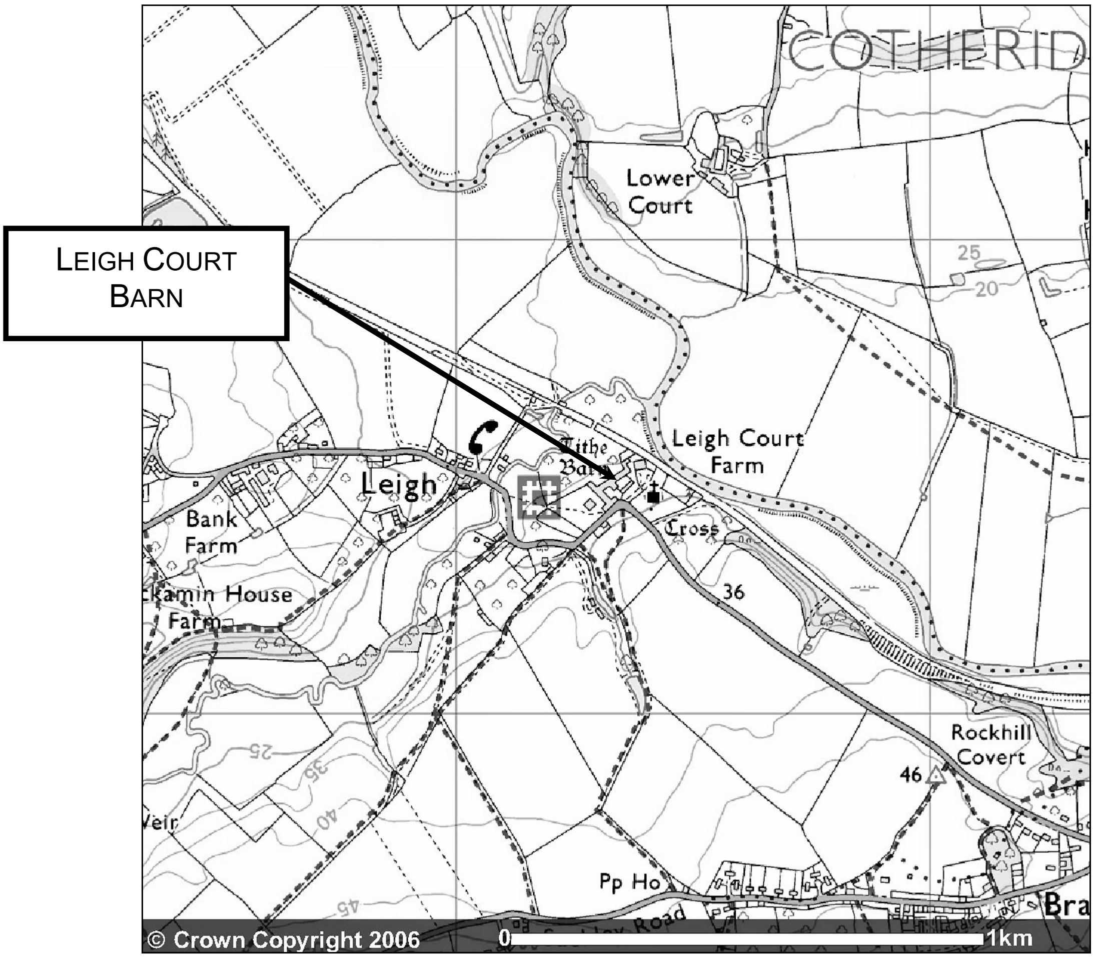

Figure 2 Location of Leigh Court Barn, Leigh, Worcestershire

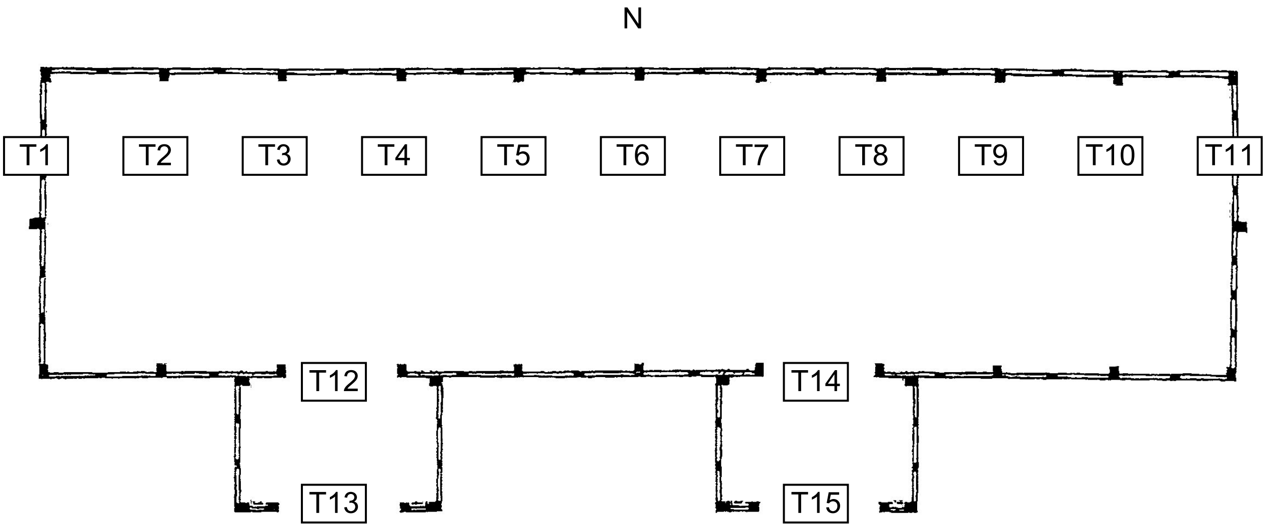

Figure 3 Plan of Leigh Court Barn, Leigh, Worcestershire showing the truss numbering scheme used in this report, which follows that of Charles and Horn, with additional numbers for the trusses in the porches (plan after Charles and Horn 1973, fig 13)

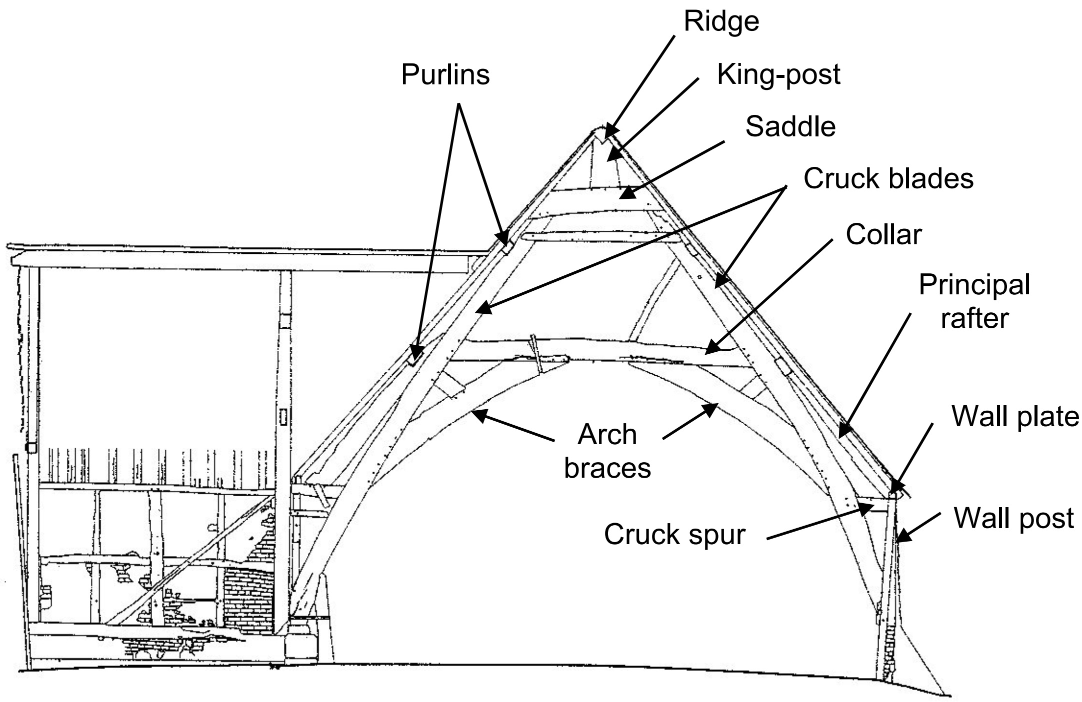

Figure 4 Typical truss from Leigh Court Barn, Leigh, Worcestershire, in this case showing Truss 3 from the main barn in elevation, and T12 and T13 from the western porch in section. Viewed from the lower, east, face of the truss hence hiding the lap joints for the cruck spurs (based on a survey by Plowman Craven and Associates supplied by English Heritage). The nomenclature for structural elements used in this report is given here, scale *c* 1:140

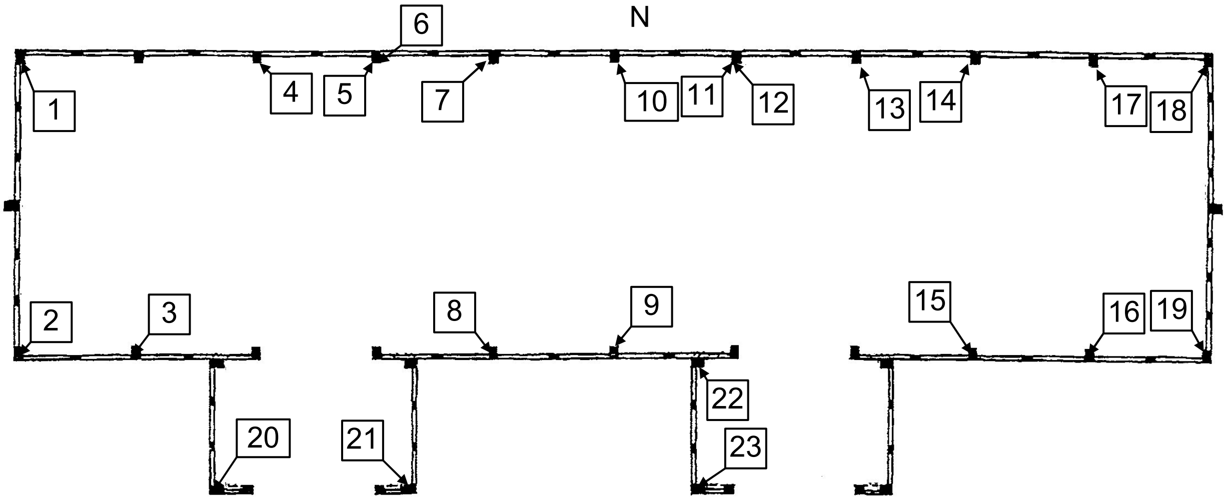

Figure 5 Plan of Leigh Court Barn, Leigh, Worcestershire showing the location and direction of the cores (plan after Charles and Horn 1973, fig 13)

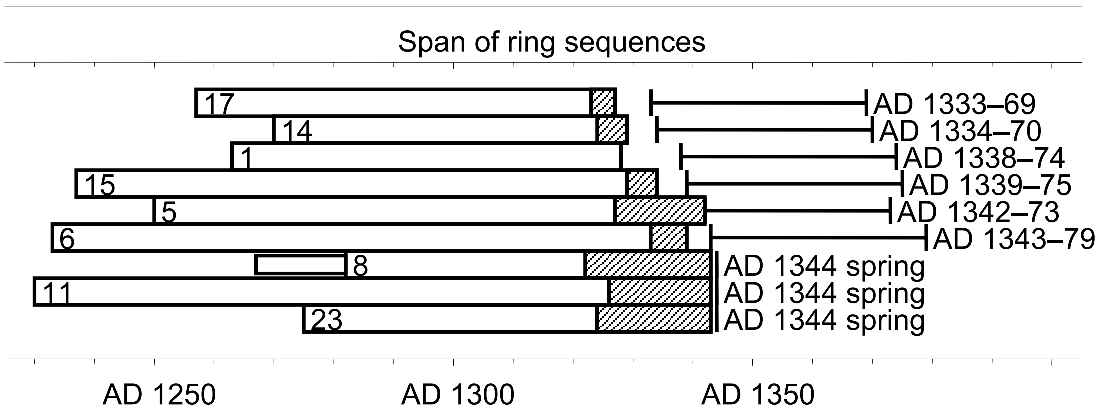

Figure 6 Bar diagram showing the chronological positions of the dated timbers from Leigh Court Barn, Leigh, Worcestershire. White bars represent heartwood, hatched bars represent sapwood, the narrow white bar represents unmeasured heartwood rings. The precise felling date is given for the three complete samples and the estimated felling period for the other six are also shown, based upon maximum and minimum likely sapwood values

<u>Table 1</u> Samples from Leigh Court Barn, Leigh, Worcestershire

Ref	Origin of core	Cross-section size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
1	T1 N cruck blade	400 x 250	66	H/S	2.63	AD 1263–1328	AD 1338–74
2	T1 S cruck blade	390 x 250	-	-	-	unmeasured	-
3	T2 S cruck blade	380 x 330	-	-	-	unmeasured	-
4	T3 N cruck blade	350 x 350	*30*+50	13	1.88	undated	-
5	T4 N principal rafter	330 x 230	93	15	1.95	AD 1250–1342	AD 1342–73
6	T4 N cruck blade	500 x 330	107	6	2.91	AD 1233–1339	AD 1343–79
7	T5 N cruck blade	450 x 340	84	6+*15*	2.56	undated	-
8	T5 S cruck blade	400 x 340	*15*+62	21+Bs	2.25	AD 1282–1343	AD 1344 spring
9	T6 S cruck blade	400 x 350	76	H/S	2.57	undated	-
10	T6 N cruck blade	440 x 370	101	4	2.67	undated	-
11	T7 N cruck blade	450 x 320	114	17+Bs	2.20	AD 1230–1343	AD 1344 spring
12	T7 N principal rafter	330 x 250	64	3	3.26	undated	-
13	T8 N cruck blade	400 x 330	*10*+69	14	1.74	undated	-
14	T9 N cruck blade	420 x 320	60	5	2.24	AD 1270–1329	AD 1334–70
15	T9 S cruck blade	440 x 330	98	5	2.90	AD 1237–1334	AD 1339–75
16	T10 S cruck blade	400 x 330	-	-	-	unmeasured	-
17	T10 N cruck blade	430 x 330	71	4	2.09	AD 1257–1327	AD 1333–69
18	T11 N cruck blade	400 x 300	-	-	-	unmeasured	-
19	T11 S cruck blade	420 x 300	*15*+71	20+Bs	2.03	undated	-
20	T13 W cruck blade	360 x 180	-	-	-	unmeasured	-
21	T13 E cruck blade	400 x 150	-	-	-	unmeasured	-
22	T14 W cruck blade	360 x 290	-	-	-	unmeasured	-
23	T15 W cruck blade	420 x 190	69	19+Bs	2.83	AD 1275–1343	AD 1344 spring

KEY See Figure 3 for truss numbers, Figure 4 for nomenclature and Figure 5 for sampling locations. N = north, S = south, E = east, W = west. Total rings = measured rings, with values in italics indicating additional rings present in the samples that could not be measured. H/S = heartwood/sapwood boundary. Bs = bark edge with start of next year's spring growth. ARW = average ring width of the measured rings. Felling period calculated using 10–46 year sapwood estimate. See table 2 for a different felling date calculation for four of these timbers.

Table 2 Additional calculation of felling date ranges using fragmented core depth and the average growth rate of the last decade of the measured sequence. These results are then rounded to the nearest whole year. This calculation can only be undertaken where dated material was cored from bark edge but this fragmented during coring

Sample	Last ring date	Fragmented core length to bark	Overall growth rate (mm/year)	Last decade growth rate (mm/year)	Calculated missing rings as depth/(1.5 x last decade rate) to depth/(0.5 x last decade rate)	Estimated felling
1	AD 1328	no bark edge				
5	AD 1342	3mm	1.88	1.90	1.1–3.2 rings	AD 1343–5
6	AD 1339	20mm	2.91	3.74	3.6–10.7 rings	AD 1343–50
14	AD 1329	no bark edge				
15	AD 1334	21mm	2.90	3.75	3.9–11.2 rings	AD 1339*–45
17	AD 1327	24mm	2.09	2.31	6.9–20.7 rings	AD 1334–48

* here also allowing 10 rings for minimum sapwood

Table 3

t-value matrix for the timbers forming the Leigh Court Barn chronology, - = *t*-values under 3.0

	5	6	8	11	14	15	17	23
1	4.83	3.11	3.03	4.63	4.92	-	4.53	4.83
5		3.26	4.62	6.31	4.24	3.14	3.98	7.35
6			-	5.50	3.56	8.00	-	7.24
8				-	3.61	-	-	4.73
11					6.17	5.09	4.67	7.79
14						3.48	5.27	5.72
15							-	5.57
17								6.15

Table 4

Dating the Leigh Court Barn mean sequence constructed from the matched samples, AD 1230–1343 inclusive. Example *t*-values with independent reference chronologies

Reference chronology	*t*-value
Berkshire, Reading Waterfront (Groves *et al* 1997)	7.72
Cambridgeshire, Peterborough Cathedral tower (Tyers 2004b)	7.39
Essex, Navestock Church (Tyers 1999)	8.44
Essex, Normans Hall Wakes Colne (Tyers *et al* 2003)	9.28
Essex, St Martins Colchester (Tyers 1998c)	7.34
Gloucestershire, Twyning Bellframe (Tyers 1996)	7.70
Surrey, Wanborough Barn (Tyers 1997)	9.28
Worcestershire, St Cuthberts Wick (Bridge 1981)	7.32
Worcestershire, Warndon Church bellframe (Tyers 1998b)	9.31
Worcestershire, Worcester Commandery (Pilcher 1998)	8.22

Appendix 1 Ring width data for measured samples from Leigh Court Barn, Leigh, Worcestershire, 100 = 1mm

lcb01
66

491	368	348	413	184	209	183	420	122	138
173	230	167	143	225	144	151	386	268	396
352	379	390	393	255	174	278	349	213	325
398	414	379	446	442	251	205	347	457	479
213	242	227	293	256	294	406	451	275	110
52	50	58	126	109	88	132	165	228	217
270	280	164	123	231	194				

lcb04
50

193	158	104	111	147	150	173	187	135	130
158	179	159	147	211	181	221	203	226	233
209	131	172	148	208	214	248	176	222	199
196	210	233	288	187	149	243	189	251	211
195	159	207	206	265	174	130	159	191	210

lcb05
93

148	130	116	163	89	167	146	270	127	207
195	241	175	151	154	166	142	154	147	134
161	184	79	81	157	143	133	322	209	186
247	252	278	375	594	555	451	199	165	215
360	180	305	362	379	277	228	224	125	116
130	132	98	92	94	115	120	126	109	131
167	144	94	148	166	232	213	277	213	245
270	329	303	276	202	137	94	154	118	134
142	118	111	154	154	203	176	109	170	241
209	279	201							

lcb06
107

361	358	400	252	565	407	450	566	461	490
636	583	521	532	626	604	637	507	350	204
83	119	239	182	192	176	173	173	166	213
91	35	50	102	86	169	132	138	224	157
243	242	256	228	236	153	214	290	284	223
178	228	221	316	194	176	326	229	242	334
303	265	217	201	313	198	176	233	261	235
196	245	210	144	227	222	199	218	139	129
237	285	362	326	349	298	303	316	392	428
435	410	273	193	497	331	400	479	300	248
285	426	528	403	348	398	321			

Icb07
84

245	252	294	480	385	322	531	335	318	283
411	301	483	379	412	358	475	582	559	528
594	404	389	348	321	478	436	92	66	74
154	157	228	177	202	160	206	111	48	79
65	111	158	200	133	120	217	200	185	367
313	276	234	284	240	212	191	108	57	70
72	88	118	123	132	150	165	164	136	194
176	227	349	381	323	183	258	244	334	288
360	297	207	96						

Icb08
62

128	118	193	299	301	271	188	233	324	293
426	337	551	298	301	350	204	220	235	254
167	106	139	144	169	212	221	208	195	288
212	252	189	255	219	223	229	217	235	291
304	290	217	179	103	143	208	182	188	176
200	194	168	200	189	130	151	191	209	176
199	253								

Icb09
76

210	227	384	520	584	378	696	361	375	314
550	251	61	55	51	63	90	94	147	177
337	295	291	353	294	376	486	361	643	197
149	112	104	104	155	183	151	141	129	233
276	371	378	191	60	60	58	55	52	105
106	162	117	133	169	283	166	194	278	240
309	419	412	399	434	387	424	347	326	301
339	331	348	196	216	200				

Icb10
101

655	898	677	475	539	448	860	307	492	762
669	474	519	517	472	433	413	382	310	455
305	469	432	188	122	157	169	224	408	312
370	414	379	237	435	435	378	490	183	80
79	103	150	232	183	297	298	119	79	80
171	243	244	274	211	281	244	225	308	332
286	205	178	249	178	186	422	419	358	125
33	52	43	48	64	78	69	69	84	82
101	56	46	53	72	83	88	104	143	169
121	104	195	335	156	104	124	143	136	163
183									

Icb11
114

197	247	201	300	151	150	209	373	379	484
568	372	409	446	349	252	296	318	227	228
228	231	186	267	205	236	141	164	158	162
192	239	247	279	215	241	274	228	338	196
221	321	204	255	226	89	91	133	93	128
229	180	141	101	202	209	256	123	123	137
204	155	183	155	137	110	119	163	117	112
157	250	246	162	145	166	138	155	175	248
250	147	186	169	320	456	418	329	195	240
234	307	228	266	218	179	143	232	174	256
207	163	118	256	300	416	270	161	152	223
168	116	136	147						

Icb12
64

470	378	983	667	543	427	343	547	450	403
399	254	464	329	272	350	418	158	170	303
302	251	267	356	376	503	336	318	417	393
245	103	61	75	82	119	193	153	141	141
244	155	190	195	205	285	313	316	381	364
263	233	401	411	333	427	515	346	311	315
422	399	402	255						

Icb13
69

61	68	92	149	234	199	191	237	207	148
218	269	322	346	249	201	288	346	190	370
363	267	164	132	169	153	163	60	101	128
131	176	163	132	175	194	145	215	205	157
142	133	230	108	214	168	210	119	147	141
154	137	166	141	131	157	151	128	91	91
141	158	139	140	102	105	129	158	163	

Icb14
60

194	294	257	329	282	184	278	272	111	124
205	174	178	140	216	264	272	110	101	81
179	98	142	170	186	177	304	354	237	218
256	299	252	157	210	177	205	211	225	192
269	264	238	181	238	311	284	376	248	440
309	254	347	353	221	188	146	180	152	123

Icb15
98

621	474	521	388	392	397	619	444	414	458
382	399	495	441	258	196	125	130	256	234
304	198	280	165	256	260	123	69	160	184
149	289	206	208	230	171	268	321	226	304
272	239	509	434	359	247	136	346	337	405
356	348	412	415	252	320	429	246	296	233
291	206	249	370	336	242	134	183	131	178
200	219	347	182	145	134	119	210	246	180
191	127	148	189	239	314	310	227	335	180
429	418	481	502	411	334	285	382		

Icb17
71

177	99	339	291	272	214	246	294	269	270
179	140	101	109	86	89	103	114	91	139
297	132	216	365	335	434	263	335	221	274
111	135	143	137	141	223	210	171	168	180
195	166	182	246	256	181	101	162	162	176
182	194	231	243	187	147	198	247	296	291
316	281	272	205	275	270	233	201	238	209
149									

Icb19
71

93	100	74	81	120	107	121	127	93	120
149	106	126	177	128	129	110	159	179	216
207	286	238	235	277	214	286	220	251	191
163	148	226	219	287	308	301	317	278	223
205	229	313	289	287	236	232	265	246	290
291	207	159	152	189	184	191	216	193	170
183	248	251	228	168	223	271	262	233	193
237									

Icb23
69

236	233	281	193	278	309	380	303	245	293
327	427	151	164	198	286	181	291	422	436
279	240	373	270	269	366	325	277	146	257
254	220	223	223	281	275	181	200	222	355
552	484	496	453	566	435	553	458	399	327
302	170	333	342	264	244	152	127	185	238
263	200	135	108	223	185	217	141	95	