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Dendrochronological Analysis of Oak Timbers

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Summary

A tree-ring dating programme was commissioned on timbers from Upper Headley farmhouse, near Thornton, West Yorkshire, by English Heritage in AD 2002. The results identify that one area of the building contains timbers felled in winter AD 1587. No other areas of the farmhouse were found to contain datable timbers.

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 Upper Headley farmhouse, near Thornton, West Yorkshire (NGR SE 0978 3215). 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.

Upper Headley is located *c* 1km to the south of Thornton, *c* 6km west of Bradford, in the Unitary Authority of Bradford, formerly in West Yorkshire, and traditionally in the West Riding of Yorkshire (Figs 1–2). The farmstead was originally built for the Midgley family, and comprises an Elizabethan hall house and a number of farm outbuildings (Fig 3). Two of the barns have been the subject of a previous dendrochronological study. This study (Tyers 2001) identified a date of spring AD 1605 for the east barn, whilst a single sample from the west barn indicated a date of AD 1583 or shortly after. Despite a number of attempts to obtain further access, no further sampling has been possible in the west barn.

The farmhouse is a complicated structure (Fig 4). The main range of the building was originally an aisled single-storeyed timber-framed structure aligned east–west, with a western two-storey timber-framed cross-wing, and possibly an eastern two-storey cross-wing potentially used for textile production. The main range appears to have been modified to a two-storey construction, with a series of subsequent alterations removing the east cross-wing but linking the farmhouse north-eastwards to the east barn, extending southwards with a porch, westwards with an outshot, and north-westwards with another porch. At some stage, possibly predating all these extensions, the timber-framed aisled hall range and west cross-wing were encased in stone. The southern elevation (Fig 5) includes a date of "1589" on the corbels of the west cross-wing, and "1604" on the corbels of the porch. It is now divided into several dwellings for members of the same family. Tree-ring analysis of timbers of the main roof, the west cross-wing, and the north-east wing was requested by Giles Proctor, the local English Heritage Historic Buildings Inspector. At the time of the request this Grade I listed building was on the Buildings at Risk register and undergoing grant-aided repairs.

Methodology

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

The building was initially visited in 2002 in the company of Shaun Richardson and Stephen Haigh, from Ed Dennison Archaeological Services, and an assessment of the dendrochronological potential of timbers in the main roof, the west cross-wing, and the north-east wing was undertaken. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in these parts of the building. This assessment concluded that the timbers in the main roof and west cross-wing areas contained a mixture of faster-grown oak timbers with few annual rings, along with a handful of apparently longer-lived trees used for the king-posts and rafters of the former and the tiebeams of the latter area. The north-east wing did not contain any material suitable for sampling. Most of the elements in all areas were considered unsuitable for sampling because they contained too few rings. On the suitable timbers the survival of sapwood was fairly extensive. The selected timbers in these two areas were sampled during a subsequent visit. 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. 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 2004). 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 composite sequences. These, and any remaining unmatched sample 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

Nine timbers were selected for sampling, seven from the main roof (Fig 6), and two from the west cross-wing (Fig 7). These samples were numbered **12–20** (Table 1; Fig 8), and were taken from king-posts, rafters, and tiebeams. No other suitable timbers were present but as main roof and west cross-wing were thought to be broadly coeval enough timbers were present to consider sampling and analysis of this material. All of the sampled timbers are oak (*Quercus* spp.).

One of the samples was unsuitable for analysis because of fragmentation during coring. The tree-ring series from the remaining eight samples were measured and the resultant series were then compared with each other. Two of the samples from the main roof (samples **12** and **13**) were found to match together to form a single group (Table 2), and the pair of samples from the west cross-wing (samples **19** and **20**) were also found to match together to form another group (Table 3). A composite chronology was calculated from both these pairs at their synchronised positions. These sequences and the unmatched individual 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 west cross-wing pair (**19+20**). Table 4 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for its two component samples by this process and their interpretation. Figure 9 shows the chronological position identified for these samples, with interpretations based on maximum and minimum likely sapwood values. Appendix 1 lists the individual sample series. The

remaining individual series, and the other composite series, failed to match reference data and remain undated by the analysis reported here.

Interpretation and discussion

The 81-year composite sequence constructed from samples **19** and **20** is dated AD 1507 to AD 1587 inclusive. Sample **20** is complete to the bark-edge. No allowance needs to be made for missing rings in this timber, which was felled in the winter of AD1587/8. Sample **19** is 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 this sample suggests it was felled between AD 1583 and AD 1619 (Fig 6; Table 1), suggesting this is consistent with the felling date identified for sample **20**. Assuming these timbers were felled for immediate usage, which was normal practice in this period (Charles and Charles 1995), and was associated with the primary construction, then these timbers suggest the extant west cross-wing roof was completed either during the winter of AD 1587, or the early part of AD 1588.

This result suggests that the west cross-wing pre-dates the east barn of AD 1605, and may well post-date the west barn dated to AD 1583 or slightly later. The lettering inscribed on the west cross-wing gable is conventionally read as "1589". If this is correct this may indicate that it took in the order of 12–18 months from the date of felling of the roof timbers before this section of the house was finished, or occupied. The lack of results means that the tree-ring results cannot establish the relationship between the dated west cross-wing roof and the undated main roof, and obviously cannot help with establishing the relationship between these and the north-east wing.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. Giles Proctor and Peter Marshall from English Heritage put together the request documentation. Freda Drake and the rest of her family kindly allowed us to sample the timbers in their properties. Ed Dennison, Sean Richardson, and Stephen Haigh from Ed Dennison Archaeological Services provided practical assistance and plans and descriptions of the building. Cathy Tyers provided useful discussion of the results.

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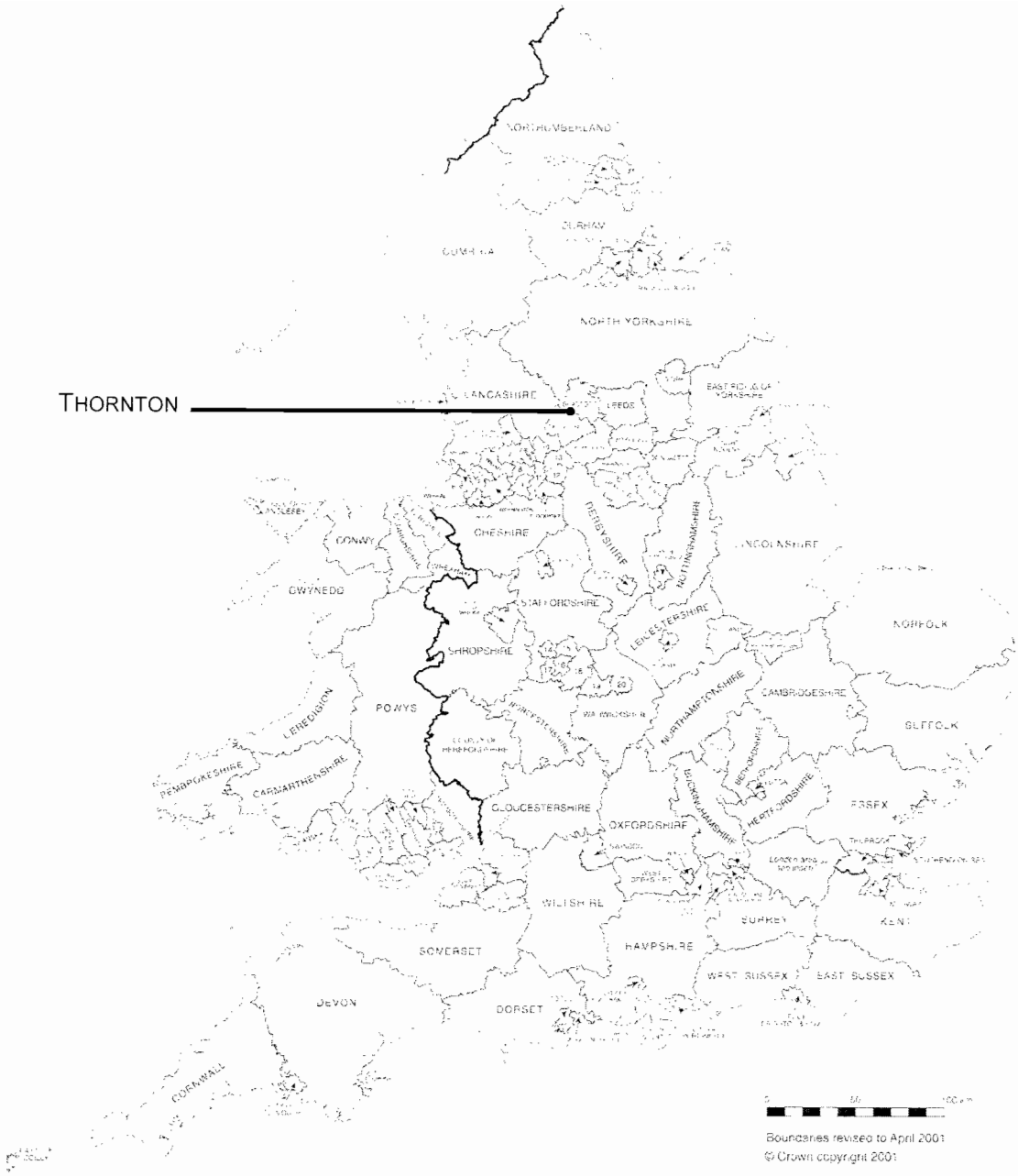

Figure 1 Location of Thornton, West Yorkshire, within England and Wales.

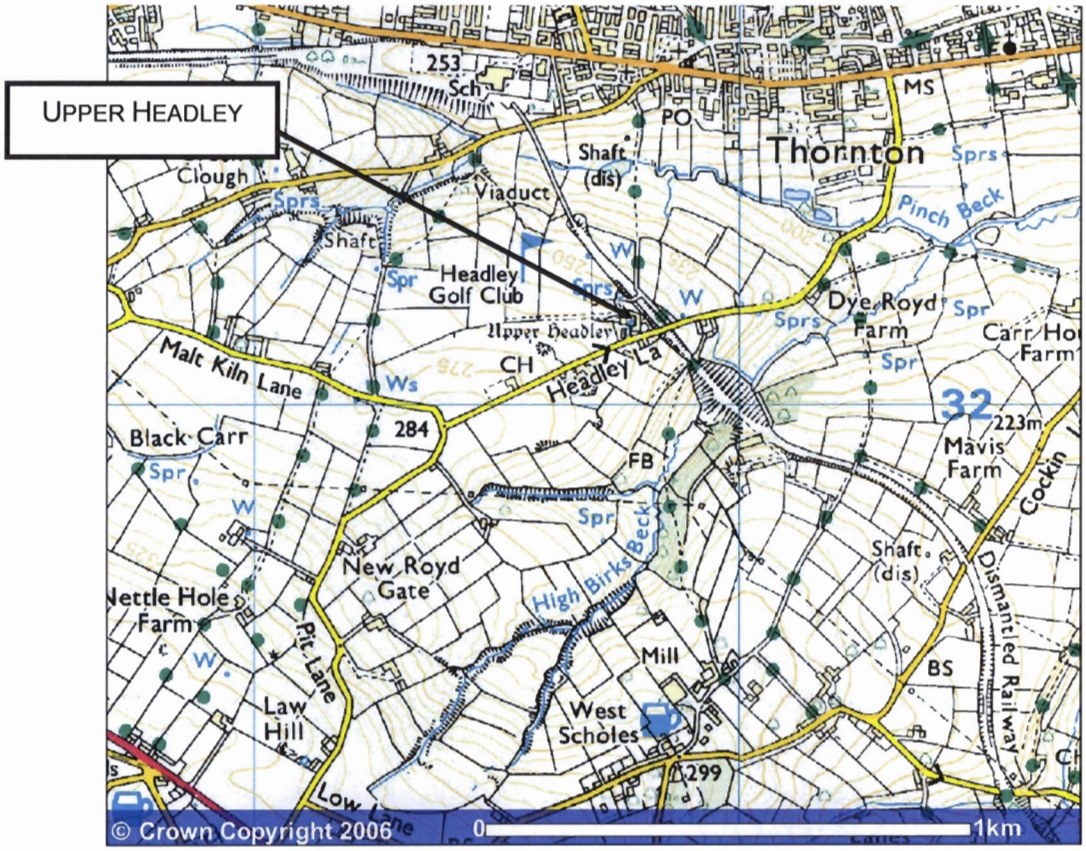

Figure 2 Location of Upper Headley, near Thornton, West Yorkshire

Figure 3 Plan of Upper Headley showing the disposition of the barns and farmhouse (figure supplied by Ed Dennison Archaeological Services)

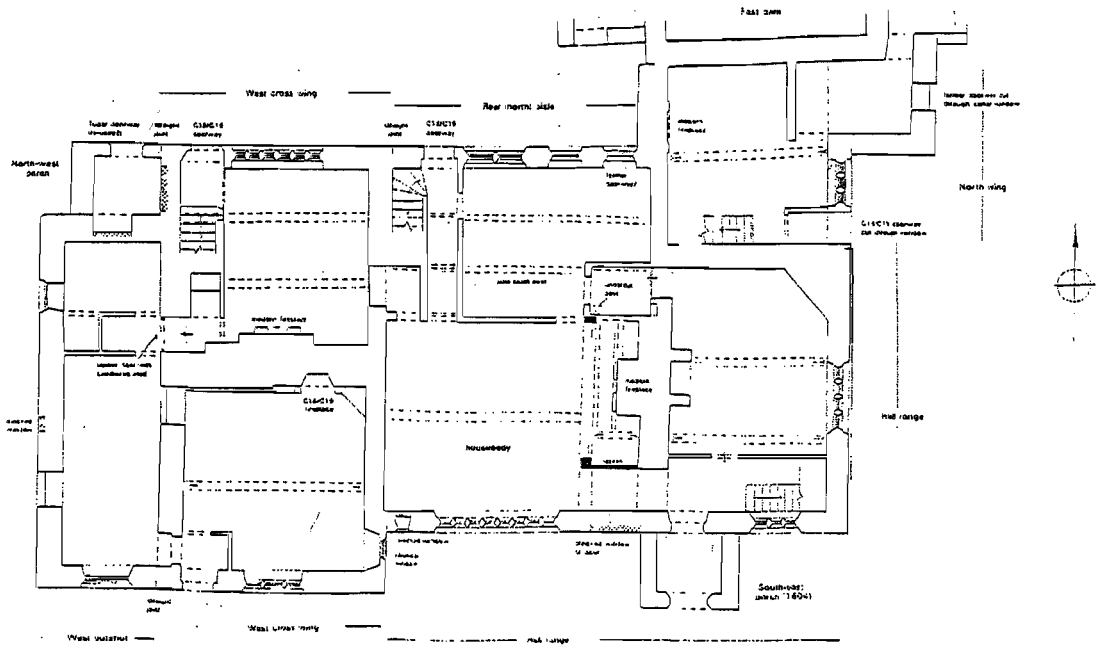

Figure 4 Ground-floor plan of the Upper Headley farmhouse showing the arrangement and nomenclature of the separate sections of the building (figure supplied by Ed Dennison Archaeological Services)

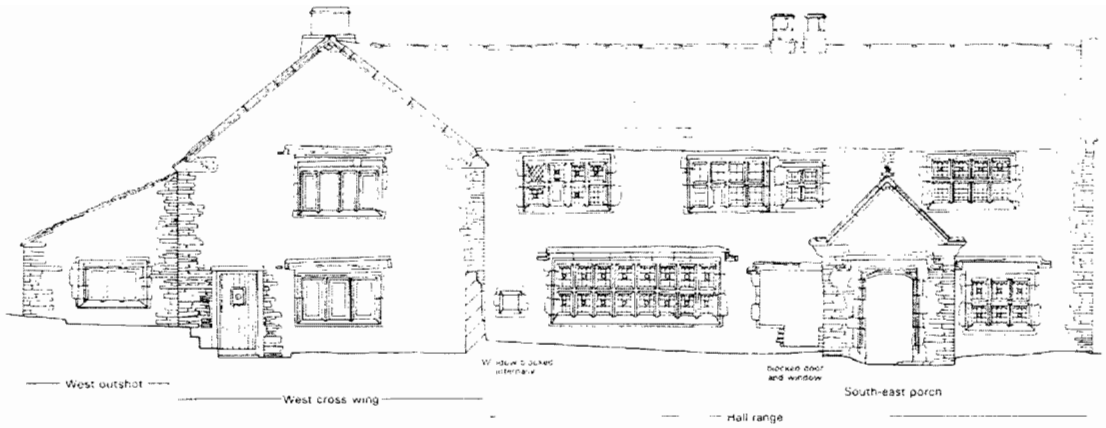

Figure 5 South elevation of Upper Headley farmhouse showing the hall range, the south porch, the west cross-wing and the west outshot (based on a figure supplied by Ed Dennison Archaeological Services)

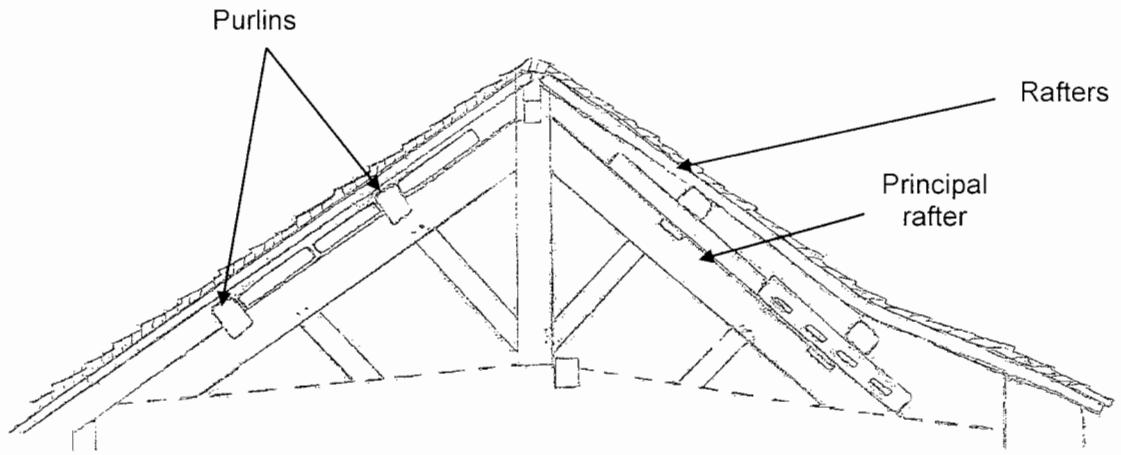

Figure 6 Truss C from the main hall range showing the nomenclature followed for this report (based on a figure supplied by Ed Dennison Archaeological Services)

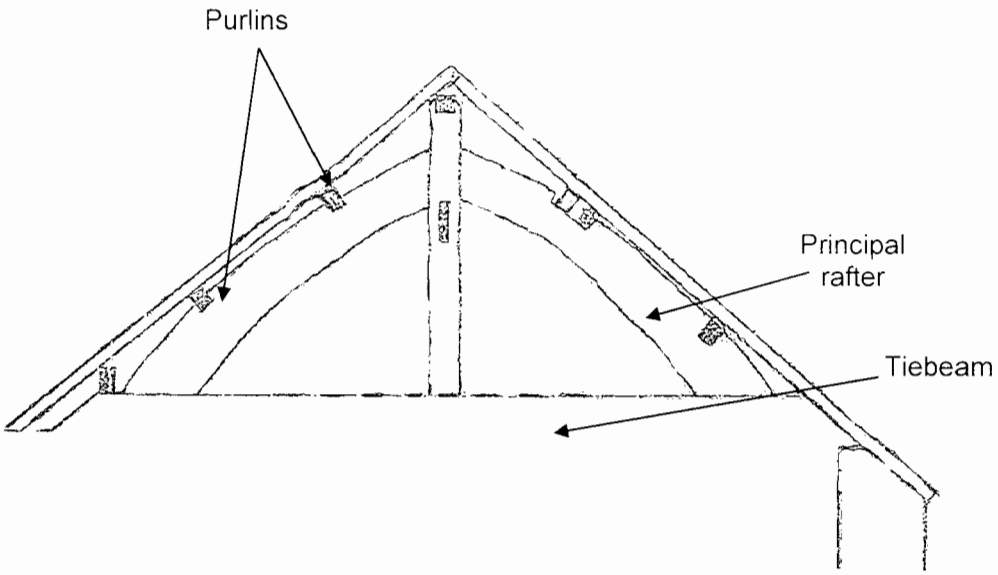

Figure 7 Truss A from the west cross-wing showing the nomenclature followed for this report (based on a figure supplied by Ed Dennison Archaeological Services)

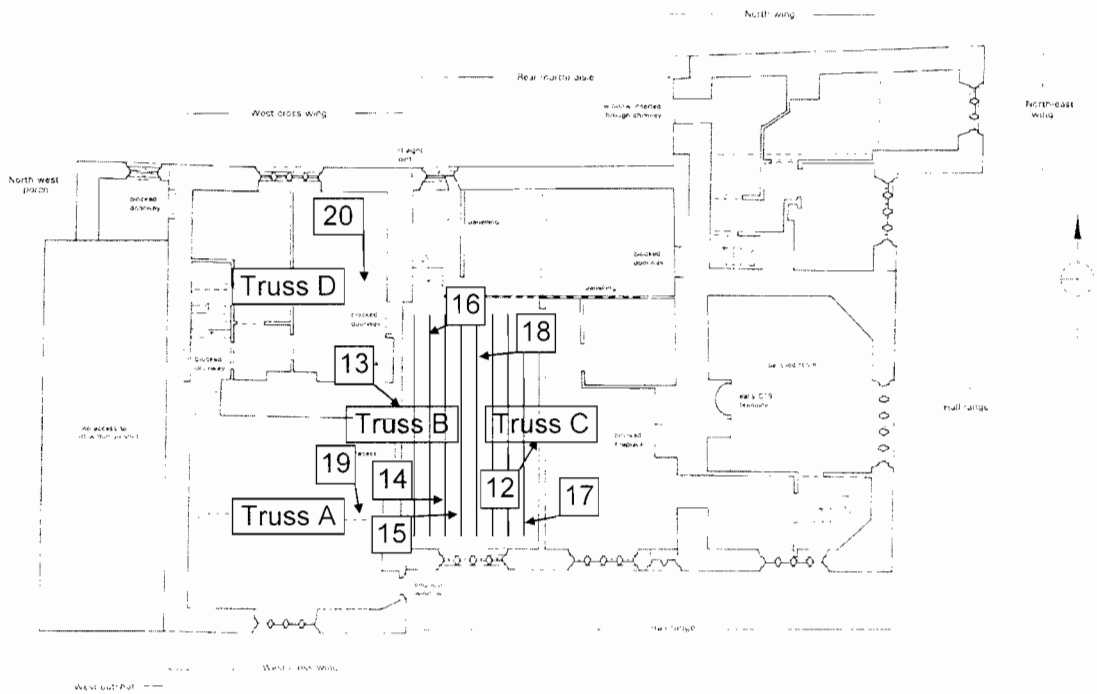

Figure 8 First floor plan of Upper Headley (based on a figure supplied by Ed Dennison Archaeological Services) with superimposed labels showing the truss labelling scheme followed, the rafters of the west bay of the main range roof and the approximate location and direction of the cores, not to scale

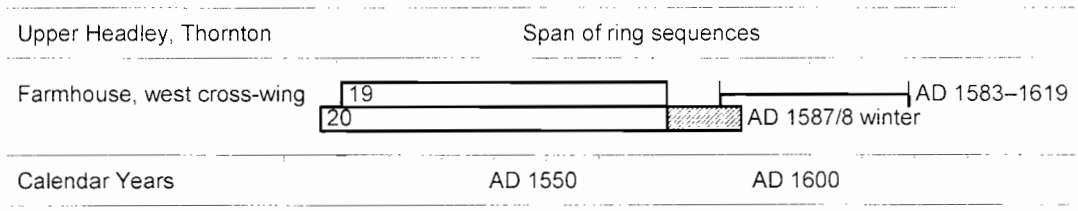

Figure 9 Bar diagram showing the chronological position of the dated timbers from Upper Headley farmhouse, near Thornton, West Yorkshire. White bars represent heartwood. The estimated felling period is also shown, based upon maximum and minimum likely sapwood values

Table 1 Samples from Upper Headley, farmhouse, near Thornton, West Yorkshire

Ref	Origin of core	Cross-section size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
12	Main Range Truss C King Post	270 x 150	90	-	1.79	undated [1]	-
13	Main Range Truss B King Post	280 x 130	123	15	1.34	undated [1]	-
14	Main Range W Bay S rafter	115 x 90	54	-	1.30	undated	-
15	Main Range W Bay S rafter	100 x 100	61	-	0.93	undated	-
16	Main Range W Bay N rafter	125 x 90	107	-	1.25	undated	-
17	Main Range W Bay S rafter	115 x 90	54	3	1.05	undated	-
18	Main Range W Bay N rafter	115 x 90	-	-	-	unmeasured	-
19	West Wing Truss A tiebeam	340 x 180	63	H/S	2.56	AD 1511–73	AD 1583–1619
20	West Wing Truss D tiebeam	330 x 170	81	14+Bw	2.63	AD 1507–87	AD 1587/8 winter

KEY See Figure 8 for truss and bay labelling, Figures 6 and 7 for nomenclature and Figure 8 for sampling locations. W = west, N = north, S = south. Total rings = measured rings. H/S = heartwood/sapwood boundary. Bw = bark-edge with full year's growth, indicating winter felling. ARW = average ring width of the measured rings. Felling period calculated for sample 19 using 10–46 year sapwood estimate.[1] This pair of samples match but they form an undated composite sequence.

Table 2

t-value matrix for the timbers forming the Upper Headley farmhouse sequence 12+13

	13
12	6.50

Table 3

t-value matrix for the timbers forming the Upper Headley farmhouse sequence 19+20

	20
19	7.17

Table 4

Dating the Upper Headley farmhouse sequence 19+20 to AD 1507–87 inclusive. Example *t*-values with independent reference chronologies

Reference chronology	*t*-value
County Durham, Fell Close Healyfield (Arnold *et al* 2004)	7.67
County Durham, Hallgarth Manor Cottages Pittington (Howard *et al* 2001)	5.26
Greater Manchester, 30-31 Market Place (Tyers 1999)	5.44
Herefordshire, Dore Abbey Church (Tyers and Boswijk 1998)	6.02
Herefordshire, Penrhos Court Kington (Tyers 1998b)	5.64
Northumberland, Corbridge Dilston Hall (Arnold *et al* 2003)	6.13
Shropshire, Bedstone Manor Farm (Miles *et al* 1995)	6.10
Shropshire, Brookgate Farm Plealy (Miles *et al* 1993)	6.09
Yorkshire, Whiston Manorial Barn (Tyers 2002)	6.96
Yorkshire, Dodworth (Tyers 2006)	5.34

Appendix 1 Ring width data for measured samples from Upper Headley farmhouse, near Thornton, West Yorkshire, 100 = 1mm

HHF12

237	337	295	272	233	247	214	232	155	192
206	162	198	157	136	139	152	213	246	240
226	279	244	164	146	161	190	256	200	225
206	214	194	264	226	112	136	144	152	155
166	149	102	148	123	116	171	157	154	129
134	115	135	149	79	130	106	153	141	175
137	188	205	199	194	208	216	196	165	201
185	168	163	211	192	170	164	159	121	140
159	162	200	214	236	159	161	117	97	112

HHF13

236	301	296	244	211	170	128	131	127	179
163	191	138	170	162	172	202	158	183	124
146	192	211	202	185	203	148	85	126	119
173	193	200	212	151	151	158	143	139	94
103	99	113	103	149	116	83	103	110	99
130	145	146	154	106	101	132	140	88	107
89	81	74	87	68	87	85	97	91	95
101	90	78	72	83	97	91	99	80	110
70	83	77	87	87	102	127	122	179	124
148	104	115	140	141	126	147	136	125	126
141	174	150	148	147	172	155	113	109	86
92	124	156	158	164	147	89	102	80	103
153	123	178							

HHF14

308	242	260	221	230	232	192	166	117	122
99	110	124	129	131	89	99	103	136	103
154	131	129	114	106	124	152	112	95	76
112	83	83	98	124	128	125	116	161	139
149	129	95	84	119	93	118	93	115	94
103	78	80	117						

HHF15

194	183	224	213	161	168	165	167	137	155
144	142	128	150	113	86	134	106	99	74
104	93	62	61	70	73	64	59	69	66
59	61	65	61	58	51	65	53	46	50
105	72	69	56	49	53	36	35	28	30
33	41	45	77	88	141	87	80	97	82
110									

HHF16

115	126	128	137	118	78	102	77	52	51
72	62	60	45	29	34	43	47	57	65
66	63	40	41	47	47	41	37	39	99
187	279	186	210	186	147	137	144	148	160
210	167	137	150	153	171	156	129	138	181
163	216	187	142	124	129	113	98	137	119
148	159	137	106	83	126	96	136	185	237
243	202	186	190	206	252	191	151	134	172
161	137	142	155	155	115	122	128	121	123
107	95	117	86	88	129	91	92	76	102
82	79	98	119	199	171	122			

HHF17

99	146	149	128	106	135	133	112	94	128
107	107	134	143	99	137	132	103	98	122
92	105	90	90	124	84	67	98	82	79
56	109	82	67	75	106	90	103	135	132
134	99	91	83	80	111	132	109	136	89
63	83	76	92						

HHF19

287	364	287	310	323	334	264	301	298	307
284	309	253	320	367	351	291	311	290	332
330	299	283	265	300	301	279	257	240	251
231	208	199	252	273	229	194	245	192	214
238	232	268	246	280	281	208	157	213	236
247	229	244	284	247	111	95	159	197	217
203	150	175							

HHF20

304	390	381	308	413	385	366	377	373	351
307	355	379	375	390	424	305	366	302	387
300	320	337	285	331	292	306	291	329	355
301	212	206	239	169	140	216	213	267	209
219	247	228	206	294	244	245	200	289	244
196	154	229	255	284	253	234	279	234	176
115	162	230	290	319	186	209	182	222	161
145	151	193	224	175	117	177	188	175	215
187									