Research Department Report 052-2006

Dendrochronological Analysis of Oak Timbers from the Nunnery, Dunster, Somerset

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Summary

A tree-ring dating programme was commissioned on timbers from the Nunnery, Dunster, Somerset, by English Heritage in AD 2003. The results identify that at least one timber in the roof of the building was felled in the second half of the fifteenth century, although no other timbers were found to be datable.

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 the Nunnery, Dunster, Somerset (NGR SS 9914 4368). 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.

Dunster is a market town *c* 30km north-west of Taunton and *c* 5km south-east of Minehead (Fig 1), in north Somerset within Exmoor National Park. The town is dominated by Dunster Castle, the former seat of the Luttrell family, now a National Trust property. The picturesque building known as the Nunnery stands on Church Street, near its corner with High Street (Fig 2). The Nunnery was originally built for Cleve Abbey, located *c* 8km to the east.

The Nunnery is a three-storey building, now divided into three dwellings. It is jettied on the front at second-floor level, and has a first-floor canopy that makes the building appear to be double-jettied. The wall to jetty height is rubble stone, with the upper storey slate-hung. The building is *c* 18m long on the street front. The roof is of six equal bays with a trapezoidal seventh bay at the west end, presumably acting as infill to the adjacent building (Fig 3). The framing below tiebeam level is obscured by other structures. The roof has simple A-trusses with cranked tiebeams and cranked collars, and there are three rows of purlins (Fig 4). Tree-ring analysis of timbers of the roof was requested by Francis Kelly, the local English Heritage Historic Buildings Inspector.

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 November 2003 in the company of Mark Clitherow, from Exmoor National Park Authority, and an assessment of the dendrochronological potential of timbers in the two western bays of the building was undertaken. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in this part of the building. This assessment concluded that the timbers in this area of the roof were a mixture of faster-grown oak timbers with few annual rings, with a handful of apparently longer-lived trees used for the principal rafters and purlins. These larger elements were all derived from halved trees, and visual inspection suggested that the pair of principal rafters on at least some of the trusses were derived from a single tree. An inspection of the tool marks and carpenter's marks showed that the trusses were faced up to the west, the timbers were

trestle-sawn, and the carpenter's marks were made with struck chisels, using both straight and curving bladed tools. Most of the smaller elements were considered entirely unsuitable for sampling because they contained too few rings. On the larger timbers the survival of sapwood was fairly extensive. Six timbers in these two bays were sampled during this visit. Unfortunately access could not be arranged to the other two properties for this visit. Access to the rest of the roof was not successfully arranged until May 2006. A further six timbers, from the remaining bays, were sampled during this second 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 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 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 1998). 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 re-use 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

Twelve timbers were selected for sampling from the roof trusses. These samples were numbered **1**–**12** (Table 1; Figs 3–5), and were exclusively taken from principal rafters and purlins. No other timbers in the structure were suitable for sampling. All of the sampled timbers are oak (*Quercus* spp.).

Two of the samples were unsuitable for analysis because of fragmentation during sampling. The tree-ring series from the remaining ten samples were measured and the resultant series were then compared with each other. Two of the samples were found to match together to form a single group (Table 2). A composite chronology was calculated from these at their synchronised position. This sequence 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 one of the individual series. Table 3 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for this sequence by this process and its interpretation. Figure 6 shows the chronological position identified for this sample, with an interpretation based on maximum and minimum likely sapwood values. Appendix 1 lists the individual sample series. The remaining individual series, and the composite series, failed to match reference data and remain undated by the analysis reported here.

Interpretation and discussion

The 98-year sequence from sample 11 is dated AD 1346 to AD 1443 inclusive. This sample 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 1453 and AD 1489 (Fig 6; Table 1). Assuming this timber was felled for immediate usage, which was normal practice in this period (Charles and

Charles 1995), and was associated with the primary construction, then this timber suggests the roof dates between AD 1453 and AD 1489.

No samples were taken from the collars, rafters, or walling of the building but, given the apparently integrated nature of the structure, it seems likely that the whole structure is principally composed of co-eval material, although a building of this date is likely to have been repaired or modified a number of times. A full architectural investigation of the roof will be necessary to identify whether the single datable timber identified during this analysis is likely to be from, and representative of, the original roof.

The high south-western moors of Exmoor, Dartmoor, and Bodmin Moor are under-represented in the reference data sets for medieval south-west England. The disappointing dating success rate of the sampled material from this structure possibly indicates this material was derived from relatively local woodland. However, since the sampled timbers in the Nunnery roof include several that contain bands of narrow rings that were probably caused by cultural modification, perhaps as the incidental results of timber harvesting activities, it is possible this material is not particularly typical of the resources used in medieval Dunster buildings.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. Francis Kelly and Peter Marshall from English Heritage put together the request documentation. The owners Mr and Mrs Rider and Dr Haskell kindly allowed us to sample roof timbers in their properties, and Mark Clitherow from Exmoor National Park provided practical assistance with the initial sampling. Cathy Tyers provided useful discussion of the results.

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Figure 1 Location of Dunster, Somerset, within England and Wales.

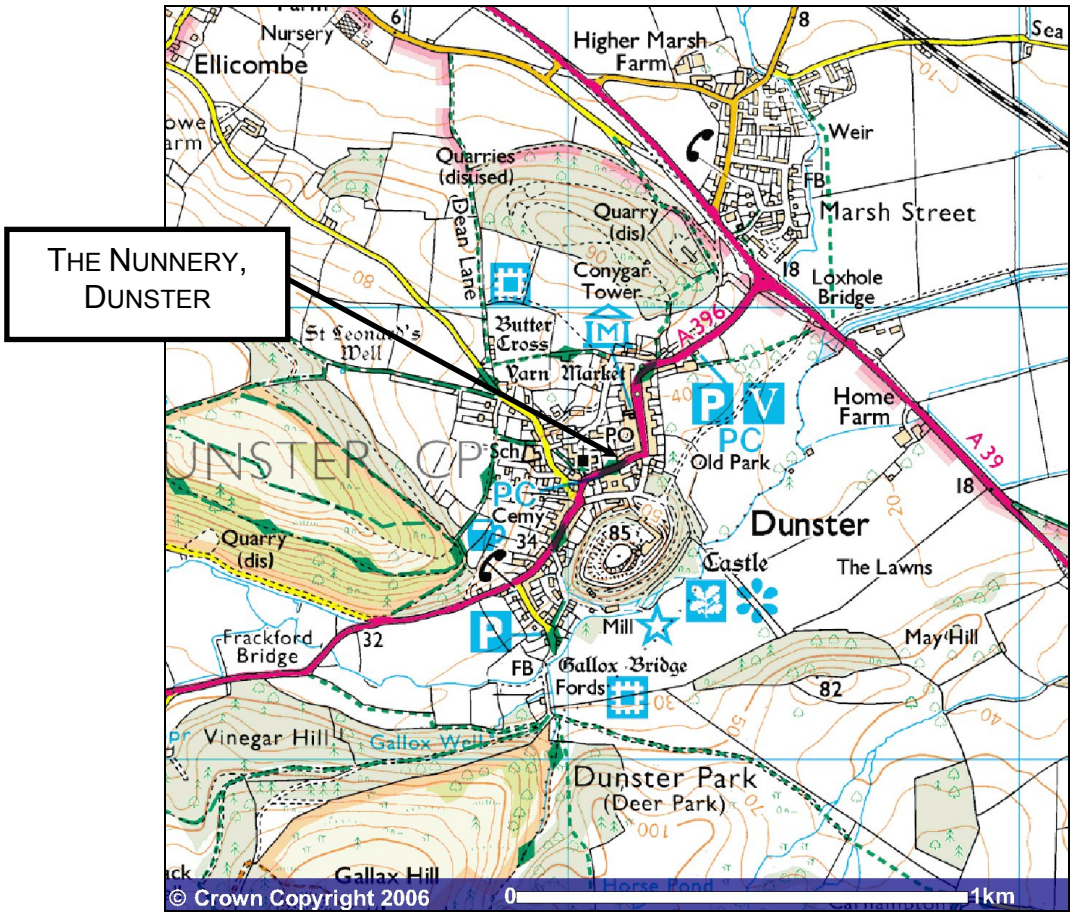

Figure 2 Location of the Nunnery, Dunster, Somerset

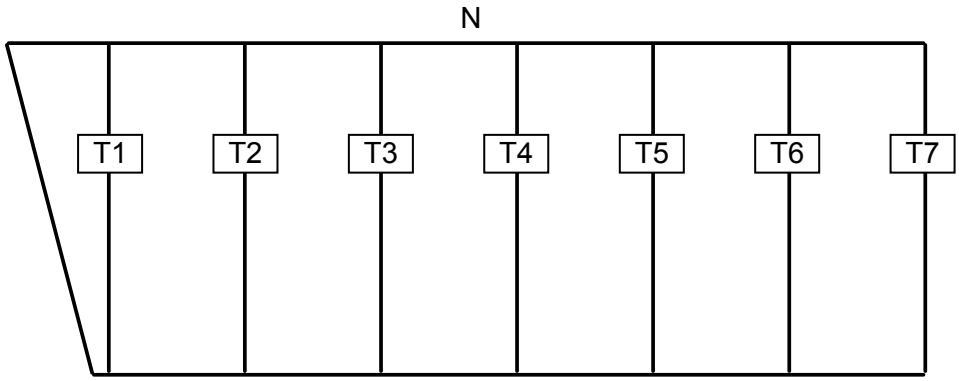

Figure 3 Sketch plan of The Nunnery, Dunster, roof showing the truss numbering scheme used in this report, not to scale

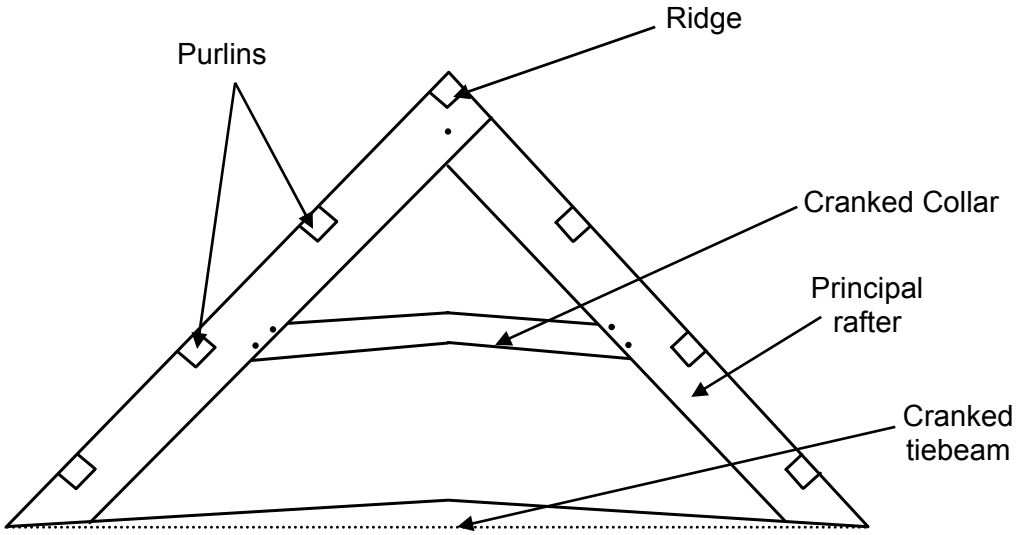

Figure 4 Sketch of a typical truss from the Nunnery, Dunster, roof. The framing below the dotted line is obscured. The nomenclature for structural elements used in this report is given here, not to scale

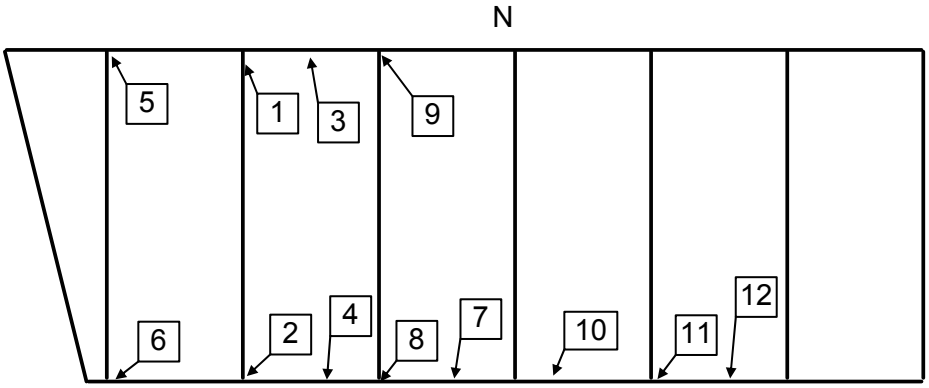

Figure 5 Sketch plan of the Nunnery, Dunster, Somerset showing the approximate location and direction of the cores

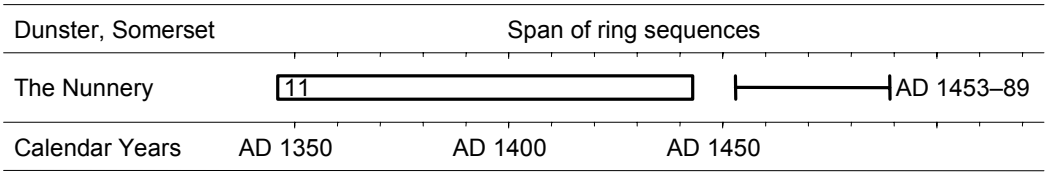

Figure 6 Bar diagram showing the chronological position of the dated timber from the Nunnery, Dunster, Somerset. White bars represent heartwood. The estimated felling period is also shown, based upon maximum and minimum likely sapwood values

Table 1 Samples from the Nunnery, Dunster, Somerset

Ref	Origin of core	Cross-section size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
1	T2 N principal rafter	280 x 140	56	H/S	2.15	undated	-
2	T2 S principal rafter	280 x 140	91	19+Bw	1.75	undated	-
3	T2-T3 N upper purlin	210 x 120	54	H/S	1.49	undated	-
4	T2-T3 S middle purlin	260 x 110	109	3	1.17	undated	-
5	T1 N principal rafter	300 x 150	84	H/S	1.76	undated	-
6	T1 S principal rafter	300 x 150	-	-	-	unmeasured	-
7	T3-T4 S middle purlin	230 x 115	72	H/S	0.98	undated	-
8	T3 S principal rafter	285 x 160	74	H/S	2.10	undated	-
9	T4 N principal rafter	290 x 150	96	H/S	1.97	undated	-
10	T4-T5 S upper purlin	220 x 110	57	H/S	1.89	undated	-
11	T5 S principal rafter	300 x 140	98	H/S	1.35	AD 1346–1443	AD 1453–89
12	T5-T6 S middle purlin	230 x 120	-	-	-	unmeasured	-

KEY See Figure 3 for truss numbers, Figure 4 for nomenclature and Figure 5 for sampling locations. 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 using 10–46 year sapwood estimate.

Table 2

t-value matrix for the timbers forming the undated Nunnery sequence dn4+dn7

	7
4	8.05

Table 3

Dating the Nunnery, Dunster sample 11 AD 1346–1443 inclusive. Example *t*-values with independent reference chronologies

Reference chronology	***t*-value**
Cornwall, Goldophin House Godolphin Cross (Groves pers comm)	5.01
Devon, Archdeacons House Exeter (Howard *et al* 1999)	4.96
Devon, Exeter Bowhill (Groves 2002)	5.10
Gloucestershire, Gloucester Mercers Hall (Howard *et al* 1996)	6.13
Herefordshire, Hereford Widemarsh St Farmers Club (Tyers 1996)	5.77
Herefordshire, Pembridge Kings House (Tyers 2004b)	5.74
Herefordshire, Pembridge Westfields (Tyers 2004b)	7.55
Shropshire, Bedstone Manor Farm (Miles *et al* 1995)	5.65
Worcestershire, St Bartholomew's Lower Sapey (Tyers 1995)	5.84
Worcestershire, Worcester Cathedral (Arnold *et al* 2003; 2004; Howard *et al* 2000)	6.22

Appendix 1 Ring width data for measured samples from the Nunnery, Dunster, Somerset, 100 = 1mm

dn01

335	309	292	305	359	232	233	207	308	336
327	357	346	350	388	248	317	306	333	305
194	183	112	112	73	100	154	147	125	146
139	116	119	111	174	185	231	202	197	217
144	194	221	196	193	223	173	186	181	165
193	135	129	126	144	203				

dn02

100	126	147	131	165	129	125	184	190	210
202	162	183	260	173	323	328	363	360	281
304	218	270	243	363	414	369	382	365	333
271	196	246	217	288	251	135	118	98	74
61	112	138	151	127	120	66	69	61	70
82	90	133	128	93	137	124	158	269	260
91	91	90	91	164	99	140	115	101	116
124	137	178	178	162	106	162	225	234	97
149	96	89	87	83	85	147	160	124	234
184									

dn03

305	156	148	125	143	133	105	142	117	139
168	194	261	215	259	201	178	135	170	177
158	127	104	115	143	132	128	104	137	146
109	152	155	85	149	106	102	123	128	189
143	165	128	166	157	126	163	129	154	125
127	116	126	135						

dn04

164	141	102	148	162	187	187	174	98	57
51	82	103	190	188	185	192	179	258	136
159	228	199	137	92	182	172	186	173	145
111	80	103	162	125	134	131	113	99	136
80	68	52	52	49	66	74	70	96	86
75	106	77	49	79	121	84	89	97	112
96	85	134	104	132	160	88	118	149	225
243	153	187	188	143	143	154	135	157	149
165	121	128	96	113	117	73	67	77	54
81	57	80	100	114	106	82	101	91	68
59	60	57	50	60	58	54	61	71	

dn05

544 482 284 331 621 471 355 112 192 252
230 289 243 209 242 294 317 257 238 288
253 302 364 303 294 227 159 170 152 138
204 163 126 137 144 92 84 70 83 78
108 130 131 140 188 192 167 167 120 123
115 113 72 110 92 107 105 110 139 134
128 86 94 92 95 149 108 100 107 93
107 109 87 76 112 113 77 106 75 93
80 97 96 107

dn07

77 55 51 53 66 57 66 64 72 79
101 64 65 75 115 100 109 86 107 77
70 78 67 82 76 61 82 162 189 172
128 129 140 110 126 139 97 136 129 147
142 183 147 183 190 116 102 101 91 121
88 108 127 124 105 89 124 102 99 75
79 78 70 59 76 76 58 62 55 69
67 49

dn08

374 382 375 313 388 324 350 337 336 358
232 351 260 282 310 259 307 186 131 114
164 231 236 243 282 312 363 253 270 286
251 240 319 126 64 46 51 84 98 103
114 94 121 131 96 107 147 129 187 81
109 119 127 206 179 189 155 257 200 236
262 179 186 136 128 161 176 204 221 197
141 160 193 212

dn09

150 81 94 161 153 110 137 166 137 150
185 66 97 93 162 212 178 230 183 104
128 169 181 166 202 152 114 147 70 93
71 130 145 168 177 122 167 131 122 133
157 136 141 141 222 292 351 217 251 279
318 358 330 320 360 163 154 224 188 187
180 133 167 171 122 162 147 105 193 202
154 120 145 219 176 194 157 300 266 322
340 334 335 195 324 224 354 288 284 291
276 281 238 385 396 302

dn10

196	211	178	189	176	263	249	227	209	242
155	148	178	160	296	222	180	171	159	194
259	324	238	207	251	263	228	137	184	202
179	212	153	206	226	204	211	180	172	262
284	266	164	115	163	146	86	113	110	130
146	123	124	102	108	135	130			

dn11

215	160	180	267	172	204	121	209	139	154
129	191	164	130	70	85	69	136	143	99
114	94	87	114	99	102	101	100	133	145
97	137	77	139	119	90	109	104	117	85
103	111	85	107	102	136	106	121	98	128
144	132	163	194	157	160	119	189	173	180
99	95	120	139	115	101	162	145	214	193
119	140	158	94	94	155	129	141	177	153
137	155	204	192	202	123	182	139	167	147
126	143	92	111	129	129	94	118		