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WICK FARM COTTAGE, HEDDINGTON WICK COMMON, HEDDINGTON, WILTSHIRE
TREE-RING ANALYSIS OF TIMBERS

SCIENTIFIC DATING REPORT

Cathy Tyers, Matt Hurford, and Martin Bridge

INTERVENTION
AND ANALYSIS

ENGLISH HERITAGE

Research Report Series 63-2014

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SUMMARY
Dendrochronological analysis was undertaken on all seven of the timbers sampled from two medieval phases at Wick Farm Cottage. This resulted in the production of two site chronologies, HWWFSQ01 and HWWFSQ02. These comprise three and two samples with overall lengths of 178 years and 67 years respectively. The first site chronology dates to AD 1158–1335, whilst the second chronology is undated. The dated samples, thought to be associated with the earliest medieval phase, indicate a programme of felling, and hence likely construction, in the mid-AD 1330s.

CONTRIBUTORS
Cathy Tyers, Matt Hurford, and Martin Bridge

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INTRODUCTION

In 2009 the Wiltshire Buildings Record (WBR) successfully obtained support through the English Heritage Historic Environment Enabling Programme for their project 'Wiltshire cruck buildings and other archaic roof types'. The detailed aims and objectives of the project are set out in the Project Design (Lloyd 2009). The overall aim was to establish a typological chronology of archaic roof types and hence elucidate the development of carpentry techniques in the county. This would then facilitate detailed comparison with other counties allowing Wiltshire to be placed in a regional context. Investigation of these late medieval buildings (*c* AD 1200–*c* AD 1550) combined building survey, historical research, and dendrochronological analysis.

A series of 25 buildings identified by the WBR as having the potential to contribute to the aims and objectives of the project was assessed for dendrochronological suitability during 2009. In order to maximise the potential for dating, these detailed dendrochronological assessments and the WBR assessments of the significance of each building informed the final selection of buildings, which were subsequently subjected to detailed study.

A single final Project Report produced by Lloyd (2012) summarises the overall results. However each building included in the project has an associated individual report produced by the WBR, whilst the primary archive of the dendrochronological analysis is the English Heritage Research Report Series.

A brief introduction to dendrochronology can be found in the Appendix. Further details can be found in the guidelines published by English Heritage (1998), which are also available on the English Heritage website (http://www.english-heritage.org.uk/publications/dendrochronology-guidelines/).

Wick Farm Cottage

Wick Farm Cottage, a Grade II listed building, is located in the hamlet of Heddington Wick (Figs 1 and 2). The current building comprises a north range, orientated on a broadly east to west axis, and a south range, on a broadly north to south axis (Figs 3 and 4). The following information is summarised from the WBR report (2012).

The north range is originally thought to have been an open hall house of at least two bays, only one of which survives. There are two extant cruck trusses, trusses A and B (Figs 4 and 5), and there is evidence that this structure originally extended to the east of truss A. The stylistic evidence suggests an early fourteenth-century date for this original timber-framed open hall structure, although it should be noted that truss B is lower than truss A and may have been part of an earlier structure also of early fourteenth-century date. This open hall structure was either extended or rebuilt to the west (Fig 6), possibly in the fifteenth century, at which time it appears that the opportunity was taken to raise the height of the roof. In the later fifteenth century the south range was added which also comprised a two-bay open hall with two extant arch-braced principal rafter trusses. During the sixteenth and seventeen centuries various alterations were undertaken including the insertion of ceilings in both the north and south ranges.

The focus of this investigation was on the north range in which it was hoped to elucidate the sequence of the development associated with this open hall building. The two trusses, trusses A and B, associated with the early fourteenth-century open hall structure are both true crucks. Truss A is constructed of elm (*Ulmus* spp) and comprises a pair of blades and a straight collar with straight braces between. It has a single row of trenched purlins. This truss is smoke-blackened as are some of the common rafters and the windbraces that survive immediately west of truss A. Truss B (Fig 5), is constructed of oak (*Quercus* spp) and also shows some evidence of smoke-blackening. It is lower than truss A and has a curved apex sitting on the cruck blades with a horizontal block above to take the diagonal ridge purlin (Fig 7). Truss C, which is of box-frame construction, is located in the west gable wall of the north range and is only partially visible. The visible original timbers comprise a tiebeam, a principal rafter, collar, wall stud, and brace from tiebeam to principal rafter (Figs 6 and 8). This truss and associated windbraces and purlins were also smoke-blackened but to a lesser extent, indicating that, although this is thought to be a slightly later rebuild or extension to the original open hall represented by trusses A and B, it was nevertheless, also originally open to the roof.

SAMPLING

Dendrochronological sampling and analysis of oak timbers associated with the remains of the medieval north range was commissioned by English Heritage. It was hoped to provide independent dating evidence for the construction of the medieval hall house and its subsequent development and hence inform the overall objectives of the 'Wiltshire cruck buildings and other archaic roof types' project. The dendrochronological study also formed a key component of the English Heritage-funded training programme for the second author, although the reporting was not completed within the duration of the training programme.

Sampling was undertaken by trainee Matt Hurford and supervised by Martin Bridge. A total of seven oak timbers associated with the extant remains of the medieval hall house were sampled by coring. Each sample was given the code HWW-F (for Heddington Wick, Wick Farm Cottage) and numbered 01–07. In two instances duplicate cores were obtained from the same timber (HWW-F01 and HWW-F03) in order to maximise the length of the derived ring sequence. The sampling strategy encompassed as wide a range of elements as possible, whilst focusing on those timbers with the best dendrochronological potential. The timbers associated with truss A were elm and hence outside of the scope of this project. The oak timbers excluded from sampling included various elements associated with trusses B and C, as well as purlins, windbraces, and common rafters. These all appeared to be derived from fast-grown trees and were therefore considered highly unlikely to provide samples with sufficient numbers of rings for reliable dendrochronological analysis.

The location of samples was noted at the time of coring and marked on the drawings provided by the WBR, these being reproduced here as Figures 7 and 8. Further details relating to the samples can be found in Table 1. In this table the timbers have been located and numbered following the scheme on the drawings provided.

ANALYSIS AND RESULTS

Each of the nine cores obtained from the seven timbers sampled was prepared by sanding and polishing. The annual growth rings of all nine cores were measured, these measurements being given at the end of this report. The measurement and analysis was undertaken using a combination of software written by Tyers (2004) and the Litton/Zainodin grouping procedure (see Appendix). Tyers (2004) facilitates cross-matching and dating through a process of qualified statistical comparison and visual comparison. It uses a variant of the Belfast CROS programme (Baillie and Pilcher 1973). The duplicate samples, HWW-F01_1 and HWW-F01_2 and HWW-F03_1 and HWW-F03_2, cross-matched with *t*-values of 16.73 and 7.04 respectively and were combined into single timber sequences HWW-F01, and HWW-F03 for the subsequent analysis.

The analysis resulted in two groups being formed, the samples of each group cross-matching with each other as shown in Tables 2 and 3 and Figures 9 and 10. Intra-site cross-matching (see below) indicated the possibility that two timbers may have been derived from the same tree as suggested by *t*-values in excess of 10.0. However, to maintain consistency between all of the dendrochronological reports on individual buildings within this project, these potential same-tree series were not combined prior to incorporation into the site chronology, hence following the Nottingham Tree-Ring Dating Laboratory standard practice. Thus, the individual sequence from each timber in each group were combined to produce two site chronologies, HWWFSQ01 and HWWFSQ02. Both site chronologies were compared to an extensive range of reference chronologies for oak. The dating evidence for HWWFSQ01, when the date of the first ring is AD 1158 and the date of its last ring is AD 1335, is presented in Table 4. No conclusive cross-matching was identified for HWWFSQ02, so this site chronology remains undated.

The site chronologies were compared with the remaining two ungrouped samples but there was no further satisfactory cross-matching. Each of the two ungrouped samples was then compared individually with the reference chronologies but again there was no satisfactory cross-matching and these samples must, therefore, remain undated.

This analysis can be summarised as follows:

Site chronology	Number of samples	Number of rings	Date span (where dated)
HWWFSQ01	3	178	AD 1158–1335
HWWFSQ02	2	67	undated
	2	-	ungrouped and undated

INTERPRETATION

Truss B is represented by three dated timbers in site sequence HWWFSQ01 (Fig 9). Each of these samples retains complete sapwood. Sample HWW-F02, from the collar, has a complete outmost ring dating to AD 1334 with no trace of growth for the following year indicating that it was felled during the winter of AD 1334/5. Samples HWW-F01 and HWW-F03, from the cruck blades, were found to have been felled during the winter of AD 1335/6.

Site sequence HWWFSQ02 (Fig 10) could not be dated. The samples represent the north principal rafter and tiebeam of truss C and both retain complete sapwood. The outermost ring on both samples is only partially formed with only spring vessels present and hence not measured. This indicates that they were both felled in late spring or early summer of the same relative year.

DISCUSSION AND CONCLUSION

The dendrochronological analysis of the samples taken from Wick Farm Cottage has demonstrated that a number of timbers associated with the earliest phase of the building, represented by truss B, were felled in the mid-AD 1330s. In this instance two felling dates, a year apart, have been identified. This variation in felling date is not uncommon (Miles 2006) and suggests short-term stockpiling of timber either pre-planned or adventitious use of available timber such as windfalls. During the medieval period timber generally was not seasoned for structural purposes; it was felled as required and used whilst green (Rackham 1990; Charles and Charles 1995). Consequently the initial construction date for this part of the hall house is likely to have been shortly after the latest felling date identified. The overall level of cross-matching between the three dated samples from truss B suggests a common woodland source. The high *t*-value of 16.95 between the samples HWW-F01 and HWW-F03, both halved timbers used as the cruck blades of truss B, suggests that they may well have been derived from the same tree. This site chronology generally produces the highest *t*-values, and thus shows the greatest degree of similarity, with reference chronologies from the south-west region (Table 4). This suggests that it is likely that the timbers were obtained from a relatively local woodland source.

It is unfortunate that it was not possible to provide any dating evidence for the samples from truss C, other than identifying that two of the elements are clearly precisely coeval and likely to be derived from the same woodland source. It is also unfortunate that the remaining timbers associated with the medieval hall house were unsuitable for dendrochronological analysis as this meant that no evidence could be provided towards the further development of this north range during the medieval period.

It is noticeable that the timbers sampled from truss B are derived from slower grown trees than those sampled from truss C. Those from truss B were also much older when felled, probably approaching 200 years, compared with those from truss C that had probably been growing for less than 100 years. This implies that those from truss B were from relatively dense woodland, whereas those from truss C were from a source with a more open canopy. The differences in characteristics of the oak timbers used do not prove that the two trusses are of different date as they could simply be constructed of timber from two rather diverse woodland sources. However this, combined with the presence of an elm truss (truss A), does support the structural evidence, in that it implies that more than one phase of construction is represented by the three extant trusses.

The two ungrouped and undated samples did not exhibit obvious growth abnormalities, such as distortion or compression of the rings, which would make cross-matching and dating difficult. However, sequences from individual timbers are generally more difficult to date than a site sequence incorporating a series of timbers, and in addition sample HWW-F06 has only 43 rings which is at the lower limit of that required for statistical reliability in the analytical process.

BIBLIOGRAPHY

Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree Ring Bulletin*, 33, 7–14

Bridge, M C, 2001 *Tree-Ring Analysis of Timbers from the Abbey Barn, Glastonbury, Somerset*, Centre for Archaeol Rep, 39/2001

Bridge, M C, 2003 *Tree-Ring Analysis of Timbers from Fiddleford Manor, Calf Close Lane, Sturminster Newton, Dorset*, Centre for Archaeol Rep, 13/2003

Charles, F W B, and Charles, M, 1995 *Conservation of timber buildings*, London

English Heritage, 1998 *Dendrochronology: Guidelines on Producing and Interpreting Dendrochronological Dates*, London

Groves, C, and Hillam, J, 1994 *Tree-ring analysis of the Tithe Barn, Englishcombe, near Bath, Avon, 1994*, Anc Mon Lab Rep, 64/94

Howard, R E, Laxton, R R, and Litton, C D, 2001 *Tree-ring analysis of timbers from Exeter Cathedral, Exeter, Devon, Part I*, Centre for Archaeol Rep, 47/2001

Hurford, M, Bridge, M, and Tyers, C, 2010a *King John's Hunting Lodge, Lacock, Wiltshire: tree-ring analysis of timbers*, English Heritage Res Dept Rep Ser, 101/2010

Hurford, M, Howard, R E, and Tyers, C, 2010b *Bremhill Court, Bremhill, Wiltshire: tree-ring analysis of timbers*, English Heritage Res Dept Rep Ser, 77/2010

Lloyd, A, 2009 *Wiltshire cruck buildings and other archaic roof types: an archaeological and dendrochronological analysis of medieval timber construction in the county*, English Heritage Historic Environment Enabling Programme 5104 Project Design

Lloyd, A, 2012 *Cruck buildings and other archaic roof types: an archaeological analysis of medieval timber construction in Wiltshire*, English Heritage Historic Environment Enabling Programme 5104 Project Report

Miles, D H, 2006 Refinements in the interpretation of tree-ring dates for oak building timbers in England and Wales, *Vernacular Architect*, 37, 84–96

Miles, D H, and Worthington, M J, 2000 Tree-ring dates for buildings: List 107, *Vernacular Architect*, 31, 90–101

Rackham, O, 1990 *Trees and Woodland in the British Landscape*, 2nd edn, London

Tyers, C, Hurford, M, and Bridge, M, 2014 *Dauntsey House, Dauntsey, Wiltshire: tree-ring analysis of timbers*, English Heritage Res Rep Ser, 62/2014

Tyers, I, 2004 *Dendro for Windows program guide 3rd edn*, ARCUS Rep, 500b

Wiltshire Buildings Record 2012 *Wick Cottage, Heddington Wick Common, Heddington*, WBR report, B6209.1

TABLES

Table 1: Details of tree-ring samples from Wick Farm Cottage, Heddington Wick Common, Heddington, Wiltshire

Sample number	Sample location	Total rings	Sapwood rings	Average Ring Width	Cross-section dimensions	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
HWW-F01	Truss B south cruck blade	159	24Cw	1.03	150x300	1177	1311	1335
HWW-F01_1	*ditto*	*120*	*24Cw*	*0.94*	*ditto*	*1216*	*1311*	*1335*
HWW-F01_2	*ditto*	*159*	*24Cw*	*0.98*	*ditto*	*1177*	*1311*	*1335*
HWW-F02	Truss B collar	143	24Cw	1.01	120x230	1192	1310	1334
HWW-F03	Truss B north cruck blade	178	23Cw	0.96	150x300	1158	1312	1335
HWW-F03_1	*ditto*	*105*	*23Cw*	*0.82*	*ditto*	*1231*	*1312*	*1335*
HWW-F03_2	*ditto*	*178*	*23Cw*	*0.89*	*ditto*	*1158*	*1312*	*1335*
HWW-F04	Truss B curved apex piece	71	12	1.35	120x170	----	----	----
HWW-F05	Truss C north principal rafter	51	21Cs	2.51	160x250	----	----	----
HWW-F06	Truss C collar	43	19Cw	2.12	180x???	----	----	----
HWW-F07	Truss C tiebeam	67	22Cs	2.09	240x???	----	----	----

Cw = complete sapwood is present on the sample, the outermost ring was measured as it appears complete and thus the timber was felled in winter

Cs = complete sapwood is present on the sample, the outermost ring was not measured as it appeared incomplete and thus the timber was felled in late spring/early summer

??? = the second dimensions are not known for HWW-F06 and F07 as they were partially embedded in the west gable wall

Table 2: Matrix showing the t-values obtained between the ring sequences in site chronology HWWFSQ01. Grey shading indicates possible same-tree match

Filenames	HWW-F02	HWW-F03
HWW-F01	7.37	16.95
HWW-F02		8.87

Table 3: Matrix showing the t-values obtained between the ring sequences in site chronology HWWFSQ02

Filenames	HWW-F07
HWW-F05	8.21

Table 4: Results of the cross-matching of site sequence HWWFSQ01 and relevant reference chronologies when the first-ring date is AD 1158 and the last-ring date is AD 1335

Reference chronology	*t*-value	Span of chronology	Reference
Dauntsey House, Dauntsey, Wiltshire	12.8	AD 1122–1355	(Tyers *et al* 2014)
Exeter Cathedral, Exeter, Devon	11.5	AD 1132–1315	(Howard *et al* 2001)
Court Farm Barn, Winterbourne, Gloucestershire	9.9	AD 1177–1341	(Miles and Worthington 2000)
Abbey Barn, Glastonbury, Somerset	9.9	AD 1095–1334	(Bridge 2001)
Bremhill Court, Bremhill, Wiltshire	9.3	AD 1111–1323	(Hurford *et al* 2010b)
King John's Hunting Lodge, Lacock, Wiltshire	9.2	AD 1148–1318	(Hurford *et al* 2010a)
Fiddleford Manor, Sturminster Newton, Dorset	8.6	AD 1167–1315	(Bridge 2003)
Tithe Barn, Englishcombe, near Bath	8.1	AD 1157–1304	(Groves and Hillam 1994)

FIGURES

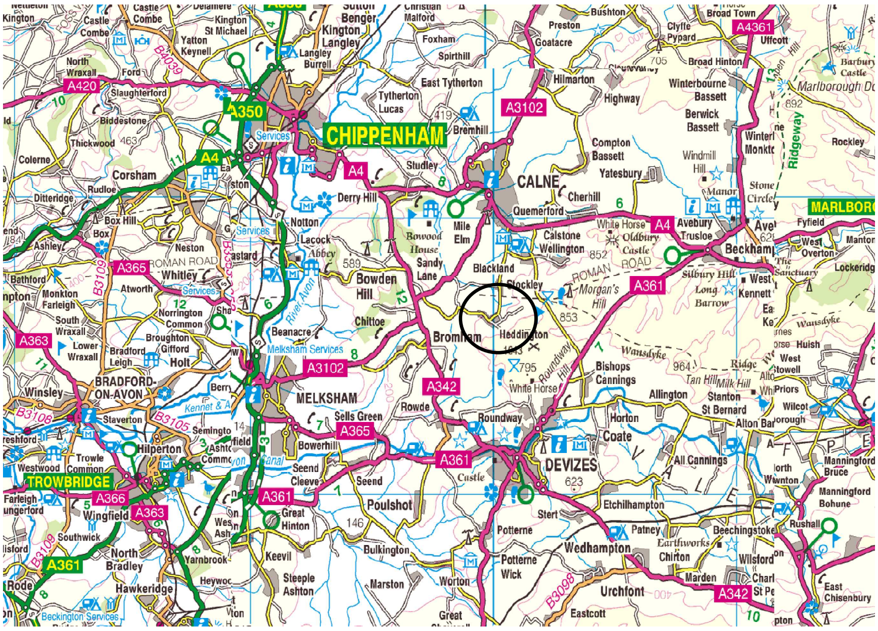


Figure 1: Map to show the location of Wick Farm Cottage, Heddington Wick, Wiltshire. © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900

Figure 2: Map to show the location of Wick Farm Cottage within the hamlet of Heddington Wick. © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900

Figure 3: General view of Wick Farm Cottage viewed looking north-west (photo Matt Hurford)

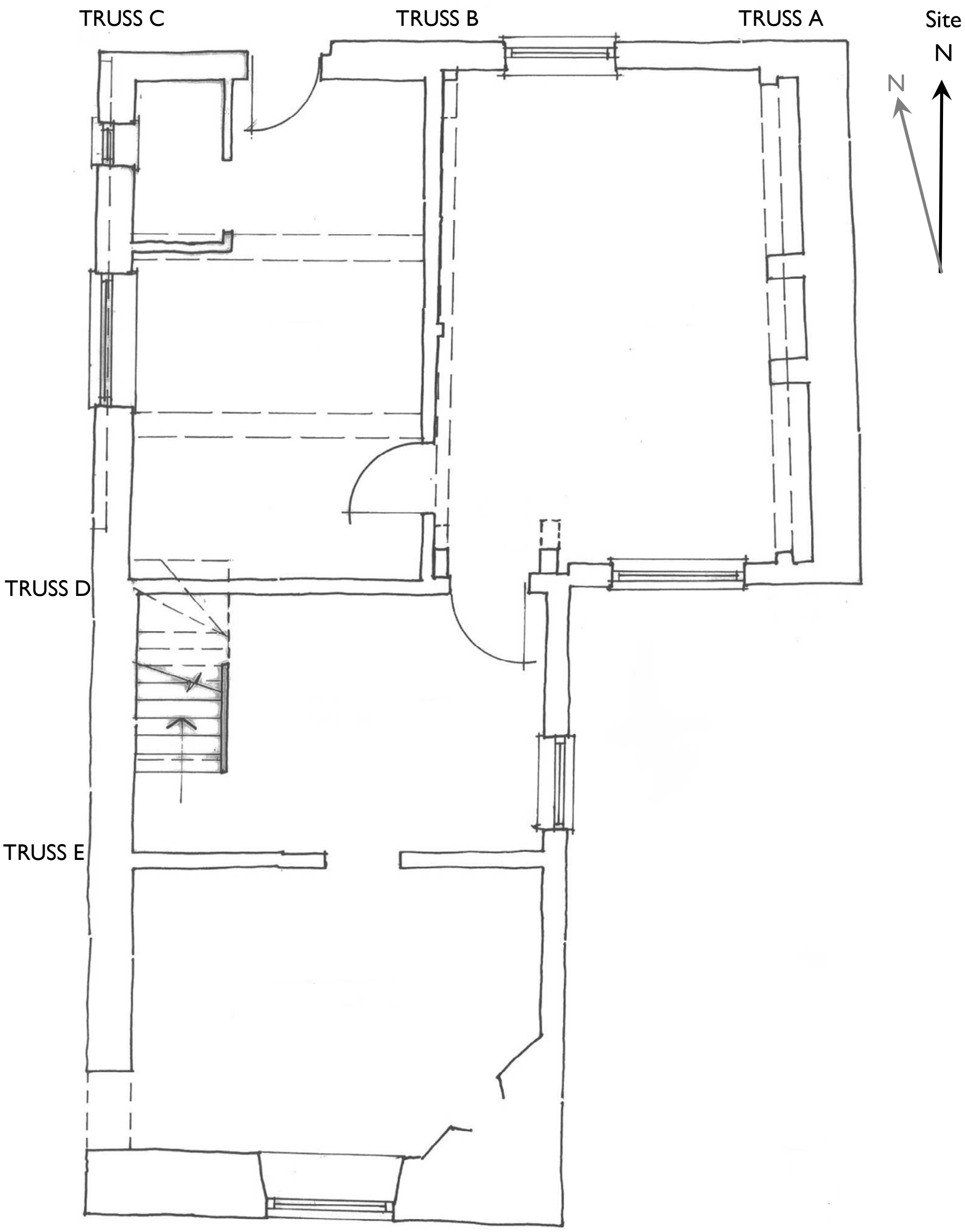


Figure 4: General plan of Wick Farm Cottage (based on a drawing by C Carter of the Wiltshire Buildings Record)

Figure 5: Truss B west face (photo Matt Hurford)

Figure 6: Truss C east face (photo Matt Hurford)

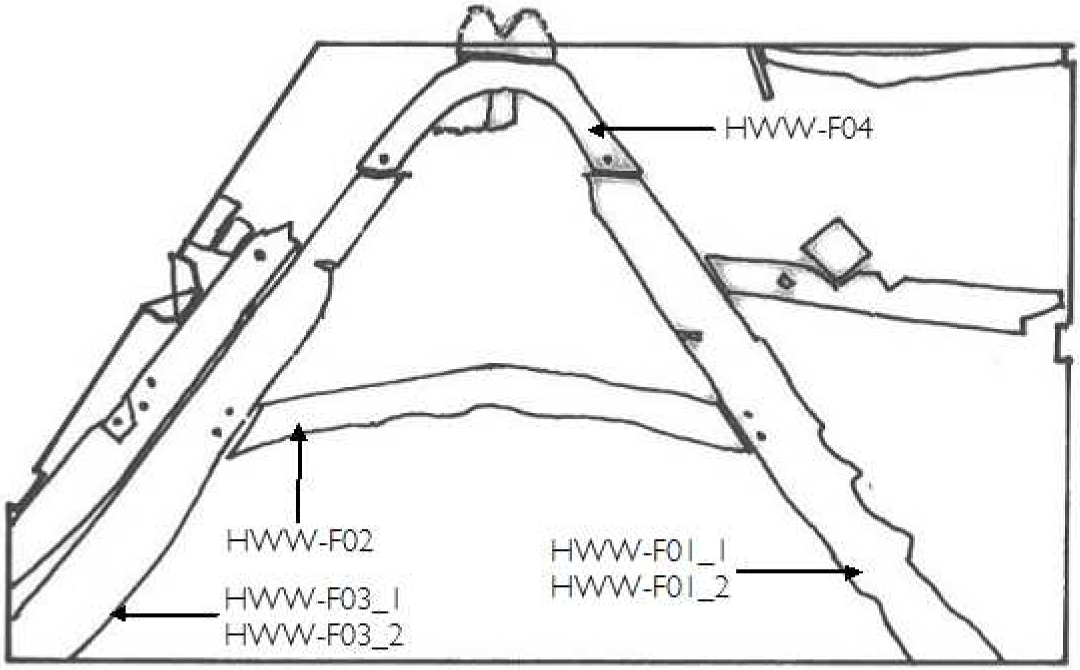


Figure 7: Truss B west face sample locations (based on a drawing by C Carter of the Wiltshire Buildings Record)

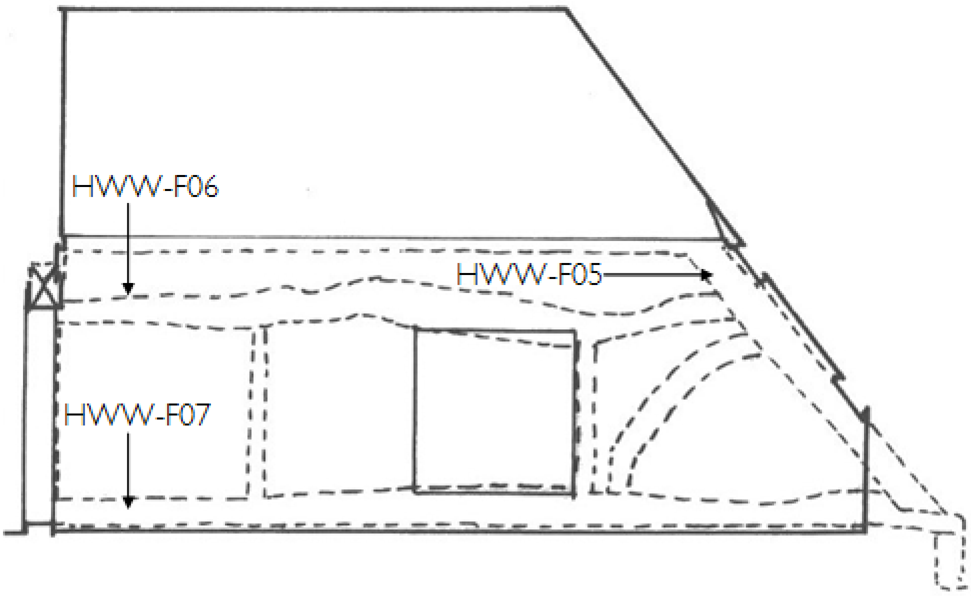
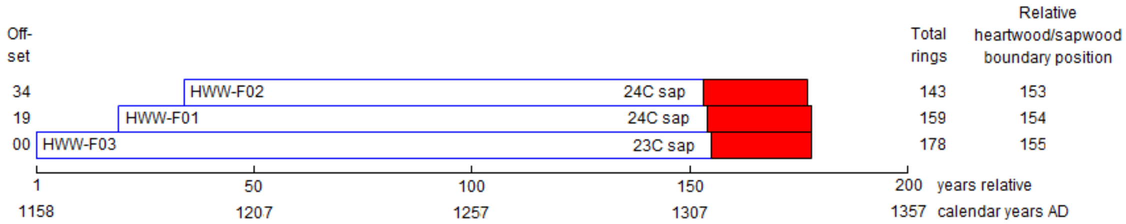
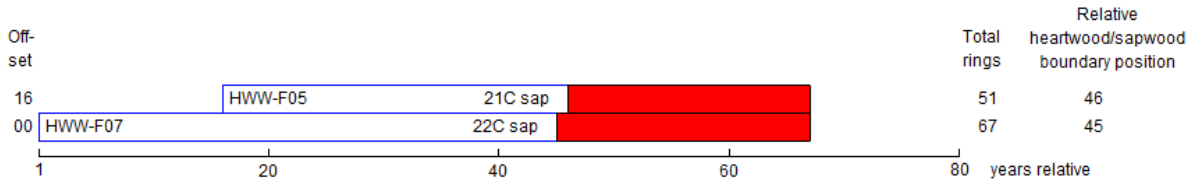


Figure 8: Truss C east face sample locations. Timbers have dashed lines as the wall has been dry lined so definitive edges for the timbers could not be discerned (based on a drawing by C Carter of the Wiltshire Building Record)



White bars = heartwood rings;
filled bars = sapwood rings
C= complete sapwood is retained on the sample

Figure 9: Bar diagram of the samples in site chronology HWWFSQ01



White bars = heartwood rings;
filled bars = sapwood rings
C= complete sapwood is retained on the sample

Figure 10: Bar diagram of the samples in site chronology HWWFSQ02

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

HWW-F01_1A 120
124 143 130 137 182 244 147 157 157 149 214 192 191 257 126 132 124 86 111 99
89 101 114 95 108 106 106 136 118 103 83 81 85 122 123 90 109 82 65 115
101 91 76 50 76 104 97 79 76 78 79 70 72 93 71 114 73 70 77 81
66 106 108 97 114 77 66 45 49 44 52 44 34 58 79 54 75 74 90 63
59 47 61 62 54 76 84 89 74 62 122 142 133 127 98 122 105 104 64 53
53 65 61 75 83 97 98 86 71 63 57 46 63 72 70 48 49 61 65 106
HWW-F01_1B 120
125 148 127 135 182 250 153 158 144 144 221 191 184 252 134 142 119 91 103 101
92 115 108 89 109 101 96 134 117 100 79 83 84 122 122 89 104 90 63 118
102 89 76 54 79 98 97 78 80 74 74 75 74 88 72 116 67 65 83 71
77 105 100 94 117 78 60 49 49 46 56 38 37 56 76 55 74 69 90 61
70 50 69 52 62 68 96 86 77 66 110 140 130 117 105 114 103 107 62 50
56 64 62 75 81 100 92 88 70 62 44 46 71 71 75 49 40 59 68 99
HWW-F01_2A 159
148 163 172 92 148 169 145 76 72 98 169 86 177 197 119 122 137 126 157 146
166 125 137 241 264 168 116 107 165 196 102 195 190 181 188 166 214 167 206 113
184 135 149 157 196 112 124 131 132 219 161 122 172 96 109 93 76 85 100 73
96 84 82 102 104 83 138 95 86 67 67 56 82 93 73 76 66 44 81 80
77 67 49 61 87 79 61 69 61 64 64 55 93 62 91 53 68 71 52 54
95 84 80 97 76 60 50 49 42 62 28 36 55 76 54 67 76 70 61 58
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47 53 60 64 84 87 78 75 47 38 59 68 63 69 44 54 63 81 127
HWW-F01_2B 159
133 166 168 98 146 171 140 81 64 97 158 81 175 193 141 130 139 127 155 148
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187 130 144 173 196 115 118 136 135 205 166 121 178 88 110 100 72 85 98 80
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49 51 57 59 70 89 72 66 57 87 98 89 98 67 92 80 80 52 30 39
52 53 58 62 89 82 82 66 46 41 51 63 63 77 47 57 63 73 123
HWW-F02A 143
66 95 92 83 81 72 50 58 91 139 72 58 43 59 62 58 81 111 110 122
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111 91 109 138 159 139 93 98 83 80 79 99 91 58 86 59 75 76 75 51
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87 96 57 72 92 70 95 116 94 107 141 127 159 143 118 65 78 72 101 137
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174 153 152 101 129 99 169 284 216 220 320 461 232 285 331 310 337 211 275 131
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HWW-F04A 71
110 131 161 156 136 133 157 125 162 166 196 163 164 158 155 216 203 201 118 103
90 120 127 110 138 100 120 128 95 110 133 116 119 138 186 121 151 187 164 143
206 86 91 67 91 136 169 153 139 130 162 168 134 119 87 93 119 154 152 129
122 109 104 136 116 117 142 132 85 107 88
HWW-F04B 71
141 140 160 149 132 130 157 125 162 163 193 163 156 155 156 219 211 196 130 94
94 117 134 110 130 100 124 123 97 109 123 109 124 142 183 115 161 194 179 153
207 91 88 73 93 140 164 149 142 128 165 168 131 110 87 98 139 161 157 129
127 111 111 134 123 121 144 126 115 78 88

HWW-F05A 51
256 320 335 261 293 247 365 285 362 461 442 502 366 212 300 442 429 340 336 265
338 338 377 370 318 459 461 315 307 117 71 95 133 133 104 145 81 53 80 106
149 92 104 98 107 138 113 191 218 142 189
HWW-F05B 51
265 320 340 263 290 251 363 284 349 460 450 502 386 213 297 450 437 351 340 273
336 333 378 390 324 462 472 327 301 124 80 87 137 130 100 151 79 50 84 100
149 97 99 98 110 133 110 191 214 146 187
HWW-F06A 43
243 232 247 286 318 238 280 132 230 220 355 231 446 244 221 370 343 332 257 274
329 320 347 271 558 135 55 61 82 102 86 73 101 127 172 167 204 96 51 53
61 55 76
HWW-F06B 43
248 231 242 283 315 239 290 136 257 215 370 213 432 250 223 365 346 326 255 269
330 371 412 262 609 144 47 53 64 104 84 74 101 131 181 170 203 89 59 51
45 51 74HWW-F07A 67
350 407 368 248 334 346 461 381 330 371 348 280 258 172 113 119 102 142 175 217
244 126 166 186 271 350 327 385 168 101 155 296 311 274 263 234 287 239 285 321
306 281 349 218 230 122 72 78 87 117 116 144 73 50 55 62 107 75 90 64
105 101 74 175 149 106 134
HWW-F07B 67
351 404 368 244 336 349 461 393 326 367 346 280 262 175 108 120 103 142 176 216
245 126 164 187 277 352 323 383 171 101 156 297 314 273 263 229 286 241 284 316
296 281 341 211 222 130 64 80 82 126 116 147 79 44 53 63 108 79 83 66
98 107 73 167 148 119 128

APPENDIX: TREE-RING DATING

The Principles of Tree-Ring Dating

Tree-ring dating, or dendrochronology as it is known, is discussed in some detail in the Nottingham Tree-ring Dating Laboratory's Monograph, *An East Midlands Master Tree-Ring Chronology and its uses for dating Vernacular Building* (Laxton and Litton 1988) and *Dendrochronology: Guidelines on Producing and Interpreting Dendrochronological Dates* (English Heritage 1998). Here we will give the bare outlines. Each year an oak tree grows an extra ring on the outside of its trunk and all its branches just inside its bark. The width of this annual ring depends largely on the weather during the growing season, about April to October, and possibly also on the weather during the previous year. Good growing seasons give rise to relatively wide rings, poor ones to very narrow rings and average ones to relatively average ring widths. Since the climate is so variable from year to year, almost random-like, the widths of these rings will also appear random-like in sequence, reflecting the seasons. This is illustrated in Figure A1 where, for example, the widest rings appear at irregular intervals. This is the key to dating by tree rings, or rather, by their widths. Records of the average ring widths for oaks, one for each year for the last 1000 years or more, are available for different areas. These are called master chronologies. Because of the random-like nature of these sequences of widths, there is usually only one position at which a sequence of ring widths from a sample of oak timber with at least 70 rings will match a master. This will date the timber and, in particular, the last ring.

If the bark is still on the sample, as in Figure A1, then the date of the last ring will be the date of felling of the oak from which it was cut. There is much evidence that in medieval times oaks cut down for building purposes were used almost immediately, usually within the year or so (Rackham 1976). Hence if bark is present on several main timbers in a building, none of which appear reused or are later insertions, and if they all have the same date for their last ring, then we can be quite confident that this is the date of construction or soon after. If there is no bark on the sample, then we have to make an estimate of the felling date; how this is done is explained below.

The Practice of Tree-Ring Dating at the Nottingham Tree-Ring Dating Laboratory

1. **Inspecting the Building and Sampling the Timbers.** Together with a building historian the timbers in a building are inspected to try to ensure that those sampled are not reused or later insertions. Sampling is almost always done by coring into the timber, which has the great advantage that we can sample *in situ* timbers and those judged best to give the date of construction, or phase of construction if there is more than one in the building. The timbers to be sampled are also inspected to see how many rings they have. We normally look for timbers with at least 70 rings, and preferably more. With fewer

rings than this, 50 for example, sequences of widths become difficult to match to a unique position within a master sequence of ring widths and so are difficult to date (Litton and Zainodin 1991). The cross-section of the rafter shown in Figure A2 has about 120 rings; about 20 of which are sapwood rings – the lighter rings on the outside. Similarly the core has just over 100 rings with a few sapwood rings.

To ensure that we are getting the date of the building as a whole, or the whole of a phase of construction if there is more than one, about 8–10 samples per phase are usually taken. Sometimes we take many more, especially if the construction is complicated. One reason for taking so many samples is that, in general, some will fail to give a date. There may be many reasons why a particular sequence of ring widths from a sample of timber fails to give a date even though others from the same building do. For example, a particular tree may have grown in an odd ecological niche, so odd indeed that the widths of its rings were determined by factors other than the local climate! In such circumstances it will be impossible to date a timber from this tree using the master sequence whose widths, we can assume, were predominantly determined by the local climate at the time.

Sampling is done by coring into the timber with a hollow corer attached to an electric drill and usually from its outer rings inwards towards where the centre of the tree, the pith, is judged to be. An illustration of a core is shown in Figure A2; it is about 150mm long and 10mm diameter. Great care has to be taken to ensure that as few as possible of the outer rings are lost in coring. This can be difficult as these outer rings are often very soft (see below on sapwood). Each sample is given a code which identifies uniquely which timber it comes from, which building it is from and where the building is located. For example, CRO-A06 is the sixth core taken from the first building (A) sampled by the Laboratory in Cropwell Bishop. Where it came from in that building will be shown in the sampling records and drawings. No structural damage is done to any timbers by coring, nor does it weaken them.

During the initial inspection of the building and its timbers the dendrochronologist may come to the conclusion that, as far as can be judged, none of the timbers have sufficient rings in them for dating purposes and may advise against sampling to save further unwarranted expense.

All sampling by the Laboratory is undertaken according to current Health and Safety Standards. The Laboratory's dendrochronologists are insured.

Figure A1: A wedge of oak from a tree felled in 1976. It shows the annual growth rings, one for each year from the innermost ring to the last ring on the outside just inside the bark. The year of each ring can be determined by counting back from the outside ring, which grew in 1976

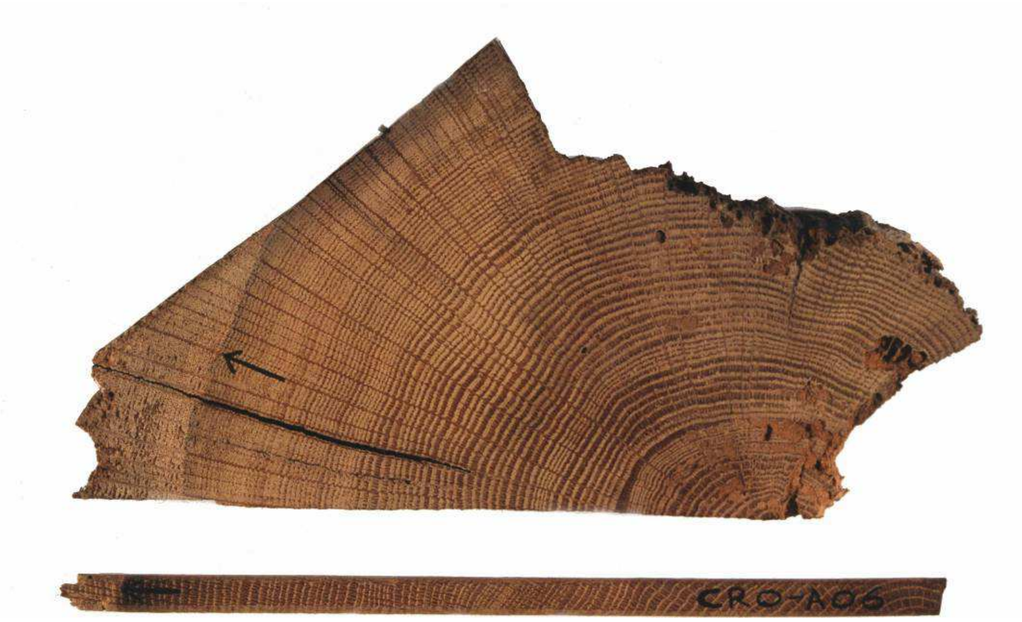


Figure A2: Cross-section of a rafter, showing sapwood rings in the left-hand corner, the arrow points to the heartwood/sapwood boundary (H/S); and a core with sapwood; again the arrow is pointing to the H/S. The core is about the size of a pencil

Figure A3: Measuring ring widths under a microscope. The microscope is fixed while the sample is on a moving platform. The total sequence of widths is measured twice to ensure that an error has not been made. This type of apparatus is needed to process a large number of samples on a regular basis

Figure A4: Three cores from timbers in a building. They come from trees growing at the same time. Notice that, although the sequences of widths look similar, they are not identical. This is typical

2. Measuring Ring Widths. Each core is sanded down with a belt sander using medium-grit paper and then finished by hand with flourgrade-grit paper. The rings are then clearly visible and differentiated from each other with a result very much like that shown in Figure A2. The core is then mounted on a movable table below a microscope and the ring-widths measured individually from the innermost ring to the outermost. The widths are automatically recorded in a computer file as they are measured (see Fig A3).

3. Cross-Matching and Dating the Samples. Because of the factors besides the local climate which may determine the annual widths of a tree's rings, no two sequences of ring widths from different oaks growing at the same time are exactly alike (Fig A4). Indeed, the sequences may not be exactly alike even when the trees are growing near to each other. Consequently, in the Laboratory we do not attempt to match two sequences of ring widths by eye, or graphically, or by any other subjective method. Instead, it is done objectively (ie statistically) on a computer by a process called cross-matching. The output from the computer tells us the extent of correlation between two sample sequences of widths or, if we are dating, between a sample sequence of widths and the master, at each relative position of one to the other (offsets). The extent of the correlation at an offset is determined by the *t*-value (defined in almost any introductory book on statistics). That offset with the maximum *t*-value among the *t*-values at all the offsets will be the best candidate for dating one sequence relative to the other. If one of these is a master chronology, then this will date the other. Experiments carried out in the past with sequences from oaks of known date suggest that a *t*-value of at least 4.5, and preferably at least 5.0, is usually adequate for the dating to be accepted with reasonable confidence (Laxton and Litton 1988; Laxton *et al* 1988; Howard *et al* 1984–1995).

This is illustrated in Figure A5 with timbers from one of the roofs of Lincoln Cathedral. Here four sequences of ring widths, LIN-C04, 05, 08, and 45, have been cross-matched with each other. The ring widths themselves have been omitted in the bar diagram, as is usual, but the offsets at which they best cross-match each other are shown; eg the sequence of ring widths of C08 matches the sequence of ring widths of C45 best when it is at a position starting 20 rings after the first ring of C45, and similarly for the others. The actual *t*-values between the four at these offsets of best correlations are in the matrix. Thus at the offset of +20 rings, the *t*-value between C45 and C08 is 5.6 and is the maximum found between these two among all the positions of one sequence relative to the other.

It is standard practice in our Laboratory first to cross-match as many as possible of the ring-width sequences of the samples in a building and then to form an average from them. This average is called a site sequence of the building being dated and is illustrated in Figure A5. The fifth bar at the bottom is a site sequence for a roof at Lincoln Cathedral and is constructed from the matching sequences of the four timbers. The site sequence width for each year is the average of the widths in each of the sample sequences which has a width for that year. Thus in Fig A5 if the widths shown are 0.8mm for C45, 0.2mm for C08, 0.7mm for C05, and 0.3mm for C04, then the corresponding width of the site sequence is the average of these, 0.55mm. The actual sequence of widths of this site sequence is stored on the computer. The reason for creating site sequences is that it is usually easier to date an average sequence of ring widths with a master sequence than it is to date the individual component sample sequences separately.

The straightforward method of cross-matching several sample sequences with each other one at a time is called the 'maximal *t*-value' method. The actual method of cross-matching a group of sequences of ring-widths used in the Laboratory involves grouping and averaging the ring-width sequences and is called the 'Litton-Zainodin Grouping Procedure'. It is a modification of the straightforward method and was successfully developed and tested in the Laboratory and has been published (Litton and Zainodin 1991; Laxton *et al* 1988).

4. **Estimating the Felling Date.** As mentioned above, if the bark is present on a sample, then the date of its last ring is the date of the felling of its tree (or the last full year before felling, if it was felled in the first three months of the following calendar year, before any new growth had started, but this is not too important a consideration in most cases). The actual bark may not be present on a timber in a building, though the dendrochronologist who is sampling can often see from its surface that only the bark is missing. In these cases the date of the last ring is still the date of felling.

Quite often some, though not all, of the original outer rings are missing on a timber. The outer rings on an oak, called sapwood rings, are usually lighter than the inner rings, the heartwood, and so are relatively easy to identify. For example, sapwood can be seen in the corner of the rafter and at the outer end of the core in Figure A2, both indicated by arrows. More importantly for dendrochronology, the sapwood is relatively soft and so liable to insect attack and wear and tear. The builder, therefore, may remove some of the sapwood for precisely these reasons. Nevertheless, if at least some of the sapwood rings are left on a sample, we will know that not too many rings have been lost since felling so that the date of the last ring on the sample is only a few years before the date of the original last ring on the tree, and so to the date of felling.

Various estimates have been made and used for the average number of sapwood rings in mature oak trees (English Heritage 1998). A fairly conservative range is between 15 and 50 and that this holds for 95% of mature oaks. This means, of course, that in a small number of cases there could be fewer than 15 and more than 50 sapwood rings. For example, the core CRO-A06 has only 9 sapwood rings and some have obviously been lost over time – either they were removed originally by the carpenter and/or they rotted away in the building and/or they were lost in the coring. It is not known exactly how many sapwood rings are missing, but using the above range the Laboratory would estimate between a minimum of 6 (=15-9) and a maximum of 41 (=50-9). If the last ring of CRO-A06 has been dated to 1500, say, then the estimated felling-date range for the tree from which it came originally would be between 1506 and 1541. The Laboratory uses this estimate for sapwood in areas of England where it has no prior information. It also uses it when dealing with samples with very many rings, about 120 to the last heartwood ring. But in other areas of England where the Laboratory has accumulated a number of samples with complete sapwood, that is, no sapwood lost since felling, other estimates in place of the conservative range of 15 to 50 are used. In the East Midlands (Laxton *et al* 2001) and the east to the south down to Kent (Pearson 1995) where it has sampled extensively in the past, the Laboratory uses the shorter estimate of 15 to 35 sapwood rings in 95% of mature oaks growing in these parts. Since the sample CRO-A06 comes from a house in Cropwell Bishop in the East Midlands, a better estimate of sapwood rings lost since felling is between a minimum of 6 (=15-9) and 26 (=35-9) and the felling would be estimated to have taken place between 1506 and 1526, a shorter period than before. Oak boards quite often come from the Baltic region and in these cases the 95% confidence limits for sapwood are 9 to 36 (Howard *et al* 1992, 56).

Even more precise estimates of the felling date and range can often be obtained using knowledge of a particular case and information gathered at the time of sampling. For example, at the time of sampling the dendrochronologist may have noted that the timber from which the core of Figure A2 was taken still had complete sapwood but that some of the soft sapwood rings were lost in coring. By measuring into the timber the depth of sapwood lost, say 20mm, a reasonable estimate can be made of the number of sapwood rings lost, say 12 to 15 rings in this case. By adding on 12 to 15 years to the date of the last ring on the sample a good tight estimate for the range of the felling date can be obtained, which is often better than the 15 to 35 years later we would have estimated without this observation. In the example, the felling is now estimated to have taken place between AD 1512 and 1515, which is much more precise than without this extra information.

Even if all the sapwood rings are missing on a sample, but none of the heartwood rings are, then an estimate of the felling-date range is possible by adding on the full compliment of, say, 15 to 35 years to the date of the last heartwood ring (called the heartwood/sapwood boundary or transition ring and denoted H/S). Fortunately it is often easy for a trained dendrochronologist to identify this boundary on a timber. If a timber does not have its heartwood/sapwood boundary, then only a *post quem* date for felling is possible.

5. Estimating the Date of Construction. There is a considerable body of evidence collected by dendrochronologists over the years that oak timbers used in buildings were not seasoned in medieval or early modern times (English Heritage 1998; Miles 1997, 50–5). Hence, provided that all the samples in a building have estimated felling-date ranges broadly in agreement with each other, so that they appear to have been felled as a group, then this should give an accurate estimate of the period when the structure was built, or soon after (Laxton *et al* 2001, fig 8; 34–5, where 'associated groups of fellings' are discussed in detail). However, if there is any evidence of storage before use, or if there is evidence the oak came from abroad (eg Baltic boards), then some allowance has to be made for this.

6. **Master Chronological Sequences.** Ultimately, to date a sequence of ring widths, or a site sequence, we need a master sequence of dated ring widths with which to cross-match it, a Master Chronology. To construct such a sequence we have to start with a sequence of widths whose dates are known and this means beginning with a sequence from an oak tree whose date of felling is known. In Figure A6 such a sequence is SHE-T, which came from a tree in Sherwood Forest which was blown down in a recent gale. After this other sequences which cross-match with it are added and gradually the sequence is 'pushed back in time' as far as the age of samples will allow. This process is illustrated in Figure A6. We have a master chronological sequence of widths for Nottinghamshire and East Midlands oak for each year from AD 882 to 1981. It is described in great detail in Laxton and Litton (1988), but the components it contains are shown here in the form of a bar diagram. As can be seen, it is well replicated in that for each year in this period there are several sample sequences having widths for that year. The master is the average of these. This master can now be used to date oak from this area and from the surrounding areas where the climate is very similar to that in the East Midlands. The Laboratory has also constructed a master for Kent (Laxton and Litton 1989). The method the Laboratory uses to construct a master sequence, such as the East Midlands and Kent, is completely objective and uses the Litton-Zainodin grouping procedure (Laxton *et al* 1988). Other laboratories and individuals have constructed masters for other areas and have made them available. As well as these masters, local (dated) site chronologies can be used to date other buildings from nearby. The Laboratory has hundreds of these site sequences from many parts of England and Wales covering many short periods.

7. **Ring-Width Indices.** Tree-ring dating can be done by cross-matching the ring widths themselves, as described above. However, it is advantageous to modify the widths first. Because different trees grow at different rates and because a young oak grows in a different way from an older oak, irrespective of the climate, the widths are first standardized before any matching between them is attempted. These standard widths are known as ring-width indices and were first used in dendrochronology by Baillie and Pilcher (1973). The exact form they take is explained in this paper and in the appendix of Laxton and Litton (1988) and is illustrated in the graphs in Figure A7. Here ring-widths are plotted vertically, one for each year of growth. In the upper sequence of (a), the generally large early growth after 1810 is very apparent as is the smaller later growth from about 1900 onwards when the tree is maturing. A similar phenomenon can be observed in the lower sequence of (a) starting in 1835. In both the widths are also changing rapidly from year to year. The peaks are the wide rings and the troughs are the narrow rings corresponding to good and poor growing seasons, respectively. The two corresponding sequence of Baillie-Pilcher indices are plotted in (b) where the differences in the immature and mature growths have been removed and only the rapidly changing peaks and troughs remain, that are associated with the common climatic signal. This makes cross-matching easier.

t-value/offset Matrix

	C45	C08	C05	C04
C45		+20	+37	+47
C08	5.6		+17	+27
C05	5.2	10.4		+10
C04	5.9	3.7	5.1	

Bar Diagram

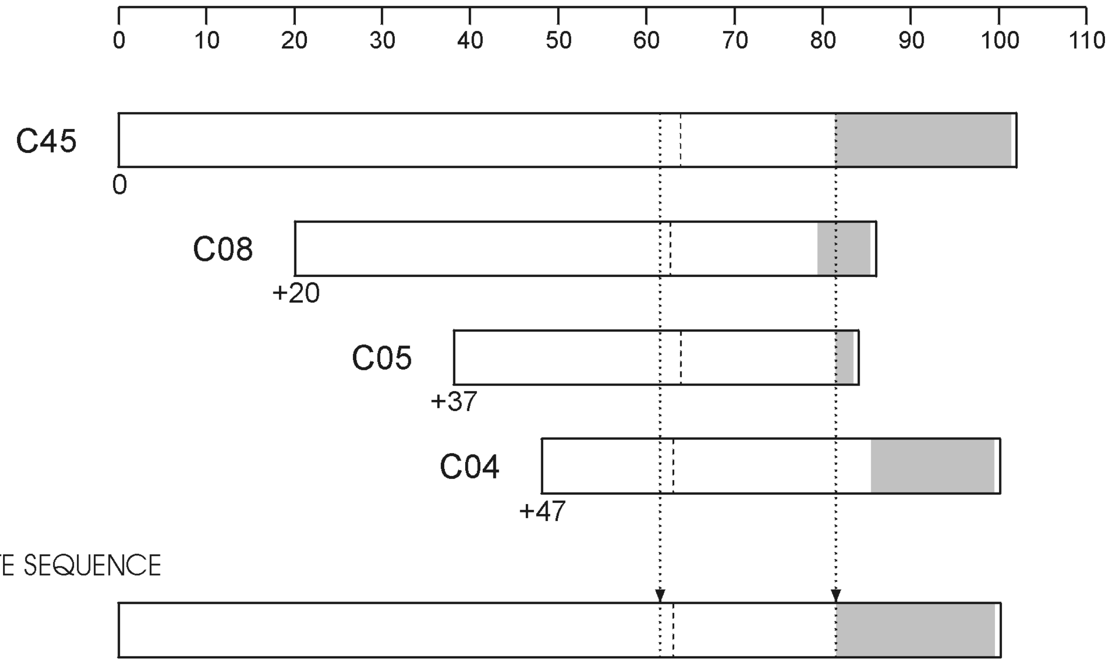


Figure A5: Cross-matching of four sequences from a Lincoln Cathedral roof and the formation of a site sequence from them

The bar diagram represents these sequences without the rings themselves. The length of the bar is proportional to the number of rings in the sequence. Here the four sequences are set at relative positions (offsets) to each other at which they have maximum correlation as measured by the *t*-values. The *t*-value/offset matrix contains the maximum *t*-values below the diagonal and the offsets above it. Thus, the maximum *t*-value between C08 and C45 occurs at the offset of +20 rings and the *t*-value is then 5.6. The site sequence is composed of the average of the corresponding widths, as illustrated with one width.

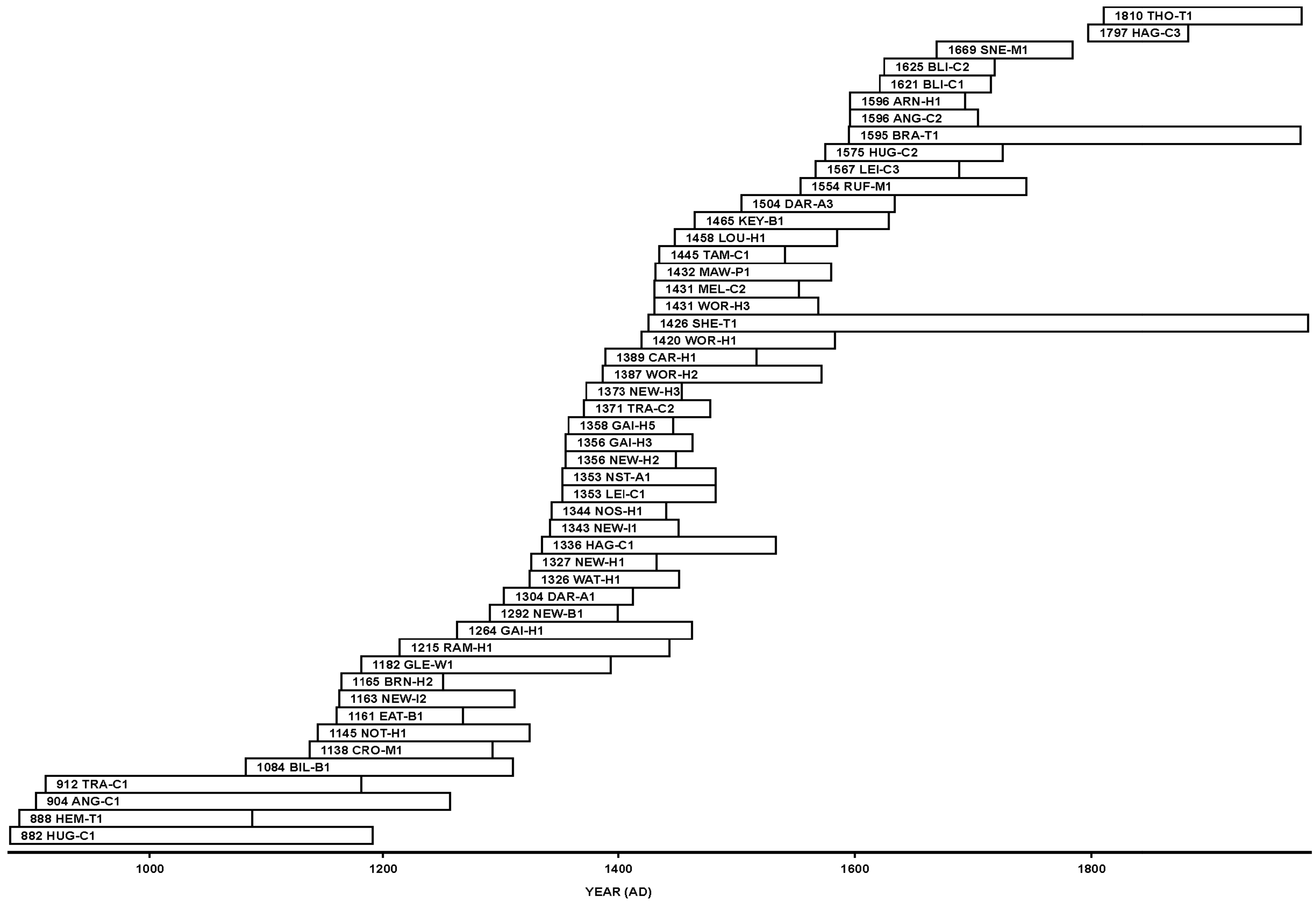
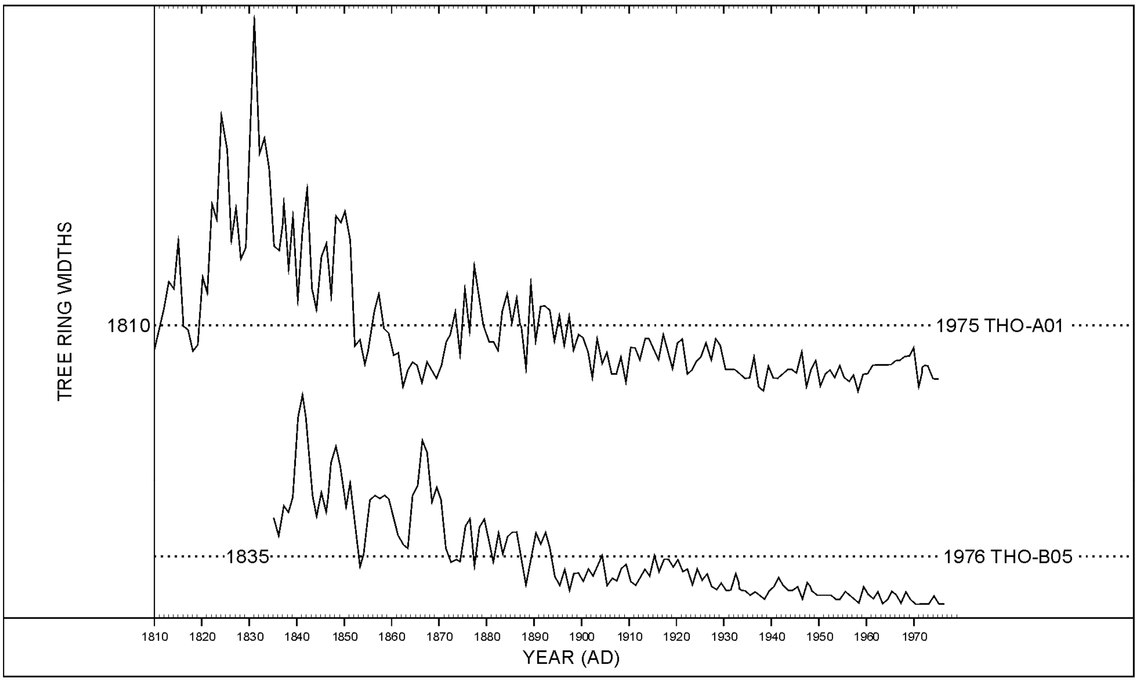


Figure A6: Bar diagram showing the relative positions and dates of the first rings of the component site sequences in the East Midlands Master Dendrochronological Sequence, EM08/87

(a)



(b)

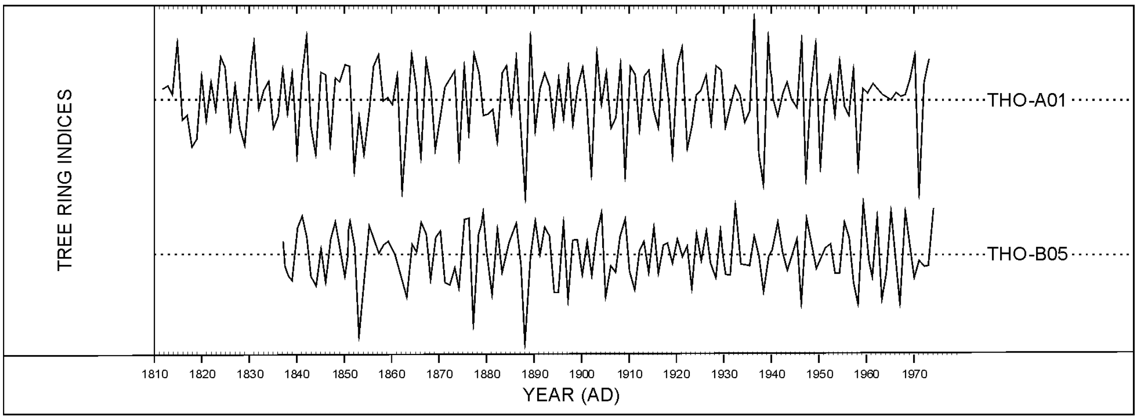


Figure A7 (a): The raw ring-widths of two samples, THO-A01 and THO-B05, whose felling dates are known

Here the ring widths are plotted vertically, one for each year, so that peaks represent wide rings and troughs narrow ones. Notice the growth-trends in each; on average the earlier rings of the young tree are wider than the later ones of the older tree in both sequences

Figure A7 (b): The Baillie-Pilcher indices of the above widths

The growth trends have been removed completely

References

Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree-Ring Bull*, 33, 7–14

English Heritage, 1998 *Dendrochronology: Guidelines on Producing and Interpreting Dendrochronological Dates*, London

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1984–95 Nottingham University Tree-Ring Dating Laboratory results, *Vernacular Architect*, 15–26

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1992 List 44 no 17 - Nottingham University Tree-Ring Dating Laboratory: tree-ring dates for buildings in the East Midlands, *Vernacular Architect*, 23, 51–6.

Laxon, R R, Litton, C D, and Zainodin, H J, 1988 An objective method for forming a master ring-width sequence, *P A C T*, 22, 25–35

Laxton, R R, and Litton, C D, 1988 *An East Midlands Master Chronology and its use for dating vernacular buildings*, University of Nottingham, Department of Archaeology Publication, Monograph Series III

Laxton, R R, and Litton, C D, 1989 Construction of a Kent master dendrochronological sequence for oak, AD 1158 to 1540, *Medieval Archaeol*, 33, 90–8

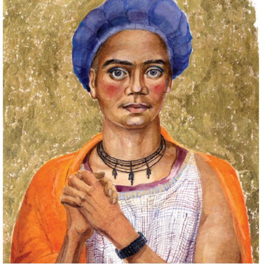
Laxton, R R, Litton, C D, and Howard, R E, 2001 *Timber: Dendrochronology of Roof Timbers at Lincoln Cathedral*, Engl Heritage Res Trans, 7

Litton, C D, and Zainodin, H J, 1991 Statistical models of dendrochronology, *J Archaeol Sci*, 18, 29–40

Miles, D W H, 1997 The interpretation, presentation and use of tree-ring dates, *Vernacular Architect*, 28, 40–56

Pearson, S, 1995 *The Medieval Houses of Kent, an Historical Analysis*, London

Rackham, O, 1976 *Trees and Woodland in the British Landscape*, London



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