

RESEARCH REPORT SERIES no. 18-2014

DRONFIELD HALL BARN, 19 HIGH STREET, DRONFIELD, DERBYSHIRE TREE-RING ANALYSIS OF TIMBERS

SCIENTIFIC DATING REPORT

Alison Arnold and Robert Howard



INTERVENTION
AND ANALYSIS



ENGLISH HERITAGE

This report has been prepared for use on the internet and the images within it have been down-sampled to optimise downloading and printing speeds.

Please note that as a result of this down-sampling the images are not of the highest quality and some of the fine detail may be lost. Any person wishing to obtain a high resolution copy of this report should refer to the ordering information on the following page.

Research Report Series 18-2014

DRONFIELD HALL BARN,
19 HIGH STREET,
DRONFIELD, DERBYSHIRE

TREE-RING ANALYSIS OF TIMBERS

Alison Arnold and Robert Howard

NGR: SK 35120 78547

© English Heritage

ISSN 1749-8775 (Print)
ISSN 2046-9802 (Online)

The Research Report Series incorporates reports by the expert teams within the Investigation & Analysis Division of the Heritage Protection Department of English Heritage, alongside contributions from other parts of the organisation. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series.

Many of the Research Reports are of an interim nature and serve to make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers must consult the author before citing these reports in any publication. Opinions expressed in Research Reports are those of the author(s) and are not necessarily those of English Heritage.

Requests for further hard copies, after the initial print run, can be made by emailing:

Res.reports@english-heritage.org.uk

or by writing to:

English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD

Please note that a charge will be made to cover printing and postage.

SUMMARY

Dendrochronological analysis was undertaken on 17 of the 19 core samples obtained from the main range and short, south wing of Dronfield Hall barn. This analysis produced a single dated site chronology comprising 13 samples, all of them from the main range. This site chronology has an overall length of 89 rings dated as spanning the years AD 1341–1429. Interpretation of the sapwood on the dated samples would suggest the likelihood that all the timbers used for the construction of the main range were cut as part of a single episode of felling in, or very shortly after, AD 1429.

One further measured sample from the lintel to the south door of the main range, plus three measured samples from the south wing, remain ungrouped and undated

CONTRIBUTORS

Alison Arnold and Robert Howard

ACKNOWLEDGEMENTS

The Nottingham Tree-ring Dating Laboratory would like to thank Professor David Hey, and other members of the local history group for the considerable help and assistance in arranging access for the assessment and sampling of the timbers, and for much of the background information given in this report's introduction. We would also like to thank Stanley Jones for further information on the history and development of the site and for the use of his plans and drawings. Finally we would like to thank Shahina Farid and Cathy Tyers (English Heritage Scientific Dating Team) for commissioning this programme of tree-ring dating.

ARCHIVE LOCATION

Derbyshire Historic Environment Record
Environmental Services Department
Shand House
Dale Road South
Matlock
Derbyshire
DE4 3RY

DATE OF INVESTIGATION

2013

CONTACT DETAILS

Alison Arnold and Robert Howard
Nottingham Tree-ring Dating Laboratory
20 Hillcrest Grove
Sherwood
Nottingham NG5 1FT
0115 960 3833
roberthoward@tree-ringdating.co.uk
alisonarnold@tree-ringdating.co.uk

CONTENTS

Introduction	1
Sampling	2
Analysis and Results	2
Interpretation and Conclusion.....	3
Main range.....	3
South wing	4
Door lintel	4
Bibliography.....	5
Tables	6
Figures	8
Data of Measured Samples	15
Appendix: Tree-Ring Dating.....	19
The Principles of Tree-Ring Dating	19
The Practice of Tree-Ring Dating at the Nottingham Tree-Ring Dating Laboratory	19
1. Inspecting the Building and Sampling the Timbers.....	19
2. Measuring Ring Widths.....	24
3. Cross-Matching and Dating the Samples.....	24
4. Estimating the Felling Date.....	25
5. Estimating the Date of Construction.....	26
6. Master Chronological Sequences.....	27
7. Ring-Width Indices	27
References	31

INTRODUCTION

Dronfield Hall barn, a Grade II* listed building, stands to the north side of Dronfield High Street, being set back some 100 metres from the road in its own enclosed grounds (Figs 1a/b). A survey, undertaken in 1970 by historic buildings archaeologist Stanley Jones, showed that the original timber-framed building had been a four-bay, two-storey structure aligned east-west. There were two equal-sized chambers at first-floor level, each chamber open to the ridge and spanned centrally by an arch-braced tiebeam truss. It was postulated, on the basis of the characteristics of the remaining framing, that this building might date to the first half of the fifteenth century. This main range may once have had a coeval range attached centrally, to its south wall (Fig 2).

The 1970 survey also showed that the timber-framed building had a south-facing elevation that differed markedly from that to the north: the north elevation presenting a sparsely timbered face of vertical studs, while the south elevation was distinguished by its use of deep curved braces. The framing to the south side, however, appears to have been interrupted which could imply that a masking structure was intended; one possibility being an external staircase. This staircase would have given access to the two first-floor chambers which appear to have been divided from each other by an internal partition.

Internally the building now retains four king-post roof trusses, there being curved braces between the king-posts and the ridge plate as well as between the single remaining south-wall post of truss 1 and the tiebeam, and from this wall post to the wall plate. The trusses carry a single purlin to each pitch of the roof (Figs 3a/b).

At some point the building was converted from domestic to agricultural use when the possible external stair tower may have been removed, and a further bay added to its west end. The timber-framed walls were mostly removed and replaced by coursed, squared, rubble walling and the requisite opposed large-wagon doors installed. It is believed that as part of these alterations a short wing was added to the east end of the south-side: this being built to accommodate stables with storage for fodder overhead. Particularly interesting in this wing is a tiebeam which may once have topped a coved canopy above the dais of an open hall, which is suggested by evidence for the curved ribs of the canopy in the form of sloping mortises.

Since the 1970 survey, Professor David Hey, Emeritus Professor of Local and Family History at the University of Sheffield and a patron of The Dronfield Heritage Trust, has unearthed considerable documentary evidence for the history of Dronfield and how this barn may relate to its remaining historic buildings, of which there are a number (Tyers 2003, Arnold and Howard forthcoming). One such document allows speculation that what is now Dronfield Hall barn may have been originally built by one Alice Deincourt.

SAMPLING

A programme of dendrochronology sampling and analysis of the timbers to the main range and short south wing of Dronfield Hall barn was requested by Bob Hawkins, English Heritage Designation Advisor, to provide more accurate and reliable independent dating evidence for the original structure of the building and the date of any reused timbers, or any timbers subsequently inserted. It was hoped that this information would inform plans to repair and conserve the building as part of the locally established Dronfield Heritage Project.

Thus from the timbers available a total of 19 samples was obtained by coring. Each sample was given the code DRN-D (for Dronfield, site 'D') and numbered 01–19 (Table 1). Thirteen samples, DRN-D01–D13, were obtained from the roof and single remaining apparently primary wall timbers of the main range, with a further five samples, DRN-D14–D18, being obtained from the roof and two ground-floor ceiling beams of the south cross-wing; these timbers believed to represent a later alteration phase. A final sample, DRN-D19, was obtained from the lintel to the south cart door to the barn, this timber also being part of the later alterations

Where possible, the locations of these samples were recorded at the time of sampling, either on a drawing made by Stanley Jones, or on photographs or simple schematic sketch plans, these being shown as Figures 4a-d. Details of the samples are given in Table 1. In this table, as in the drawings, the trusses of the barn have been numbered from east to west, with individual timbers then being further identified on a north-south basis as appropriate.

ANALYSIS AND RESULTS

Each of the 19 samples obtained from the two parts of the barn was prepared by sanding and polishing. It was at this stage that two samples were rejected, both from the south wing, as having too few rings for reliable dating. The annual growth ring-widths of the remaining 17 samples were measured, the data of these measurements being given at the end of this report. The data of the 17 measured samples were then compared with each other by the Litton/Zainodin grouping procedure (see Appendix), allowing a single group comprising 13 cross-matching samples to be formed into site chronology DRNDSQ01. The 13 samples combined at their indicated offset positions are shown in Figure 5, producing a sequence with an overall length of 89 rings.

Site chronology DRNDSQ01 was then compared to an extensive corpus of reference material for oak, indicating a consistent and repeated match with a number of these when the date of its first ring is AD 1341 and the date of its last measured ring is AD 1429. The evidence for this dating is given in Table 2.

Site chronology DRNDSQ01 was also compared to the four remaining measured but ungrouped samples, but there was no further satisfactory cross-matching. These four

ungrouped samples were then compared individually to the full corpus of reference data, but again there was no satisfactory cross-matching and these samples must, therefore, remain undated.

INTERPRETATION AND CONCLUSION

Analysis by dendrochronology of the timbers of Dronfield Hall barn has produced a single dated site chronology comprising 13 of the 17 samples measured. The 89 dated span the years AD 1341–1429 and all dated samples are from the main range.

Main range

As may be seen from Table 1 and Figure 5, four of the dated samples retain complete sapwood, the last ring produced by the tree before it was cut down. In each case this last growth ring, and thus the felling date of the trees from which the timbers derive, is identical at AD 1429. The other nine dated samples in the site chronology retain some sapwood or at least the heartwood/sapwood boundary. The relative position and date of this boundary, and the amount of sapwood the samples retain, is such that it is likely that all these other samples also represent timbers which were felled in, or around, AD 1429. All dated samples, therefore, appear to represent timbers cut as part of a single episode of felling specifically for the construction of the main range of the barn which would have taken place shortly thereafter.

The overall cross-matching between the 13 samples in the dated site chronology suggests that each timber was probably derived from a single, albeit potentially extensive, woodland source. Furthermore, although compared with reference data for all parts of England, the highest levels of similarity between the site chronology and the reference chronologies are found predominantly with sites in Derbyshire and the surrounding counties suggesting that the timbers used in the construction of the main range of Dronfield Hall barn are from relatively local woodland.

Of further note in respect of this programme of analysis are the relatively low numbers of sapwood rings found on some of the samples from the main range. As will be seen from Table 1, sample DRN-D05 has 15 sapwood rings (the lower limit of the usual 95% confidence interval of 15–40 sapwood rings), while samples DRN-D09 and D04 have fewer at 14 and 13 sapwood rings respectively. Given that it has a heartwood/sapwood boundary date of AD 1417, and working on the assumption it was also felled in AD 1429, the timber represented by sample DRN-D10 would have had only 12 sapwood rings. The highest number of sapwood rings, 28, would be found on sample DRN-D02, this figure also based on the belief that the timber was felled in AD 1429. As such, these numbers of sapwood rings might be considered a little low, and, without the presence of complete sapwood on some of the samples, would have given an estimated felling date range of 1429–54, a range which just includes the actual felling date, but which could have been taken to suggest a potentially later felling date.

South wing

None of the five samples from the timbers of the south wing have dated. Two of these samples, from the king post and a principal rafter, although relatively large timbers, had too few rings for reliable dating, while a third sample, from the dias beam, had a very low number of rings. All such timbers are from the roof. Two other south-wing timbers, both ground-floor ceiling beams, did have higher numbers of rings, but still remain undated. There is some structural indication that these two timbers may have been inserted later, either together as a pair or at different times, thus possibly making them 'singletons'. While such timbers can occasionally be dated, it is usually much more difficult than with well replicated groups of samples. It is possible that these timbers are from trees grown in locations, and/or at times, for which there is, as yet, insufficient local reference material available for cross-matching and dating.

Door lintel

Likewise, the lintel to the south doorway of the main range is believed to be a later insertion, and this too may represent an isolated timber of a different date and from a different source. It too, at least for the moment, is undated.

BIBLIOGRAPHY

Alcock, N W, Howard, R E, Laxton, R R, Litton, C D, and Miles, D H, 1991 Leverhulme Cruck Project Results: 1990, *Vernacular Architect*, **22**, 45–7

Arnold, A J, and Howard R E, 2007 *Tree-ring analysis of timbers from All Hallows' Church, Kirkburton, West Yorkshire*, EH Res Dept Rep Ser, **49/2007**

Arnold, A J, and Howard, R E, 2008 *Primrose Hill House and Barn, Meadowsweet Avenue, Kings Norton, Birmingham; Tree-Ring Analysis of Timbers*, EH Res Dept Rep Ser, **41/2008**

Arnold, A J, and Howard, R E, 2009 *The Manor House, Hall Green Road, West Bromwich, West Midlands; Tree-Ring Analysis of Timbers*, EH Res Dept Rep Ser, **49/2009**

Arnold, A J, and Howard, R E, forthcoming *7–12 Church Street, Dronfield, Derbyshire; Tree-Ring Analysis of Timbers*, EH Res Dept Rep Ser

Jones, S, 1970 *Summary of a Survey of Dronfield Hall Barn*, unpubl

Laxton, R R, and Litton, C D, 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings*, University of Nottingham, Dept of Classical and Archaeol Studies, Monograph Series, III

Tyers, I, 1997 *Tree-ring analysis of timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/1997**

Tyers, I, 2003 *Tree-Ring Analysis of Oak Timbers from a Building on the Lea Road Foundry Site, Church Street, Dronfield, Derbyshire*, Centre for Archaeol Rep, **75/2003**

TABLES

Table 1: Details of tree-ring samples from the Dronfield Hall Barn, Dronfield, Derbyshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date AD	Last heartwood ring date AD	Last measured ring date AD
	Main range					
DRN-D01	North principal rafter 1, truss 1	54	h/s	1367	1420	1420
DRN-D02	South main wall post, truss 1	60	25	1367	1401	1426
DRN-D03	Brace, south main wall post to tiebeam, truss 1	55	17C	1375	1412	1429
DRN-D04	South wall plate, truss 1-2	76	13C	1354	1416	1429
DRN-D05	Tiebeam, truss 2	79	15C	1351	1414	1429
DRN-D06	North principal rafter, truss 2	68	h/s	1346	1413	1413
DRN-D07	South principal rafter, truss 2	65	h/s	1354	1418	1418
DRN-D08	Tiebeam, truss 3	60	h/s	1364	1423	1423
DRN-D09	Tiebeam, truss 4	67	14C	1363	1415	1429
DRN-D10	King post truss 4	60	10	1368	1417	1427
DRN-D11	South principal rafter, truss 4	73	h/s	1348	1420	1420
DRN-D12	South common rafter 1, bay 4	66	h/s	1341	1406	1406
DRN-D13	South common rafter 2, bay 4	64	h/s	1243	1406	1406
	South wing					
DRN-D14	Dias beam, truss 5	44	h/s	-----	-----	-----
DRN-D15	King post, truss 5	nm	---	-----	-----	-----
DRN-D16	West principal rafter, truss 5	nm	---	-----	-----	-----
DRN-D17	Ground-floor ceiling beam 1 (north beam)	125	22C	-----	-----	-----
DRN-D18	Ground-floor ceiling beam 2 (south beam)	101	14	-----	-----	-----
	Main range					
DRN-D19	South doorway lintel	60	2	-----	-----	-----

h/s = the heartwood/sapwood ring is the last ring on the sample

C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the tree represented

nm = sample not measured

Table 2: Results of the cross-matching of site sequence DRNDSQ01 and relevant reference chronologies when the first-ring date is AD 1341 and the last-ring date is AD 1429

Reference chronology	Span of chronology	<i>t</i> -value	Reference
7–12 Church Street, Dronfield, Derbyshire	AD 1313–1526	10.5	(Arnold and Howard forthcoming)
Manor House, West Bromwich, West Midlands	AD 1318–1590	10.2	(Arnold and Howard 2009)
Sinai Park, Burton upon Trent, Staffordshire	AD 1227–1750	10.2	(Tyers 1997)
Lea Road Foundry Site, Church Street, Dronfield, Derbyshire	AD 1344–1526	10.2	(Tyers 2003)
Primrose Hill, Kings Norton, Birmingham	AD 1354–1593	10.0	(Arnold and Howard 2008)
All Hallows Church, Kirkburton, West Yorkshire	AD 1306–1633	8.5	(Arnold and Howard 2007)
East Midlands Master Chronology	AD 882–1981	8.2	(Laxton and Litton 1988)
Anne Hathaway's Cottage, Stratford upon Avon, Warwickshire	AD 1319–1462	8.0	(Alcock <i>et al</i> 1991)

FIGURES



Figure 1a: Map to show the location of Dronfield (circled). © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900



Figure 1b: Map to show the location of Dronfield Hall barn (circled). © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900

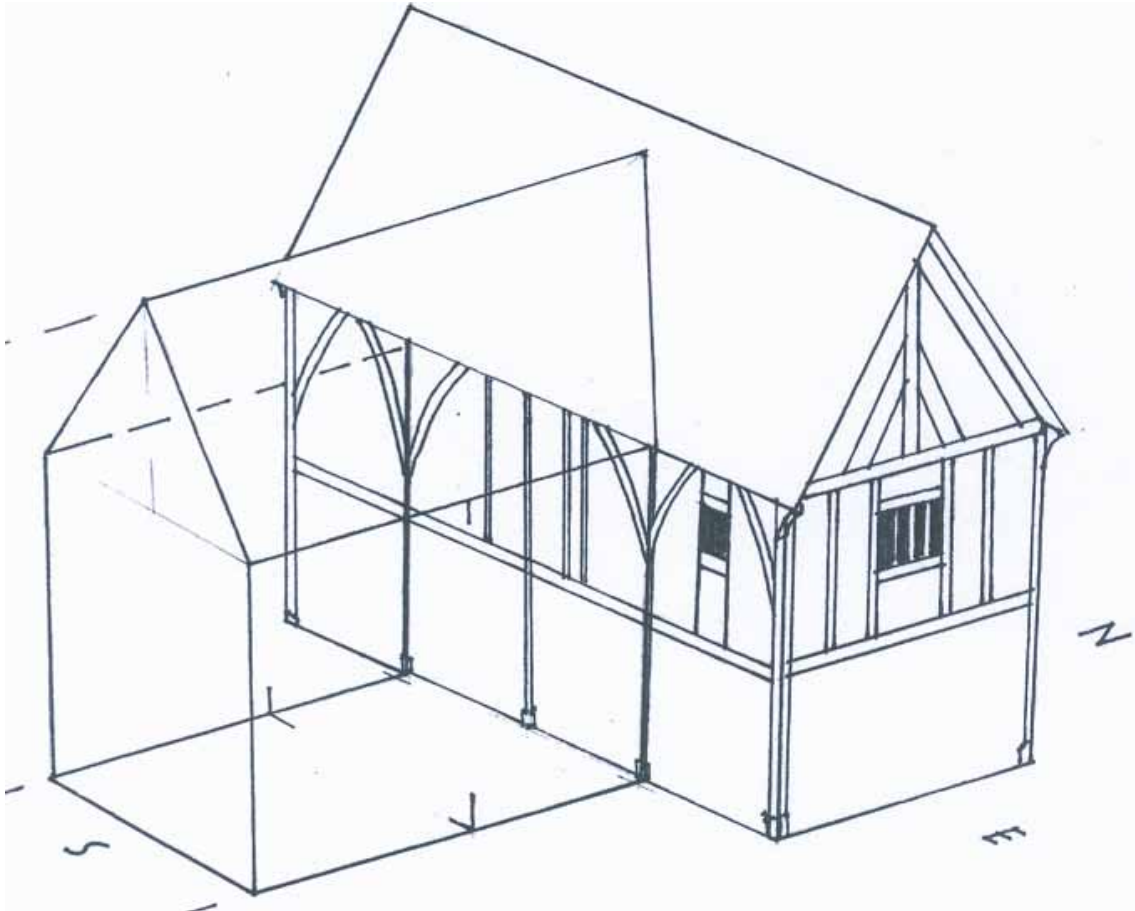


Figure 2: Suggested arrangement of the main range and the probably coeval range set centrally to the south (after Stanley Jones)



Figure 3a/b: Views of the barn looking east to west (top) and from truss 1 into present short south wing (bottom) (Robert Howard)

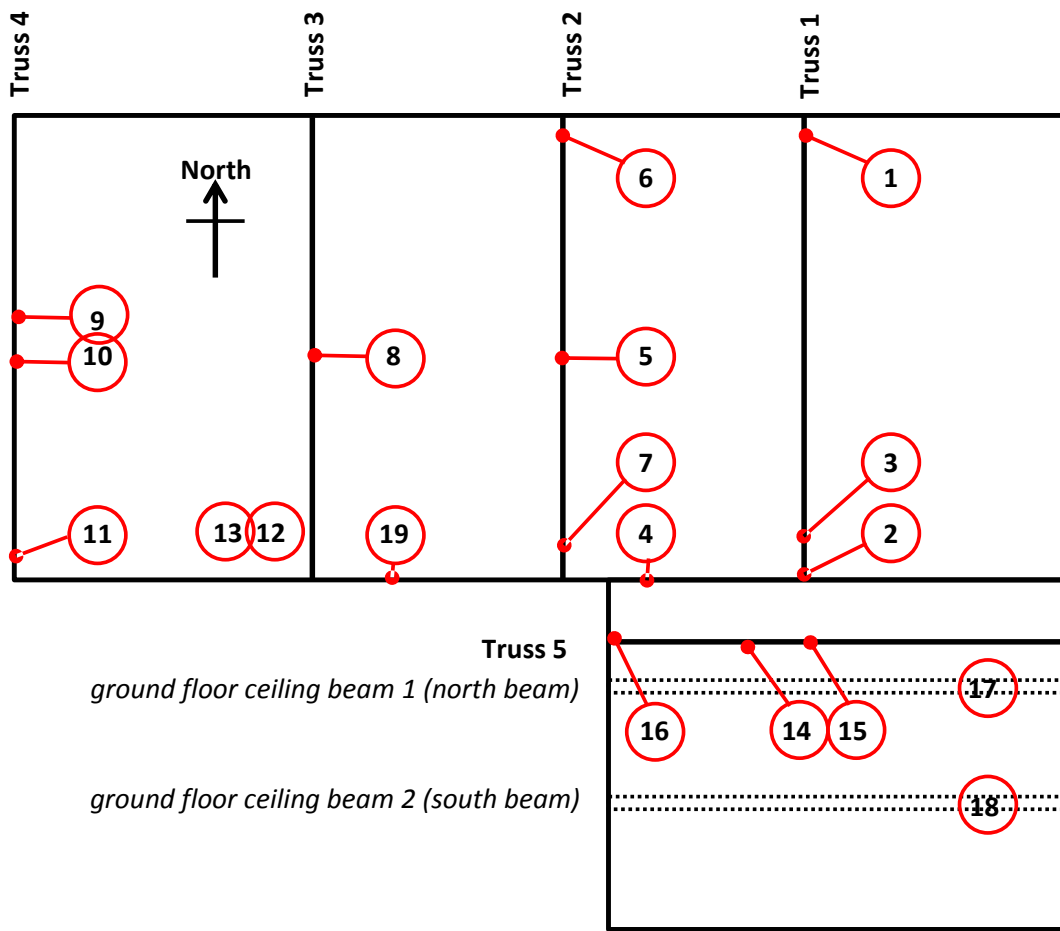


Figure 4a: Simple schematic sketch plan to locate sampled timbers

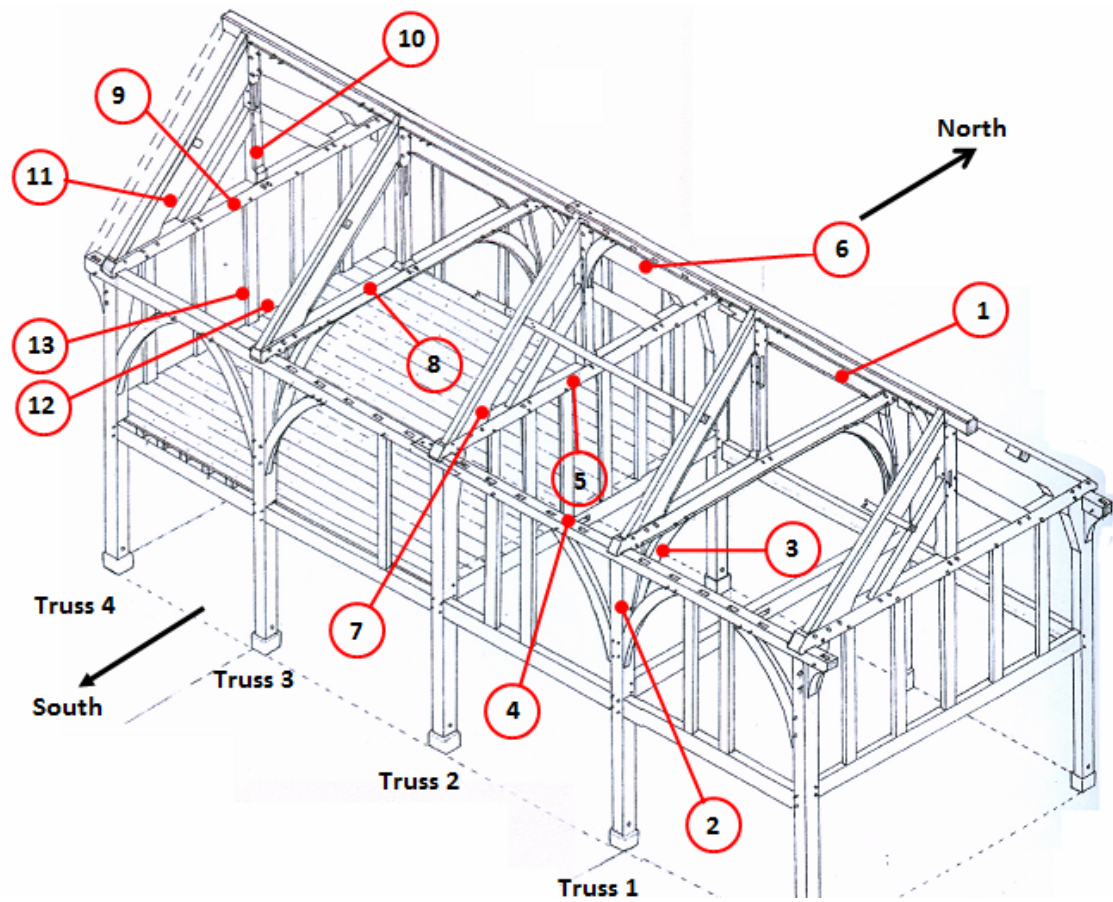


Figure 4b: Drawing of the main range of the barn to locate the sampled timbers (based on a part reconstruction by Stanley Jones)

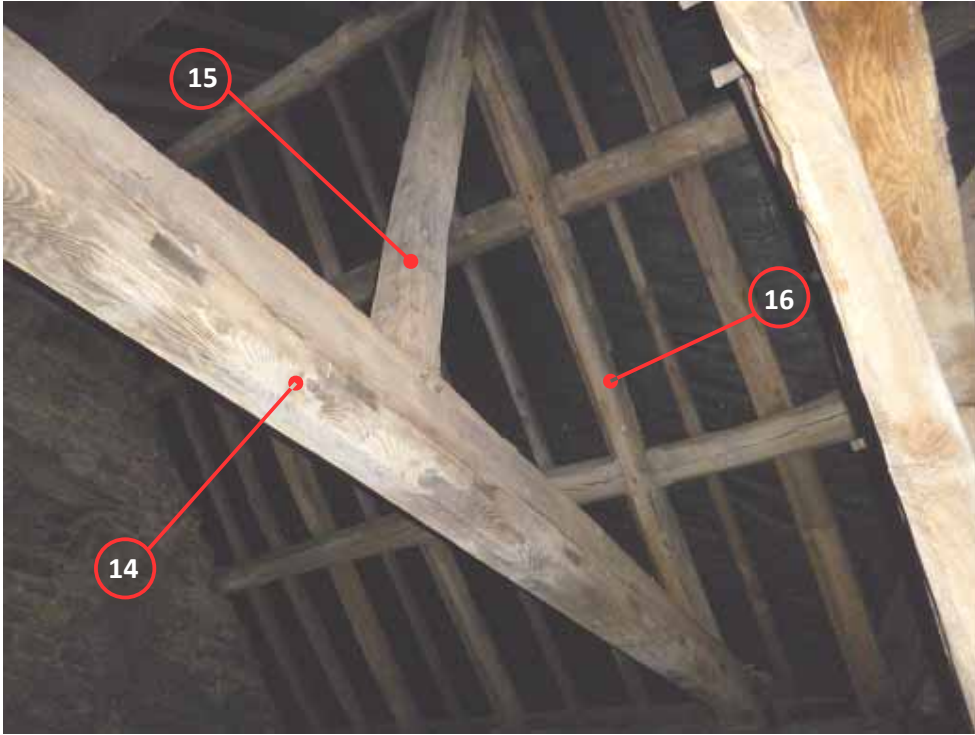
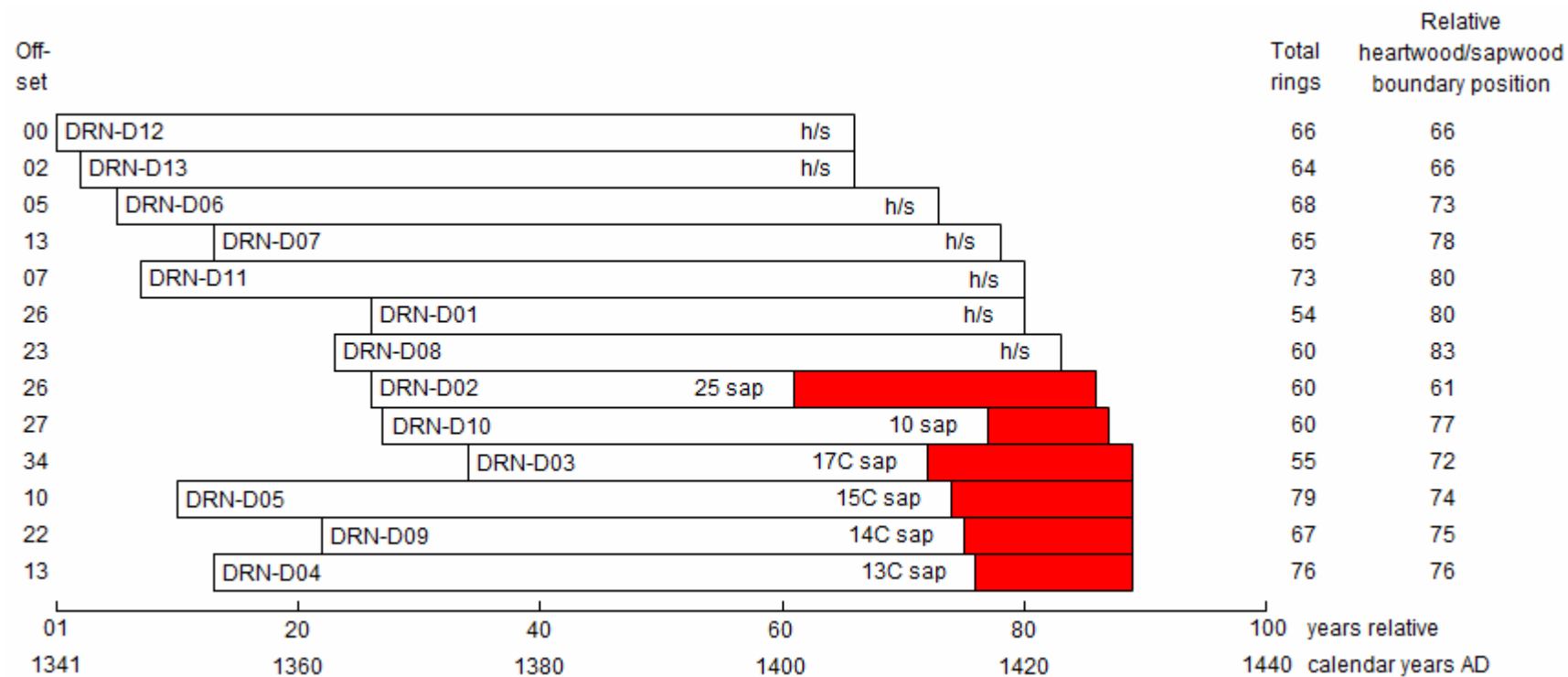


Figure 4c/d: Views of truss 5 (top) and the exterior of the barn (bottom) to locate sampled timbers (Robert Howard)



White bars = heartwood rings, red bars = sapwood rings; h/s = heartwood/sapwood boundary; C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the tree represented

Figure 5: Bar diagram of the samples in site chronology DRNDSQ01

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

DRN-D01A 54

168 167 426 394 184 334 284 223 147 173 209 310 250 147 142 205 112 159 111 192
171 148 247 139 254 189 275 199 289 322 306 362 235 292 315 210 235 178 161 211
154 168 184 150 148 193 160 151 156 140 167 190 129 218

DRN-D01B 54

195 171 430 384 191 352 277 225 150 176 215 280 252 155 145 200 110 161 120 178
170 170 247 164 258 185 257 196 288 315 317 350 245 315 257 229 233 178 160 202
145 171 201 145 146 203 161 150 143 132 179 204 117 180

DRN-D02A 60

340 368 391 375 305 409 301 403 295 339 451 300 306 276 239 276 278 258 300 269
302 196 209 196 231 162 213 258 236 163 150 159 250 275 200 168 231 175 190 186
196 188 281 171 228 221 225 181 246 218 185 127 162 264 260 182 203 153 143 209

DRN-D02B 60

337 348 414 379 302 414 302 403 290 351 457 300 312 285 245 290 278 251 290 297
313 197 212 196 228 165 210 256 237 181 142 160 246 262 202 168 238 184 190 187
143 228 261 156 243 235 218 178 256 218 168 111 153 265 287 205 208 171 121 199

DRN-D03A 55

136 119 136 149 179 188 193 230 240 229 239 341 450 363 290 289 496 291 396 268
306 414 283 250 214 303 227 225 303 255 220 181 125 208 262 181 208 258 232 167
171 147 158 151 134 278 212 173 207 132 181 137 92 130 145

DRN-D03B 55

137 121 137 151 169 180 200 229 236 227 230 350 484 372 289 293 500 293 386 273
294 422 282 240 221 293 226 228 305 259 212 187 146 217 228 202 206 239 207 178
196 132 160 154 134 295 215 168 215 131 182 125 104 118 142

DRN-D04A 76

321 387 411 317 339 373 326 321 495 360 374 332 349 369 385 423 355 268 392 371
351 323 326 337 264 266 269 264 250 246 267 264 325 345 267 214 207 192 200 268
200 212 262 247 237 209 250 227 203 223 203 163 152 134 202 214 189 128 186 115
122 134 179 170 196 122 203 170 185 236 140 140 104 167 143 149

DRN-D04B 76

289 369 417 311 318 375 326 323 508 357 365 329 353 367 381 405 356 278 395 373
356 323 325 292 260 278 277 278 259 251 264 243 323 325 268 215 187 187 200 266
194 218 256 259 231 217 250 224 198 225 196 173 142 137 200 223 184 140 192 113
121 137 181 178 191 128 209 179 184 230 160 141 105 128 131 137

DRN-D05A 79

202 148 204 302 295 344 282 444 464 280 296 449 348 354 314 368 285 257 328 307
286 301 300 337 221 259 307 320 286 199 206 214 201 306 246 297 340 235 256 206
254 223 235 195 214 229 189 198 193 256 185 182 175 162 165 171 141 170 172 152
118 113 103 84 95 81 109 103 77 90 121 102 100 112 127 100 113 112 126

DRN-D05B 79

204 152 203 299 302 351 283 431 468 280 294 453 349 357 314 368 286 250 344 305
299 304 306 335 228 267 325 308 273 217 193 229 200 306 257 289 335 243 250 206
249 218 236 196 200 221 177 190 195 246 181 186 166 164 162 175 142 173 167 150
113 121 108 79 90 92 104 103 71 96 109 107 98 111 125 109 113 118 121

DRN-D06A 68

268 227 319 359 310 262 320 330 250 153 171 189 266 232 162 242 252 222 239 192
178 103 133 168 90 102 139 162 168 147 123 146 154 176 192 194 227 245 232 231
337 367 270 214 165 201 162 196 200 162 229 146 131 150 250 181 226 218 308 225

226 187 267 294 205 163 159 200

DRN-D06B 68

288 244 309 308 297 274 310 334 232 175 159 178 249 215 185 224 257 220 228 175
166 125 139 160 92 94 150 152 167 136 124 134 171 164 181 212 234 237 217 220
360 356 276 231 156 190 153 189 210 155 220 164 131 156 251 177 229 217 328 220
243 176 270 298 204 163 189 197

DRN-D07A 65

395 423 354 336 477 425 276 273 301 296 346 301 318 283 382 378 260 306 346 337
360 209 165 171 134 128 101 95 140 115 129 141 171 262 193 146 96 167 143 123
134 100 139 85 118 129 204 185 131 164 181 165 220 154 214 254 161 172 187 131
83 157 64 67 90

DRN-D07B 65

469 413 365 359 480 421 273 271 306 309 330 307 310 282 377 377 242 297 348 352
359 213 158 166 127 134 101 100 123 107 125 129 176 257 189 146 98 159 138 131
123 101 145 84 100 139 232 187 142 154 187 167 218 154 213 241 170 181 183 132
91 149 81 58 87

DRN-D08A 60

301 308 337 331 398 443 439 326 346 357 386 210 279 368 368 323 275 273 254 192
284 229 292 376 286 242 178 265 229 286 250 295 251 210 253 251 290 278 215 250
270 182 250 153 215 250 185 175 218 157 154 153 151 215 187 165 202 225 218 205

DRN-D08B 60

303 294 336 333 403 453 444 325 353 359 412 200 289 360 368 329 262 272 263 182
284 225 299 378 296 243 154 271 225 259 257 285 264 213 244 254 290 276 220 246
275 185 248 157 216 250 190 190 215 159 156 156 159 199 194 148 203 234 205 221

DRN-D09A 67

321 323 257 251 262 216 297 284 219 221 235 246 209 151 221 193 200 153 138 193
115 214 167 263 268 228 207 167 216 186 165 179 198 196 154 145 203 281 292 232
309 326 292 291 233 296 289 256 240 275 219 214 223 259 263 283 181 245 250 180
218 212 231 209 248 230 240

DRN-D09B 67

304 313 265 258 276 207 303 276 244 217 226 256 207 146 233 182 206 153 143 187
121 207 177 239 273 218 214 157 218 168 184 178 214 195 159 139 213 295 293 225
300 339 287 278 246 292 299 253 242 287 209 232 225 245 257 282 181 259 268 181
211 218 246 200 206 235 244

DRN-D10A 60

188 205 243 181 166 174 209 163 248 250 282 251 207 227 182 164 209 157 316 293
223 280 253 242 196 302 253 164 208 216 235 245 292 265 222 199 211 207 162 191
155 152 159 114 148 143 156 178 173 175 209 99 139 164 146 202 192 183 171 185

DRN-D10B 60

200 197 251 181 162 184 213 200 257 264 264 259 217 219 208 175 194 163 328 292
239 271 248 265 199 271 247 178 193 234 251 250 283 267 212 203 215 211 168 178
152 167 143 129 156 152 159 184 169 193 184 109 132 154 146 193 189 189 170 243

DRN-D11A 73

281 284 265 266 204 268 276 259 253 242 264 190 180 135 255 268 226 191 208 194
205 325 290 310 340 269 300 243 189 228 253 193 174 178 181 182 218 181 281 315
250 168 157 190 176 167 170 148 158 148 181 161 216 171 165 178 177 191 214 174
125 188 226 195 233 166 130 168 133 139 174 117 170

DRN-D11B 73

270 284 252 255 209 275 259 262 249 242 257 194 186 137 253 274 217 199 203 196
173 324 343 325 337 276 301 230 200 233 246 195 182 183 178 174 217 178 293 313
246 172 150 201 171 176 169 150 161 135 161 154 210 181 164 157 192 194 212 160

150 172 214 188 210 184 129 175 139 155 176 121 152

DRN-D12A 66

122 198 193 164 200 200 227 230 280 246 262 259 274 235 246 242 187 216 176 127
104 171 169 167 145 178 166 180 242 198 197 191 124 106 126 126 152 138 100 68
65 64 62 71 53 84 126 103 73 73 64 90 90 97 85 86 81 75 57 107
79 79 92 107 59 90

DRN-D12B 66

119 197 196 159 199 205 230 232 284 248 253 265 268 236 245 244 183 227 164 135
112 158 185 169 152 160 175 178 231 194 201 201 123 113 123 129 151 145 109 71
65 68 62 60 76 90 140 101 78 68 55 85 81 90 85 81 72 72 56 98
64 75 68 79 93 90

DRN-D13A 64

176 313 346 212 133 225 325 289 275 265 300 252 232 196 200 211 167 102 125 146
128 103 114 105 97 92 100 85 78 96 100 175 97 132 147 165 122 107 114 120
93 125 100 139 164 124 92 62 46 75 78 85 74 81 67 70 101 146 122 94
133 121 66 110

DRN-D13B 64

133 311 358 208 131 225 337 308 262 255 289 253 235 203 193 207 160 103 119 153
128 100 117 110 92 95 99 77 76 109 96 171 110 150 160 164 111 103 106 112
87 131 98 150 157 127 83 66 55 74 79 87 73 73 50 73 106 134 114 112
104 123 98 93

DRN-D14A 44

362 409 297 412 495 401 432 519 432 493 419 503 375 339 394 332 304 340 350 415
345 332 354 385 434 351 300 396 378 418 406 322 290 190 140 169 207 182 231 175
131 87 131 147

DRN-D14B 44

362 363 293 404 501 398 435 489 464 514 421 492 378 320 414 314 303 335 351 410
362 348 345 376 446 354 315 386 390 423 415 315 306 198 136 171 193 196 231 174
134 116 106 114

DRN-D17A 125

96 103 159 120 204 174 124 137 214 200 187 126 76 87 176 216 150 60 98 144
162 160 205 56 89 50 82 128 171 162 117 73 46 50 46 56 53 26 45 117
125 103 56 93 116 142 133 131 185 128 113 93 107 132 131 209 189 178 139 62
40 26 31 54 56 56 90 103 62 55 117 62 79 129 100 92 151 103 93 67
34 53 43 84 71 37 21 23 39 39 42 53 75 82 82 56 42 34 98 93
93 82 100 92 89 140 214 85 64 50 31 46 59 112 114 98 115 160 53 101
135 134 106 98 151

DRN-D17B 125

117 104 154 141 205 176 127 137 225 202 181 121 81 86 189 235 139 71 105 140
151 157 208 63 90 41 86 132 171 163 117 73 48 53 40 57 47 30 47 110
128 109 57 88 125 140 142 121 193 125 105 97 102 153 128 201 198 193 137 59
45 25 24 42 64 57 100 113 58 60 120 62 71 123 107 100 159 105 91 68
48 44 45 90 71 40 21 22 42 35 45 46 79 80 85 53 40 39 100 90
87 85 106 82 89 145 210 93 67 46 32 51 56 113 114 102 104 173 51 95
125 127 120 98 139

DRN-D18A 101

153 197 233 325 481 428 330 312 342 350 357 411 362 387 235 303 299 245 259 236
166 142 210 178 167 196 137 154 143 118 134 96 100 93 146 210 106 78 75 55
42 82 73 64 56 73 81 57 43 78 93 85 168 218 173 168 159 91 121 132
122 161 158 141 89 115 109 146 209 251 284 256 250 235 296 326 268 274 277 245
259 280 328 322 268 316 312 158 118 187 262 238 121 87 201 241 200 209 158 155
164

DRN-D18B 101

129 210 216 316 493 433 312 321 348 345 370 409 343 389 236 298 305 270 257 235
175 135 211 181 162 185 145 141 142 113 140 95 93 87 140 209 89 81 76 50
53 90 70 60 67 67 73 66 61 90 84 93 160 215 170 173 149 95 115 143
123 157 162 150 84 117 107 156 190 268 286 264 251 237 294 324 272 259 264 274
256 269 337 325 268 309 321 155 121 188 264 284 85 92 189 240 202 173 173 165
205

DRN-D19A 60

281 263 316 349 233 284 396 263 286 341 367 313 303 232 221 292 210 185 178 196
215 205 214 182 211 192 190 225 279 373 360 240 211 204 207 265 202 237 234 157
204 329 358 473 368 342 321 317 228 271 195 240 275 299 228 331 275 283 326 245

DRN-D19B 60

377 234 310 368 217 295 319 328 291 353 384 293 300 228 228 280 180 196 167 187
213 199 211 166 201 198 192 229 287 372 337 237 218 178 203 244 178 243 203 175
214 332 368 459 353 303 267 323 244 278 193 262 289 266 242 310 275 233 319 318

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 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 complement 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. As m 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

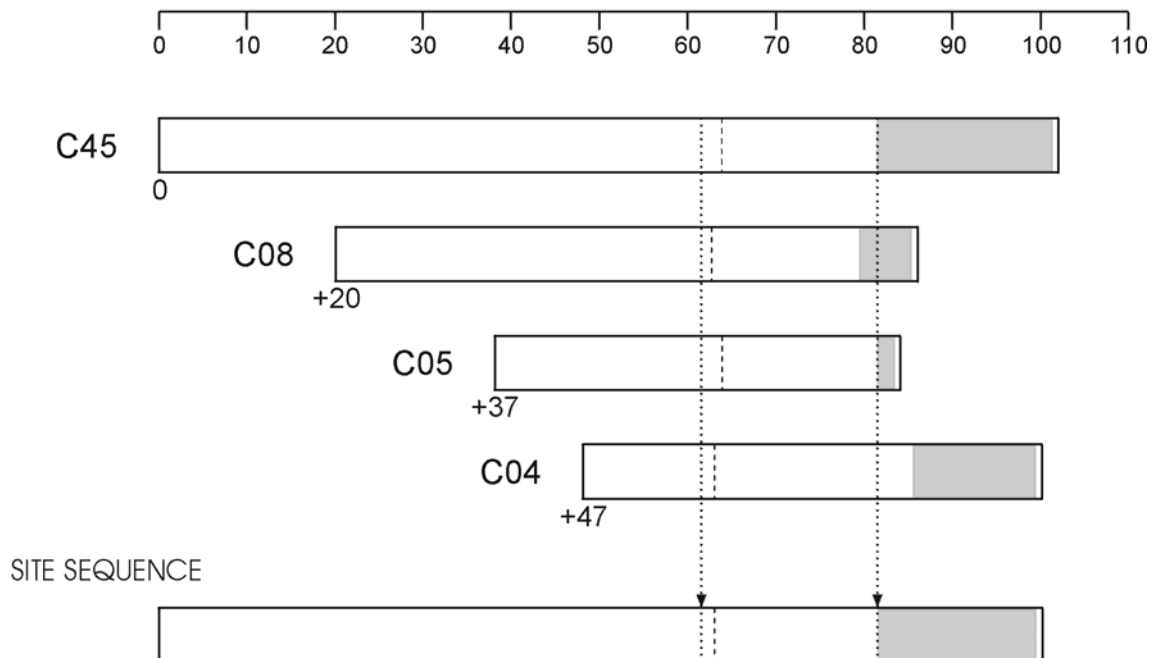


Figure A5: Cross-matching of four sequences from a Lincoln Cathedral roof and the formation of a site sequence from them

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.

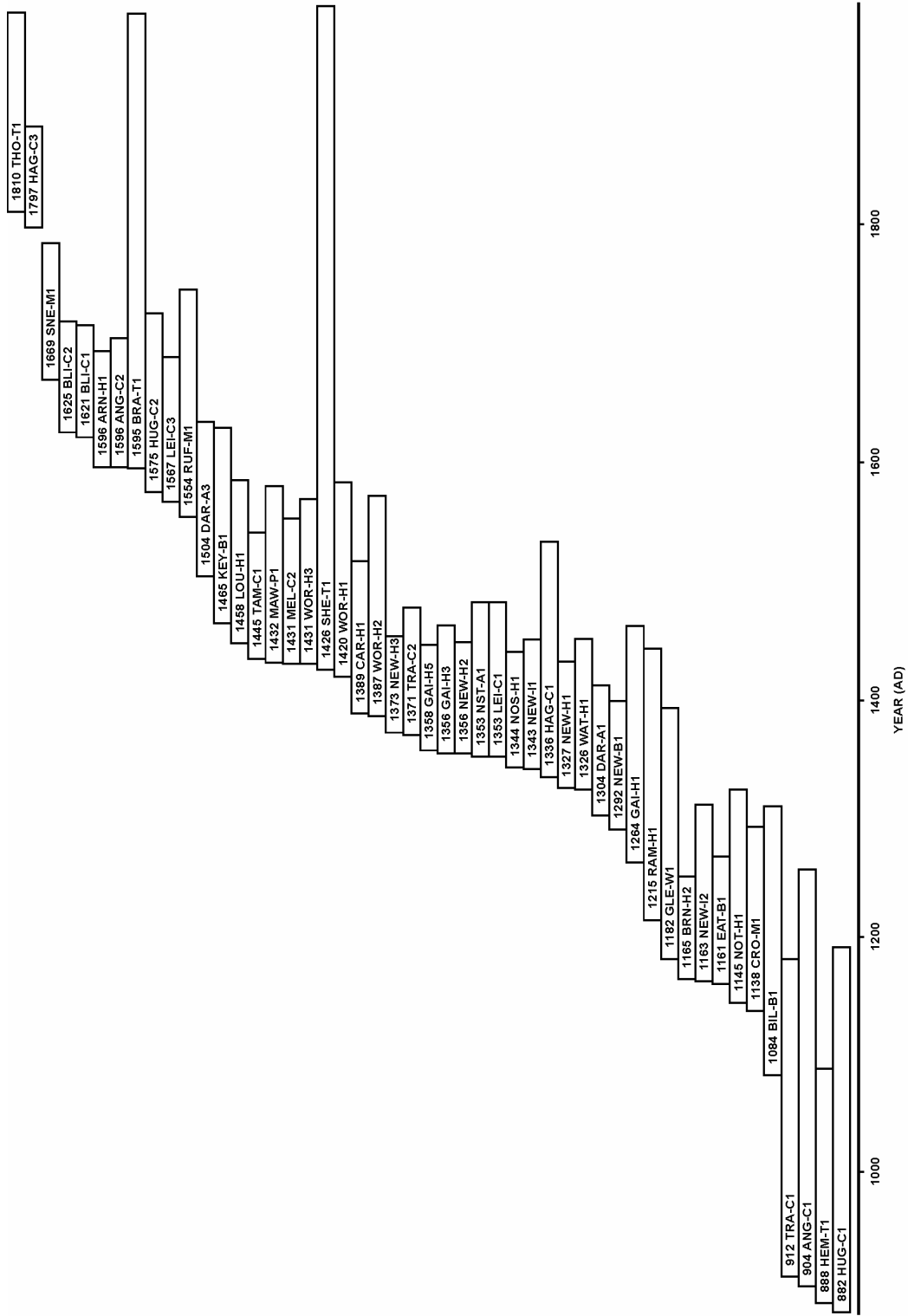
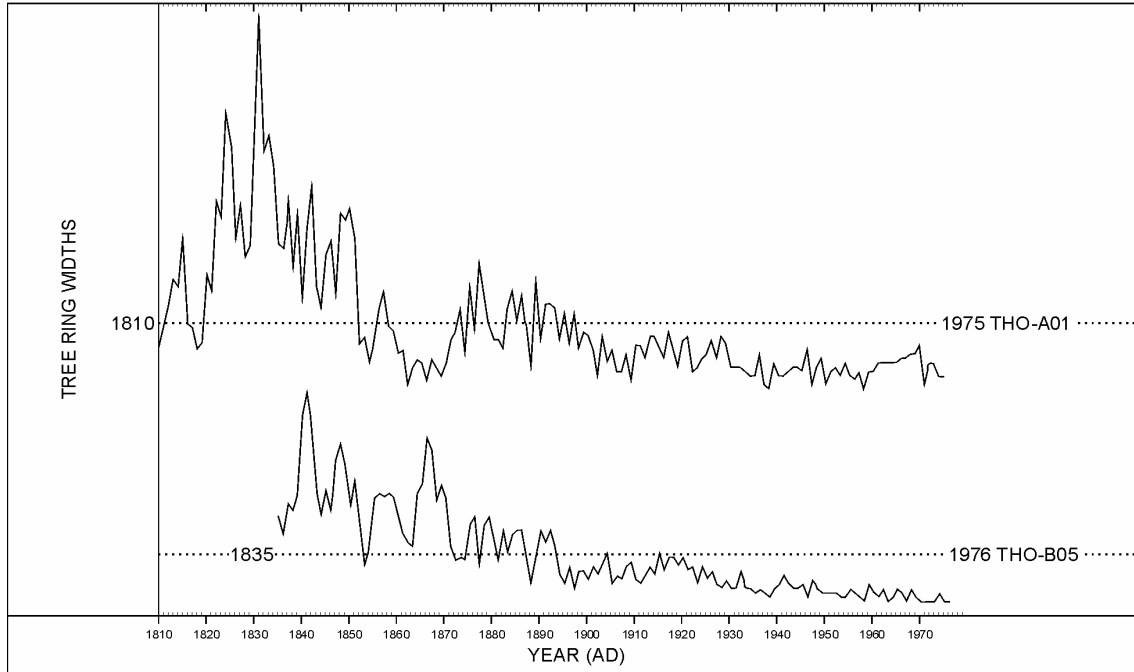


Figure A6: Bar diagram showing the relative positions and dates of the first rings of the component site sequences in the East Midlands Master Dendrochronological Sequence, EM08/87

(a)



(b)

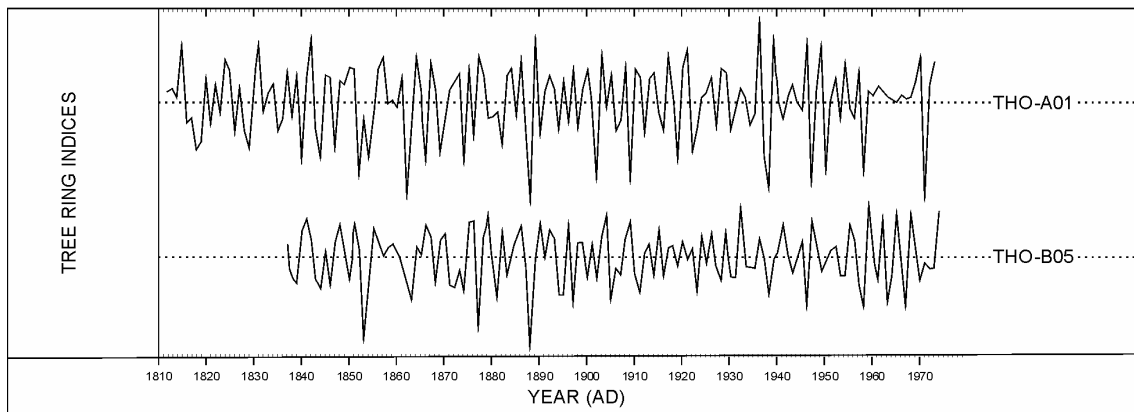


Figure A7 (a): The raw ring-widths of two samples, THO-A01 and THO-B05, whose felling dates are known

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
- Hillam, J, Morgan, R A, and Tyers, I, 1987 Sapwood estimates and the dating of short ring sequences, *Applications of tree-ring studies*, BAR Int Ser, **3**, 165–85
- 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.
- Hughes, M K, Milson, S J, and Legett, P A, 1981 Sapwood estimates in the interpretation of tree-ring dates, *J Archaeol Sci*, **8**, 381–90
- 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



ENGLISH HERITAGE RESEARCH AND THE HISTORIC ENVIRONMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for the protection and sustainable management of the resource, and to promote the widest access, appreciation and enjoyment of our heritage. Much of this work is conceived and implemented in the context of the National Heritage Protection Plan. For more information on the NHPP please go to <http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/>.

The Heritage Protection Department provides English Heritage with this capacity in the fields of building history, archaeology, archaeological science, imaging and visualisation, landscape history, and remote sensing. It brings together four teams with complementary investigative, analytical and technical skills to provide integrated applied research expertise across the range of the historic environment. These are:

- * Intervention and Analysis (including Archaeology Projects, Archives, Environmental Studies, Archaeological Conservation and Technology, and Scientific Dating)
- * Assessment (including Archaeological and Architectural Investigation, the Blue Plaques Team and the Survey of London)
- * Imaging and Visualisation (including Technical Survey, Graphics and Photography)
- * Remote Sensing (including Mapping, Photogrammetry and Geophysics)

The Heritage Protection Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support community engagement and build this in to our projects and programmes wherever possible.

We make the results of our work available through the Research Report Series, and through journal publications and monographs. Our newsletter *Research News*, which appears twice a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities.

A full list of Research Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

