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# Tree-Ring Analysis of Oak Timbers from St Brannock Church, Braunton, Devon

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## Summary

A tree-ring dating programme was commissioned on timbers from the nave roof and some fire damaged pews from St Brannock church, Braunton, Devon, by English Heritage in AD 2003 and AD 2004. The tree-ring results indicate that timbers felled between AD 1388 and AD 1413 are present in the nave roof and timbers felled after AD 1475 are present in a pew.



## Keywords

Dendrochronology
Standing Building



## Author's address

Sheffield Dendrochronology Laboratory, Archaeology and Archaeological Science Research School, Department of Archaeology and Pre-History, University of Sheffield, 2 Mappin Street, Sheffield S1 4DT. Telephone: 0114 2225107. Email: i.tyers@sheffield.ac.uk

## Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the nave roof and pews of St Brannock church, Braunton, Devon (NGR SS 489 371). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication, or an archive deposition, on the building.

Braunton stands on the northern headland of Bideford Bay in north Devon, *c* 10km from both Barnstaple and Ilfracombe (Fig 1). St Brannock church stands to the north-east of the present town centre (Fig 2). Cherry and Pevsner (1989, 207-8) describe the church as one of the most puzzling in north Devon. The unusually wide nave has a wagon roof of 45 common rafter trusses (Fig 3), each with upper and lower curving braces and a collar. There are three decorative bosses on every fifth truss. There is a remarkable set of pews and carved bench ends that entirely fill the nave (Fig 4), Cherry and Pevsner quote parish records recording the enlarging of the benches in AD 1560, AD 1568, AD 1578, AD 1579, AD 1583, and AD 1593, and note that there are no renaissance details on the bench ends. The church was badly damaged by fire in July AD 2003. Tree-ring analysis of timbers in the nave roof that could be accessed during its cleaning and restoration was commissioned by Francis Kelly, the local English Heritage Historic Buildings Inspector. This commission was subsequently extended to include the analysis of some of the damaged pews.

## Methodology

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

The church was initially visited with Rev Roger Reeve, and an assessment of the dendrochronological potential of the nave was undertaken. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in this part of the structure. This assessment identified that the nave roof contained suitable material, and also noted the potential of the pews. The nave timbers were sampled during a subsequent visit. These samples were analysed and, following the interim results, the sampling brief was extended to include some of the timbers from the most badly damaged pews. Following their conservation these timbers were despatched to the laboratory and analysed before they were re-installed in the church.

The dendrochronological sampling of the nave timbers mostly obtained samples from the lower curving elements of the wagon roof because it was difficult to safely access

the other structural elements. The timbers selected for analysis were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were filled with oak plugs. The ring sequences in the cores were revealed by sanding.

All the dismantled pew timbers were not examined. Instead following an exchange of photographs and drawings, and some subsequent discussions between ourselves and the restoration team a number were selected for dispatch to Sheffield. At the laboratory the surfaces of each of these timbers was carefully examined to determine which of them could be measured directly with the minimum of intervention and which contained the most suitable ring sequences.

The complete sequences of growth rings in the usable cores and the selected pew timbers were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

Examination of the bench ends revealed they were mostly derived from tangentially sawn and knotty trees and that their tenons had been damaged during an earlier dismantling. The plainer planks forming the backs and seats were more suitable for analysis. These were selected for cleaning and measurement. The sequences obtained from the selected cores from the nave roof and the selected pew timbers were compared with each other and any found to cross-match were combined to form site master curves. These, and any remaining unmatched ring sequences, were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range (Tyers 1998). These figures are applicable to oaks from England and Wales. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers, seasoning, and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

**Results**

Ten timbers were selected for sampling from the nave roof. These samples were numbered **1-10** (Table 1; Fig 3). Ten timbers were available from the dismantled pews these were lettered **A-J** (Table 1; Fig 4). All of these timbers are oak (*Quercus* spp.).

Three of the nave roof core samples were found to be unsuitable for analysis either because of their fragmentation or because they contained series of irresolvable bands of narrow rings. The tree-ring series from the remaining seven cored timbers were measured and the resultant series were then compared with each other. All seven were found to match together to form an internally consistent group (Table 2). A site mean chronology was calculated, named BSB-NAVE. This site mean was then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well correlated position was identified for this sequence. Table 3 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample by this process and their interpretation. Figure 5 shows the chronological position identified for each component sample. Appendix 1 lists the individual sample series.

Five of the available pew timbers were not selected for measurement because of the problem of recovering reliable sequences with the minimum of intervention. The tree-ring series from the remaining five timbers were measured and the resultant series were

then compared with each other. Three were found to match together to form an internally consistent group (Table 4). A site mean chronology was calculated, named BSB-PEWS. This site mean was then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well correlated position was identified for this sequence. Table 5 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample by this process and their interpretation. Figure 5 shows the chronological position identified for each component sample. Appendix 1 lists the individual sample series. The two unmatched pew sequences were compared to the reference chronologies but they are undated by the analysis reported here.

**Interpretation and discussion**

The 164-year chronology BSB-NAVE is dated AD 1215 to AD 1378 inclusive. It was created from seven of the sampled timbers. None of the datable samples are complete to the original bark surface and none retain sapwood, although all are complete to the heartwood/sapwood boundary. Adding the minimum and maximum expected number of sapwood rings to the date of the heartwood/sapwood boundary on these seven samples, and assuming that all are contemporaneous, suggests they were felled between AD 1388 and AD 1413 (Fig 5; Table 1). The dated timbers are integral parts of the original construction of the present roof since they are fully pegged and the original carpenters numbering sequence is identifiable. The datable samples are derived from a common rafter, a north lower brace, and five south lower braces. Although no samples could be taken from the upper parts of the roof because of the conditions and difficulties of getting equipment into these areas, it is likely that this result is applicable to the entire nave roof, except for the readily apparent nineteenth and twenty-first century repairs.

The 125-year chronology BSB-PEWS is dated AD 1321 to AD 1445 inclusive. It was created from three of the long planks from the dismantled pews. In each case there were additional rings present in these planks that were not measurable because they were not exposed at either end. The numbers of these rings were estimated. None of these timbers retains sapwood, nor are any complete to the heartwood/sapwood boundary. Adding the estimated numbers of missed rings and then the minimum expected number of sapwood rings to the date of the last measurable rings on these samples, and assuming that all are contemporaneous, suggests they were felled sometime after *c* AD 1475 (Fig 5; Table 1). The dated timbers are plank elements of a single pew that was fully pegged and on which the original carpenters numbering was still identifiable. The documentary evidence suggests that pews were augmented on a large number of occasions in the later sixteenth century. It is therefore likely that this tree-ring result is applicable to only some of the pews in the church.

## Conclusion

Assuming the timbers were felled for immediate usage, which was normal practice in this period (Charles and Charles 1995), then the nave roof dates from the end of the fourteenth century or beginning of the fifteenth century.

There may be many heartwood rings missing from the dated pew planks but given their size and growth rates it is likely this planking dates from either the last quarter of the fifteenth century or perhaps to the earlier sixteenth century. All the dated timbers derive from a single pew (pew #3). None of the decorated timbers were datable but the presence of the same carpenters numbers on both the planks and the bench ends suggests that this group of timbers is co-eval, for example the three dated planks from pew #3 are numbered VIIII, VIIII, and VIIII° respectively whilst the bench end is numbered VIIII. The plank from pew #4 is numbered VIII° and the bench end VIII. Curiously the frontal end is labelled X whilst the bench end from pew #2 is constructed from parts of 3 other carved ends, possibly like the narrower frontal pieces, the bench end from pew #1 has no obvious number. This may suggest some of the later modifications involved re-organising the distribution of pews and frontals to utilise the spaces between the original settings, perhaps utilising additional pews constructed from cannibalised parts. The damaged tenons and peg holes suggest they have been dismantled on at least one previous occasion (Chappell pers comm). The planks and bench ends exhibit characteristic distortions that indicate that these were first used whilst still green.

The two groups of samples from St Brannock church yield chronologies that partially overlap but which only match each other relatively poorly ($t$ = 3.65), this may indicate the source of the timbers for the nave roof may be different from that used for the pews.

**Acknowledgements**

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**Figure 1** Location of Braunton, Devon, within England and Wales.

**Figure 2** Location of St Brannock church, Braunton, Devon

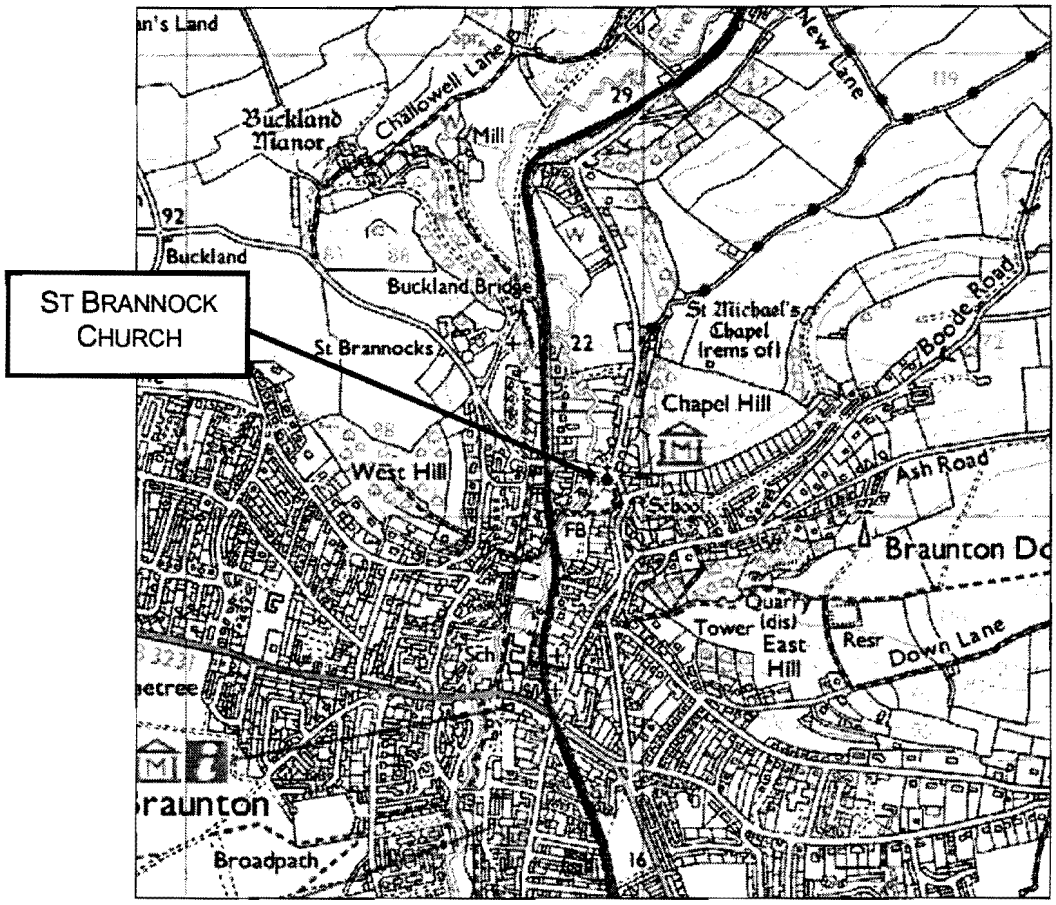


**Figure 3** Nave roof plan of St Brannock church, Braunton, Devon showing the truss numbering scheme used in this report. The labelled arrows indicate the approximate locations of the sampled timbers and the direction of the core (based on a plan by Jonathan Rhind Architects supplied by English Heritage)

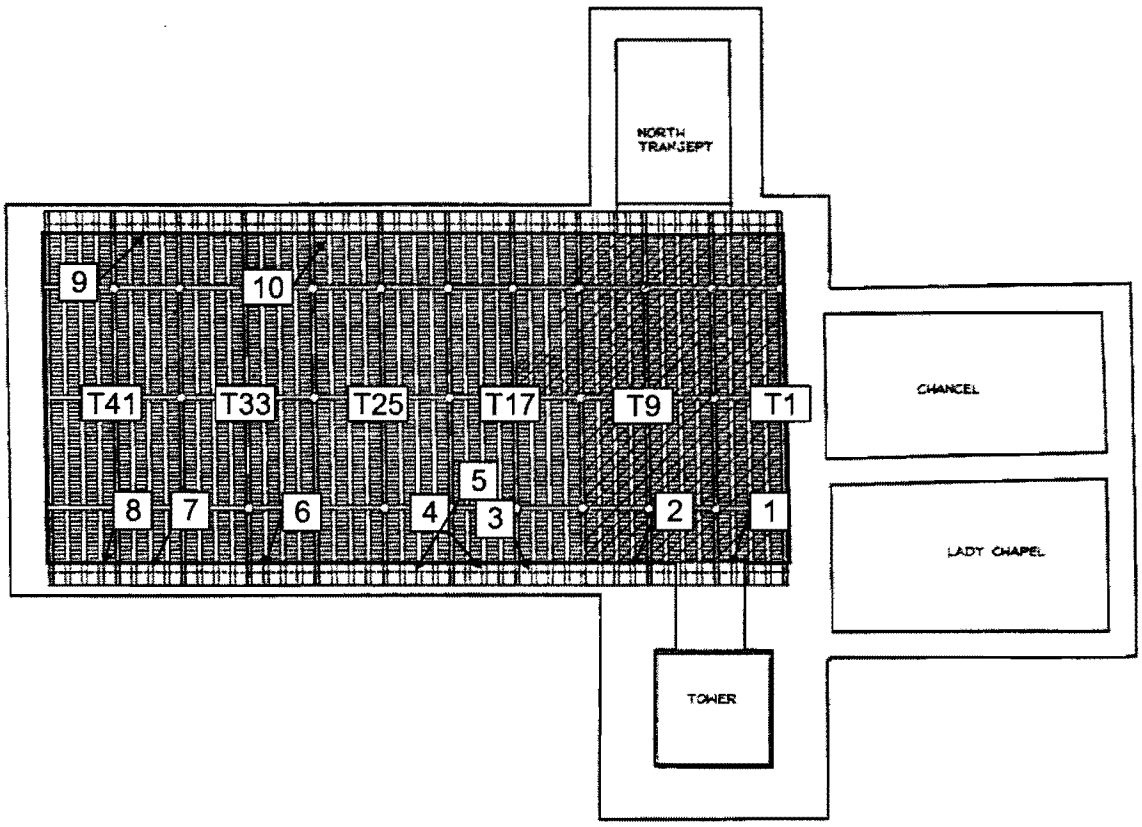


**Figure 4** Floor plan of St Brannock church, Braunton, Devon showing the location of the fire damaged pews (based on a plan by Jonathan Rhind Architects supplied by English Heritage) pews not to scale

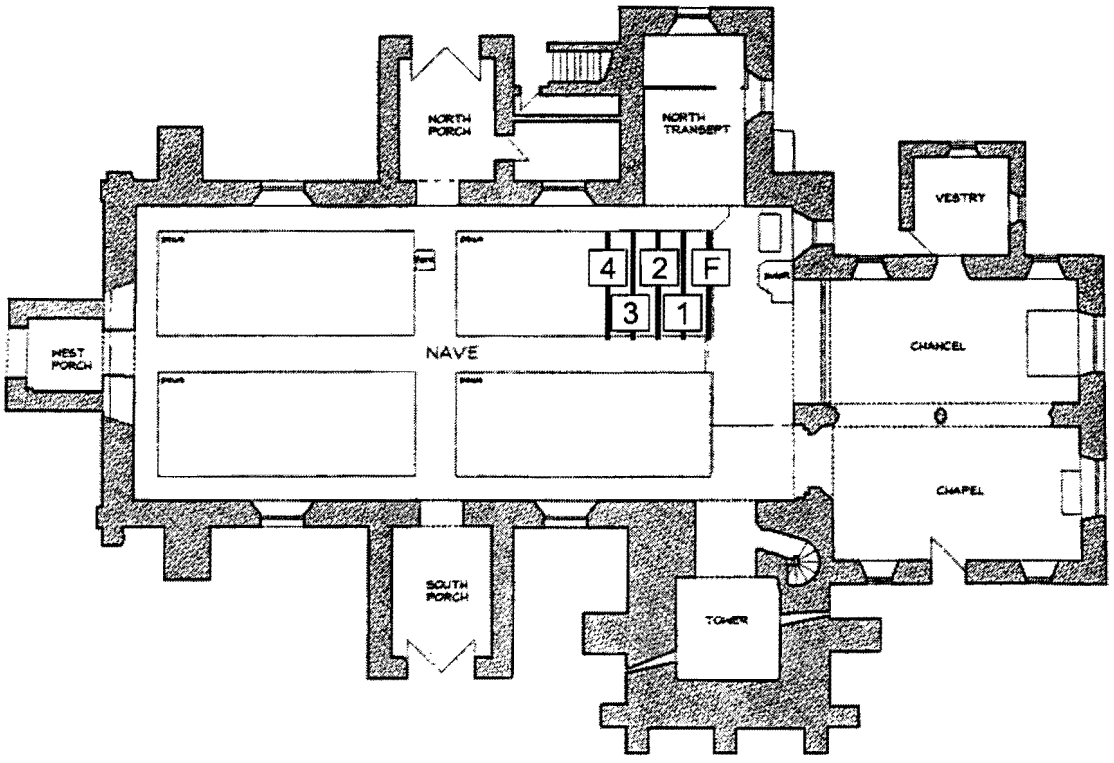
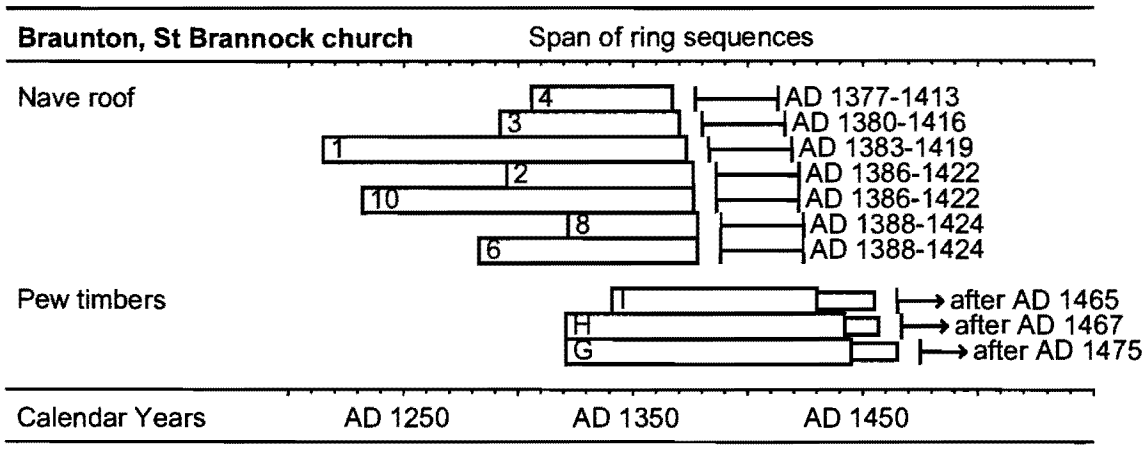



**Figure 5** Bar diagram showing the chronological positions of the dated timbers from St Brannock church, Braunton, Devon. The narrow bars indicate unmeasured rings. The estimated felling period for each sequence is also shown




**KEY for figure 5**

heartwood

unmeasured heartwood

**Table 1** The samples from the nave roof (**1-10**) and the pew timbers (**A-J**) at St Brannock church, Braunton, Devon

| Ref | Origin of core or description of timber | Cross-section size (mm) | Total rings | Sapwood rings | ARW (mm/year) | Date of sequence | Felling period |
|---|---|---|---|---|---|---|---|
| **1** | S lower brace T4 | 200 x 170 | 159 | H/S | 1.28 | AD 1215-AD 1373 | AD 1383-1419 |
| **2** | S lower brace T10 | 190 x 171 | 82 | H/S | 2.41 | AD 1295-AD 1376 | AD 1386-1422 |
| **3** | S lower brace T16 | 180 x 160 | 79 | H/S | 2.71 | AD 1292-AD 1370 | AD 1380-1416 |
| **4** | S lower brace T19 | 180 x 160 | 62 | H/S | 2.30 | AD 1306-AD 1367 | AD 1377-1413 |
| **5** | S lower brace T23 | 180 x 170 | - | - | - | Not measured | - |
| **6** | S lower brace T32 | 190 x 180 | 96 | H/S | 1.21 | AD 1283-AD 1378 | AD 1388-1424 |
| **7** | S lower brace T39 | 180 x 170 | - | - | - | Not measured | - |
| **8** | S rafter T42 | 190 x 180 | 57 | H/S | 2.49 | AD 1322-AD 1378 | AD 1388-1424 |
| **9** | N lower brace T39 | 190 x 170 | - | - | - | Not measured | - |
| **10** | N lower brace T28 | 170 x 160 | 145 | H/S | 1.21 | AD 1232-AD 1376 | AD 1386-1422 |
| **A** | Pew #2 N bench end | 445 x 70 | - | - | - | Not measured | - |
| **B** | Frontal N bench end | 290 x 95 | - | - | - | Not measured | - |
| **C** | Pew #1 N bench end | 395 x 95 | - | - | - | Not measured | - |
| **D** | Pew #3 N bench end | 445 x 105 | - | - | - | Not measured | - |
| **E** | Pew #4 N bench end | 425 x 100 | 117 | - | 1.34 | Not dated | - |
| **F** | Pew support | 265 x 60 | 109 | - | 1.65 | Not dated | - |
| **G** | Pew #3 S plank | 330 x 10 | 125+*20* | - | 1.02 | AD 1321-AD 1445 | after AD 1475 |
| **H** | Pew #3 S plank | 260 x 20 | 122+*15* | - | 1.35 | AD 1321-AD 1442 | after AD 1467 |
| **I** | Pew #3 N plank | 340 x 15 | 90+*25* | - | 1.10 | AD 1341-AD 1430 | after AD 1465 |
| **J** | Pew #4 plank | 360 x 15 | - | - | - | Not measured | - |

**KEY for Table 1** See Figs 3 and 4 for truss numbers, pew numbers, and sampling locations. S south, N north, Total rings = measured rings, with values in italics indicating additional rings present in the timbers that could not be accessed for measurement. H/S heartwood/sapwood boundary, ARW average ring width of the measured rings

**Table 2**

*t*-value matrix for the timbers forming the chronology BSB-NAVE, KEY - = *t*-value less than 3.0

| | 2 | 3 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| 1 | 3.54 | - | 3.90 | 4.63 | - | 4.64 |
| 2 | | 4.39 | 5.01 | - | 3.59 | 4.85 |
| 3 | | | 4.30 | - | 5.27 | 4.90 |
| 4 | | | | 3.03 | 3.25 | 3.98 |
| 6 | | | | | - | - |
| 8 | | | | | | - |

**Table 3**

Dating the mean sequence BSB-NAVE, AD 1215-1378 inclusive. Example *t*-values with independent reference chronologies

| Reference chronology | *t*-value |
|---|---|
| Devon, Bradworthy Church (Tyers 2003) | 8.91 |
| Devon, Rudge Morchard Bishop (Tyers *et al* 1997) | 6.11 |
| Devon, The Deanery Exeter (Howard *et al* 2000) | 7.78 |
| Devon, Thorne Clannaborough (Tyers *et al* 1997) | 5.66 |
| Devon, West Challacombe (Tyers and Groves 1999) | 7.78 |
| Dorset, Fiddleford Manor Sturminster Newton (Bridge 2003) | 6.04 |
| Oxfordshire, Bayllols Manor Harwell (Haddon-Reece and Miles 1992) | 7.10 |
| Somerset, Bridge Farm West Bradley (Miles *et al* 1997) | 6.44 |
| Somerset, Muchelney Abbey (Bridge 2002) | 5.93 |
| Wiltshire, Bradford on Avon Barn (Groves and Hillam 1994) | 6.87 |

**Table 4**

*t*-value matrix for the timbers forming the chronology BSB-PEWS

| | H | I |
|---|---|---|
| **G** | 5.61 | 8.84 |
| **H** | | 7.73 |

**Table 5**

Dating the mean sequence BSB-PEWS, AD 1321-1445 inclusive. Example *t*-values with independent reference chronologies

| **Reference chronology** | ***t*-value** |
|---|---|
| Cornwall, Roscarrock nr St Endellion (Tyers 2004c) | 5.10 |
| Devon, West Challacombe (Tyers and Groves 1999) | 5.94 |
| Devon, West Hele Kings Nympton (Tyers *et al* 1997) | 4.99 |
| Gloucestershire, Kingswood Abbey Gatehouse (Arnold *et al* 2003) | 5.83 |
| Herefordshire, Colwall nr Great Malvern (Hillam 1991) | 4.36 |
| Herefordshire, Pembridge Duppa Cottages (Tyers 2004b) | 5.13 |
| Herefordshire, Woodhouse Farm Staplow (author unpubl) | 4.92 |
| Leicestershire, Medbourne Manor (Howard *et al* 1999) | 4.62 |
| Nottinghamshire etc., East Midlands region (Laxton and Litton 1988) | 4.60 |
| Wiltshire, Bishops Palace Salisbury (Miles 2002) | 4.38 |

**Appendix 1** Ring width data for measured samples from St Brannock Church, Braunton, Devon, 100 = 1mm

BSB01

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 147 | 258 | 273 | 132 | 113 | 176 | 228 | 159 | 160 | 127 |
| 197 | 268 | 175 | 208 | 229 | 172 | 97 | 92 | 74 | 79 |
| 108 | 95 | 95 | 114 | 144 | 135 | 102 | 96 | 151 | 166 |
| 130 | 166 | 177 | 140 | 160 | 190 | 151 | 134 | 150 | 118 |
| 175 | 188 | 177 | 183 | 133 | 160 | 176 | 154 | 128 | 105 |
| 87 | 127 | 162 | 152 | 125 | 102 | 114 | 99 | 128 | 151 |
| 110 | 107 | 92 | 73 | 72 | 105 | 97 | 103 | 76 | 142 |
| 128 | 129 | 92 | 87 | 69 | 122 | 110 | 161 | 94 | 109 |
| 100 | 88 | 78 | 82 | 70 | 66 | 52 | 91 | 87 | 108 |
| 137 | 147 | 159 | 112 | 146 | 143 | 114 | 88 | 64 | 99 |
| 88 | 84 | 106 | 86 | 87 | 115 | 146 | 157 | 149 | 111 |
| 100 | 117 | 151 | 135 | 134 | 92 | 75 | 89 | 115 | 117 |
| 119 | 147 | 142 | 154 | 132 | 106 | 114 | 145 | 199 | 148 |
| 121 | 106 | 97 | 162 | 137 | 108 | 175 | 139 | 133 | 116 |
| 119 | 147 | 125 | 120 | 100 | 117 | 124 | 144 | 139 | 148 |
| 164 | 134 | 108 | 93 | 110 | 115 | 104 | 113 | 136 | |

BSB02

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 427 | 449 | 319 | 340 | 253 | 212 | 218 | 237 | 154 | 206 |
| 278 | 263 | 295 | 307 | 318 | 337 | 325 | 273 | 205 | 202 |
| 261 | 297 | 297 | 212 | 236 | 275 | 318 | 402 | 341 | 183 |
| 168 | 150 | 335 | 277 | 217 | 145 | 106 | 159 | 147 | 201 |
| 210 | 348 | 295 | 225 | 233 | 189 | 214 | 234 | 253 | 203 |
| 248 | 185 | 180 | 225 | 247 | 214 | 324 | 214 | 244 | 242 |
| 200 | 140 | 245 | 218 | 217 | 160 | 164 | 165 | 317 | 365 |
| 233 | 346 | 262 | 239 | 239 | 219 | 138 | 178 | 142 | 141 |
| 169 | 159 | | | | | | | | |

BSB03

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 597 | 452 | 432 | 379 | 376 | 303 | 241 | 214 | 267 | 380 |
| 329 | 197 | 220 | 244 | 351 | 511 | 379 | 429 | 351 | 268 |
| 289 | 288 | 174 | 324 | 287 | 356 | 177 | 244 | 246 | 262 |
| 323 | 354 | 227 | 177 | 185 | 362 | 236 | 450 | 230 | 181 |
| 185 | 162 | 240 | 265 | 199 | 379 | 314 | 271 | 212 | 211 |
| 270 | 230 | 189 | 314 | 177 | 165 | 256 | 309 | 227 | 316 |
| 181 | 255 | 197 | 277 | 189 | 225 | 232 | 227 | 178 | 142 |
| 263 | 253 | 237 | 264 | 305 | 251 | 195 | 211 | 144 | |

BSB04

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 326 | 374 | 305 | 317 | 317 | 296 | 232 | 238 | 241 | 243 |
| 256 | 290 | 201 | 245 | 291 | 356 | 337 | 334 | 278 | 202 |
| 256 | 300 | 247 | 274 | 159 | 125 | 144 | 134 | 184 | 236 |
| 195 | 263 | 232 | 295 | 238 | 216 | 210 | 244 | 231 | 288 |
| 208 | 198 | 246 | 254 | 161 | 242 | 169 | 188 | 241 | 159 |
| 179 | 210 | 150 | 185 | 143 | 149 | 141 | 157 | 227 | 177 |
| 160 | 171 | | | | | | | | |

BSB06

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 169 | 166 | 269 | 274 | 136 | 97 | 101 | 144 | 242 | 241 |
| 222 | 247 | 255 | 190 | 218 | 160 | 96 | 111 | 126 | 168 |
| 146 | 154 | 154 | 114 | 175 | 192 | 170 | 137 | 80 | 90 |
| 67 | 66 | 83 | 112 | 121 | 96 | 107 | 147 | 150 | 117 |
| 153 | 104 | 101 | 76 | 124 | 114 | 126 | 96 | 93 | 87 |
| 69 | 102 | 105 | 116 | 151 | 131 | 108 | 101 | 107 | 122 |
| 182 | 107 | 63 | 71 | 58 | 96 | 103 | 79 | 87 | 50 |
| 41 | 41 | 32 | 56 | 61 | 48 | 60 | 112 | 117 | 109 |
| 152 | 182 | 153 | 117 | 51 | 45 | 88 | 110 | 95 | 108 |
| 121 | 73 | 65 | 117 | 115 | 122 | | | | |

BSB08

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 473 | 479 | 359 | 279 | 268 | 403 | 353 | 427 | 352 | 271 |
| 266 | 341 | 401 | 357 | 319 | 397 | 349 | 309 | 253 | 295 |
| 284 | 261 | 236 | 270 | 219 | 210 | 233 | 269 | 242 | 275 |
| 158 | 260 | 216 | 196 | 194 | 221 | 185 | 152 | 122 | 147 |
| 216 | 219 | 238 | 157 | 183 | 171 | 94 | 148 | 150 | 154 |
| 186 | 176 | 206 | 172 | 138 | 137 | 149 | | | |

BSB10

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 250 | 254 | 256 | 205 | 122 | 162 | 163 | 152 | 97 | 78 |
| 87 | 147 | 123 | 151 | 122 | 101 | 78 | 82 | 69 | 41 |
| 43 | 60 | 57 | 49 | 62 | 49 | 78 | 71 | 59 | 66 |
| 91 | 104 | 113 | 113 | 125 | 104 | 137 | 127 | 86 | 105 |
| 97 | 130 | 106 | 73 | 76 | 81 | 113 | 130 | 156 | 139 |
| 131 | 131 | 162 | 143 | 164 | 105 | 63 | 113 | 122 | 194 |
| 169 | 126 | 117 | 120 | 136 | 109 | 107 | 103 | 80 | 94 |
| 83 | 90 | 62 | 101 | 174 | 181 | 127 | 147 | 154 | 87 |
| 108 | 123 | 107 | 145 | 131 | 144 | 118 | 113 | 126 | 144 |
| 204 | 208 | 144 | 137 | 118 | 210 | 197 | 234 | 116 | 81 |
| 104 | 115 | 136 | 88 | 122 | 137 | 137 | 158 | 126 | 158 |
| 151 | 170 | 190 | 155 | 76 | 68 | 113 | 112 | 108 | 152 |
| 136 | 136 | 133 | 130 | 96 | 129 | 142 | 153 | 148 | 189 |
| 173 | 163 | 182 | 110 | 109 | 74 | 80 | 76 | 65 | 50 |
| 70 | 77 | 53 | 69 | 54 | | | | | |

BSBP_E

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 194 | 212 | 216 | 147 | 127 | 117 | 145 | 137 | 180 | 199 |
| 224 | 303 | 216 | 172 | 218 | 160 | 106 | 96 | 70 | 82 |
| 156 | 193 | 125 | 158 | 188 | 245 | 196 | 206 | 156 | 111 |
| 84 | 105 | 146 | 213 | 140 | 89 | 140 | 120 | 161 | 196 |
| 150 | 196 | 114 | 118 | 135 | 87 | 106 | 150 | 118 | 133 |
| 83 | 96 | 97 | 104 | 81 | 70 | 50 | 60 | 50 | 37 |
| 40 | 53 | 74 | 47 | 67 | 114 | 180 | 188 | 130 | 93 |
| 109 | 145 | 141 | 158 | 92 | 79 | 51 | 46 | 35 | 45 |
| 78 | 90 | 132 | 97 | 114 | 205 | 183 | 171 | 103 | 157 |
| 155 | 134 | 127 | 83 | 143 | 119 | 121 | 73 | 86 | 136 |
| 104 | 117 | 135 | 112 | 239 | 180 | 248 | 211 | 153 | 124 |
| 150 | 173 | 177 | 138 | 167 | 175 | 219 | | | |

BSBP_F

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 314 | 219 | 249 | 131 | 114 | 146 | 184 | 160 | 136 | 161 |
| 211 | 259 | 292 | 227 | 226 | 270 | 287 | 335 | 474 | 587 |
| 403 | 262 | 203 | 235 | 369 | 318 | 235 | 345 | 186 | 166 |
| 285 | 198 | 217 | 301 | 282 | 170 | 165 | 213 | 263 | 334 |
| 303 | 258 | 276 | 322 | 218 | 121 | 127 | 189 | 178 | 165 |
| 173 | 189 | 151 | 138 | 149 | 154 | 103 | 102 | 94 | 107 |
| 122 | 123 | 94 | 77 | 86 | 59 | 77 | 82 | 85 | 110 |
| 114 | 171 | 99 | 91 | 106 | 117 | 166 | 131 | 107 | 63 |
| 51 | 81 | 72 | 85 | 88 | 60 | 48 | 50 | 61 | 52 |
| 49 | 54 | 48 | 56 | 50 | 64 | 55 | 74 | 85 | 83 |
| 83 | 93 | 109 | 153 | 128 | 139 | 111 | 124 | 102 | |

BSBP_G

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 151 | 149 | 131 | 72 | 107 | 49 | 96 | 108 | 197 | 138 |
| 148 | 109 | 106 | 101 | 108 | 147 | 201 | 168 | 163 | 149 |
| 143 | 167 | 193 | 145 | 158 | 102 | 93 | 89 | 158 | 130 |
| 122 | 103 | 79 | 83 | 138 | 147 | 127 | 94 | 127 | 125 |
| 132 | 120 | 193 | 159 | 129 | 141 | 124 | 115 | 111 | 73 |
| 75 | 106 | 94 | 86 | 95 | 134 | 130 | 117 | 120 | 128 |
| 111 | 137 | 101 | 101 | 114 | 121 | 141 | 120 | 116 | 107 |
| 82 | 100 | 74 | 86 | 69 | 77 | 73 | 81 | 92 | 94 |
| 90 | 69 | 82 | 81 | 59 | 63 | 55 | 60 | 57 | 40 |
| 43 | 50 | 83 | 74 | 56 | 49 | 39 | 53 | 39 | 44 |
| 47 | 43 | 60 | 69 | 68 | 66 | 75 | 83 | 75 | 73 |
| 90 | 92 | 77 | 81 | 109 | 110 | 86 | 69 | 49 | 82 |
| 73 | 63 | 142 | 113 | 107 | | | | | |

BSBP_H

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 266 | 342 | 353 | 201 | 192 | 222 | 316 | 210 | 249 | 240 |
| 194 | 178 | 184 | 205 | 210 | 256 | 243 | 222 | 163 | 175 |
| 234 | 216 | 250 | 225 | 237 | 192 | 244 | 243 | 274 | 243 |
| 208 | 162 | 155 | 134 | 181 | 169 | 177 | 121 | 149 | 160 |
| 149 | 210 | 217 | 186 | 146 | 154 | 139 | 123 | 109 | 98 |
| 92 | 94 | 88 | 98 | 128 | 143 | 110 | 95 | 101 | 120 |
| 115 | 109 | 87 | 85 | 82 | 98 | 132 | 113 | 101 | 101 |
| 108 | 116 | 107 | 91 | 114 | 97 | 86 | 88 | 109 | 111 |
| 99 | 88 | 84 | 79 | 63 | 90 | 87 | 89 | 89 | 69 |
| 63 | 72 | 96 | 102 | 92 | 82 | 68 | 79 | 63 | 71 |
| 68 | 61 | 100 | 95 | 73 | 77 | 58 | 66 | 69 | 65 |
| 66 | 66 | 71 | 63 | 75 | 75 | 71 | 66 | 48 | 68 |
| 77 | 81 | | | | | | | | |

BSBP_I

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 299 | 255 | 273 | 227 | 242 | 214 | 205 | 233 | 298 | 200 |
| 171 | 131 | 127 | 124 | 164 | 174 | 184 | 130 | 132 | 117 |
| 106 | 136 | 194 | 164 | 131 | 137 | 122 | 101 | 88 | 58 |
| 60 | 93 | 82 | 68 | 116 | 135 | 104 | 86 | 111 | 91 |
| 98 | 101 | 85 | 78 | 83 | 103 | 125 | 115 | 101 | 102 |
| 100 | 101 | 103 | 87 | 85 | 90 | 79 | 86 | 88 | 103 |
| 82 | 71 | 69 | 67 | 53 | 73 | 81 | 81 | 68 | 52 |
| 51 | 68 | 73 | 67 | 62 | 42 | 33 | 49 | 36 | 38 |
| 50 | 40 | 60 | 67 | 64 | 70 | 98 | 81 | 84 | 76 |