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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

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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 VIII, VIII, and VIII° respectively whilst the bench end is numbered VIII. 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

The sampling and analysis programme was funded by English Heritage. Francis Kelly and Derek Hamilton from English Heritage put together the request documentation. Francis Kelly, Hugh Harrison, and Cathy Groves provided useful discussion of the results. Rev Roger Reeve provided access to the building for the initial assessment, Ellis and Co (Restoration and Building) Ltd provided access to the building during the sampling of the roof, Bob Chappell delivered the pew timbers to Sheffield after their conservation treatment.

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



Figure 2 Location of St Brannock church, Braunton, Devon

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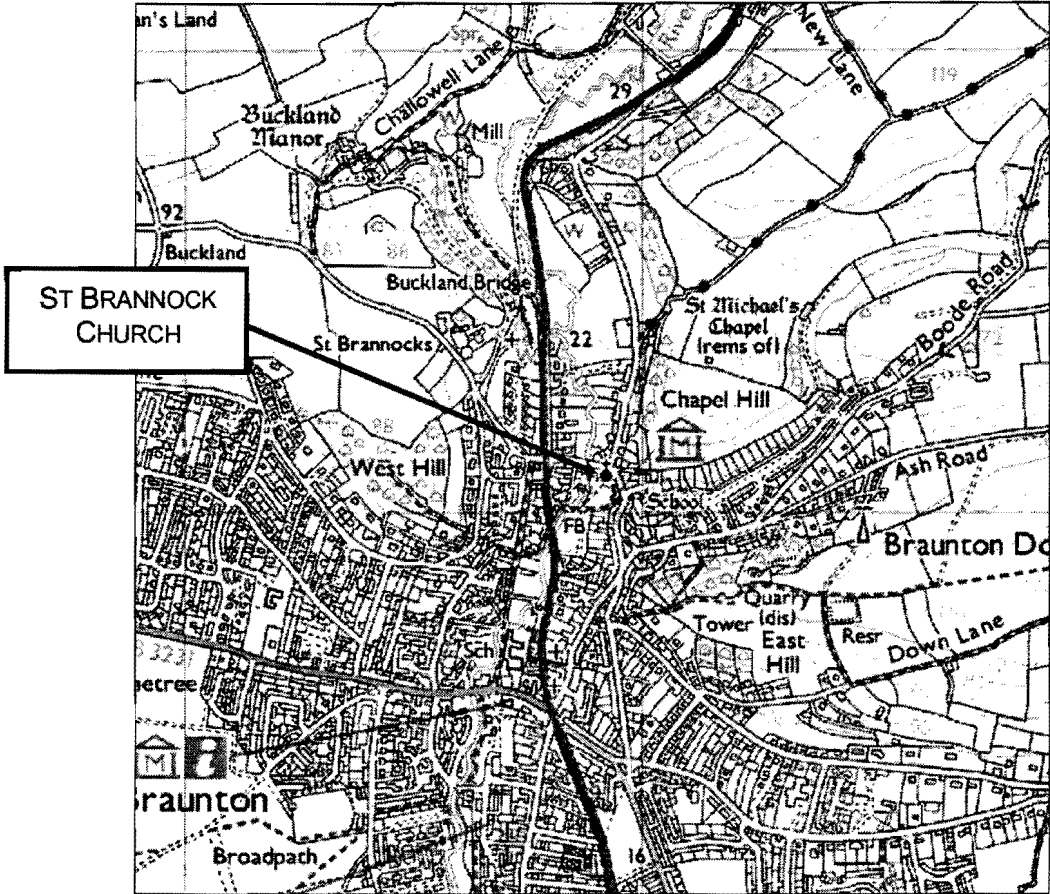


Figure 3 Nave roof plan of St Brannock church, Braunton, Devon showing the truss numbering scheme used in this report. The labelled arrows indicate the approximate locations of the sampled timbers and the direction of the core (based on a plan by Jonathan Rhind Architects supplied by English Heritage)

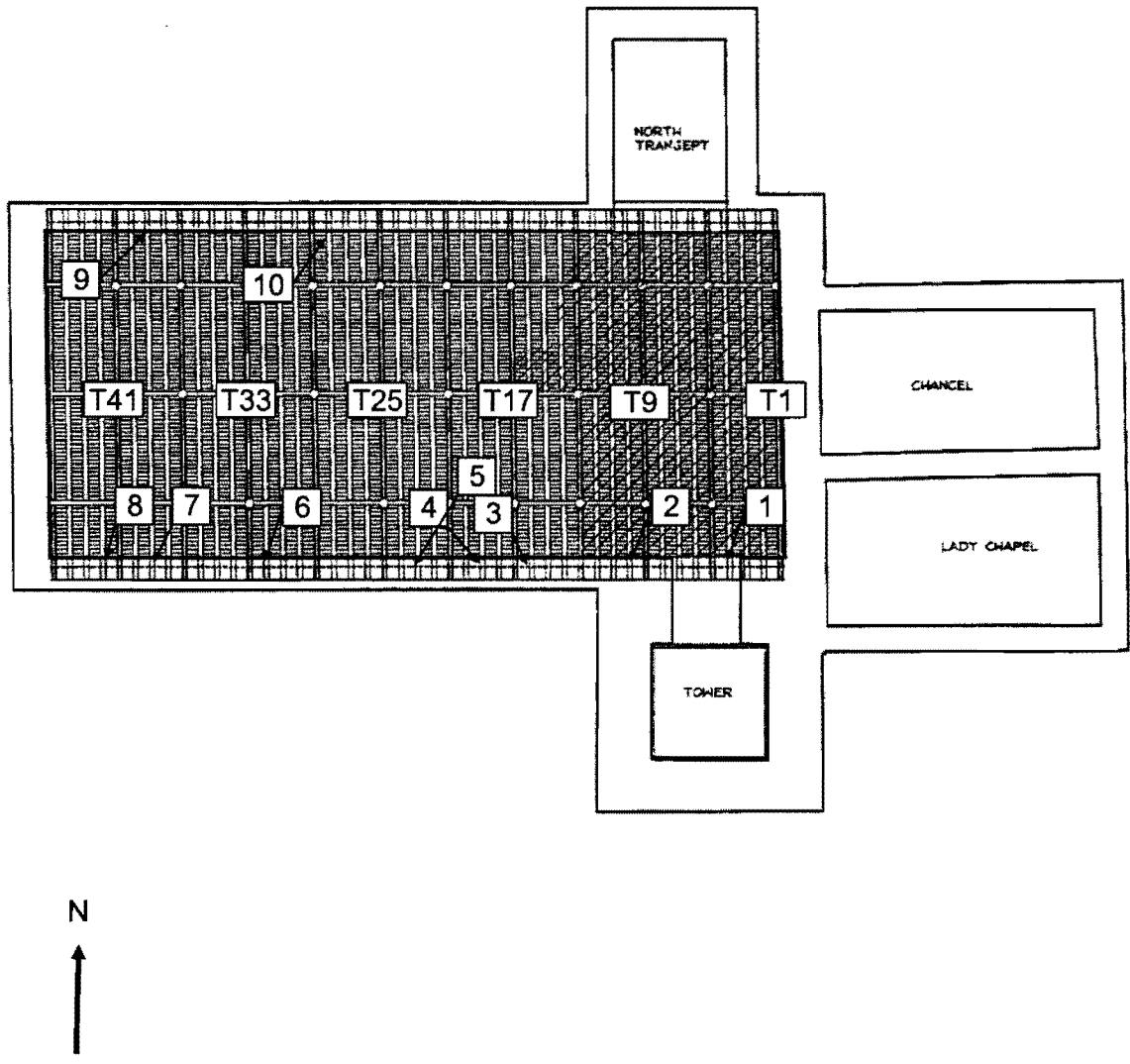


Figure 4 Floor plan of St Brannock church, Braunton, Devon showing the location of the fire damaged pews (based on a plan by Jonathan Rhind Architects supplied by English Heritage) pews not to scale

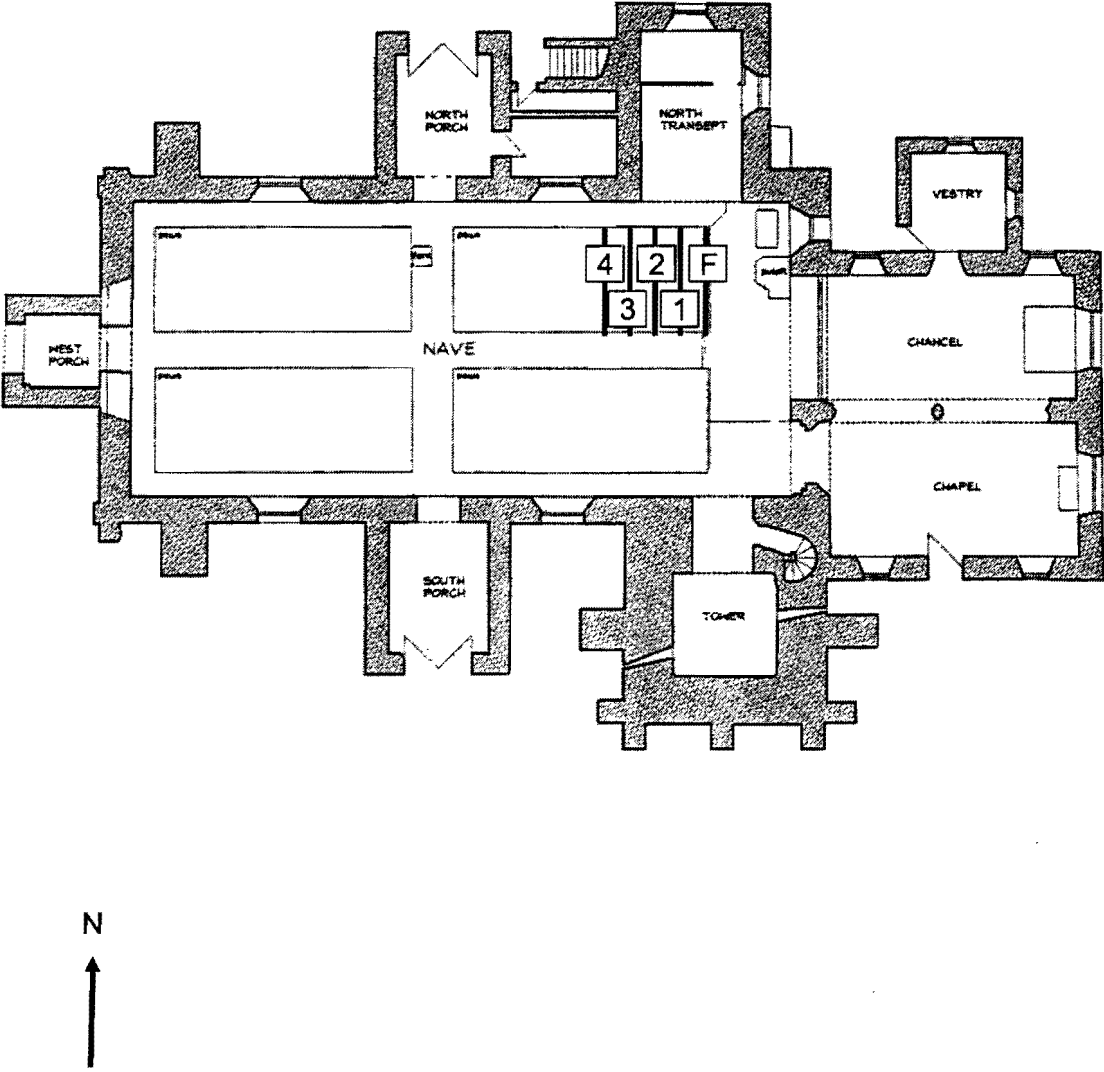
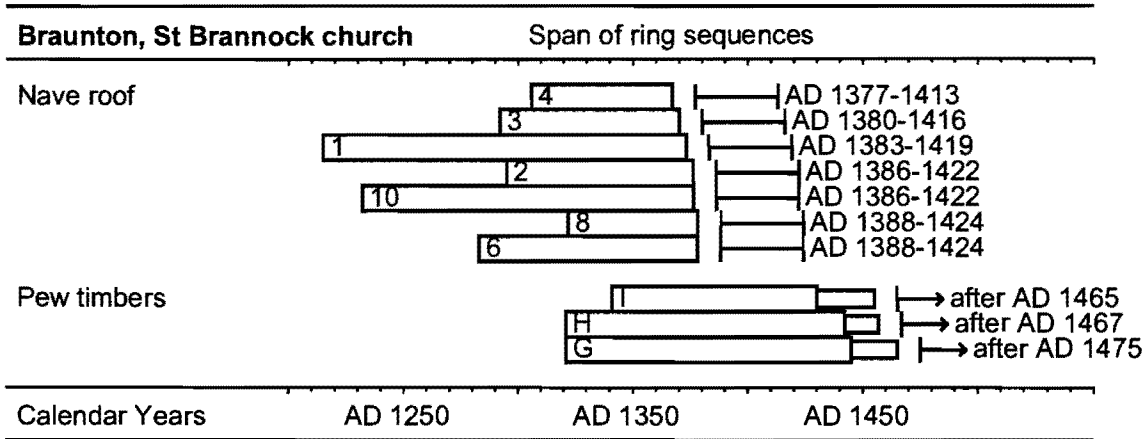


Figure 5 Bar diagram showing the chronological positions of the dated timbers from St Brannock church, Braunton, Devon. The narrow bars indicate unmeasured rings. The estimated felling period for each sequence is also shown



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	<i>t</i> -value
Devon, Bradworthy Church (Tyers 2003)	8.91
Devon, Rudge Morchard Bishop (Tyers <i>et al</i> 1997)	6.11
Devon, The Deanery Exeter (Howard <i>et al</i> 2000)	7.78
Devon, Thorne Clannaborough (Tyers <i>et al</i> 1997)	5.66
Devon, West Challacombe (Tyers and Groves 1999)	7.78
Dorset, Fiddleford Manor Sturminster Newton (Bridge 2003)	6.04
Oxfordshire, Baylols Manor Harwell (Haddon-Reece and Miles 1992)	7.10
Somerset, Bridge Farm West Bradley (Miles <i>et al</i> 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	<i>t</i>-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 <i>et al</i> 1997)	4.99
Gloucestershire, Kingswood Abbey Gatehouse (Arnold <i>et al</i> 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 <i>et al</i> 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