DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM 63 FORE STREET, TROWBRIDGE, WILTSHIRE, ENGLAND

Tree-Ring Services Report: BAFS/03/13

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SUMMARY

63 Fore Street lies on the north side of the street. In the rear range a remarkable complete 2-bay timber-frame building survives. Only roof timbers appear to survive in the front range, and these show signs of re-use. Unusually, the roof of the rear range has both a crown strut and queen-strut trusses. The roof is gabled and has in-line butt purlins and curved wind braces. The principal rafters do not diminish. Little of the wall-framing was evident, but most of the posts survive and these are jowled.

Eight of the eleven samples taken from 63 Fore Street are matched together to form a 135-year site chronology which spans AD 1378 to AD 1512. A probably precise felling date in AD 1513, together with compatible felling-date ranges from four other timbers, provides good evidence to indicate that construction of the rear range occurred in AD 1513, or soon after.

Three samples from re-used principal rafters in the front range are also dated. The similarity of the timbers' dimensions, high cross-matching between all the series dated and the similarity of felling-date ranges between the rear and front range timbers suggest that the two ranges were originally built around the same time. While most of the front range timbers have been lost during later changes, this analysis indicates that it is likely that the timbers from the earlier front range were re-used in the current front range roof.

KEYWORDS

Dendrochronology, 16th Century, Timber-framed standing building, Wiltshire, Trowbridge.

Figures

Tables

Photos

INTRODUCTION

There is an increasing interest in Britain's past as evinced by such television programmes as "Time Team" and "The House Detectives", which both promote and respond to this interest. More and more people wish to know precisely when ancient buildings were constructed in order to better understand the history of the land in which we live. However, although there is some ability to date a building on stylistic grounds, a precise date is rarely known except when there is a date-stone or documentary evidence.

The advent of dendrochronology (tree-ring dating) is changing this scenario, at least for buildings with timbers containing sufficient rings for analysis. The science is simple in concept. The width of a tree's growth rings varies from year to year, so that each series of years has a unique pattern of narrow and wide rings. We now know in detail the pattern of rings shown by oak trees in England for at least the last 2000 years, and there is some work in progress on other species. Small cores of wood taken from the structural timbers of a building show the pattern of rings laid down during the lifetime of the trees from which the timbers were cut. If this pattern is then compared with "master chronologies" it is often possible to identify the felling date of the trees with astonishing accuracy. Where bark is present, it is possible to give a precise year, sometimes even the season of the year. We know that oak for building was almost always used "green", (unseasoned, not having been felled and prepared until required), so construction dates can be determined in which we can place considerable confidence.

Recording Timber-Framed Buildings

National trends in building activity inevitably conceal regional differences that can only be explained by detailed local studies. The Royal Commission on the Historical Monuments of England (RCHME) has analysed 53 medieval buildings in Kent (Pearson 1994). Hampshire County Council has analysed well over 100 buildings in the county (Roberts 2003). These projects utilize the specific dates provided by tree-ring analysis to refine the typological and stylistic dating of buildings.

Harris (1978) provides a useful introduction to the study of timber-framed buildings, while Brunskill (2000) details the study of vernacular architecture. Alcock's (1996) glossary provides illustrative drawings which are particularly useful in facilitating the naming of timbers in a building.

Figure 1: Area location map

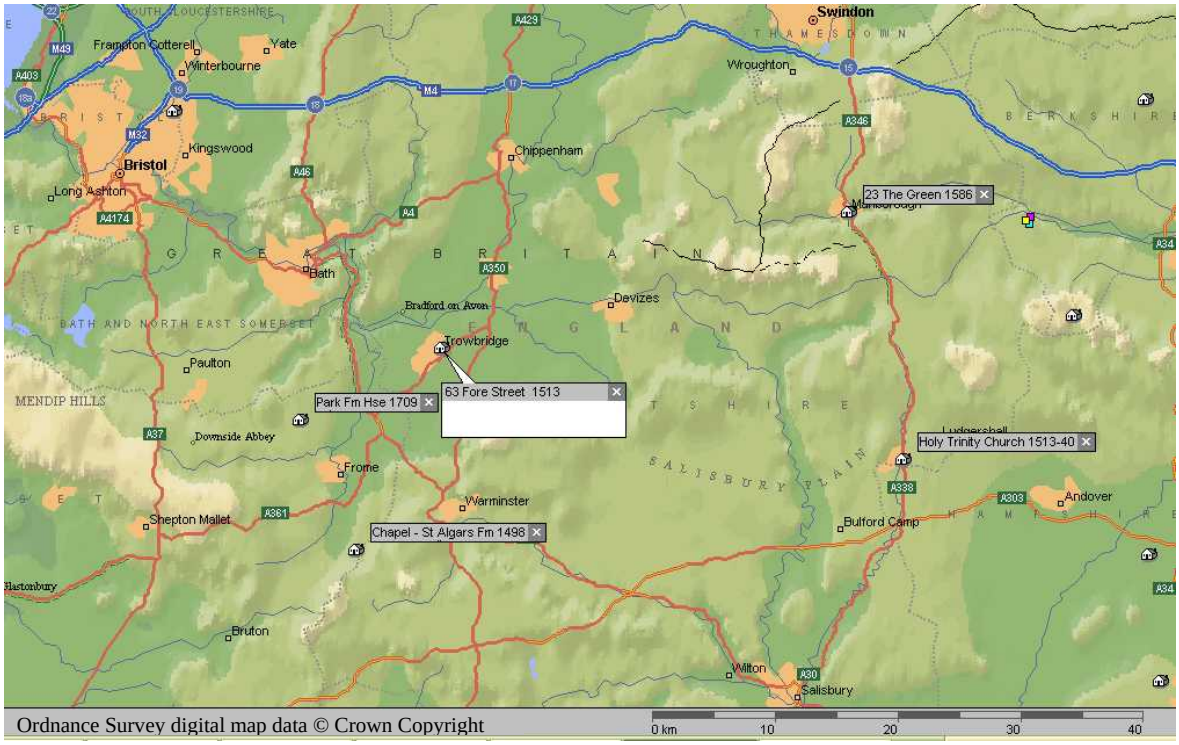
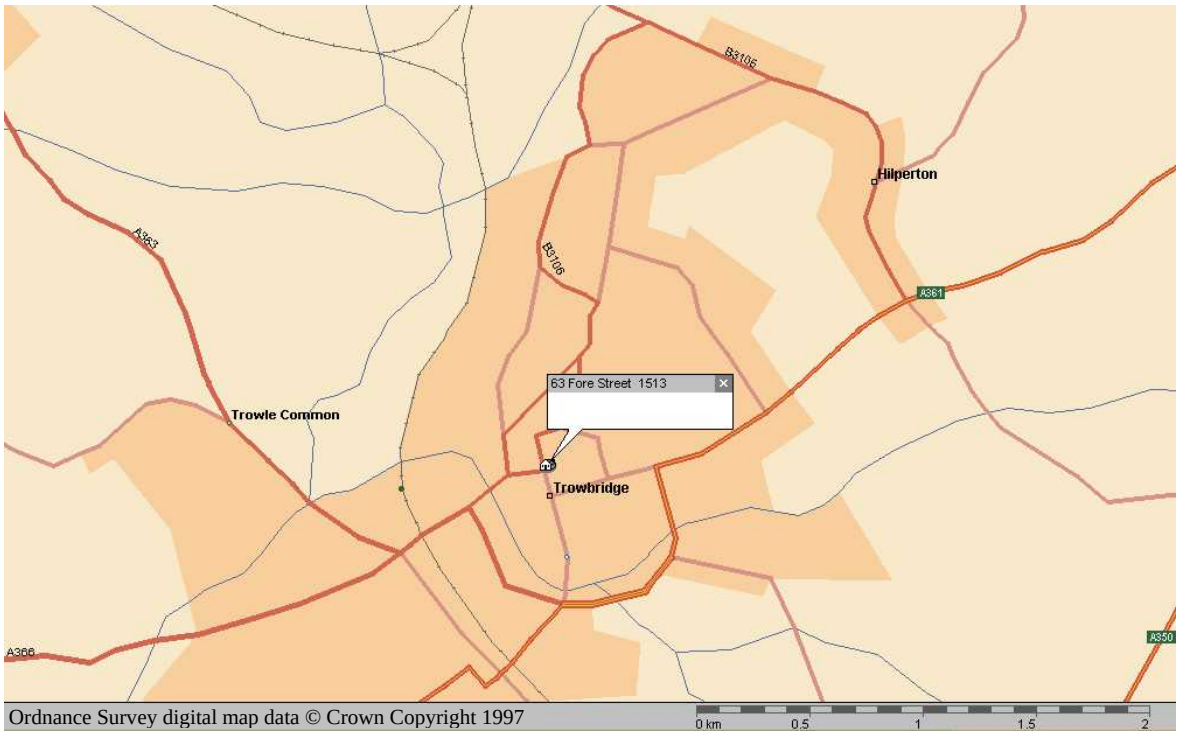


Figure 2: Site location map



63 Fore Street (NGR: ST 8556 5807).

There are a number of timber framed houses in Trowbridge which have been re fronted in a later style as previous generations wanted up to date dwellings and if there was not sufficiently money to rebuild completely, then a new front kept up appearances. Number 63 Fore Street lies on the north side of the street and is a medieval building with a front

built in 1789 (Rogers 1984). In the rear range a remarkable complete 2-bay timber-frame building survives. Only roof timbers appear to survive in the front range, and these show signs of re-use.

Unusually, the roof of the rear range has both a crown strut and queen-strut trusses. The roof is gabled and has in-line butt purlins and curved wind braces. The principal rafters do not diminish. Little of the wall-framing was evident, but most of the posts survive and these are jowled.

Photo 2: Front range of 63 Fore Street - south aspect

Photo 1: Roof truss of the rear range of 63 Fore Street

Objective of the Analysis

The main objective of this analysis was to provide dendrochronological evidence to date the primary phase of construction.

Dendrochronological Assessment

63 Fore Street was visited on the 8th March 2013 and the timbers assessed for their potential use in dendrochronological study. Oak timbers with more than 50 rings, traces of sapwood or bark, and accessibility were the main considerations. The timbers of the rear range were remarkably complete above tiebeam level and sufficient suitable timbers were identified for sampling to proceed. Only roof timbers appear to have survived in the front range, but empty mortises indicate that the principal rafters have been re-used. Nevertheless, these principal rafters contained sufficient rings for analysis and it was requested that an attempt was made to date them also.

METHODOLOGY

Methods employed by Tree-Ring Services in general are those described in English Heritage guidelines (Hillam 1998). Part 2 of the Guidelines is designed for large projects in conjunction with other specialist disciplines and is not applicable to the type of privately commissioned dendrochronological analysis generally conducted by Tree-Ring Services and is therefore not used. Details of the methods employed for the analysis of this building are described below.

Sampling and Preparation

Photo 3: Extraction of a core in progress

Whenever possible, timbers with more than 50 annual growth rings are selected for sampling. This is necessary to provide a pattern of rings of sufficient length to be unique to the period of time when the parent tree was growing. Timbers are sampled using purpose-made 12mm and 15mm diameter corers attached to an electric drill. Sampling is located as discreetly as possible in what appear to be original timbers and is orientated in the most suitable direction to maximize the numbers of rings for subsequent analysis. Extracted core samples are immediately taped and glued onto wooden laths on site and then labelled, ready for subsequent analysis.

Tree-ring series are revealed through sanding with progressively finer grits to a 600 abrasive grit finish to produce results suitable for measuring, see **Photo 4**. When required, for example where bands of narrow rings occur, further preparation is performed manually. Where requested, extraction holes are "made good", employing pine dowelling, wood-glue, sawdust and wood stains to restore the timbers to their original appearance.

Photo 4: An example of the tree-ring series revealed through the sanding of cores

Measuring and Cross-matching

Tree-ring series are measured under a ×20 stereo microscope to an accuracy of 0.01mm using a microcomputer-based travelling stage. All samples are measured from the centremost ring to the outermost. Samples considered unsuitable for dating purposes are then rejected. These include samples with disturbed ring series which cannot be measured due to knots or bands of extremely narrow rings, and those samples with fewer than 40 rings.

Samples of fewer than 50 rings are sometimes rejected from dendrochronological analysis because their ring patterns may not be unique (Hillam *et al.* 1987). Although this is certainly true of all ring series of fewer than 30 rings, which should not be used in dating (Mills 1988), samples with 30 to 50 rings may be dated in some circumstances (Hillam 1998). Because samples taken by Tree-Ring Services are often from listed structures, it has been felt wise to maximize the recorded amount of data, and series of 40–50 rings are included in analysis and considered for dating, usually when they match well with a

number of other series. Samples are measured twice and the two sets of measurements cross-matched and plotted visually as a check. Where series match satisfactorily they are averaged and the resulting series are used in subsequent analysis. Series containing fewer than 50 rings are suffixed '-S', and series from managed trees '-M' to help indicate that additional caution must be exercised in dating.

Cross-correlation algorithms are then employed to search for the positions where tree-ring series correlate and therefore possibly match. All statistical correlations are reported as *t*-values derived from the original CROS73 algorithm (Baillie and Pilcher 1973). A value of 3.5 or over is usually indicative of a good match as it represents the value of *t* which should occur by chance only once in every 1000 mismatches (Baillie 1982), and the higher the *t*-value the closer to congruency in the cross-matching. However, due to the remaining small risk of high *t*-values being produced by chance, all indicated correlations are further checked to ensure that corroborative high results are obtained at the same relative position against a range of independent tree-ring series. Visual comparisons of series are also employed to support or reject possible cross-matches and serve as a means of identifying measuring errors.

Timber Groups

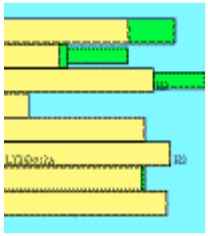
A further element of the tree-ring analysis of buildings and archaeological assemblages is the grouping of timbers within the sampled material. Inspection of *in situ* timbers may indicate that samples derive from a common timber, while common arrangements of anatomical features (knots & branching) may also indicate that samples are derived from a single tree.

Tree-ring analysis is used to support suggestions of same-tree groups between samples based on a combination of information. Timbers derived from the same tree are generally expected to have *t*-values over 10, although lower *t*-values may be produced when different radii measured from the same tree are compared. Tree-ring series producing *t*-values of 10 or above are examined to identify same-tree groups. Good comparisons of visual matching, growth rates, short and longer-term growth patterns, are combined with pith information, sapwood boundaries, bark and anatomical anomalies, to help decide whether timbers are likely to come from the same tree. Where timbers are assessed as deriving from the same tree, to avoid bias the series are averaged to produce a single tree-ring series before inclusion in the final site chronology, but inevitably some same-tree samples go undetected by dendrochronology.

Chronology Building and Cross-dating

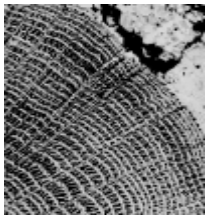
The process of cross-matching compares all tree-ring series against one another and those found to cross-match satisfactorily together are combined to create an average series. The site mean(s) and individual ring series which remain unmatched with the site mean are then tested against a range of established reference series (reference chronologies). Significant *t*-values replicated against a range of series at the same position with satisfactory visual matching are similarly used to establish cross-matches with reference chronologies. Where cross-matching is established against dated reference chronologies, calendar dates can be assigned to the site series. The dates of the first and last rings of dated series are produced as date spans. These dates should not be confused with felling dates.

Felling Dates



Series dated by the cross-dating process provide calendar year dates for the final tree-ring present in the measured timber sample. The interpretation of these dates then relies upon the nature of the final rings in the series. Where bark survives intact on a sample a felling date is given as the date of the last ring measured on the tree-ring series. Based on the completeness of the final ring it is sometimes even possible to distinguish between spring, summer or winter fellings, corresponding to approximately March to May, June to September and October to February, respectively. Where timbers were felled in either spring or summer and the final ring is incomplete and therefore not measured, allowance has to be made for the one-year discrepancy between the end of a measured series and the actual year of felling.

Sapwood Estimates

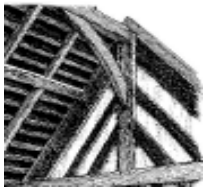


Where bark is missing from oak samples, as long as either sapwood or the heartwood/sapwood boundary have been identified, an estimated felling-date range can be calculated using the maximum and minimum number of sapwood rings that were likely to have been present. Sapwood estimates have varied over time with different data sets, geographical location and researchers. A general trend identified is that the number of sapwood rings in oak decreases from north to south and from west to east across Europe.

However, simply not enough is yet understood about sapwood variations and the mechanisms responsible for them. A generally accepted sapwood estimate of between 10 and 55 rings for British and Irish oaks (at 95% confidence) was given in 1987 (Hillam *et al.* 1987). Analysis of the increased data set available ten years later indicates a range of 10 to 46 rings to be more appropriate for England (Tyers 1998). Currently, as research in areas improves, sapwood estimates are refined and new estimates applied. Therefore, when dendrochronological dates are produced, the reference to the sapwood estimate used in its calculation should always follow.

This report applies a sapwood estimate of a minimum of 9 and maximum of 41 annual rings, which means that 19 out of every 20 trees examined is expected have between 9 and 41 sapwood rings. This sapwood estimate is currently applied to most of the south-east region and has been arrived at by Oxford Dendrochronology Laboratory (Haddon-Reece *et al.* 1990, Miles 1997). Felling-date ranges have been calculated by adding the sapwood estimate of minimum and maximum missing rings to the date of the heartwood/sapwood boundary. Felling-date ranges have been refined by the presence of surviving sapwood where appropriate, see **Table 3**. Where samples ending in heartwood were dated, "felled after dates" have been calculated by adding the minimum expected number of missing sapwood rings to the samples' final ring dates. These dates represent the earliest probable felling dates. However, the actual felling date of a tree may be decades later due to an unknown number of missing heartwood rings.

Felling Groups



It is common to find that timbers used in the construction or repair of smaller buildings, or identifiable parts of larger buildings, date into groups whose felling dates occur within a narrow range of years. These groups are called associated fellings. Where they are identified the average heartwood/sapwood boundary of the component timbers is used to calculate an overall estimated period of felling. Close location association and a short (21 years at most) range of heartwood-sapwood boundary dates are normally used to define these groups. The estimates do not assume that trees within a group were felled at the same time. However, evidence published by the Nottingham University Tree-Ring Dating Laboratory indicates that the range estimate encompasses the possible different individual felling dates (English Heritage 2001). Where bark is present within a group of timbers and other evidence does not dispute the date, it is assumed that all the trees within a felling group were felled in the same year.

Date of Construction

It is vitally important to understand that dendrochronological analysis provides dates for when trees were felled and not necessarily when their timbers were used. Green or freshly felled wood is, however, far easier to work and it is standard practice to assume that medieval timbers were felled as required and used green (Rackham 1990, Miles 1997). However, the use of previously felled timbers in vernacular construction was not uncommon, with short-term stockpiling of usually not more than 1 to 2 years (Miles 1997), and the use of leftovers or re-used timbers may certainly give rise to differences between felling dates and the date of construction where samples are analysed in isolation. A number of samples having a close range of felling dates are required from different elements of a building either to strongly indicate a single date of construction or to identify separate phases of construction.

Tree-Ring Services - Methods and Criteria

Tree-ring analysis and graphics are achieved via a dendrochronological programme suite developed by Ian Tyers of Sheffield University (Tyers 1999). Location maps are produced using *Microsoft AutoRoute Express GB 98 Auto Street Navigator*, which uses Ordnance Survey digital map data © Crown Copyright 1997. Alcock's (1996) timber-framed building nomenclature has been adopted throughout to facilitate regional comparisons.

For the analysis of a building an initial assessment is conducted with the owner and recommendations in line with English Heritage guidelines on sampling strategies made, (i.e., that a minimum of 8 to 10 samples are obtained per building or per phase). However, the final decision concerning the number of samples taken for analysis rests with the individuals who commission the analysis. It is generally beyond the scope of an analysis to describe a building in detail or to undertake the production of detailed drawings. Without the benefit of other specialist disciplines there is always the danger that re-used timbers may be inadvertently selected, and the conclusions presented in a report may be modified in the light of subsequent work.

RESULTS

A total of eleven core samples were taken from 63 Fore Street on the 8th March 2013. Eight were sampled from the rear range and three re-used principal rafters in the front range were also sampled. The main timber trusses were labelled from 1A in the south-west corner to 6C in the north-east corner. Sampling locations are indicated on a sketch plan of the building (see **Appendix I**) and the locations of cores taken are also shown in the photographs below.

Photo 5: Cores BAFS01 (bottom), BAFS02 (top right) & BAFS03 (top left)

Photo 6: Cores BAFS04 (left) & BAFS05 (right)

Photo 7: Cores BAFS06 (left) & BAFS07 (right)

Photo 8: Core BAFS08

Photo 9: Core BAFS09

Photo 10: Cores BAFS10 (left) & BAFS11 (right)

All eleven samples were confirmed as oak (*Quercus* spp). Three samples BAFS01, BAFS03 and BAFS06 were taken from where the sapwood was complete. However, the outermost ring of sample BAFS03 and the outer most 4 mm of sample BAFS06, broke off during coring. Sample BAFS02 contained only 30 rings and therefore this sample was rejected from further analysis at this stage.

Ten series were of sufficient length to be considered for cross-matching. Eight series were found to match together (see **Table 1**); these series were combined to form a 135-year site chronology named TROWB-FS.

Table 1: Cross-matching between 8 series from 63 Fore Street, which form the site chronology TROWB-FS

Filenames	Start date	End date	BAFS05	BAFS06	BAFS07	BAFS08	BAFS09	BAFS10	BAFS11
BAFS03	AD1415	AD1512	-	7.04	4.15	4.88	5.74	5.47	3.08
BAFS05	AD1414	AD1492		-	4.32	-	-	3.60	3.09
BAFS06	AD1414	AD1505			-	7.56	8.15	4.34	3.43
BAFS07	AD1390	AD1493				5.25	-	4.16	-
BAFS08	AD1378	AD1484					5.44	5.19	3.20
BAFS09	AD1412	AD1496						4.69	-
BAFS10	AD1403	AD1494							5.94
BAFS11	AD1413	AD1475							

KEY: - = t-values less than 3.00. \ = overlap < 30 years.

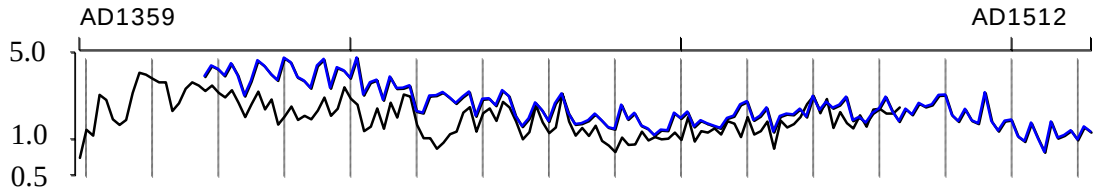
This site chronology was found to produce consistently high *t*-values against reference chronologies (**Table 2**) and to visually cross-match (**Figure 3**), with the first ring of the series at AD 1378 and the final ring of the series at AD 1512.

Table 2: Dating evidence for site chronology TROWB-FS against reference chronologies

TROWB-FS dated AD 1378 TO AD 1512					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
SOMERST29	AD1095	AD2011	11.63	135	Somerset County Chronology (Author, unpublished)
BROMHAM	AD1359	AD1483	10.12	106	Bayntun Chapel - Bromham - Wiltshire (Howard *et al.* 2008)
SENG18	AD1028	AD1591	9.67	135	Southern England Update of (Bridge 1988)
MUCHLNEY	AD1148	AD1498	9.23	121	Muchelney Abbey - Muchelney - Somerset (Bridge 2002)
CAPEL-TE	AD1366	AD1571	8.47	135	Temple Elfande - Capel - Surrey (Moir 2003a)
NWDGT-NX	AD1396	AD1524	8.45	117	St Peters Church - Newdigate - Surrey (Moir 2003b)
KNWH0304	AD1384	AD1441	8.18	58	West Hele - King's Nympton - Devon (Groves 2005)
TCKNHM1X	AD1372	AD1475	7.77	98	Tickenham Ct - Tickenham - Somerset (Bridge and Miles 2004)
FORD	AD1286	AD1511	7.43	134	St Andrews Church - Ford - West Sussex (Bridge 2000)
THEGREEN	AD1384	AD1503	7.35	120	The Green - Worplesdon - Surrey (Moir 2002)
CHARL-GB	AD1330	AD1538	7.33	135	Greenings Farm Barn - Charlwood - Surrey (Moir 2004)
HUBS04	AD1384	AD1532	7.30	129	2 Bridge Street - Hungerford - Berks (Moir 2011)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies.

Figure 3: Plot of site chronologies TROWB-FS (blue) and BROMHAM from Bayntun Chapel - Bromham - Wiltshire (black), which cross-match together with a *t*-value of 10.1



Note: The ring width (mm) is plotted on a (y axis) logarithmic scale using a common axis for both samples.

All the remaining undated series were individually compared against each other and a database of reference chronologies. Series BAFS01 and BAFS04 failed to cross-match and therefore both these series remain undated at this time.

INTERPRETATION

Felling Dates

The sapwood allowance used to calculate the felling dates now discussed is presented in **Table 3**, and the bar diagram (see **Figure 4**) helps to demonstrate the findings visually.

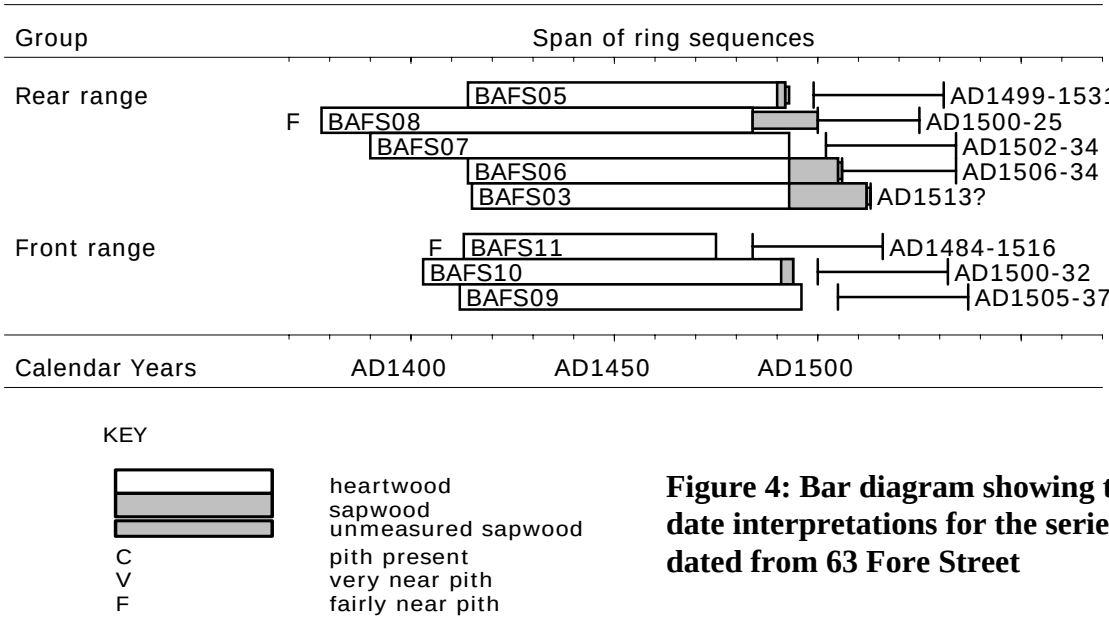


Figure 4: Bar diagram showing the date interpretations for the series dated from 63 Fore Street

The rear range of 63 Fore Street produces one probably precise felling date in AD 1513. This date is within the felling-date ranges of the four other samples dated from the rear range and together this provides good evidence to indicate that construction of the rear range occurred in AD 1513, or soon after. The felling-date ranges of the three samples taken from the front range are consistent with the felling date identified for the rear range. The high cross-matching between all the series dated (**Table 1**), the similar felling-date ranges, and the similarity of dimensions between the timbers from both the rear and front ranges, all suggest it is likely that the two ranges were originally built around the same time. While the front range has clearly been changed, the evidence presented here supports a theory that the timbers from the earlier front range have been re-used within its roof.

Table 3: Summary of dendrochronological analysis

Sample	Timber and Position	Timber Conversion	Timber Dimensions (mm)	Rings	Sapwood	Average Growth Rate (mm/yr)	Sequence Date Range	Felling Date	Rings to Pith	Age Estimate
BAFS01	Rear range - tiebeam - truss 6	B2	200 x 200	73	16+¼B	2.27			15	
BAFS02	Rear range - west queen strut - truss 6	C2	160 x 160	30					15	
BAFS03	Rear range - west principal rafter - truss 6	C2	280 x 160	98	19+1+?B	1.51	AD1415-AD1512	*c*. AD1513	15	**113**
BAFS04	Rear range - post 6C	C2	0 x 0	92	+HS	1.75			5	
BAFS05	Rear range - post 5C	C2	280 x 430	79	2(+1)	2.52	AD1414-AD1492	AD1499-1531	15	**94**
BAFS06	Rear range - west purlin - bay 4	B2	280 x 130	92	12(+1)	1.32	AD1414-AD1505	AD1506-34	15	107
BAFS07	Rear range - west principal rafter - truss 5	B2	300 x 140	104	+HS	1.90	AD1390-AD1493	AD1502-34	15	119
BAFS08	Rear range - post 4C	?	0 x 0	107	+16	1.53	AD1378-AD1484	AD1500-25	10	**104**
BAFS09	Front range - east principal rafter - truss 2A to 2B	?	275 x 130	85	+HS	1.67	AD1412-AD1496	AD1505-37	15	100
BAFS10	Front range - west principal rafter - truss 3A to 3B	?	240 x 130	92	3	1.97	AD1403-AD1494	AD1500-32	15	107
BAFS11	Front range - east principal rafter - truss 3A to 3B	?	255 x 130	63	+HS	1.86	AD1413-AD1475	AD1484-1516	10	73

KEY	
+	= additional information not measured on the core
(+)	= unmeasured heartwood rings at the beginning or end of the core
HS	= heartwood/sapwood boundary
?B	= probable bark
¼B	= spring bark
½B	= summer bark
Bw	= winter bark
A2	= boxed heartwood & trimmed
B2	= halved & trimmed
C2	= quartered & trimmed
E2	= tangential & trimmed
Bold	= samples used in age estimate

Note: Timber dimensions were generally taken at the core sample location and are not necessarily the maximum dimensions of the timber.

Timber analysis

There are insufficient available references chronologies in the immediate area of a similar date to indicate whether the dated timber came from a local source, although this is most likely the case.

All the timbers sampled were oak. Using the largest structural timbers (in this case posts), the average age of the source trees used in the construction is 104 years.

CONCLUSIONS

Eight of the eleven samples taken from 63 Fore Street are matched together to form a 135-year site chronology which spans AD 1378 to AD 1512. A probably precise felling date in AD 1513, together with compatible felling-date ranges from four other timbers, provides good evidence to indicate that construction of the rear range occurred in AD 1513, or soon after.

Three samples from re-used principal rafters in the front range are also dated. The similarity of the timbers' dimensions, high cross-matching between all the series dated, and the similarity of felling-date ranges between the rear and front range timbers suggest that the two ranges were originally built around the same time. While most the front range timbers have been lost during later remodelling, this analysis indicates it is likely that the timbers from the earlier front range were re-used in the current front range roof.

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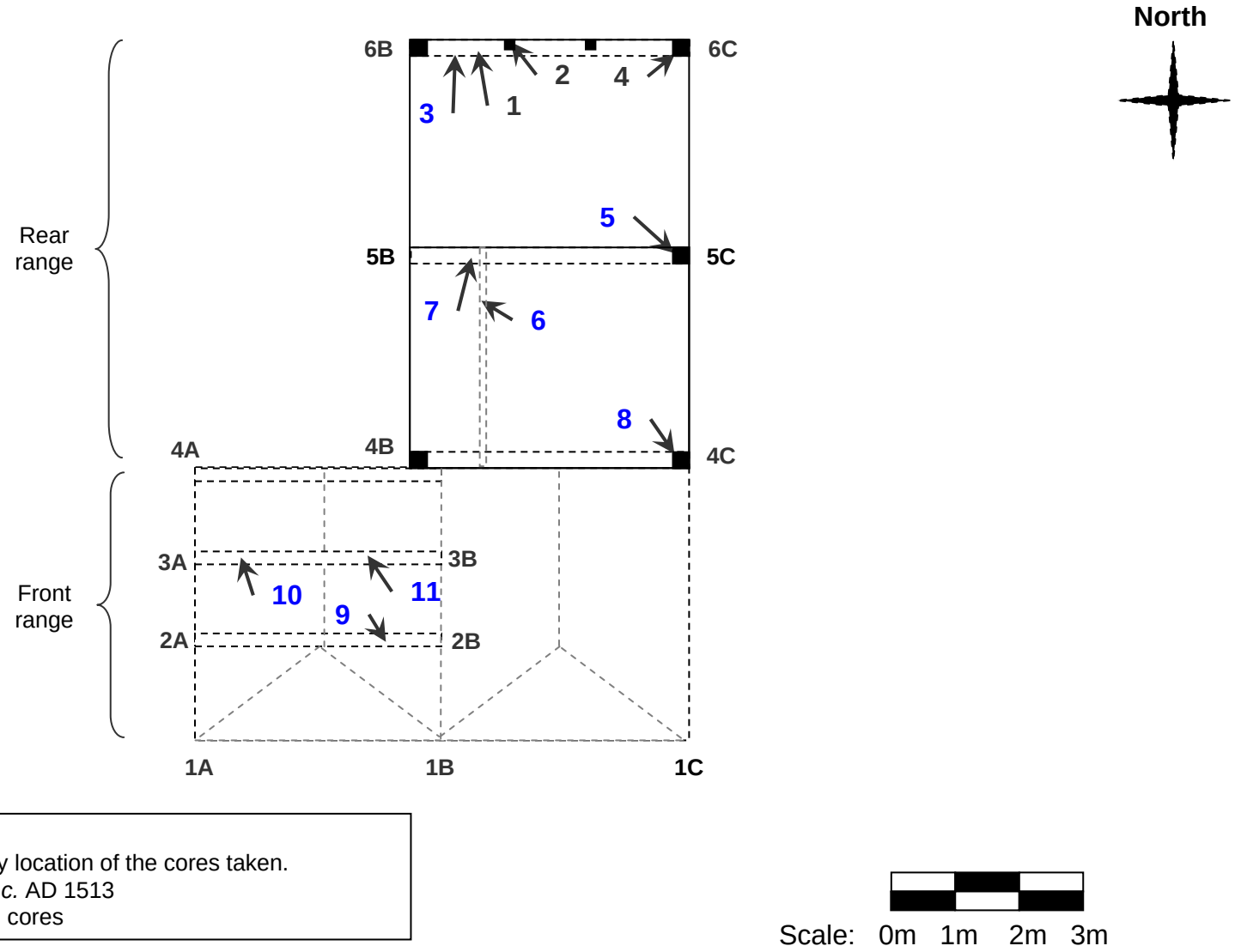
APPENDIX I: Approximated plan of 63 Fore Street



KEY:
Numbers identify location of the cores taken.
Blue = dated to *c.* AD 1513
Grey = Undated cores

Scale: 0m 1m 2m 3m

APPENDIX II: Raw ring-width data

Ring widths (0.01mm), starting with innermost measured ring

BAFS01

198	294	268	264	232	287	243	320	246	300
258	308	269	219	284	245	207	192	244	207
284	278	172	248	307	240	208	196	255	226
290	184	197	142	147	174	220	190	217	243
304	184	120	146	167	145	135	200	139	165
187	186	202	243	188	179	209	236	313	350
215	126	193	253	280	231	216	223	268	224
258	295	260							

BAFS03

283	217	282	309	228	210	188	206	233	226
184	128	136	162	161	125	174	173	150	99
107	114	129	102	86	111	155	176	162	119
153	106	120	123	146	148	164	114	123	148
130	155	139	171	213	186	161	157	185	127
168	166	128	106	128	148	136	138	176	177
176	133	128	115	128	167	194	122	109	154
155	164	153	134	140	132	134	122	141	125
151	215	170	146	167	145	129	119	151	120
94	137	102	107	117	99	125	114		

BAFS04

544	404	229	321	377	445	342	283	262	200
143	54	42	54	67	86	127	124	169	177
209	124	110	181	163	138	79	140	186	190
142	199	229	187	134	136	164	225	148	98
132	238	218	192	147	144	149	165	208	326
263	269	175	152	119	125	151	111	110	133
179	206	129	127	227	138	161	173	90	76
72	90	119	213	183	158	140	103	124	161
159	237	200	140	100	161	178	208	226	182
149	140								

BAFS05

194	151	93	157	131	66	146	215	186	283
329	123	164	244	400	314	236	325	360	300
229	157	271	264	252	270	127	309	159	186
174	123	166	114	94	320	273	400	260	233
206	177	178	242	135	235	356	200	183	272
136	135	227	310	332	267	655	507	603	404
503	668	215	198	189	266	255	337	317	196
148	160	216	213	229	425	457	189	153	

BAFS06

188	161	141	192	211	140	186	217	164	203
196	114	101	150	169	125	108	183	229	122
91	142	179	178	121	98	166	247	154	194
135	151	102	153	156	136	117	113	104	107
119	115	117	187	216	236	202	119	124	176
108	128	134	108	154	100	122	100	110	90
99	93	73	118	92	103	112	132	79	78
126	76	110	112	113	86	107	100	99	90
92	107	152	107	86	112	140	81	73	117
84	64								

BAFS07

576	535	345	316	282	490	574	311	493	425
383	610	328	282	311	168	376	294	298	276
200	154	97	134	132	183	108	162	142	112
206	169	149	249	192	118	88	59	134	134
135	120	250	161	139	130	107	156	142	121
113	142	151	131	125	133	106	133	118	114
168	145	138	147	124	105	80	108	100	93
107	95	89	125	91	117	106	118	95	111
125	96	130	149	140	181	170	90	90	148
198	252	194	171	156	185	264	163	210	230
245	163	148	233						

BAFS08

312	379	356	316	394	317	219	287	416	377
325	291	298	269	272	262	225	269	278	195
240	270	223	267	118	199	219	140	235	157
147	170	91	95	107	115	157	119	105	113
96	80	91	113	103	159	140	121	91	94
118	96	63	91	114	84	76	76	74	80
82	63	87	102	86	77	70	60	48	70
81	98	91	100	70	93	96	107	89	104
146	111	142	94	123	138	87	129	89	107
169	128	126	100	152	152	143	126	103	123
135	144	175	176	87	92	142			

BAFS09

408	345	303	226	171	140	164	141	191	174
150	160	154	143	116	174	223	163	135	301
308	154	115	142	124	139	118	84	112	180
130	138	120	103	66	85	85	163	134	107
63	127	108	106	115	119	174	234	210	140
164	176	116	160	190	146	215	163	236	139
156	171	141	185	137	250	157	152	133	204
198	145	250	151	179	223	222	225	188	150
125	143	151	142	332					

BAFS10

356	346	302	321	302	315	348	209	234	266
231	265	264	359	351	419	206	330	234	212
284	213	194	127	137	167	190	160	166	200
159	153	174	131	182	162	134	137	178	133
206	131	127	138	144	148	212	175	190	158
175	152	147	133	147	143	167	154	123	171
162	111	178	169	163	154	147	172	142	145
138	148	152	149	142	162	180	184	215	164
177	235	213	223	220	218	227	212	196	186
257	193								

BAFS11

281	400	324	344	330	418	247	296	362	309
371	297	232	197	169	185	172	149	170	197
150	146	138	121	141	156	136	114	180	157
188	154	123	125	127	134	105	69	95	97
115	116	133	109	129	131	207	230	196	208
189	142	199	188	172	163	160	166	138	136
129	143	139							

APPENDIX III: Mean ring-width data

Title: 63 Fore Street - Trowbridge - Wiltshire [TROWB-FS] 8 timber mean
Ring-width QUSP data of 135 years length
Dated AD1378 to AD1512
Unit of Measurement 0.01mm
Average ring width 197.25 Sensitivity 0.19

AD1378								312	379	356
	316	394	317	219	287	416	377	325	291	437
	402	308	289	253	379	426	253	366	347	303
AD1401	438	223	279	292	203	310	251	253	264	166
	161	219	221	234	213	192	215	236	152	207
	209	184	242	218	153	126	145	194	169	138
	191	228	160	131	133	140	158	141	124	120
	186	143	160	128	121	107	118	117	161	146
AD1451	164	125	140	133	127	122	146	152	187	198
	141	152	177	114	151	158	156	173	150	218
	169	196	176	186	215	140	149	134	160	174
	215	165	138	173	156	192	180	187	222	223
	155	138	172	140	133	233	138	116	139	142
AD1501	105	96	134	102	79	137	102	107	117	99
	125	114								