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Tree-Ring Analysis of Timbers from the Roof of St Leonard's Chapel, Farleigh Hungerford Castle, Norton St Philip, Somerset

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Tree-Ring Analysis of Timbers from the Roof of St Leonard's Chapel, Farleigh Hungerford Castle, Norton St Philip, Somerset

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Summary

A dendrochronological investigation of the roof of this mid fourteenth-century stone chapel was carried out in order to determine the age of the existing roof and the extent of original timbers remaining. One section of the roof was clearly rebuilt and thought to be of eighteenth-century origin. The study was unable to confirm whether or not some of the existing wallplates were from an earlier structure, although the one wallplate that did date was found to be contemporaneous with the rest of the main roof structure, from a group of trees most likely felled in the period AD 1600-22. The replacement truss and associated purlins were made from a group of trees most likely felled in the period AD 1765-95. One of the eighteenth-century timber group which could not be dated had a growth pattern suggesting that it was from a pollarded tree.

Keywords

Dendrochronology
Standing Building

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Introduction

The Chapel of St Leonard was originally the parish church, but is now regarded as a chapel to Farleigh Hungerford Castle, within which it is located (NGR ST 801577; Fig 1). The site is a Scheduled Ancient Monument. The stonework dates from the mid-fourteenth century. The present roof over the nave and chancel is thought to be later in origin than the fourteenth century. It consists of five bays (Fig 2) divided by trusses with stop-moulded chamfers of the ties and collars, and moulded plates. There are two purlins on each side. Each bay contains seven common rafters (Figs 3 and 4), some of which have been replaced at some time. The older common rafters have nail holes and are readily distinguishable. The inner and outer wallplates have what appear to be original dovetailed ties between them, but there is some question as to whether they all belong to the present roof. There is evidence of ashlar pieces having been removed, and it was thought possible that the wallplates could be re-used from an earlier roof. One truss (truss 3) is clearly different to the others and is an old replacement, along with the purlins to either side. It is thought that this dates from the eighteenth century when the chapel is known to have fallen into disrepair and become almost roofless.

Dendrochronological dating of the roof was requested by the local English Heritage Architect, Arnold Root and the Regional Project Coordinator, Ian Ashby, in order to date the primary construction of the present roof, and determine how much of the current structure is pre-eighteenth century. Although not part of the original brief, it was agreed on-site that dating of the suspected eighteenth-century replacement truss would give more information about the history of the roof and therefore be of interest, as well as potentially providing useful tree-ring data for this period

Methodology

The site was visited on two different occasions. The first visit was in March AD 2000 when a scaffold tower allowed limited access to truss 4 of the roof and four samples were taken with the aim of giving some dating information about the roof and assessing the potential for a wider study. The second visit was made in October AD 2001 when full scaffolding allowed access to the whole roof, and recording was taking place.

The timbers were assessed for their potential use in dendrochronological study. Oak timbers with more than 50 rings, traces of sapwood, and accessibility were the main considerations in the initial assessment. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis. Sometimes cores have less than 50 rings when extracted; those with over 40 rings are analysed.

The cores were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm using a specially constructed system utilizing a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC. The software used in measuring and subsequent analysis was written by Ian Tyers (1999).

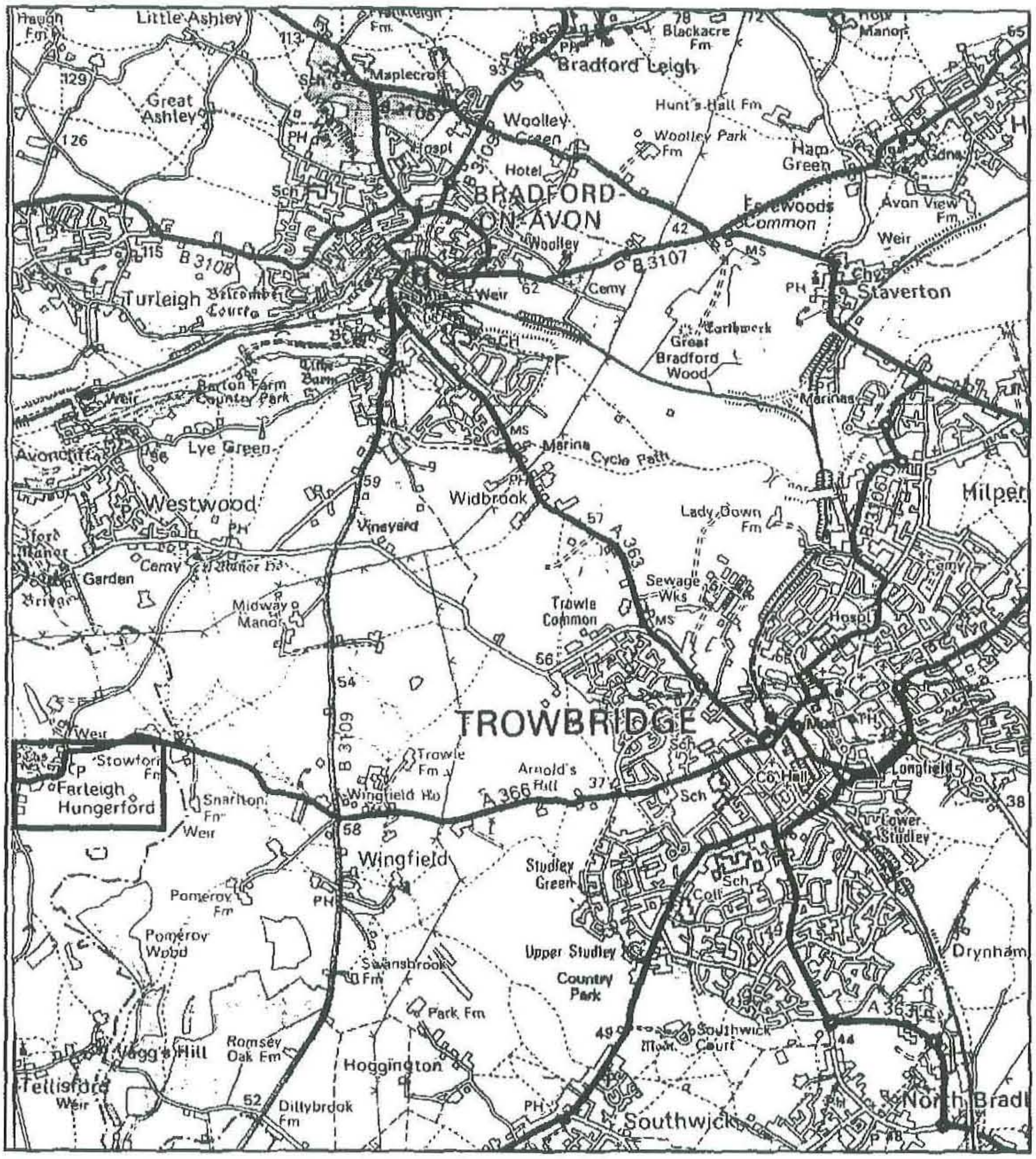

Figure 1: Map to show the general location of Farleigh Hungerford Castle

Ring series were plotted to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements when the samples crossmatch. Statistical comparisons were made using Student's *t*-test (Baillie and Pilcher 1973; Munro 1984). The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973). Those *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches, and give consistent matching positions.

When crossmatching between samples is found, the ring-width sequences are meaned to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established, which is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the rings available on each sample. Interpretation of these dates then has to be undertaken to relate these findings to the construction date of the phase under investigation. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. In this instance, the sapwood estimates are based on those proposed for this area by Miles (1997), in which 95% of samples are likely to have from 9 to 41 sapwood rings. Where bark is present on the sample the exact date of felling of the tree used may be determined. For a group of contemporaneous timbers, the sapwood estimate is added to the mean last heartwood ring date to obtain the likely felling date for the group.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Results

All the timbers sampled were of oak (*Quercus* sp.). The locations of the sampled timbers are given in Table 1, and illustrated in Figures 2 - 4. Two samples from the main structure of the roof had insufficient rings and were rejected from further analysis.

Ten samples from the main roof were crossmatched, the level of crossmatching between individual samples is shown in Table 2. These samples were meaned at the appropriate positions (Figure 5) to form the site master FARLEIGH1. This was subsequently dated by comparison with reference material, the best matches being shown in Table 4.

Although few samples were available from the repairs to the roof, three samples did crossmatch (Table 3). As no match was found between samples FHC10 and FHC12, the individual samples were also dated independently against reference material (Table 4) which confirmed the internal crossmatching (Figure 6). The three timbers were meaned to form a second site chronology FARLEIGH2, which was dated by comparison with reference material, the best results being shown in Table 6.

The data for the two site chronologies are presented in Table 7.

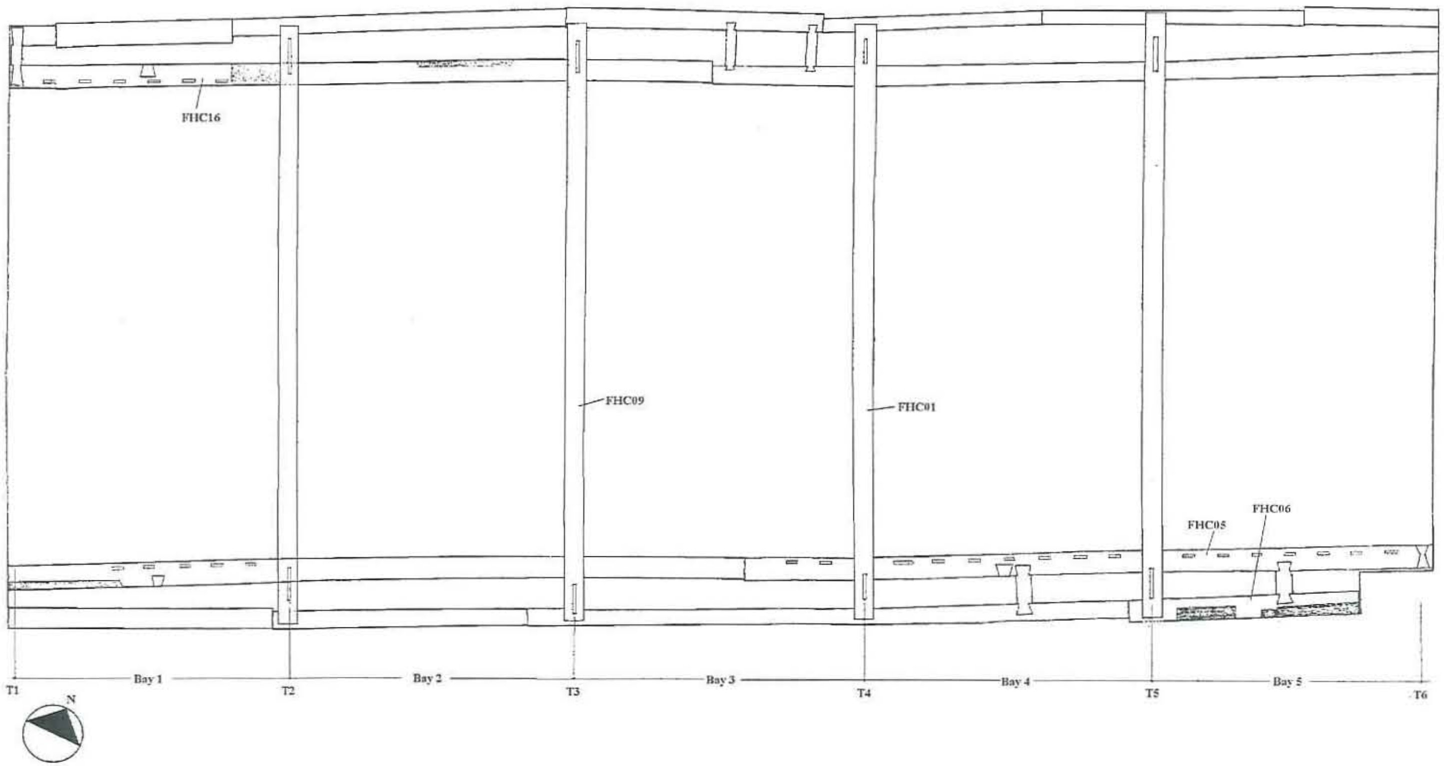

Figure 2: Drawing of the wallplate level of the nave roof, showing the approximate locations of samples taken for dendrochronology. Adapted from an original drawing by N Joyce

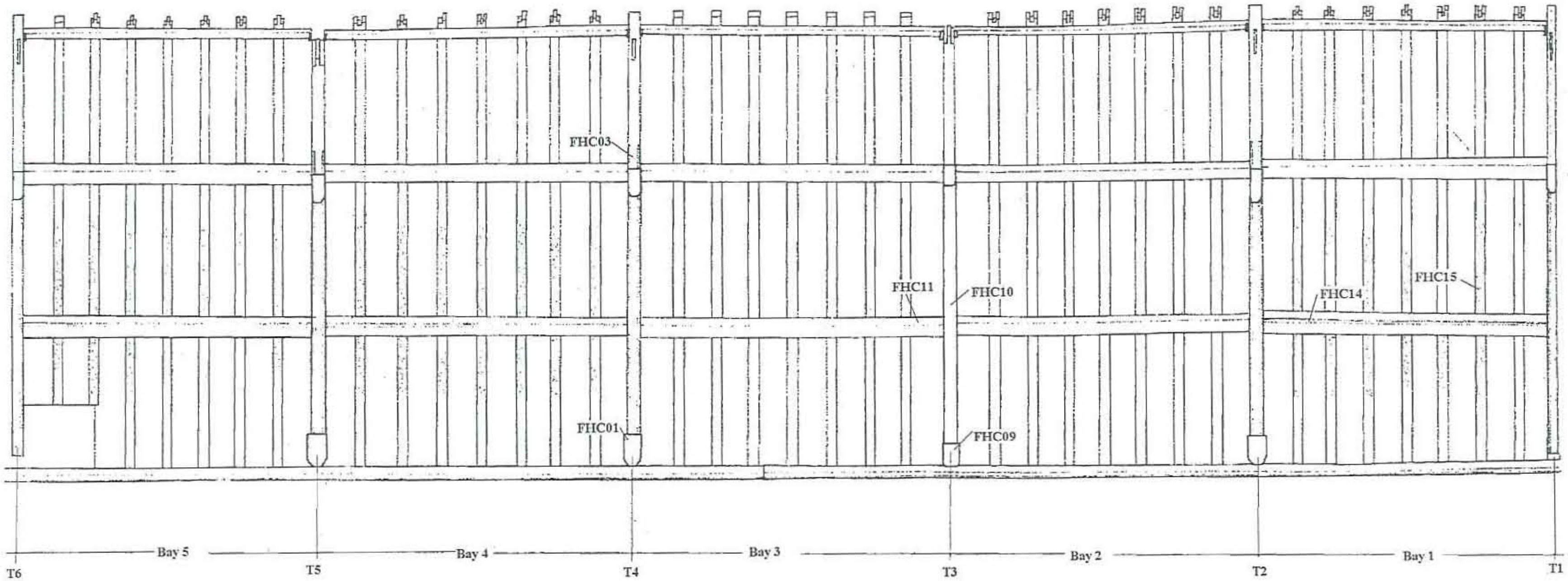

Figure 3: Drawing of the north slope of the nave roof, showing the approximate locations of samples taken for dendrochronology. Adapted from an original drawing by N Joyce

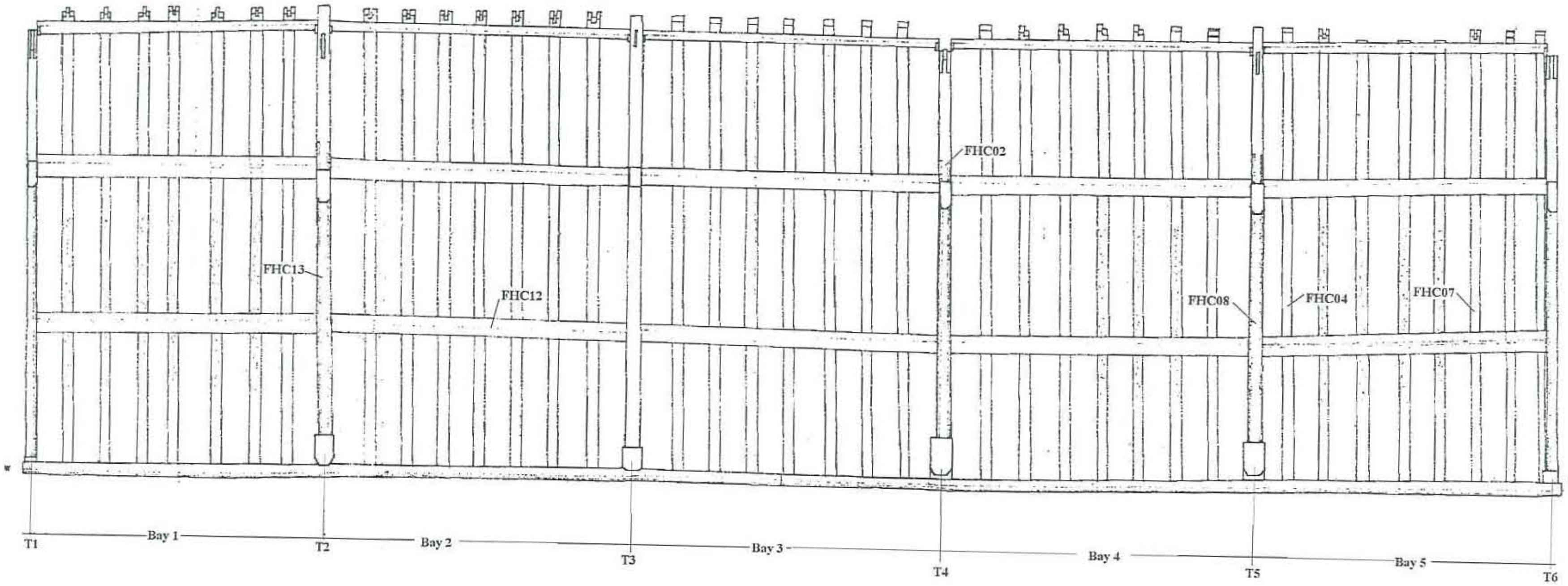

Figure 4: Drawing of the south slope of the nave roof, showing the approximate locations of samples taken for dendrochronology. Adapted from an original drawing by N Joyce

Table 1: Oak (*Quercus* spp.) timbers sampled from the roof of St Leonard's Chapel, Farleigh Hungerford Castle. h/s = heartwood-sapwood boundary

Sample number	Origin of core	Total no of years	Average growth rate (mm yr^{-1})	Date of last heartwood ring AD	Sapwood details	Date of sequence AD	Felling date of timber AD
Original roof							
FHC01	Tie 4	79	1.89	1581	h/s	1503 - 81	1590 - 1622
FHC02	Principal rafter 4 south	95	1.84	1585	h/s	1491 - 1585	1594 – 1626
FHC03	Principal rafter 4 north	79	1.54	1571	-	1493 - 1572	after 1580
FHC04	Common rafter bay 5 south	60	1.66	1576	h/s	1517 - 76	1585 – 1617
FHC05	Inner wallplate bay 5 south	(+22) 68	1.63	1577	11	1521 - 88	1588 – 1618
FHC06	Outer wallplate bay 5 south	<40	unmeasured	-	-	undated	unknown
FHC07	Common rafter bay 5 south	63	1.99	1591	h/s	1529 - 91	1600 – 32
FHC08	Principal rafter 5 south	150	0.91	1579	h/s	1430 - 1579	1588 – 1620
FHC13	Principal rafter 2 south	(+25) 88	1.09	1575	h/s	1488 - 1575	1584 – 1616
FHC14	Lower purlin bay 1 north	54	2.78	1581	2	1530 - 83	1590 – 1622
FHC15	Common rafter bay 1 north	58	2.08	1582	-	1525 - 82	after 1591
FHC16	Inner wallplate bay 1 north	<40	unmeasured	-	-	undated	unknown

continued:

Table 1 continued:

Sample number	Origin of core	Total no of years	Average growth rate (mm yr^{-1})	Date of last heartwood ring AD	Sapwood details	Date of sequence AD	Felling date of timber AD
Renewed truss and purlins							
FHC09	Tie 3	61	1.47	1756	h/s	1696 - 1756	1765 - 97
FHC10	Principal rafter 3 north	94	1.68	1755	h/s	1662 - 1755	1764 - 96
FHC11	Lower purlin bay 3 north	74	1.70	-	-	undated	unknown
FHC12	Lower purlin bay 2 south	51	1.77	1750	1	1701 - 51	1759 - 91

Table 2: The level of crossmatching between samples included in FARLEIGH1, illustrated by the *t*-value results between each series. A hyphen represents a value of *t* below 3.0

	t value								
SAMPLE	**FHC02**	**FHC03**	**FHC04**	**FHC05**	**FHC07**	**FHC08**	**FHC13**	**FHC14**	**FHC15**
FHC01	4.5	-	4.9	4.0	7.0	7.2	4.4	4.1	3.4
FHC02		8.4	7.2	4.3	4.5	5.3	4.9	-	-
FHC03			3.5	-	-	4.3	4.7	-	3.2
FHC04				4.8	4.9	6.6	4.6	4.8	3.1
FHC05					4.5	4.1	-	3.6	5.2
FHC07						3.8	4.0	4.4	3.7
FHC08							8.1	4.1	4.1
FHC13								4.5	4.1
FHC14									3.6

Table 3: The level of crossmatching between samples included in FARLEIGH2, illustrated by the *t*-value results between each series. A hyphen represents a value of *t* below 3.0

	t value	
SAMPLE	**FHC10**	**FHC12**
FHC09	4.3	4.2
FHC10		-

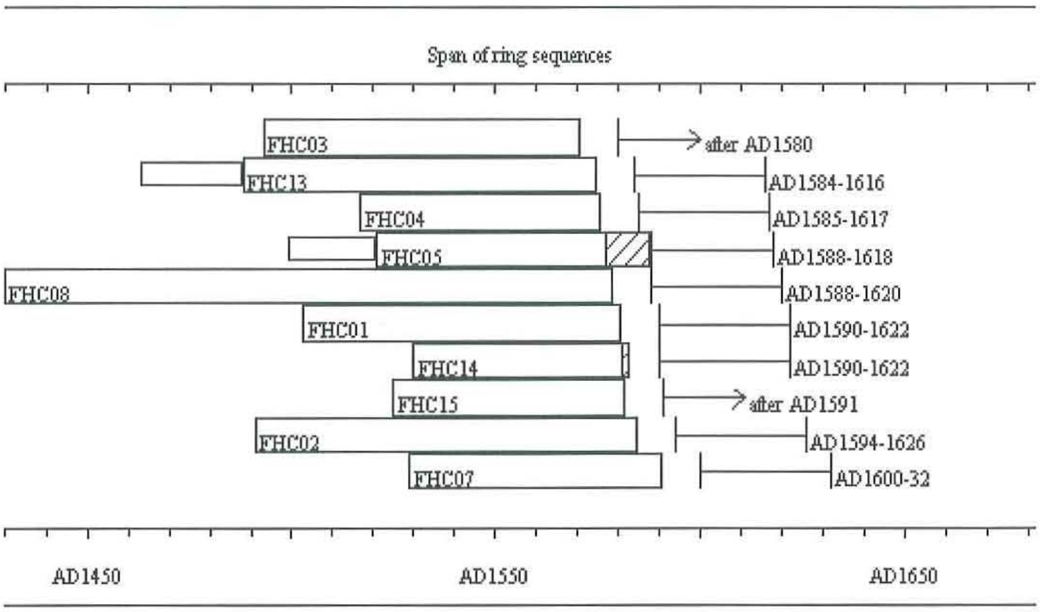

Figure 5: Bar diagram showing the relative positions of overlap and the likely felling dates of the samples included in FARLEIGH1. Sapwood rings are shown hatched, narrow bars represent unmeasured rings

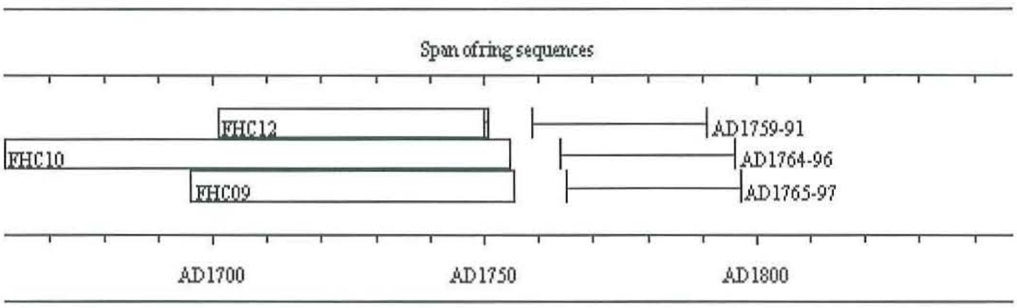

Figure 6: Bar diagram showing the relative positions of overlap and the likely felling dates of the samples included in FARLEIGH2. Sapwood rings are shown hatched

Table 4: Dating of the oak site chronology FARLEIGH1

	FARLEIGH1 AD 1430 - 1591	
Dated multi-site or single-site master chronology	*t*-value	Overlap (yrs)
Hants97 (Miles pers comm)	7.9	162
London1175 (Tyers pers comm)	7.6	162
East Midlands (Laxton and Litton 1988)	6.7	162
Welsh Borders (Siebenlist-Kerner 1978)	5.5	162
Vowchurch, Herefordshire (Nayling 1999)	7.9	162
Langley, Shropshire (Hillam and Groves 1993)	7.5	101
Wimpole, Cambridgeshire (Bridge 1998a)	6.6	123
Nuffield, Oxfordshire (Haddon-Reece *et al* 1989)	6.5	162
Upwich3, Worcestershire (Groves and Hillam 1997)	6.4	138
Brook Gate, Shropshire (Miles and Haddon-Reece 1993)	6.4	162
Dore Abbey, Herefordshire (Tyers and Boswijk 1998)	6.1	162
Milk Street, Shrewsbury, Shropshire (Miles 1996)	6.1	136

Table 5: Independent crossdating of the individual samples in FARLEIGH2. A (-) represents no significant match

	t – value (overlap)		
Dated multi-site or single-site master chronology	**FHC09** AD 1696-1756	**FHC10** AD 1662 -1755	**FHC12** AD 1701 - 51
Hants97 (Miles pers comm)	7.3 (61)	6.7 (94)	5.2 (51)
Oxon93 (Miles pers comm)	5.6 (61)	5.5 (94)	4.8 (51)
FEB2000 (Bridge unpubl)	5.9 (61)	5.3 (94)	4.5 (51)
East Midlands (Laxton and Litton 1988)	5.7 (61)	4.4 (94)	5.2 (51)
Oriel College, Oxford (Miles and Haddon-Reece 1994)	5.5 (61)	7.1 (94)	5.0 (51)
Claydon, Buckinghamshire (Tyers 1995)	3.5 (61)	6.6 (94)	4.6 (51)
Winchester, Hampshire (Barefoot 1975)	6.4 (61)	5.9 (94)	5.7 (51)
Mamble, Worcestershire (Tyers 1996)	4.7 (54)	3.4 (54)	5.4 (51)
Chatham, Kent (Bridge 1998b)	5.8 (61)	4.0 (94)	4.5 (51)
Saffron Walden, Essex (Bridge 2001)	5.0 (56)	-	4.4 (51)
Old Basing, Hampshire (Bridge 1996)	7.1 (61)	4.8 (72)	4.1 (51)

Table 6: Dating of the oak site chronology FARLEIGH2

	FARLEIGH2 AD 1662 - 1756	
Dated multi-site or single-site master chronology	*t*-value	Overlap (yrs)
Hants97 (Miles pers comm)	7.7	95
Oxon93 (Miles pers comm)	7.5	95
FEB2000 (Bridge unpubl)	6.3	95
East Midlands (Laxton and Litton 1988)	5.7	95
Oriel College, Oxford (Miles and Haddon-Reece 1994)	9.4	95
Claydon, Buckinghamshire (Tyers 1995)	7.3	95
Winchester, Hampshire (Barefoot 1975)	7.3	95
Mamble, Worcestershire (Tyers 1996)	6.1	57
Chatham, Kent (Bridge 1998b)	5.8	95
Saffron Walden, Essex (Bridge 2001)	5.8	56
Old Basing, Hampshire (Bridge 1996)	5.5	73

Amongst the timbers sampled, the wallplates were found to be very long timbers, each spanning half the length of the roof, but only one sample, the inner plate in bay 5, dated. The other wallplate cores did not yield sufficient rings to warrant further investigation, despite being halved trunks. Some common rafters were found to be quartered trees retaining sapwood.

Of the samples from the repaired section of the roof, sample FHC11 from a purlin did not date. This ring-width series showed a number of near regular rapid growth declines

Interpretation and Discussion

Two groups of timbers were clearly identified at the outset of this study – those of the main structure of the present roof, thought to represent a replacement roof to the original fourteenth century structure, and those of the later repair known to have taken place in the late eighteenth century. In addition, the wallplates were considered possibly to represent remnants of a roof structure now otherwise disappeared.

If one assumes that all the timbers from the main body of the existing roof represent a single group of timbers all felled at the same time (or at least within a few years of each other), one way to calculate the most likely felling period from the samples is to calculate the mean heartwood-sapwood transition date for all those samples with evidence of sapwood, and then to add the appropriate sapwood estimate for the region to this date. The mean date for the last heartwood ring amongst the dated timbers is AD 1581. Adding the appropriate sapwood estimate therefore results in in most likely felling period for these timbers of AD 1590 – 1622.

It was not possible to date the wallplates on the northern side of the chapel, and possibility that these represent remnants from an earlier roof on this stone chapel still exists. A resolution to this question may emerge from a closer study of structure itself. The one wallplate that did date, the inner plate in bay 5 on the south side, is part of the group of timbers dated from the above period.

The timbers making up truss 4 and the purlins to either side were recognised as being eighteenth-century repairs. Although these replacement timbers were few in number, it was felt that they might yield useful dating information about the history of the present roof. The three timbers dated in this study, taken as a single group, and treated in the same manner as the first group, have a likely felling period of AD 1765-95. This realtes well to the known history of the building and represents a period when the chapel was again returned to regular use.

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Table 7: Ring width data for the site masters FARLEIGH1 and FARLEIGH2

ring widths (0.01mm)										no of trees									
FARLEIGH1 AD1430 to AD1591																			
132	225	129	201	171	86	101	113	112	113	1	1	1	1	1	1	1	1	1	1
138	126	119	97	85	113	111	95	60	65	1	1	1	1	1	1	1	1	1	1
110	67	72	117	64	67	69	83	44	47	1	1	1	1	1	1	1	1	1	1
104	84	95	56	58	60	51	55	55	87	1	1	1	1	1	1	1	1	1	1
78	121	105	90	69	37	69	63	132	118	1	1	1	1	1	1	1	1	2	2
138	116	113	166	219	184	223	222	113	140	2	3	3	4	4	4	4	4	4	4
181	164	192	212	207	149	124	141	160	170	4	4	4	5	5	5	5	5	5	5
159	157	176	162	158	115	96	81	121	193	5	5	5	5	5	5	5	6	6	6
139	166	184	124	109	100	170	182	194	168	6	7	7	7	7	8	8	8	8	9
187	219	124	127	159	249	244	213	188	225	10	10	10	10	10	10	10	10	10	10
243	215	112	161	148	194	168	153	159	196	10	10	10	10	10	10	10	10	10	10
184	204	164	151	171	184	137	146	134	166	10	10	10	10	10	10	10	10	10	10
148	170	229	150	171	130	100	112	150	210	10	10	10	10	10	10	10	10	10	10
195	207	166	130	126	131	142	150	134	146	10	10	9	9	9	9	8	7	7	7
198	176	137	158	192	201	210	215	128	152	6	6	5	4	3	3	2	2	2	1
180	273									1	1								
FARLEIGH2 AD1662 to AD1756																			
224	208	225	212	232	261	305	207	217	357	1	1	1	1	1	1	1	1	1	1
218	330	196	319	204	234	275	147	325	406	1	1	1	1	1	1	1	1	1	1
454	476	239	181	388	228	196	156	116	141	1	1	1	1	1	1	1	1	1	1
243	167	175	163	141	149	172	138	168	133	1	1	1	1	2	2	2	2	2	3
137	265	186	137	195	167	241	202	100	122	3	3	3	3	3	3	3	3	3	3
107	130	93	127	149	121	129	124	167	167	3	3	3	3	3	3	3	3	3	3
154	104	124	160	164	187	186	152	140	124	3	3	3	3	3	3	3	3	3	3
178	173	166	214	152	125	157	237	140	122	3	3	3	3	3	3	3	3	3	3
101	127	121	146	158	125	98	98	107	158	3	3	3	3	3	3	3	3	3	3
120	90	116	128	103						2	2	2	2	1					