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Riding House, Wolfeton House, Charminster Dorset
Tree-ring analysis of further oak timbers

Martin Bridge and Cathy Tyers

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RIDING HOUSE
WOLFETON HOUSE
CHARMINSTER
DORSET

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SUMMARY
Previous dendrochronological work at the Riding House, Wolfeton House, established that three original floor beams were from trees felled in the late sixteenth, or early seventeenth century and that timbers from the replacement roof were all from trees felled in, or around, AD 1720. As this could potentially be the earliest riding house in the country, further work was undertaken to attempt to refine these dates. Unfortunately, complete sapwood present on some original timbers did not survive sampling, but did allow further refinement of the date ranges previously obtained. Four floor beams appear likely to have all been felled before AD 1603 and most likely in the AD 1590s, whilst felling dates ranging from spring AD 1720 to winter AD 1720/21 have been obtained for roof timbers.

CONTRIBUTORS
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The front cover photo shows the exterior view of the north elevation (DP034595 ©Historic England Archive).

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INTRODUCTION

The Riding House (List Entry Number 1119102) is situated a little more than 100m north of Wolfeton House which originates from the fifteenth century, and forms part of a farm complex, near the village of Charminster (Fig 1). The building measures 33.5m by 9.1m externally, and 31.4m by 7.5m (103 feet by 24 feet 6 inches) internally, has a basic rectangular shape, a show-front and an entrance (in the south elevation) large enough for a horse and originally had two ranges projecting at right angles to the north wall (Drury 1985; Rodwell 1986; Worsley 2003). Although latterly used as a barn, it was not until the RCHME applied the terms 'Riding House' and 'Riding School' to the building (RCHME 1970), that its historical and architectural significance were re-evaluated.

In 1985, Paul Drury, English Heritage Assistant Inspector of Historic Buildings, described the structure as 'A building of *c*1590–1610 intended for recreational use, perhaps a purpose-built riding house, constructed in a predominantly gothic style. Later converted to a barn, then a cowhouse; now virtually derelict (Drury 1985, 1). As the building was 'rather narrow' to be a purpose-built riding house Drury concluded it was probably a multi-functional recreation building possibly used for activities such as tennis, bowls, archery and banqueting.

In 1985 English Heritage commissioned Kirsty Rodwell to undertake a detailed archaeological investigation of the Riding House to better understand the function of the building. The work published in the Archaeological Journal (Rodwell 1991) alongside research on a similar building, the Hospice at Ansty in Wiltshire, concluded that the building at Wolfeton was a purpose-built riding house, and that the building at Ansty functioned as a lodge to Old Wardour with both designed by the Somerset mason-architect William Arnold (Rodwell 1991). The date of construction of the riding house was suggested to be between *c* AD 1610 and AD 1620, and therefore to post-date the riding house at St James's Palace (Rodwell 1991, 288).

In 2003, Giles Worsley, concluded that the building at Wolfeton 'would be uncomfortably narrow for a riding house' and further supported Drury's suggestion that it was not a purpose-built riding house, but a 'multi-purpose recreational building similar to 'The Hospice' at Ansty Manor, Wiltshire' (Worsley 2003, 88)

The interior has an inserted floor made from coniferous wood. Eight large floor beams, 0.3m square, of which the second from the west was represented by only a stump in the north wall, removed during works after 2005, are set nearly 1m below wall plate level. These broadly align with the roof trusses above where present, but are not found associated with all trusses. Each of these supported 21 ceiling joists, represented by mortices in the east underside of each beam. On the west side a continuous pulley mortice enabled the joists to be inserted after the beams had been set in position. At least one slot in the south-east corner suggests that the wall may have been built around an upper east-west joist.

Eleven roof trusses are set on the walls, though it is clear that the original wall plates have gone, and the principals must have been reset. Pairs of principals were joined by a single tenoned and pegged collar and there were three trenched purlins. A long series of modifications has taken place since, as the roof structure proved

inadequate to prevent lateral spread. Additional collars have been added between the lower and middle purlins, the original collars being found between the middle and upper purlins. Trusses four and five, numbered from the west end, have doubled principal rafters immediately adjacent to each other, and it is thought these represent two pairs of original trusses and later repairs. The older principals are highly degraded and one had been truncated before reaching wall plate level.

The dendrochronological investigation in 2005 (Bridge 2005) dated three timbers from the original floor as being from trees most likely felled in the very late sixteenth or very early seventeenth century, with one timber thought to have been from a tree felled *c* AD 1600, confirming that this was indeed an early example of a riding house, but not giving a precise date. Six timbers from the replacement roof were found to have been felled in, or around, AD 1720. Subsequently, as more timbers were made accessible during extensive works at the site, further dendrochronological work was requested by Sarah Ball (Historic Buildings Architect), and suggestions for other timbers, possibly original, but re-used in the eighteenth-century conversion of the building, were made by Philip Hughes. In addition, further early eighteenth-century timbers were thought useful to investigate to learn the extent of new material used at that time, and give further precise dates. The additional fieldwork was carried out in February 2013 prior to the roof being re-covered.

METHODOLOGY

An assessment of the timbers for dendrochronological study sought further accessible oak timbers with more than 50 rings and with sapwood, although slightly shorter sequences were sometimes sampled if it was felt they may provide useful additional information, and on occasion some timbers may be sampled more than once to maximise sapwood information. Those timbers judged to be potentially useful were cored in February 2013 using a 16mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80–400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a process of qualified statistical comparison by computer, supported by visual checks. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-

value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values, however, do not preclude same tree derivation.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring (ie if it has only the spring vessels or early wood formed, or the latewood or summer growth) a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997). It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

RESULTS AND DISCUSSION

The results from the previous study (Bridge 2005) are included here to give a more complete picture of the evidence gained. Some timbers were resampled in the present study in an attempt to refine the dates obtained by getting more sapwood information, however, the sapwood was found to be very fragile, and often disintegrated. Measurements were made of the amounts of sapwood lost so that better felling date estimates could be made, based for example on the mean ring-width of the outer rings of the core. A number of timbers in the eighteenth-century roof were thought to be re-used, and possibly to represent primary timbers (highlighted in Figs 2 and 3) and these were assessed, but in most cases found to have too few rings for reliable dating purposes. The exception to this were the principal rafter in trusses 4 and 5 (samples wrh14, wrh15, and wrh16, sampled in the 2005 investigation), but none of these timbers subsequently dated (Table 1). The timbers sampled are located in Figures 2 and 3, whilst Figures 4 and 5 show two of the timbers sampled. The timbers from which samples wlf05 and wlf06 were taken are not shown in Figures 2 and 3 as they are from collars (not visible on drawings) but the trusses they are part of are shown. There are two levels of collar, the lower ones (sampled) being between the lower and middle purlins, the upper between the middle and upper purlins. In addition the floor beam from which

sample wrh07 was taken is not located on the drawings as it is uncertain from the original report (Bridge 2005: Fig 5) whether it was the floor beam associated with truss 9 or truss 10.

Table 1 gives the details of all samples taken in both investigations. Samples with fewer than 45 rings were not measured, although some short sequences of less than 45 rings were measured if they were either the second sample from a timber or they were an inner or outer section of a fractured core. The ring width data for all the measured samples are given in the Appendix. The friable nature of the extant sapwood led to a number of timbers being sampled twice to maximise sapwood information. Each pair of samples from these timbers cross-matched (Table 2a) and were combined to form new series for subsequent analysis. Cross-matching of these new series and the other timber series identified two groups of coeval timbers (Tables 2b and 2c; Figs 6 and 7). Each group was combined resulting in the formation of a four-timber mean of 84 years length, WOLFETN3, which supersedes the WOLFETN1 series from 2005, and dates to the period AD 1503–86 (Table 3a), and WOLFETN4, a ten-timber mean replacing WOLFETN2, a 138-year long series dating to the period AD 1583–1720 (Table 3b).

The additional dated timbers combined with the second cores taken from three timbers originally sampled in 2005 has allowed some refinement of the felling date ranges obtained in 2005. In Table 1 the number of millimetres of sapwood lost from the outer bark edge on coring is shown, and this figure has allowed the likely range of sapwood ring numbers to be determined. In the cases of samples wlf03 and wlf04, the mean ring width of the outermost 10 rings on the core was determined and the amount of sapwood lost (mm) was divided by this value to give a likely number of rings lost. A value of ±3 rings was then applied to this figure to give a narrow likely felling date range. In the cases of wlf01 and wlf07, the complete sapwood remained intact, but was separated from the heartwood rings on the core. In these cases a felling date range was calculated allowing for a maximum of 6 rings being lost between the heartwood and the detached sapwood.

Amongst the primary timbers, three floor beams were found to have been felled before AD 1603, and most likely in the AD 1590s, with a fourth floor beam being likely to be coeval (Fig 6). This is a clear confirmation of the conclusion from the 2005 investigation as it demonstrates the early origin of the building, which if built as a riding house would make it the earliest example in the country.

The replacement roof was thought to contain some re-used, possibly primary timbers, but many such timbers were found to be unsuitable for dendrochronological study, having too few rings, and no evidence could be found to support this hypothesis. Ten timbers were however dated from this roof structure. Felling dates for four of the timbers range from spring AD 1720 to winter AD1721/22 with the remaining six timbers appearing likely to be coeval. This indicates that construction of this replacement roof occurred in the early AD 1720s shortly after felling.

The trees used in both phases are likely to have come from relatively local sources, the wider geographical extent of the eighteenth-century matches probably reflecting the distribution of dated reference material in this period, rather than actual differences in the geographical origin of the trees.

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FIGURES

Figure 1: Maps to show the location of the Riding House, Wolfeton House, Charminster, Dorset. Top right: Scale 1:20,000. Bottom: Scale 1:2000 © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England

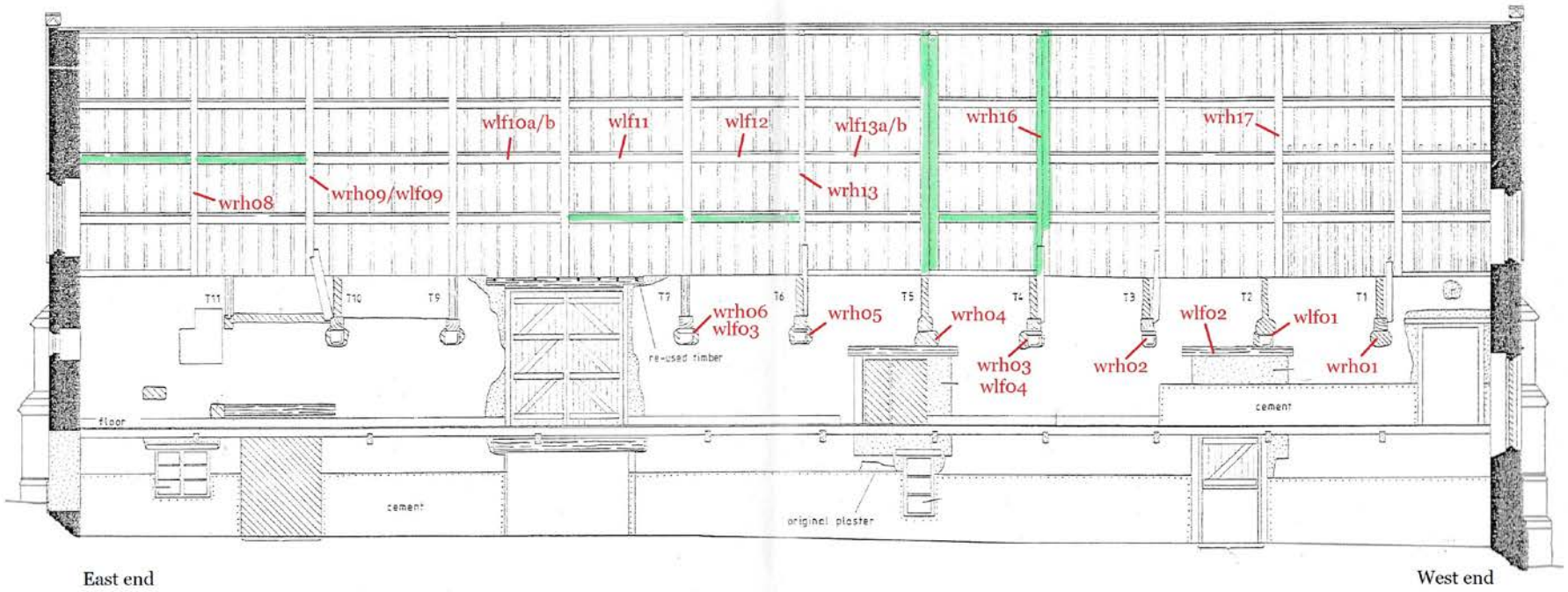

Figure 2: Drawing of the interior elevation of the south wall and roof (looking south) showing the timbers sampled for dendrochronology, (floor beam 8, wrh07 is not shown) adapted from an original by Philip Hughes Associates. The timbers marked in green were thought possibly to be re-used primary timbers

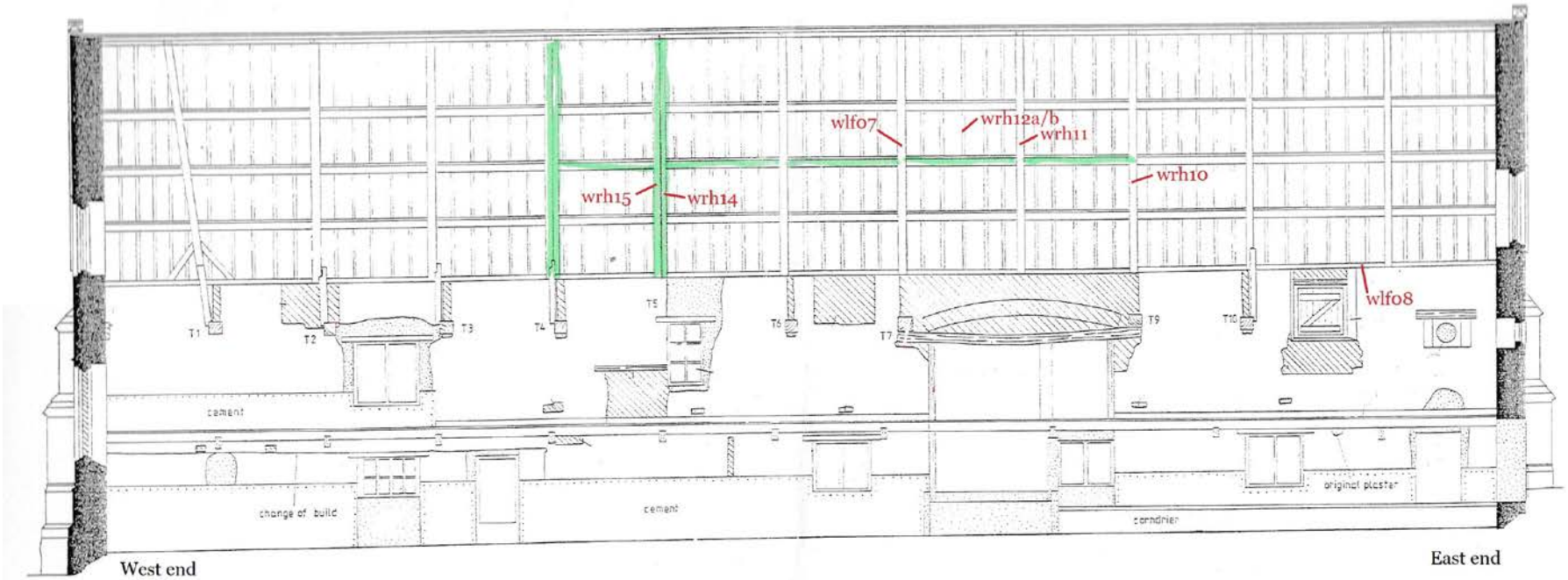

Figure 3: Drawing of the interior elevation of the north wall and roof (looking north) showing the timbers sampled for dendrochronology, adapted from an original by Philip Hughes Associates. The timbers marked in green were thought possibly to be re-used primary timbers

Figure 4: The ex situ floor beam 2 sampled as wlf01, photo Martin Bridge

Figure 5: Floor beam 7, sampled as wrh06 and wlf03, photo Martin Bridge

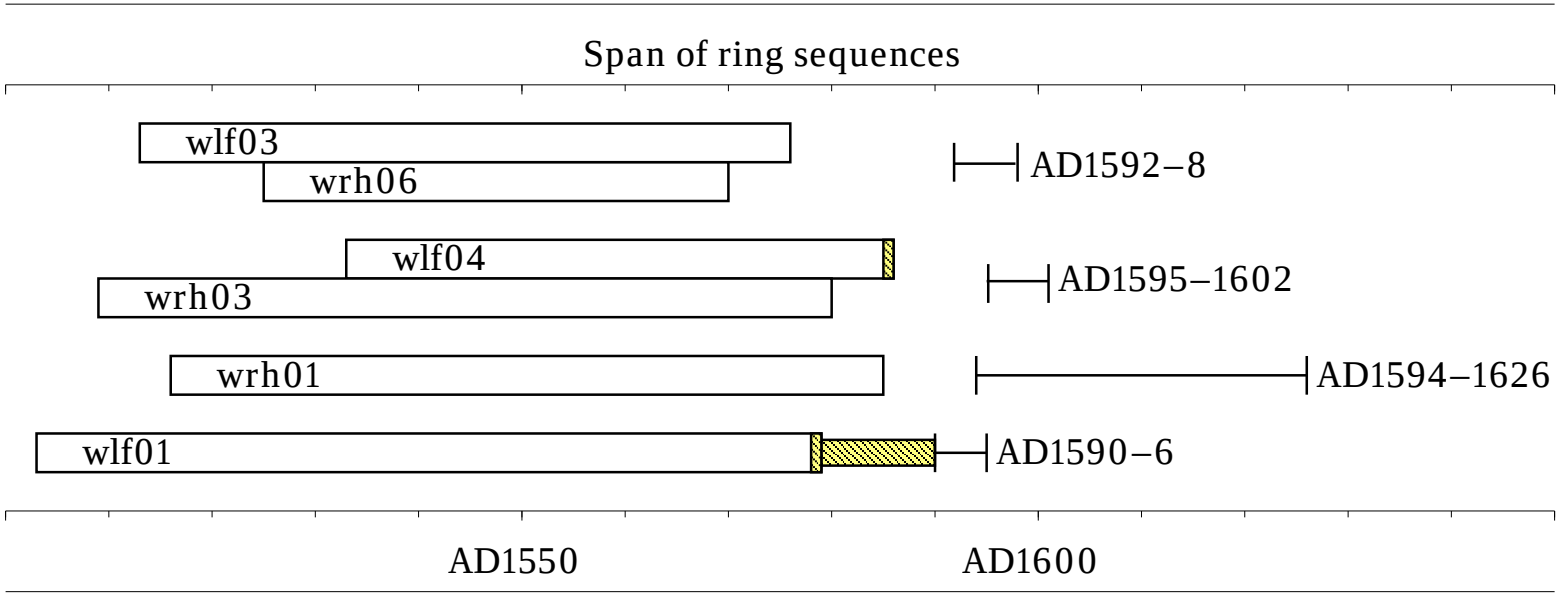

Figure 6: Bar diagram showing the relative positions of overlap of the dated series from primary timbers, with their associated likely felling date ranges. Samples wrh06 and wlf03 are both from floor beam 7; samples wrh03 and wlf04 are both from floor beam 4. White bars represent heartwood rings, yellow hatched bars represent sapwood, and narrow bar sections represent additional unmeasured rings

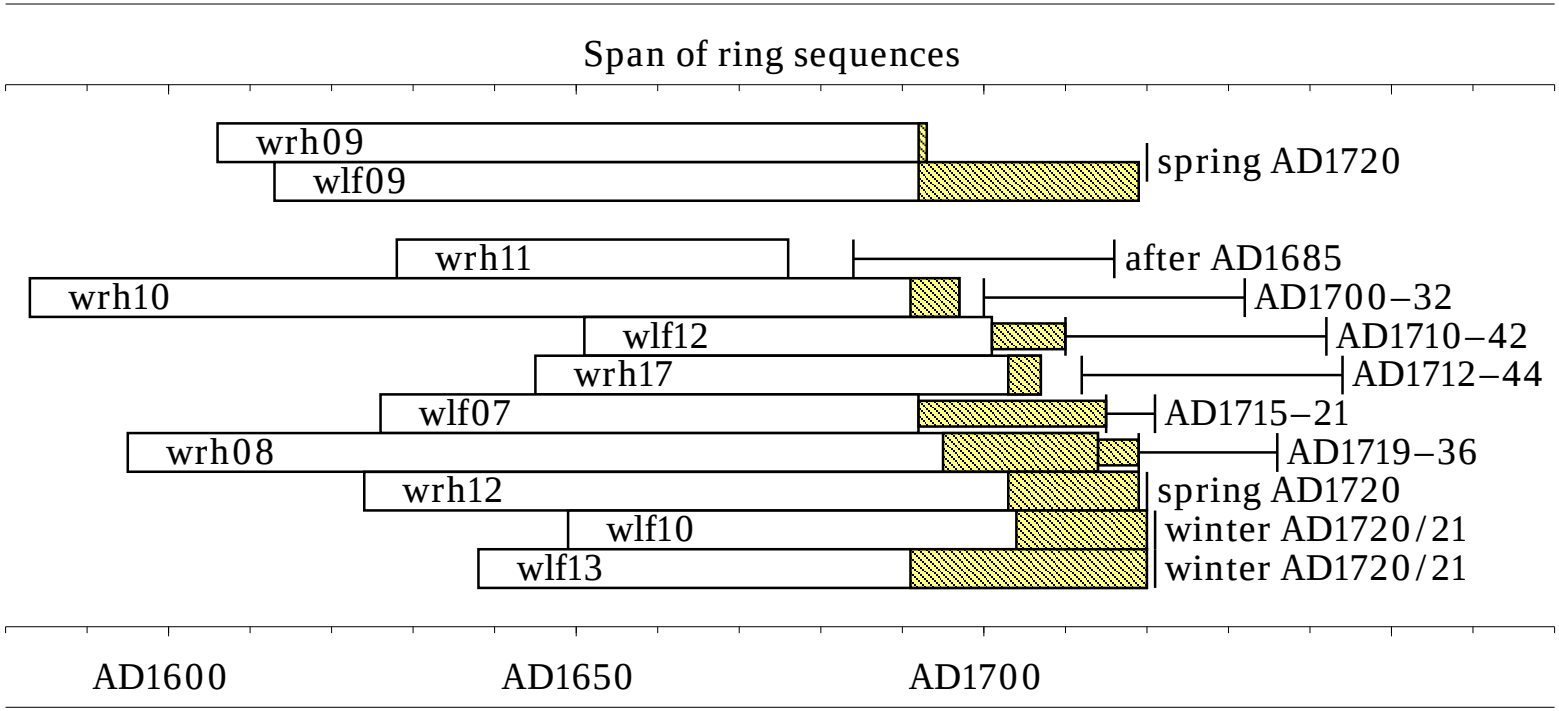

Figure 7: Bar diagram showing the relative positions of overlap of the dated timbers from the replacement roof, with their associated likely felling date ranges. Samples wrh09 and wlf09 are both from principal rafter 10 south. White bars represent heartwood rings, yellow hatched bars represent sapwood, and narrow bar sections represent additional unmeasured rings

TABLES

Table 1. Details of the samples taken from timbers in the Riding House, Wolfeton House. Samples prefixed wrh are from the 2005 investigation and wlf from the 2013 fieldwork. Floor beams and trusses are numbered from the west end

Sample No	Location	Number of rings	Date of sequence (AD)	Sapwood	Mean ring width (mm)	Mean sensitivity	Felling date range (AD)
Primary timbers							
wrh01	Floor beam 1	70	1516–85	h/s	3.36	0.31	1594–1626
wlf01	Floor beam 2 *ex situ*	77	1503–79	1 (+11C NM)	2.41	0.25	1590–96*
wrh02	Floor beam 3	135	-	h/s	1.63	0.34	-
wrh03wlf04	Floor beam 4	78	1509–86	1 (+29mmC)	2.97	0.22	1596–1602Ω
wrh03	*ditto*	72	1509–80	h/s	2.94	0.28	*ditto*
wlf04	*ditto*	54	1533–86	1 (+29mmC)	2.89	0.16	*ditto*
wrh04	Floor beam 5	33	-	h/s	NM	-	-
wrh05i	Floor beam 6 (inner)	45	-	-	2.95	0.21	-
wrh05ii	*ditto* (outer)	29	-	h/s	1.71	0.20	-
wrh06wlf03	Floor beam 7	64	1513–76	h/s (+27C NM)	2.09	0.21	1592–98Ω
wrh06i	*ditto* (inner)	22	-	-	2.67	0.14	*ditto*
wrh06ii	*ditto* (outer)	46	1525–70	h/s (+27C NM)	2.25	0.19	*ditto*
wlf03	*ditto*	64	1513–76	h/s (+27mmC)	2.00	0.22	*ditto*
wrh07	Floor beam 8	33	-	h/s	NM	-	-
wlf02	Lintel over window in south wall bay 2–3	78	-	h/s (+7C NM)	1.60	0.21	-
Possible primary timbers							
wrh16	Principal rafter 4 south (east)	<45	-	h/s	NM	-	-
wrh14	Principal rafter 5 north (east)	<45	-	h/s	NM	-	-
wrh15	Principal rafter 5 north (west)	51	-	-	2.36	0.31	-
wlf05	Collar, truss 4 (re-used?)	45	-	?h/s (+18mmC)	2.14	0.19	-
wlf06	Collar, truss 5 (re-used?)	63	-	h/s (+23mmC)	1.84	0.24	-
wlf08	Wall plate, bay 10-11 north	<45	-	-	NM	-	-

Table 1. (continued)

Sample No	Location	Number of rings	Date of sequence (AD)	Sapwood	Mean ring width (mm)	Mean sensitivity	Felling date range (AD)
Replacement roof timbers							
wrh17	Principal rafter 2 south	63	1605–1707	4	4.74	0.35	1712–44
wrh13	Principal rafter 6 south	42	-	h/s	NM	-	-
wlf07	Principal rafter 7 north	67	1626–92	h/s (+23C NM)	2.02	0.18	1715–21*
wrh11	Principal rafter 8 north	49	1628–76	-	4.43	0.28	after 1685
wrh10	Principal rafter 9 north	115	1583–1697	6	2.86	0.22	1700–32
wrh09wlf09	Principal rafter 10 south	114	1606–1719	27¼C	2.04	0.19	spring 1720
wrh09	*ditto*	88	1606–93	1	2.42	0.19	*ditto*
wlf09	*ditto*	107	1613–1719	27¼C	1.88	0.21	*ditto*
wrh08	Principal rafter 11 south	120	1595–1714	19 (+5 NM)	2.29	0.23	1719–36
wrh12	Common rafter bay 7–8 north	96	1624–1719	16½C	1.42	0.26	summer 1720
wrh12a	*ditto*	96	1624–1719	16½C	1.43	0.25	*ditto*
wrh12b	*ditto*	23	1697–1719	16½C	1.46	0.20	*ditto*
wlf13	Middle purlin, bay 5–6 south	83	1638–1720		1.85	0.26	winter 1720/21
wlf13a	*ditto*	76	1635–1713	22	1.89	0.26	*ditto*
wlf13b	*ditto*	28	1693–1720	28C	1.27	0.23	*ditto*
wlf12	Middle purlin, bay 6–7 south	51	1651–1701	h/s (+9 NM)	1.68	0.19	1710–42
wlf11i	Middle purlin, bay 7–8 south	20	-	-	2.10	0.17	-
wlf11ii	*ditto*	50	-	16½C	1.50	0.24	-
wlf10	Middle purlin, bay 8–9 south	72	1649–1720	16C	2.35	0.24	winter 1720/21
wlf10a	*ditto*	58	1663–1720	16C	2.26	0.25	*ditto*
wlf10b	*ditto*	68	1649–1716	12 (+4C NM)	2.33	0.26	*ditto*

Key: h/s = heartwood/sapwood boundary; NM = not measured; C = complete sapwood, felled in winter; ¼C = complete sapwood, felled the following spring; ½ C = complete sapwood, felled the following summer; +xx NM = rings present in detached sapwood; +xxC NM = rings present in detached complete sapwood; +xxmmC = amount of complete sapwood lost on coring; * = range calculated allowing a likely maximum of 6 rings to have been lost between the measured core and the detached sapwood; Ω = range calculated by taking the mean ring-width of the last 10 measured rings, dividing the amount of sapwood lost by this mean figure, and then taking a range of ±3 around this date (calculated for wlf04 and applied to the combined wrh03wlf04; similarly, the range for wlf03 is applied to the combined wrh06wlf03)

Table 2a. Cross-matching between the pairs of samples taken from the same timber 3, values of t of 3.5 or over are considered significant, shaded cells show same timber pairs from resampled timbers

	t-value (years overlap)
Sample	wlf04
wrh03	7.0 (48)

	t-value (years overlap)
Sample	wlf03
wrh06ii	5.3 (46)

	t-value (years overlap)
Sample	wfl09
wrh09	11.2 (81)

	t-value (years overlap)
Sample	wrh12b
wrh12a	10.6 (23)

	t-value (years overlap)
Sample	wlf13b
wlf13a	4.9 (21)

	t-value (years overlap)
Sample	wlf10b
wlf10a	20.0 (54)

Table 2b. Cross-matching between the dated timber series making up the site chronology WOLFETN3, values of t of 3.5 or over are considered significant

	t-value (years overlap)		
Sample	wrh03wlf04	wrh06wlf03	wlf01
wrh01	5.7 (70)	3.5 (61)	2.1 (64)
wrh03wlf04		8.5 (64)	3.2 (71)
wrh06wlf03			5.6 (64)

Table 2c. Cross-matching between the dated timber series making up the site chronology WOLFETN4, values of t of 3.5 or over are considered significant

Sample	wrh09wlf09	wrh10	wrh11	wrh12	wrh17	wlf07	wlf10	wlf12	wlf13
wrh08	5.3 (109)	7.6 (103)	5.0 (49)	4.8 (91)	3.9 (63)	3.9 (67)	4.2 (66)	2.5 (51)	6.0 (77)
wrh09wlf09		3.1 (92)	3.5 (49)	4.3 (96)	3.3 (63)	9.4 (67)	3.1 (71)	2.3 (51)	5.1 (82)
wrh10			4.2 (49)	2.6 (74)	3.3 (53)	1.8 (67)	3.3 (49)	1.0 (47)	4.7 (60)
wrh11				3.9 (49)	4.7 (32)	2.0 (49)	3.5 (28)	1.6 (26)	3.2 (39)
wrh12					2.8 (63)	3.1 (67)	3.7 (71)	3.9 (51)	4.8(82)
wrh17						0.9 (48)	5.2 (59)	3.2 (51)	3.2 (63)
wlf07							1.4 (44)	2.9 (42)	2.8 (55)
wlf10								7.3 (51)	6.6 (72)
wlf12									4.8 (51)

Table 3a. Dating evidence for the site chronology WOLFETN3, AD 1503–86

Source region	Chronology	Reference	Filename	Span of chronology (AD)	Overlap (years)	*t*-value
Somerset	St Leonard's Chapel	Bridge 2002	FARLEGH1	1430–1591	84	8.3
Hampshire	Blaegrove Cottage, Up Nately	Bridge *et al* 2011	BLAEGROV	1347–1610	84	8.2
Hampshire	Kings Worthy	Miles *et al* 2005	KNGWRTHY	1485–1609	84	8.0
Wiltshire	Dog Kennel Farm	Miles *et al* 2004	CLRENDN7	1351–1603	84	7.6
London	White Tower, Tower of London	Miles 2007	WHTOWR7	1463–1616	84	7.6
Dorset	Lodge Farm, Kingston Lacy	Groves 1994	KINGLCY2	1470–1568	66	7.5
Hampshire	Chawton House	Miles and Worthington 2002	CHAWTON6	1289–1589	84	7.1
Oxfordshire	Rose Farmhouse	Haddon-Reece *et al* 1989	ROSE	1543–1613	44	7.0
London	Abbey Road, Barking (AYR99)	Tyers 2001	AYRBRRLS	1314–1599	84	7.0
Berkshire	Shaw House, Newbury	Miles *et al* 2004	SHAW1	1391–1579	77	6.9

Table 3b. Dating evidence for the site chronology WOLFETN4, AD 1583–1720

Source region	Chronology	Reference	Filename	Span of chronology (AD)	Overlap (years)	*t*-value
Wiltshire	Salisbury Cathedral	Miles 2005	SARUM12	1556–1703	121	9.3
Devon	Poltimore House, Poltimore	Arnold *et al* 2005	POLBSQ04	1534–1725	138	8.7
Kent	Longport Farmhouse	Tyers 1996	LPH2_T7	1617–1760	104	8.3
Oxfordshire	Radcliffe Camera	Worthington and Miles 2007	RADCLIFF	1660–1740	61	7.3
Oxfordshire	Old Clarendon Building, Oxford	Worthington and Miles 2006	CLRNDNOX	1539–1711	129	7.0
Wiltshire	Bishop's Palace, Salisbury	Miles and Worthington 2000	SARUMBP7	1562–1661	79	6.9
Norfolk	Thrigby Post Mill	Fletcher 1984	THRIGBY	1674–1790	47	6.9
Northants	Apethorpe Hall, Apethorpe	Arnold *et al* 2008	APTASQ02	1574–1749	138	6.9
Bristol	Pooles Wharf	Tyers and Groves 1997	BPW039	1639–1747	82	6.8
Devon	Pound Farm, Luppit	Tyers *et al* forthcoming	LPPBT12A	1557–1664	82	6.8

APPENDIX

Ring width values (0.01mm) for the sequences measured

wrh01

332	373	486	491	275	608	596	506	486	395
695	761	721	528	607	578	387	483	466	582
377	374	391	500	320	500	332	286	373	305
235	224	297	413	218	244	191	224	362	355
85	253	246	223	256	211	466	215	302	174
145	218	367	296	255	379	138	176	306	186
110	181	114	182	259	170	179	135	190	198

wrh02

192	141	232	192	143	154	117	311	374	480
250	218	286	308	241	113	193	133	165	260
110	213	168	114	88	134	143	70	93	116
213	137	102	121	213	121	57	130	176	123
77	58	125	109	108	220	93	178	122	94
163	309	200	141	140	117	98	124	181	181
211	292	213	255	173	129	106	126	166	180
236	150	122	113	173	177	227	104	224	264
275	184	75	135	104	145	161	112	101	163
90	137	88	137	162	267	106	104	210	103
103	126	170	123	194	162	154	214	193	173
187	127	181	129	163	193	205	112	229	298
193	169	155	158	122	175	177	115	180	129
171	110	114	64	106					

wrh03

290	367	465	319	257	328	281	173	366	362
329	245	332	325	459	218	265	441	457	513
339	363	400	363	313	477	598	600	459	481
612	445	499	168	233	278	345	263	220	250
357	272	323	173	203	207	311	182	236	176
181	277	178	273	159	252	237	132	285	173
238	219	208	162	157	215	131	113	152	113
113	234								

wrh05i

260	286	380	359	408	423	259	331	304	368
390	422	380	344	260	260	291	380	240	350
290	225	258	157	176	228	348	393	303	249
334	284	148	191	288	276	408	283	233	283
201	202	217	292	312					

wrh05ii

216	175	231	217	218	178	231	185	188	172
291	155	184	141	174	163	151	233	147	154
150	121	168	116	122	120	114	93	154	

wrh06i

245 322 310 319 316 298 260 332 293 316
321 297 304 328 198 136 157 225 236 199
211 247

wrh06ii
169 267 274 315 257 188 316 252 206 228
309 235 241 221 275 313 356 188 235 181
233 199 218 231 317 245 245 158 179 172
208 168 235 233 242 211 228 222 170 225
161 124 171 169 184 186

wrh08
417 444 372 377 386 362 481 469 323 273
245 270 328 382 247 292 368 209 344 291
219 144 246 251 190 179 237 187 242 142
236 244 209 295 287 260 246 323 318 217
246 173 266 315 376 361 261 256 144 187
187 276 170 391 210 192 185 168 159 212
277 178 215 240 165 283 271 205 223 212
224 221 141 154 175 166 112 240 267 279
208 111 120 151 151 218 171 254 220 144
128 172 172 236 206 193 181 165 187 181
169 254 232 209 139 183 185 154 266 178
91 79 88 166 180 165 177 153 178 122

wrh09
297 290 286 173 257 246 335 363 317 313
220 255 449 469 449 448 431 448 338 405
264 307 321 425 280 214 310 333 169 312
242 313 353 248 266 236 207 159 167 183
194 160 247 267 205 170 173 185 276 264
247 195 235 174 229 207 222 192 282 166
137 86 142 155 173 167 183 236 225 193
126 153 158 156 171 193 222 151 146 124
197 208 206 277 200 170 185 207

wrh10
385 431 484 500 364 470 476 179 279 373
368 471 422 466 430 395 357 312 436 406
334 333 247 254 316 303 222 273 298 217
408 342 310 298 335 304 243 288 252 198
279 199 316 355 251 283 320 312 247 370
135 254 326 246 302 405 355 370 284 273
266 247 307 245 211 377 297 281 241 222
251 280 287 204 269 322 191 312 367 282
260 316 280 244 174 296 213 176 204 232
327 262 255 155 130 159 199 289 208 346
322 168 136 253 295 314 252 225 276 165
164 115 94 96 135

wrh11
414 326 338 349 515 539 319 416 387 481
740 783 731 582 773 501 585 593 444 372

824 571 501 491 393 583 315 822 456 348
472 254 449 411 326 362 450 357 326 212
462 289 187 195 211 403 330 249 260

wrh12a
169 157 131 127 170 185 182 108 172 134
109 126 147 183 191 126 148 129 76 53
53 54 81 82 170 150 118 123 140 134
51 129 140 113 113 76 107 129 178 121
147 116 170 81 177 206 227 101 171 209
190 93 130 117 105 128 192 172 226 155
150 82 119 202 158 165 138 167 114 176
184 149 253 205 190 160 127 182 175 270
229 170 103 108 120 128 120 136 112 106
132 127 149 115 170 155

wrh12b
188 184 151 128 182 182 267 205 159 98
103 122 136 115 122 110 85 120 126 142
97 169 160

wrh15
242 190 190 266 402 265 137 152 108 136
271 224 192 165 115 72 120 123 132 450
344 385 349 147 158 214 259 216 116 122
95 135 144 152 317 236 220 118 167 235
123 107 401 373 488 475 430 450 424 505
202

wrh17
638 557 495 937 619 804 676 440 764 536
893 564 584 485 376 462 215 538 486 842
725 487 305 648 385 281 332 398 703 462
317 215 608 348 311 578 426 584 401 273
308 648 395 408 456 350 525 456 648 330
407 690 448 382 270 282 282 358 484 293
171 263 295

wlf01
516 468 247 195 209 250 288 228 361 392
506 405 248 256 296 399 598 371 364 275
171 146 132 349 345 368 332 282 347 236
166 184 249 180 274 194 244 250 303 101
214 148 102 102 133 165 278 207 199 138
188 225 168 167 220 167 212 206 240 201
177 191 199 116 171 230 275 231 209 239
145 150 153 182 181 117 152

wlf02
389 403 419 228 128 109 108 135 125 148
152 129 160 224 214 270 386 483 242 277
324 236 232 190 212 197 201 157 182 196
136 178 141 211 202 230 175 188 148 208

134 134 44 42 35 47 53 72 75 57
77 95 113 99 89 72 84 86 101 122
117 192 122 152 156 89 85 112 149 124
108 129 121 110 105 68 114 86

wlf03
434 342 220 100 202 255 339 251 253 258
187 127 135 258 268 308 255 234 277 170
161 199 329 252 267 248 252 233 268 133
166 120 166 142 172 165 266 191 201 189
185 157 235 157 154 126 146 176 147 198
175 186 163 151 234 150 168 151 160 124
134 116 81 110

wlf04
454 542 524 526 427 470 517 370 508 331
333 344 344 279 257 270 434 320 331 221
264 290 377 239 248 216 237 264 198 247
202 273 207 179 295 256 244 248 195 199
203 197 161 206 199 169 220 212 190 194
196 290 262 235

wlf05
219 235 211 263 202 191 263 490 311 335
340 434 416 394 307 298 294 106 64 74
93 94 104 89 103 108 126 116 130 134
163 192 248 261 308 287 341 311 274 302
95 74 62 76 96

wlf06
441 544 225 201 227 300 282 365 106 43
62 66 71 80 123 148 137 177 201 225
278 224 182 133 248 220 225 270 307 279
276 229 276 274 114 42 66 63 89 115
90 142 126 151 132 145 188 187 193 175
197 233 265 281 203 206 238 103 93 75
77 75 101

wlf07
182 251 271 352 223 177 266 251 134 213
158 221 214 203 172 177 157 153 192 185
221 155 197 222 201 158 183 164 229 154
205 185 204 177 243 227 244 191 240 192
159 113 125 154 188 176 238 299 320 247
186 186 174 185 175 196 193 143 193 160
181 224 253 238 210 212 239

wlf09
272 286 297 186 188 349 386 355 272 202
272 277 391 230 210 309 438 267 207 221
234 164 221 197 362 314 179 254 194 182
149 204 180 184 134 164 201 159 132 165
145 221 199 218 182 208 142 184 159 188

166 205 164 130 85 124 171 177 162 160
196 205 142 102 148 172 174 219 227 262
215 198 128 228 202 230 210 226 131 185
175 147 127 119 143 117 83 90 95 96
116 151 118 90 100 93 126 120 134 119
121 83 112 165 158 154 173

wlf10a
199 282 263 237 228 390 370 197 168 232
419 291 200 259 332 306 173 381 236 381
220 190 155 217 146 202 199 207 144 90
99 126 113 187 158 137 79 128 133 176
253 268 197 271 298 254 309 238 273 260
249 233 215 179 266 235 233 244

wlf10b
311 285 276 240 262 246 288 272 339 273
194 245 327 336 220 349 301 266 250 359
320 176 136 209 431 266 156 260 337 411
196 378 254 421 226 164 124 180 116 153
141 152 123 80 91 103 87 154 131 119
68 143 126 151 217 234 181 262 281 264
347 296 268 271 303 237 230 203

wlf11i
230 219 272 240 163 181 261 262 259 280
141 231 246 225 226 208 213 180 119 121
140

wlf11ii
160 147 190 197 146 99 80 316 214 211
256 315 253 124 180 148 162 139 210 195
150 182 115 131 152 125 191 188 146 107
155 153 95 135 156 99 94 109 87 94
90 97 98 127 95 140 140 102 130 96

wlf12
266 244 269 273 287 355 277 244 205 169
189 204 111 179 167 158 119 118 165 102
80 95 181 132 120 117 139 129 107 168
150 209 118 135 130 134 101 136 125 127
127 112 157 169 173 251 184 209 161 176
135

wlf13a
263 353 336 311 252 250 196 261 228 208
269 217 191 246 243 160 263 291 221 217
208 142 223 260 237 128 281 177 181 120
224 227 241 163 212 318 229 163 184 136
177 152 268 203 418 191 210 117 180 167
156 169 202 144 112 170 110 116 159 147
178 97 139 142 96 167 123 108 67 90
90 92 81 101 92 118

wlf13b

206	105	130	165	166	170	129	144	130	114
188	115	89	67	85	87	91	102	104	112
150	108	164	96	151	124	154	121		

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