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Scientific Dating

Little (Great) Chishill Windmill, Barley Road, Great Chishill, Cambridgeshire

Tree-ring Dating of Oak Timbers

Martin Bridge

Discovery, Innovation and Science in the Historic Environment

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SUMMARY

Samples were taken from ten oak timbers in the Little Chishill windmill of which six were dated. A reused diagonal front brace gave a likely felling date range of AD 1696–1728, making it much earlier than the other dated timbers. The remaining five dated timbers formed a coherent group of which one, with complete sapwood, was derived from a tree felled in the winter of AD 1817/18. It is therefore suggested that the major part of the buck seen today was constructed in AD 1818 or within a few years after this date, which is in accordance with a published note that the mill may have been rebuilt in AD 1819.

CONTRIBUTORS

Dr M C Bridge

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ARCHIVE LOCATION

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DATE OF INVESTIGATION

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CONTENTS

INTRODUCTION

The windmill is on the western edge of the village of Great Chishill, which lies approximately half-way between the towns of Royston, Hertfordshire, and Saffron Walden, Essex (Figs 1 and 2). There is some confusion over the name of this windmill, which is listed as Little Chishill Windmill, but which after boundary changes now comes into the village of Great Chishill, and is now widely known as Great Chishill Windmill, cared for by the Great Chishill Windmill Trust. This windmill has been identified as one of the earliest surviving windmills in England. One record suggests a mill may have existed as early as AD 1592, whilst the earliest recorded miller dates to AD 1677. A date of AD 1712 is scratched on a stud and it was possibly rebuilt in AD 1819. Records also state that the main post was renewed in AD 1868, as dated underneath the mill. The mill was last used in AD 1951. Ownership was transferred to Cambridgeshire County Council in the early AD 1960s, and renovation undertaken in AD 1966.

Dendrochronological dating was requested by Will Fletcher, English Heritage Inspector of Ancient Monuments, to provide independent dating evidence for any reused or other timbers of historic interest, and to determine the extent of surviving primary construction timbers.

METHODOLOGY

Fieldwork for the present study was carried out in November 2012, following an initial assessment of the potential for dating some weeks beforehand. In the initial assessment, accessible oak timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. 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.

The cores were polished on a belt sander using 80 to 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 combination of visual matching and a process of qualified statistical comparison by computer. 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.

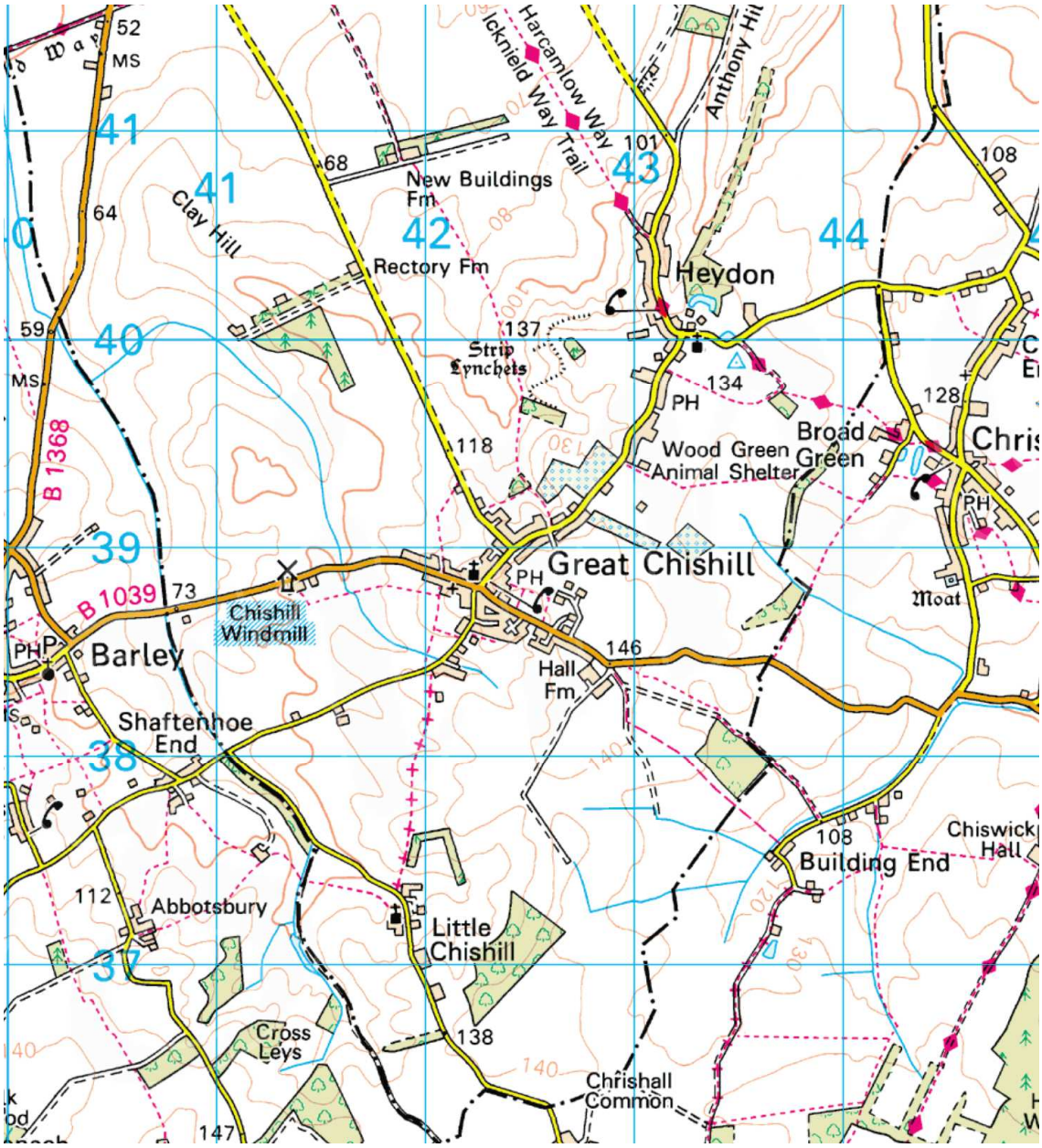

Figure 1: Location of the mill in relation to the nearby settlements of Barley and Great Chishill.
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Figure 2: Location of the mill with respect to neighbouring buildings on the western fringe of Great Chishill. © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900

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 sampled timbers are listed in Table 1 and illustrated in Figures 3 and 4, except gcm06, which is not shown in these drawings. One of the major timbers of interest, the crown tree, along with the main gear wheel and several minor timbers, was found to be made of elm (*Ulmus* spp) and was not therefore sampled. Cross-matching was found between five of the series (Table 2) and these were combined into an 86-year long chronology, CHISHILL. This series was found to date, by comparison with dated reference material, to the period AD 1732–1817, the dating evidence being presented in Table 3a. The remaining five series were compared individually with the dated reference material. This resulted in one, gcm05, being dated to the period AD 1628–87, the strongest matches being shown in Table 3b. The dated timbers all appear to have been derived from relatively locally-grown trees, as evidenced by the proximity of the sites against which the strongest matches were found (Tables 3a and 3b).

The relative positions of overlap of the dated samples are shown, along with the likely felling date or felling date range, in Figure 5. This clearly shows that there are two different periods of felling represented by these timbers.

Sample gcm05, from a small diagonal brace from the front of the buck, retained the heartwood/sapwood boundary, and therefore has a derived most likely felling date range of AD 1696–1728. It was noted at the time of sampling that this timber may have been reused, as it contained mortices not relating to the current structure. This could represent a reused timber from an earlier mill on the site, but there is no evidence to support this idea.

The remaining five dated timbers all have similar likely felling date ranges, with one timber (gcm09), a weather beam, retaining complete sapwood found to have been felled in the winter of AD 1817/18. The side girt, gcm10, had complete sapwood on the timber, but the outermost rings were lost during coring. It was noted at the time of coring that only a very small amount of this core had been lost and hence, bearing this in mind, the outermost measured ring date of AD 1815 suggests that this too was felled at around the

same date as gcm09. The remaining three dated timbers all produce felling date ranges that suggest they were also felled at the same time. Hence it appears likely that construction of the major framework of the buck took place in AD 1818 or very soon after this date. This is in accordance with the note by Wailes (1948) that the mill may have been rebuilt in AD 1819. It may well have replaced an earlier mill on the site, and it is possible that the diagonal brace incorporated into the front wall of the buck is a timber from this previous mill. Several cases have been found by the author where the main post is much older than the rest of the structure, for instance Drinkstone, Suffolk (Bridge 2001) and Nutley, Sussex (Bridge 2006), but in this case the main post could not be dated.

The dating of windmills can be problematic, as they are rarely all of one build (Bridge 2006). This mill was thought to be one of the oldest surviving mills, although this work has shown that the major part of the structure is early nineteenth century. The one older timber dated is later than the earliest recorded miller on the site (AD 1677).

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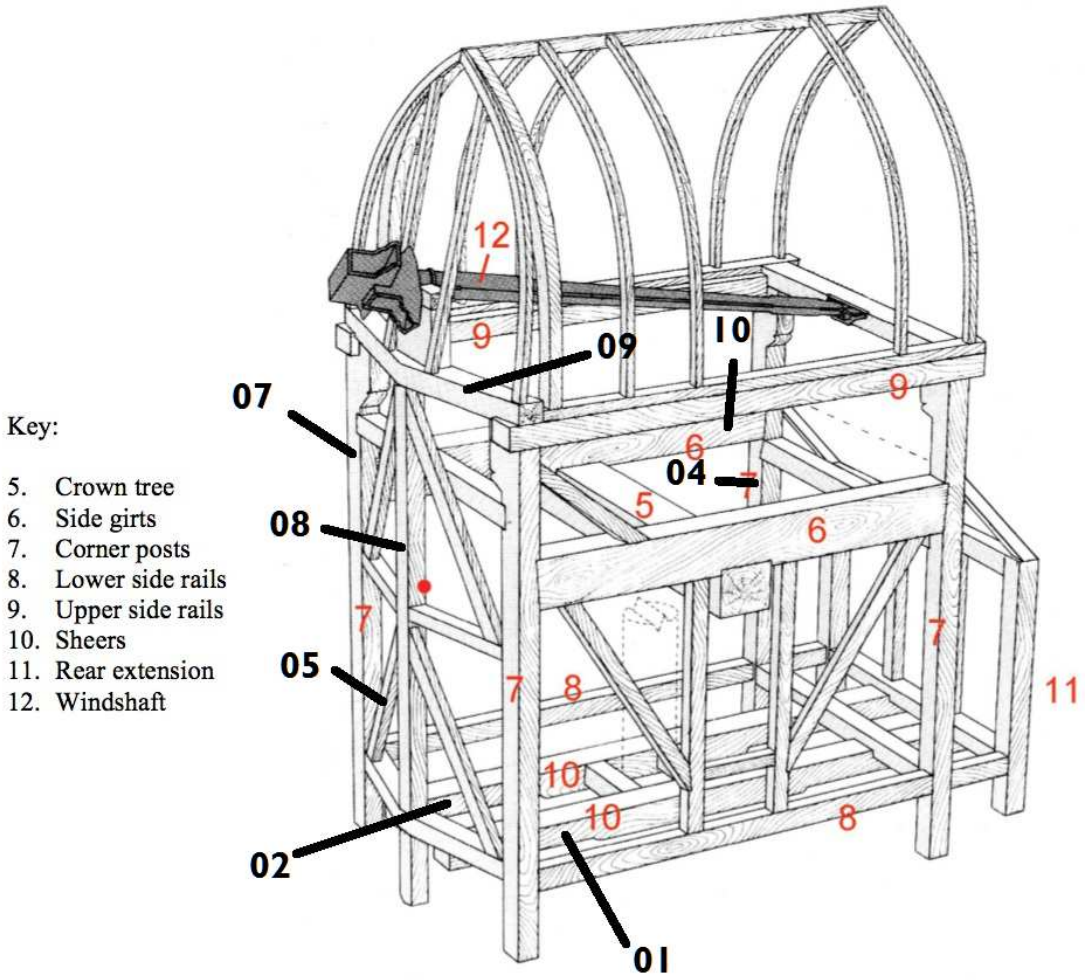

Figure 3: Drawing of the buck of the mill, from an original by Roland Smith, modified by Luke Bonwick, showing most of the timbers sampled for dendrochronology (black numbering) and key features of the mill (red numbering)

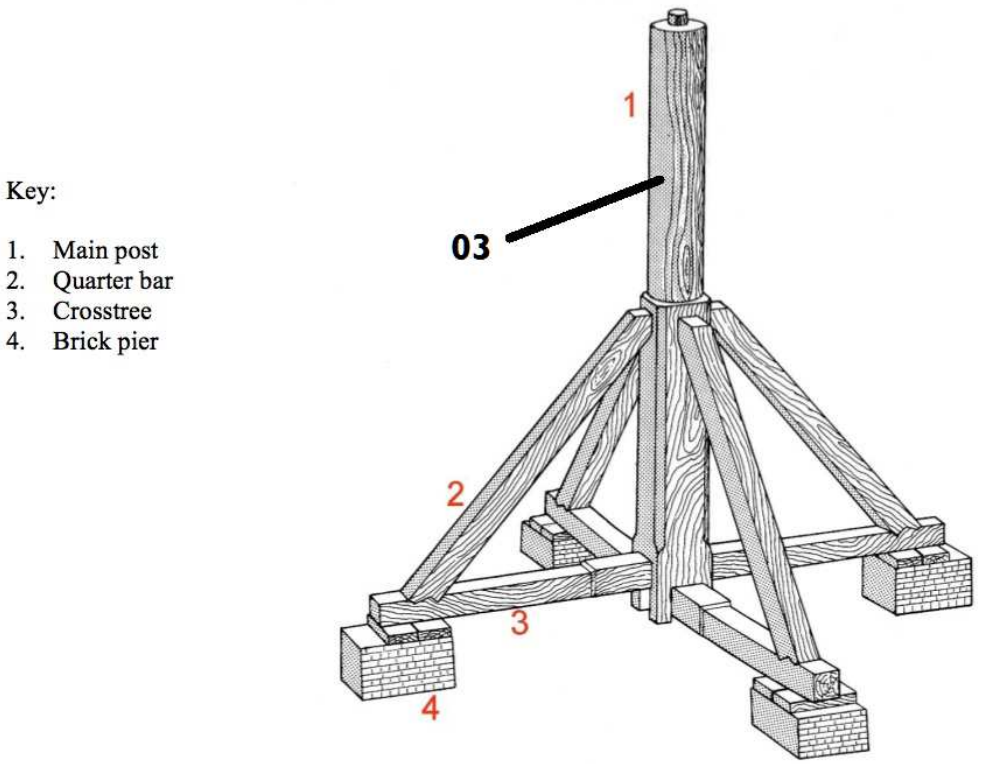

Figure 4: Drawing of the trestle, from an original by Roland Smith, modified by Luke Bonwick, showing the main post sampled (black numbering) and the other main trestle features (red numbering)

Table 1: Details of the samples taken from Little (Great) Chishill Windmill, Cambridgeshire

Sample number	Timber and position	No of rings	Mean HW ring width (mm)	Dates spanning (AD)	h/s boundary (AD)	Sapwood rings	Mean sens	Felling date ranges (AD)
gcm01	Left sheer	51	2.52	1764–1814	1802	12	0.18	1814–43
gcm02	Right sheer	48	1.71	-	-	11C	0.23	-
gcm03	Main post	113	2.85	-	-	5	0.23	-
gcm04	Right rear corner post, lower floor	75	1.47	1733–1807	1798	9	0.30	1807–39
gcm05	Right side, front diagonal brace - reused	60	2.52	1628–87	1687	h/s	0.25	1696–1728
gcm06	Stone bearer (a joist) - reused	41	1.90	-	-	h/s	0.21	-
gcm07	Front right corner post	75	2.07	1732–1806	1796	10	0.29	1806–37
gcm08	Prick post	57	2.91	-	-	-	0.24	-
gcm09	Weather beam	81	1.37	1737–1817	1786	31C	0.19	Winter 1817/18
gcm10	Right side girt	76	2.89	1740–1815	1797	18*	0.22	*c*1815–20

Key: HW = heartwood; h/s = heartwood/sapwood boundary: * the final 5 rings revert to heartwood, thus there is included sapwood; C = complete sapwood, winter felled

Table 2: Cross-matching between the dated nineteenth-century samples, values of 3.5 and above are significant

	t-values			
Sample	gcm04	gcm07	gcm09	gcm10
gcm01	3.0	3.8	4.0	4.4
gcm04		7.4	2.8	3.6
gcm07			3.7	4.1
gcm09				2.4

Table 3a: Dating evidence for the site master series CHISHILL, AD 1732–1817

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	*t*-value
Regional reference chronologies						
England	South Central England	(Wilson *et al* 2012)	SCENG	663–2009	86	8.7
Somerset	Somerset Master Chronology	(Miles 2004)	SOMRST04	770–1979	86	6.9
Hampshire	Hampshire Master Chronology	(Miles 2003)	HANTS02	443–1972	86	6.1
East Anglia	East Anglia Master Chronology	(Bridge 2003)	ANGLIA03	944–1789	58	5.5
Individual site chronologies						
Bedfordshire	Chicksands Priory	(Howard *et al* 1998a)	CHKSPQ02	1611–1814	83	8.1
Buckinghamshire	Pitstone Windmill	(Miles *et al* 2004)	PTSTONE1	1729–1823	86	7.7
Oxfordshire	Bayswater Mill, Headington	(Miles *et al* 2013)	BAYH	1744–1833	74	7.6
Cambridgeshire	Great Gransden Windmill	(Bridge 2015)	GRANSDEN	1706–1836	86	7.6
Buckinghamshire	Kya House, Ludgershall	(Miles *et al* 2003)	KYA10	1719–1794	63	7.0
Suffolk	Sotterley Park	(Briffa *et al* 1986)	SOTTERLY	1586–1981	86	6.1
Oxfordshire	Manor Farm, Stanton St John	(Miles and Worthington 1998)	ssj51	1710–1800	69	6.1
Buckinghamshire	The Hovel, Ludgershall	(Miles and Worthington 1999)	THEHOVEL	1671–1811	80	5.9
London	Eastcote House, Hillingdon	(Arnold and Howard 2012)	ECTASQ03	1720–1820	86	5.5

Table 3b: Dating evidence for the site series gcm05, AD 1628–1687

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	*t*-value
Regional reference chronologies						
Oxfordshire	Oxfordshire Master Chronology	(Haddon-Reece *et al* 1993)	OXON93	632–1987	60	5.8
England	South Central England	(Wilson *et al* 2012)	SCENG	663–2009	60	5.7
London	London Master Chronology	(Tyers per comm)	LONDON	413–1728	60	5.3
Individual site chronologies						
Bedfordshire	Westminster Abbey	(Miles *et al* 2003)	wa13	1606–1701	60	6.2
Buckinghamshire	Claydon House	(Tyers 1995)	CLAYDON	1613–1756	60	6.1
Oxfordshire	Bay Hall, Benington	(Howard *et al* 1998b)	BENASQ01	1591–1717	60	6.1
Cambridgeshire	St John the Baptist Church, Flitton	(Howard *et al* 2003)	FLTASQ01	1510–1726	60	6.1
Buckinghamshire	Gilbert White's House, Selbourne	(Miles *et al* 2004)	SELBRNE2	1620–1722	60	5.7
Suffolk	Brill Windmill	(Miles *et al* 2007)	BRILL	1585–1759	60	5.7

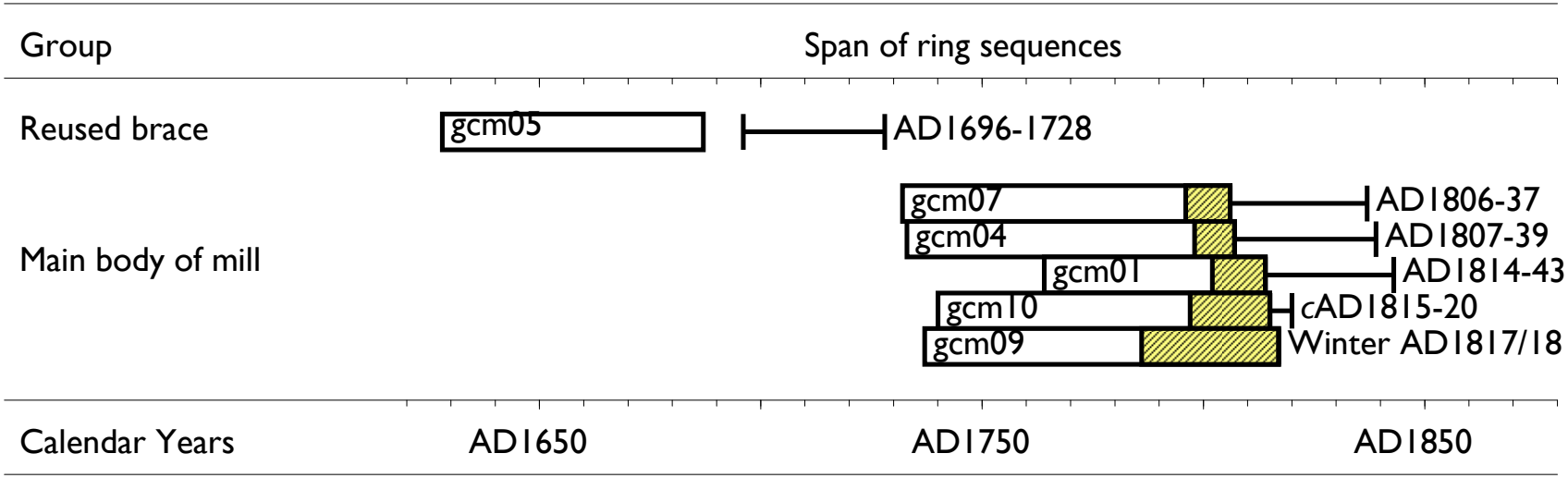

Figure 5: Bar diagram showing the relative positions of overlap and likely felling date ranges of the dated timbers from Little (Great) Chishill Windmill, Cambridgeshire. White bars indicate heartwood rings, the yellow hatched sections represent sapwood rings

APPENDIX

Ring width values (0.01mm) for the sequences measured

gcm01

370	294	379	348	355	352	369	213	226	314
362	312	307	275	231	224	238	188	211	202
213	151	124	175	242	287	219	207	280	190
244	248	201	275	247	227	191	181	159	133
165	157	225	200	115	160	124	163	233	207
165									

gcm02

237	244	265	300	250	200	145	204	155	218
182	173	120	78	150	189	215	195	148	112
117	135	193	293	205	212	244	163	139	102
84	103	117	144	122	103	63	79	102	119
152	161	178	115	84	88	179	146		

gcm03

279	301	404	228	394	265	166	215	128	117
242	332	190	197	163	323	267	336	167	193
189	124	231	238	201	270	349	476	408	399
346	324	388	381	394	304	271	214	195	268
174	281	181	185	240	227	276	251	257	222
268	347	262	210	281	290	291	232	336	251
293	237	235	257	235	186	268	276	226	234
287	376	314	301	242	237	328	272	205	215
240	210	315	402	293	218	275	494	459	346
429	329	369	277	267	326	532	488	391	230
416	432	425	202	264	276	316	381	443	424
413	366	303							

gcm04

184	148	235	151	128	233	142	198	177	129
95	108	203	194	130	123	77	57	82	163
114	226	283	255	108	125	133	115	98	90
131	180	109	180	123	124	101	98	63	69
140	205	208	224	278	169	149	141	277	304
132	118	60	60	53	87	186	188	130	256
114	119	146	86	75	100	161	125	97	107
81	122	150	150	131					

gcm05

358	268	241	276	417	199	126	167	185	182
323	284	358	412	377	385	300	356	365	321
466	307	318	244	266	164	204	281	288	230
277	297	442	364	325	299	223	259	222	149
139	123	119	171	158	227	200	135	91	156
225	181	305	145	289	283	189	156	202	115

gcm06

202	194	222	256	162	171	170	110	68	111
140	172	217	219	149	165	162	171	144	112
150	215	227	212	208	134	143	234	180	243
241	225	240	176	140	153	279	257	367	274
183									

gcm07

241	197	193	219	195	137	188	131	231	348
275	215	227	278	276	259	228	151	168	257
239	155	292	225	219	144	122	163	123	178
81	190	285	176	315	362	368	196	201	142
163	231	271	216	204	289	201	197	163	238
396	248	190	126	93	128	149	247	178	129
228	129	113	239	79	159	164	142	130	88
78	80	82	75	116					

gcm08

428	359	522	865	694	572	413	302	297	238
219	164	217	140	232	325	366	295	350	325
226	192	170	180	177	189	359	412	343	430
379	265	354	152	117	104	175	143	124	90
168	197	170	237	173	178	179	156	219	284
403	460	479	241	396	373	369			

gcm09

203	262	244	206	144	137	195	186	156	170
110	83	82	88	114	110	88	106	113	129
129	123	181	109	180	119	143	152	132	161
127	145	133	149	120	106	147	146	147	116
140	145	90	111	100	137	116	148	80	90
93	95	129	107	58	68	53	80	88	58
110	92	85	80	64	66	55	63	67	55
41	48	48	39	49	72	51	58	54	55
56									

gcm10

272	200	247	319	295	399	470	430	416	241
237	312	402	261	429	349	335	453	418	332
282	257	249	433	376	306	324	213	315	272
262	180	234	366	367	287	317	291	231	198
178	173	272	240	299	296	217	288	252	265
270	240	260	145	172	196	150	262	191	241
212	145	180	103	175	150	182	192	113	128
158	237	180	181	132	128				

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