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Cusgarne Manor Farmhouse
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Tree-ring Analysis of Oak, Elm, and Conifer Timbers

Martin Bridge and Cathy Tyers

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Research Report Series no. 213-2020

Front Cover: Cusgarne Manor Farmhouse, Cornwall. Photograph: By courtesy of the owner, taken from A Heritage Statement & Heritage Impact Assessment, Mercian Heritage Series 1077. 2017. Pl.4: The front of Cusgarne Manor prior to the start of restoration.

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SUMMARY
Several phases of construction within the building were assessed and found to have timbers with too few rings to be suitable for dendrochronology. Three *ex situ* oak lintels were sampled, but could not be dated. Two timbers from the stair turret were found to be of elm, and were not dated. Ten samples were taken from conifer timbers in the roof and attic floor over the west end of the house. Three timbers were combined into a working site master that did not date, but a further two samples matched each other and were combined into a site master that matched against chronologies from Norway and Sweden, dating the series to the period AD 1707–1810. The insertion of the truss from which these timbers were sampled cannot pre-date AD 1811.

CONTRIBUTORS
Martin Bridge and Cathy Tyers

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DATE OF INVESTIGATION
2017

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CONTENTS

INTRODUCTION

The house is situated a few miles to the west of Truro in Cornwall (Fig 1). Although Listed Grade II* (LEN 1140913), there is some confusion about the history and development of the property. A recent survey by Morriss (2017) concludes that the house is probably mid-seventeenth century in origin but was extensively modernised and re-fenestrated in the early–mid eighteenth century, at which time service ranges were added to the east end. A dendrochronological survey was requested by Rhiannon Rhys, HE Inspector of Historic Buildings and Areas, in order to assist the interpretation of the historic development of the property. It was hoped that this would inform advice provided in relation to repair work and the future management and protection of the building.

Some window lintels of possible seventeenth- and eighteenth-century origin had been extracted and were available *ex situ* for sampling. The roof over the main range is of crude construction, made of coniferous wood, with tiebeam, principal-rafter, and queen-strut construction using timbers of small scantling. It has two tiers of purlins which sit on the principals with no trenching. Many of the joints are nailed, rather than pegged. This is assumed to be a replacement roof.

METHODOLOGY

Fieldwork for the present study was carried out in November 2017. In the initial assessment, accessible 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 16 mm 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 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 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 them. 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 oak 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. Threshold values for conifer samples are as yet unknown, but on-going work by the second author suggests that they will be higher than those for oak.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or felling 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 in the case of oak or elm, if it has only the spring vessels or early-wood formed, or the late-wood 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* or felled-after date.

A review of the geographical distribution of dated sapwood data from historic oak timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, the empirically derived estimate for this area being 9–41 rings (Miles 1997). In the case of conifers, sapwood can be much more difficult to determine, and sapwood numbers are far more variable (eg Vitas and Zunde 2019).

RESULTS

An extensive assessment of the building concluded that few timbers from the primary phase of construction with sufficient numbers of rings for dendrochronology were available. None of the outbuildings contained suitable timbers for dating. The roof over the west end of the building (the oldest part) was found to be of conifer, with enough rings to make dating a possibility, and this roof was sampled, along with hardwood timbers in the stair turret (Figs 2–3). The roof over the east end (also of conifer construction) was made from timbers of small scantling, machine-sawn timbers, and none were considered for further analysis. A very fragile fireplace lintel was also assessed, but thought to be too fragile to sample, and *in situ* window lintels were found to be inaccessible internally and showed no evidence of surviving sapwood. Three *ex situ* hardwood lintels were thought possibly to represent the seventeenth- or eighteenth-century development of the building, and these were sampled by taking cross-sectional slices. All other samples were obtained by coring. Basic details of all timbers sampled are given in Table 1 and the locations of the samples from *in situ* timbers are illustrated on Figure 2. The ring width data for all measured samples is given in the Appendix.

The two timbers sampled from the stair turret, considered by Morriss (2017) to be a primary part of the building, were found to be of elm (*Ulmus* spp) with 47 and 51 rings respectively. They did not match each other, and could not be dated despite comparison with an extensive range of reference chronologies, most of which were for oak. Sample 02 broke into two sections, measured as 02i and 02ii, but sample 11 fragmented into several parts, with one section of 26 rings (not measured) being the longest part.

The *ex situ* oak (*Quercus* sp) lintels were also found to contain relatively few rings (57, 59, and 69 rings) as expected from the assessment, but these had been sampled because of their potential importance to the building. The three series did not match each other, neither did any of them date individually when compared to the same extensive range of reference chronologies.

Amongst the ten coniferous roof timbers sampled, those over 40 years long were measured, along with the two shorter parts of cusg02. Two groups of timbers cross-matched. One group of three, cusg01, cusg04, and cusg05, (Fig 4; Table 2) were combined to form a 179-year long series, cusg541m, but no consistent matching was found with the available reference material for conifer species, and the series remains undated. Two other timbers (cusg06 and cusg07) also matched each other. These represented two rafters from the same truss, and the series matched with a *t*-value of 10.8 with 85 years of overlap (Fig 5). A combined 104-year long series, cusg67m, gave consistent matches with reference material from Norway and Sweden, as well as a number of sites in England with dated imported timbers, at a position corresponding to the period AD 1707–1810 (Table 3).

INTERPRETATION

At the time of sampling, the rafter cusg07 was noted as having a natural looking edge that was thought to potentially represent the waney edge. As in many conifer series however, it was not possible to clearly distinguish sapwood on the sample itself. Whilst it is possible that AD 1810 was the final complete ring, with the tree having been felled in winter AD 1810/11, all that can be safely concluded is that the truss in question must, allowing for transportation from the source region to this building, have been erected in or after AD 1811. A previously unknown phase of major changes to the building has therefore been identified with an indication of its likely date.

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TABLES

Table 1: Details of samples taken from Cusgarne Manor Farmhouse

Sample No	Location	No rings	Date of sequence	Sapwood	Mean ring width (mm)	Mean sensitivity	Date of sequence
Ex situ oak lintels							
cusgX01	Lintel from C18th century remodelling	59		C	1.54	0.28	
cusgX02	Window lintel from C17th, re-used timber	69		?h/s	2.25	0.30	
cusgX03	Window lintel	57		18 (+6NM)	1.57	0.29	
Stair turret (elm)							
cusg03	Wallplate to stair turret	47 (+4NM)		-	1.55	0.22	
cusg12	Lintel supporting lower flight of stairs	51		?h/s	2.00	0.27	
Main roof and attic floor (coniferous wood) – trusses numbered from the east end							
cusg01	North principal rafter, truss 2	87		?C	0.75	0.16	
cusg02i	South principal rafter, truss 3 (inner rings)	33		-	1.19	0.20	
cusg02ii	South principal rafter, truss 3 (outer rings)	25		-	0.93	0.19	
cusg04	South principal rafter, truss 2	175		?C	0.52	0.14	
cusg05	South principal rafter, truss 4	71		?h/s	0.54	0.15	
cusg06	South principal rafter, truss 6	95	1707–1801	?h/s	0.93	0.20	after 1801
cusg07	North principal rafter, truss 6	94	1717–1810	?C	0.70	0.22	?1810
cusg08	Floor joist, first from east end	36		-	NM	-	
cusg09	Tie, truss 3	49		-	0.94	0.22	
cusg10	North principal rafter, truss 3	38		-	NM	-	
cusg11	South principal rafter, truss 5 (core fragmented)	26		-	NM	-	

Key: C = complete sapwood, felled the following winter; h/s = heartwood/sapwood boundary; NM = not measured

Table 2: Cross-matching between the conifer series combined to form the undated site master, cusg541m

	t-value (yrs overlap)	
Sample	cusg04	cusg05
cusg01	8.5 (83)	5.8 (63)
cusg04		6.8 (71)

Table 3: Dating evidence for the conifer mean series cusg67m as spanning AD 1707–1810

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (yrs)	*t*-value
SE Norway	Flesberg	(Eidem 1959)	FLESBERG	1383–1954	104	6.2
SE Norway	Sor-Hovstua, Flesberg	(Eidem 1959)	SORHOVSTUA	1665–1797	91	6.1
Norway	Jordalen	(Briffa *et al* 1986)	NORJORD	1605–1981	104	5.8
SE Norway	Dewar's Lane Granary, Berwick	(Arnold *et al* 2008)	BWKASQ03	1701–1825	98	5.5
Sweden	Muddas National Park	(Axelson 2003)	SWED305	1450–2002	104	5.3
Sweden	Dalarna	(Bartholin pers comm 1994)	SWED_DAL	1001–1852	104	4.8
SE Norway	Storfossas, Flesberg	(Eidem 1959)	STORFOSSAS	1702–1954	104	4.4
Import	Crucible Works, Sheffield	(Tyers and Groves 2003)	CWS-T7A	1650–1804	98	6.4
Import	Godolphin House, Cornwall	(Tyers and Tyers forthcoming)	GGCP-T6A	1528–1769	63	5.5
Import	Wallace Collection, London	(Tyers forthcoming)	WALLACE1	1604–1773	67	4.7

FIGURES

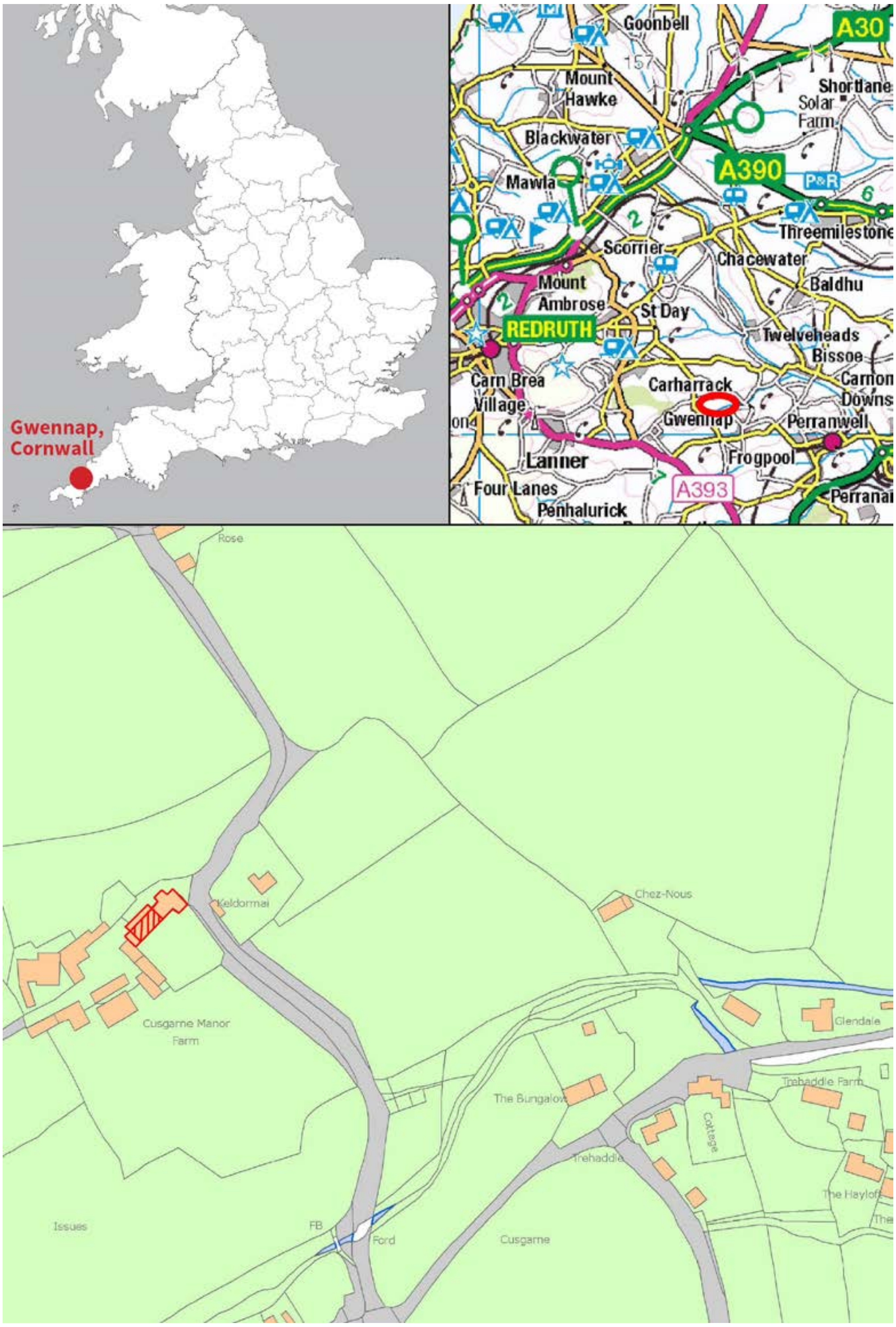


Figure 1: Maps to show the location of Cusgarne Manor Farmhouse, Gwennap in Cornwall, marked in red. Scale: top right 1:114000; bottom 1:2000 with hachured sampled area. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England

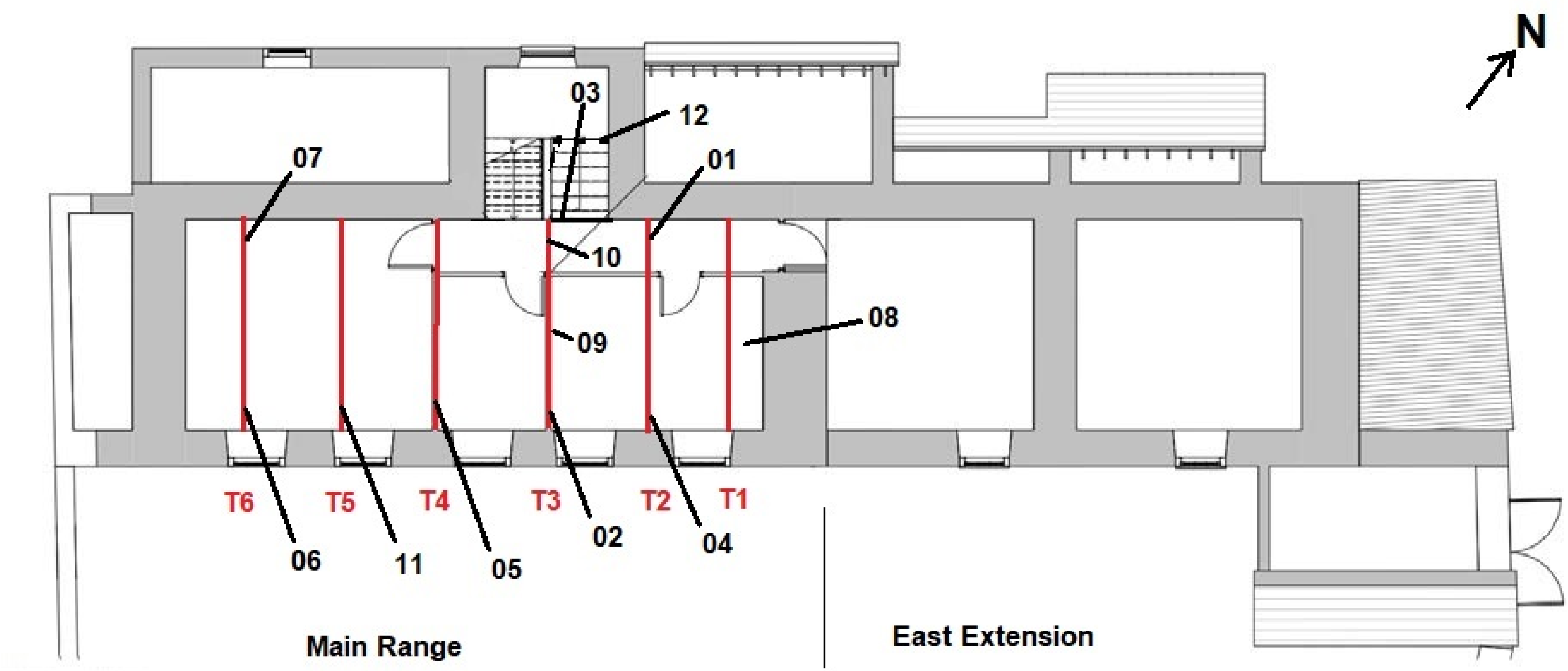


Figure 2: Sketch plan of the roof area, superimposed on a first-floor plan (after Morriss 2007,) showing the approximate position of trusses and the timbers sampled for dendrochronology

Figure 3: View of the roof, looking west, showing small scantling conifer timbers (photograph Martin Bridge)

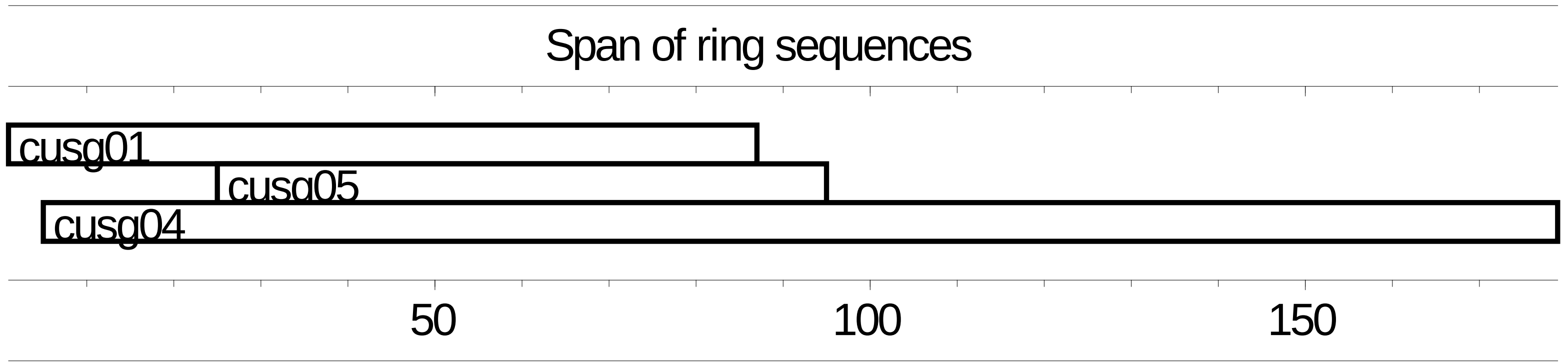


Figure 4: Bar diagram showing the relative positions of overlap of the three crossmatched but undated conifer sequences

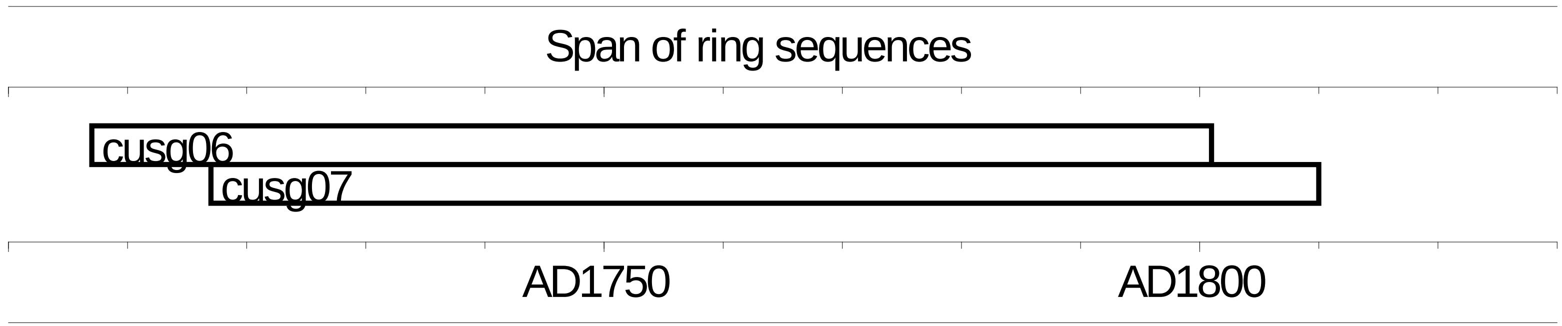


Figure 5: Bar diagram showing the relative overlapping positions of the two crossmatched and dated conifer sequences

APPENDIX

Ring width values (0.01mm) for the sequences measured

Oak

cusgX01

198	282	250	187	232	235	317	276	288	253
166	226	132	186	253	159	189	162	116	167
118	140	197	259	220	207	133	95	123	78
103	82	93	133	61	98	128	207	180	233
197	82	61	131	168	102	75	81	95	77
77	112	102	76	82	71	101	93	147	

cusgX02

245	244	283	208	94	125	167	182	136	257
241	378	279	362	360	261	166	185	236	487
363	295	306	232	197	132	193	348	248	331
363	315	345	210	447	285	225	116	279	210
139	270	164	176	152	151	174	213	285	212
227	194	112	44	58	57	129	121	145	162
182	232	264	287	202	382	177	185	124	

cusgX03

245	59	62	146	215	316	267	237	192	350
186	208	219	279	326	272	288	312	282	172
208	216	140	224	149	83	78	128	136	164
103	58	85	119	127	155	159	158	94	113
103	63	94	89	113	144	145	136	57	81
59	97	126	127	77	58	53			

Elm

cusg03

306	368	296	298	250	122	141	120	106	62
46	46	30	29	23	32	39	70	84	67
69	59	53	63	75	82	166	183	170	121
151	158	231	284	206	239	285	171	187	235
254	286	258	241	133	214	191			

cusg12

207	209	175	178	117	154	315	288	362	347
338	286	354	366	298	304	336	272	299	194
227	192	139	244	375	302	247	137	94	99
136	74	74	78	78	92	70	58	65	216
233	154	215	97	125	67	94	131	298	228
166									

Conifer

cusg01

166	137	119	118	101	129	134	123	143	120
124	105	112	113	99	117	157	141	162	125

103	83	62	40	41	48	44	48	63	70
57	69	80	77	86	68	83	74	105	99
99	99	79	74	92	110	64	47	80	68
50	60	50	57	52	42	58	60	52	47
46	58	51	50	46	55	43	51	57	36
33	40	53	40	40	38	39	40	47	51
39	43	51	49	58	50	40			

cusg02i

167	191	164	139	116	107	140	162	162	108
130	84	105	138	90	121	81	76	89	93
102	97	131	109	85	74	117	133	129	161
134	100	87							

cusg02ii

64	107	95	107	125	126	80	132	115	102
96	97	75	93	89	94	116	97	107	54
51	80	68	74	82					

cusg04

118	165	128	121	142	116	111	103	108	112
99	88	110	102	89	72	69	68	51	37
48	46	46	50	53	62	68	90	99	88
66	59	65	59	74	62	63	75	62	59
63	81	51	50	61	60	56	50	54	49
43	47	55	58	53	51	50	66	55	55
51	69	51	46	54	44	38	54	61	48
47	45	35	42	48	48	50	41	53	47
57	55	30	39	37	43	40	42	37	40
37	30	36	40	32	30	31	28	28	28
26	28	37	48	37	30	35	33	39	52
37	36	32	36	40	37	28	30	21	33
37	37	44	45	45	47	41	42	42	32
31	32	33	39	36	42	39	44	41	41
50	40	37	49	42	49	51	51	56	48
46	61	38	28	22	27	31	34	35	31
33	37	33	35	34	45	45	38	48	39
51	37	35	58	48					

cusg05

50	57	49	47	48	53	74	86	85	69
72	66	81	52	73	65	76	84	54	55
62	73	62	44	62	70	57	63	51	66
54	55	60	70	54	52	44	55	48	33
46	51	41	38	50	41	37	46	62	56
44	35	36	34	34	41	41	40	39	45
61	64	44	41	49	48	45	44	40	47
48									

cusg06

226	174	202	217	189	144	132	87	115	96
126	164	168	244	218	208	177	176	172	117

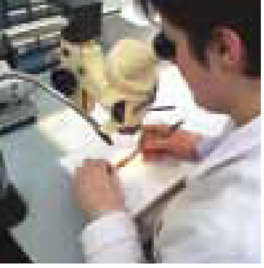
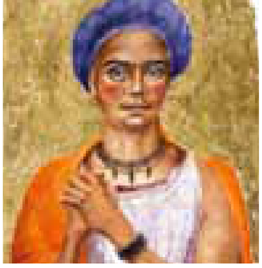
108	81	103	119	80	81	103	124	86	43
62	60	50	52	34	87	106	99	106	53
57	55	78	122	94	93	65	58	72	76
83	72	83	75	64	66	97	100	86	100
106	47	58	78	80	102	118	98	79	125
118	108	77	88	65	69	52	66	58	54
52	52	49	57	66	52	39	41	43	44
39	28	25	17	22					

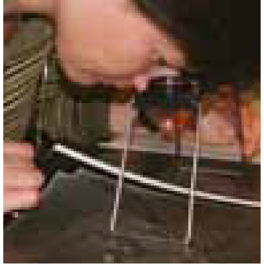
cusg07

77	85	109	178	210	212	152	201	147	130
117	83	83	97	74	56	72	108	78	40
42	46	22	35	18	44	62	68	70	34
42	38	74	75	59	65	63	55	77	87
75	77	73	66	44	51	76	100	96	108
93	59	66	76	74	74	66	51	47	76
62	67	71	96	68	63	63	80	87	64
67	59	67	57	79	75	61	68	53	47
42	38	21	15	16	28	35	34	25	23
32	28	28	39						

cusg09

120	179	196	171	148	117	175	104	73	73
74	27	29	67	84	107	114	105	120	144
140	115	78	87	70	60	69	66	72	41
47	74	51	57	50	67	92	104	93	102
131	105	106	79	79	110	80	88	76	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