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Monuments at Risk in Somerset Peatlands Project : Tree-Ring Analysis of Oak Samples from Dewar's B (Nidons) Tracks, Harter's Hill Pile Alignment and Bog Oaks, and Street-Glastonbury Causeway, Somerset

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Summary

Twenty-nine samples from oak timbers uncovered during excavations in AD 2003 at three sites within the Monuments at Risk in Somerset Peatlands project were submitted for dendrochronological analysis. In addition another twenty-one samples taken in AD 1996 and AD 1997 from Harter's Hill were analysed.

No absolute dating evidence was obtained for samples from either the Dewar's B (Nidons) tracks or the Street-Glastonbury causeway. Twenty-five samples were successfully dated from the Harter's Hill pile alignment indicating at least two different phases of felling activity in the mid-eleventh century BC. A possible bog oak from Harter's Hill was also dated and has a felling date of after 1019 BC.

Keywords

Dendrochronology

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers uncovered during archaeological excavations at three sites in the Monuments at Risk in the Somerset Peatlands (MARISP) project in AD 2003. The three sites are Dewar's B (Nidons) tracks, Harter's Hill, and Street-Glastonbury causeway (Figs 1 and 2). In addition a series of samples taken in AD 1996 and AD 1997 from Harter's Hill analysed by Jennifer Hillam (pers comm) are reported on. It is beyond the dendrochronological brief to describe the excavations in detail or to undertake the production of detailed drawings. This analysis is a component part of a multi-disciplinary series of studies on the sites and thus the conclusions presented here may be modified in the light of other archaeological or environmental evidence.

The Dewar's B (Nidons) tracks site is located on Shapwick Heath approximately seven kilometres west of Glastonbury (ST 4279 4000; Fig 2). Samples were taken from two timbers revealed in the ploughsoil that may represent the remains of one of the trackways thought to be of late Bronze Age or early Iron Age date.

Harter's Hill pile alignment lies approximately four kilometres north-east of Glastonbury on Queen's Sedge Moor (ST 5335 4225; Fig 2). The site was discovered in AD 1996 by the farmer, Mr Harding, during ploughing. A number of posts were extracted and five were sampled for dendrochronological analysis. An assessment excavation of the pile alignment was undertaken in AD 1997 (Brunning 1997 unpubl). This revealed a large deposit of wood around the posts comprising a mass of small roundwood, twigs, woodchips, short plank fragments, offcuts from woodworking, and whole logs from which 15 samples were obtained. During further excavations as part of the MARISP project in AD 2003 samples were taken from 15 timbers or offcuts associated with the dryland end of this late Bronze Age ritual pile alignment. A bog oak, potentially considerably older than the pile alignment, was sampled during AD 2003. Another possible bog oak found about 50 metres away from the pile alignment was sampled in AD 1997.

The Street-Glastonbury causeway is located between Street and Glastonbury immediately to the south-west of Glastonbury (ST 487 375; Fig 2). The causeway is constructed of stone and timber and is thought most likely to date to the early medieval period. Samples were taken from seven piles and four offcuts.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The following summarises relevant methodological details used for the analysis of the samples from these three sites.

The waterlogged samples were prepared by being frozen for a minimum of 48 hours before their cross-sectional surface was cleaned with a surform plane, scalpels, and razor blades until the annual growth rings were clearly defined. The sequence of growth rings in each sample were measured to an accuracy of 0.01mm using a purpose-built travelling stage attached to a microcomputer-based measuring system (Tyers 1999). The ring sequences were plotted onto semi-logarithmic graph paper to

enable visual comparisons to be made between them with the aid of a lightbox. In addition, cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The Student's *t*-test is then used as a significance test on the correlation coefficient. The *t*-values quoted below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match (Baillie 1982, 82-5), provided that high *t*-values are obtained at the same relative or absolute position with a series of independent sequences and that the visual match is satisfactory.

Dating is usually achieved by cross-correlating, or crossmatching, ring sequences within a phase or structure and combining the matching patterns to form a phase or site master curve. This master curve and any remaining unmatched ring sequences are then tested against a range of reference chronologies, using the same matching criteria as above. The position at which all the criteria are met provides the calendar dates for the ring sequences. A master curve is used for absolute dating purposes whenever possible as it enhances the common climatic signal and reduces the background 'noise' resulting from the local growth conditions of individual trees.

During the crossmatching stage an additional important element of tree-ring analysis is the identification of 'same-tree' timber groups. The identification of 'same-tree' groups is based on very high levels of similarity in year to year variation, longer term growth trends, and anatomical anomalies. Such information ideally should be used to support possible 'same-tree' groups identified from similarities in the patterns of knots/branches during detailed recording of timbers for technological and woodland characterisation studies. Timbers originally derived from the same parent log generally have *t*-values of greater than 10.0, though lower *t*-values do not necessarily exclude the possibility. It is a balance of the range of information available that provides the 'same-tree' link.

The crossdating process provides precise calendar dates only for the rings present in the timber. The nature of the final ring in the sequence determines whether the date of this ring also represents the year the tree from which the timber was derived died. Oak consists of inner inert heartwood and an outer band of active sapwood. If the sample ends within the heartwood of the original tree, a *terminus post quem* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings that are missing. This is the date after which the timber was felled but the actual year of felling may be many decades later depending on the number of outer rings removed during timber conversion. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimate applied throughout this report is a minimum of 10 and maximum of 46 rings, where these figures indicate the 95% confidence limits of the range and are applicable to oak trees of all periods from England and Wales (Tyers 1998). Alternatively, if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination

of felling season must be treated cautiously. The delicate nature of sapwood, particularly on waterlogged timbers, increases the likelihood of damage/degradation to the outermost surface of the sample and hence increases the difficulties of positive identification of bark-edge.

The felling dates produced do not by themselves necessarily indicate the construction date of the structure from which they are derived. At this stage, factors such as seasoning, reuse, and stockpiling have to be considered. Seasoning is unlikely to have had an impact on these structures as evidence suggests that seasoning of timber for structural purposes was a fairly rare occurrence until relatively recent times and timber was generally felled as required and used whilst green (Hollstein 1980; Rackham 1990; Charles and Charles 1995). However, the reuse of timber has been a common practice since prehistoric times and stockpiling, albeit potentially short term, may occur. Therefore, although the production of tree-ring dates is an independent process, the interpretation of these dates may be refined by drawing on other archaeological evidence.

Results

All of the samples submitted for analysis were oak (*Quercus* spp.). Details of the samples from all sites are presented in Table 1.

Dewar's B (Nidons) tracks

Both samples, **16** and **17**, were suitable for measurement and their ring sequences were found to crossmatch (Table 2). The very high *t*-value produced and the excellent visual match suggests that these two timbers are likely to have been derived from the same tree (Fig 3; Table 2). The ring sequences from these two matching samples were combined to produce a mean sequence for this site (Table 3). This site mean sequence, **DEW-S2**, was compared with a range of dated reference chronologies from Britain and elsewhere in northern Europe spanning the last 7000 years. No conclusive results were obtained, thus the two timbers from the Dewar's B (Nidons) tracks site remain undated by dendrochronology.

Harter's Hill pile alignment

A total of 35 samples was submitted for analysis from the Harter's Hill pile alignment. These represented 14 piles, eight woodchips/offcuts, seven radially split offcuts, three radially split planks, two stakes, and one half split (Table 1). Six samples were rejected as unsuitable for analysis as they contained too few rings. A further sample was rejected as, although it contained approximately 50 annual growth rings, the outermost rings were badly crushed and hence the rings were severely distorted and the ring boundaries could not be distinguished. The ring sequences of the remaining 28 samples were compared with each other. Twenty five were found to crossmatch, and these were combined to produce a site master sequence, **HH-T25** (Fig 4; Tables 4 and 5). This site master sequence was compared with a range of dated reference chronologies from Britain and elsewhere in northern Europe and was dated to the period 1187-1049 BC (Table 6).

The three unmatched ring sequences from the pile alignment were compared individually with a range of dated reference chronologies from Britain and elsewhere

in northern Europe. No conclusive results were produced, so these samples remain undated.

Harter's Hill bog oaks

Both bog oak samples contained sufficient rings for analysis. The ring sequence derived from sample **2003-131**, showed no similarities with the material from the pile alignment, nor could it be conclusively dated when compared individually with a range of dated reference chronologies from Britain and elsewhere in northern Europe. However sample **1997-99** was successfully dated by comparison with the samples from the pile alignment (Fig 4; Tables 4 and 7).

Street-Glastonbury causeway

A total of 11 samples was submitted for analysis from the Street-Glastonbury causeway. Five samples were from the east pile line, two samples from the west pile line, and four samples were from offcuts associated with contexts 5 and 10 which represent material washed up or dumped adjacent to the causeway. The single offcut from context 5, sample **4**, was rejected as unsuitable for analysis as it contained too few rings. Samples **21** and **22** were slightly crushed causing some possible distortion to the growth rings, though these were considered suitable for analysis. The ring sequences of the ten measured samples were compared with each other. Three were found to crossmatch, and these were combined to produce a site master sequence, **STC-T3,** (Fig 5; Tables 8 and 9). This site master sequence was compared with a range of dated reference chronologies from Britain and elsewhere in northern Europe. No conclusive results were obtained, thus these three timbers remain undated by dendrochronology.

The remaining unmatched samples were compared individually with a range of dated reference chronologies from Britain and elsewhere in northern Europe. No conclusive results were produced, so these samples also remain undated.

Interpretation/Discussion

Dewar's B (Nidons) tracks

The analysis has failed to successfully date the two timbers from one of the trackways but has shown that they are both likely to have been derived from a single tree. The lack of absolute dating is not particularly surprising as single tree sequences have a significantly reduced chance of reliable dating compared to a site master sequence that incorporates data from several different trees. In addition whilst the chronological network for the historic period is strong both temporally and geographically, thereby increasing the likelihood of successful analysis, for the prehistoric period the network is far less well replicated.

Harter's Hill pile alignment

The analysis has successfully dated 25 samples. This comprises piles, radially split offcuts, radially split planks and woodchip/offcuts all of which are broadly contemporary (Fig 6). The results therefore clearly indicate that the wood deposits surrounding the piles are associated with the construction of the pile alignment.

Only three samples, all from piles, had retained any sapwood. The earliest definite felling activity is represented by pile **1997-7**, the outer surface of which was thought

likely to be bark edge and was therefore probably felled in 1076-5 BC. It is however possible that some of the samples without sapwood could have been felled up to approximately 25 years before this. The next definite felling activity is represented by pile **2003-130** which has a felling date range of 1049-21 BC. The other pile with sapwood, **1997-15**, has a felling date range of 1076-40BC. A probable felling date range of 1085-49 BC can also be calculated for pile **1997-14**, the outermost ring of which was thought likely to be the heartwood/sapwood transition. Consequently these two piles could be contemporary with either **1997-7** or **2003-130** or alternatively they could represent additional felling phases. The *terminus post quem* for felling for the remaining samples ranges from after 1103 BC to after 1060 BC.

The results show that there are at least two different phases of felling during the mid-eleventh century BC but the general lack of sapwood prevents a more detailed understanding of the phasing. The pile alignment was probably in use for a minimum of approximately 30 years.

If further archaeological excavation of this alignment occurs in the future any timbers revealed with sapwood could prove important in refining the results already obtained from the dendrochronological analysis.

Harter's Hill bog oak

Sample **1997-99** was felled after 1019 BC and therefore appears to have died or been felled after the felling activity associated with the pile alignment (Figs 4 and 6). This timber was a radial fragment sticking out from a ditch. It had consequently suffered from severe desiccation and decay, but it showed no evidence of working and was therefore thought potentially to represent a bog oak that may have been disturbed during ditch cleaning. The fact that it is broadly contemporary with the pile alignment is of interest. If it is a bog oak located on the wetland edge then it was clearly growing within close proximity to the pile alignment. Alternatively, if it was a worked timber then it may represent another structure of similar, though slightly later, date to the pile alignment.

Street-Glastonbury causeway

Two of the three samples incorporated into **STC-T3** are from piles from the east and west lines, whilst the third sample is an offcut from context 10 (Fig 5). None of the samples had retained any sapwood but the dendrochronological analysis clearly has demonstrated that they are broadly contemporary indicating that both pile lines and the offcuts are of similar date.

Unfortunately the analysis has failed to provide absolute dates for any of the timbers from the Street-Glastonbury causeway. Although it has been possible to produce a site master sequence this was only 68 years long. The inability to date this site master sequence is probably related to its length and relatively poor replication. The reference data available for the later medieval period in this region is relatively abundant but the early medieval period is dominated by material from Bristol. This lack of local reference chronologies is likely to be a contributory factor in the failure to date the causeway timbers. The overall lack of intra-site crossmatching and hence the inability to produce a well-replicated long site master sequence is probably a result of the generally short ring sequences derived from the timbers, either due to the conversion of the timber or the use of young trees. If further excavations were

undertaken on the causeway, then more extensive sampling may overcome these difficulties and allow the production of a well-replicated, long site master for which the chances of obtaining a date would be substantially increased.

Conclusion

Dendrochronological analysis has not been able to provide independent dating evidence for either the Dewar's B (Nidons) tracks or the Street-Glastonbury causeway, although it has demonstrated that the two pile lines and the discarded material associated with the causeway are broadly contemporary.

Timbers from the Harter's Hill pile alignment structure have been shown to have been felled during the mid-eleventh century BC. There are at least two felling phases represented by the dated timbers and they suggest that the pile alignment was in use for a minimum of approximately 30 years. A possible bog oak has been dated slightly later than the construction of the pile alignment.

Acknowledgements

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Figure 1

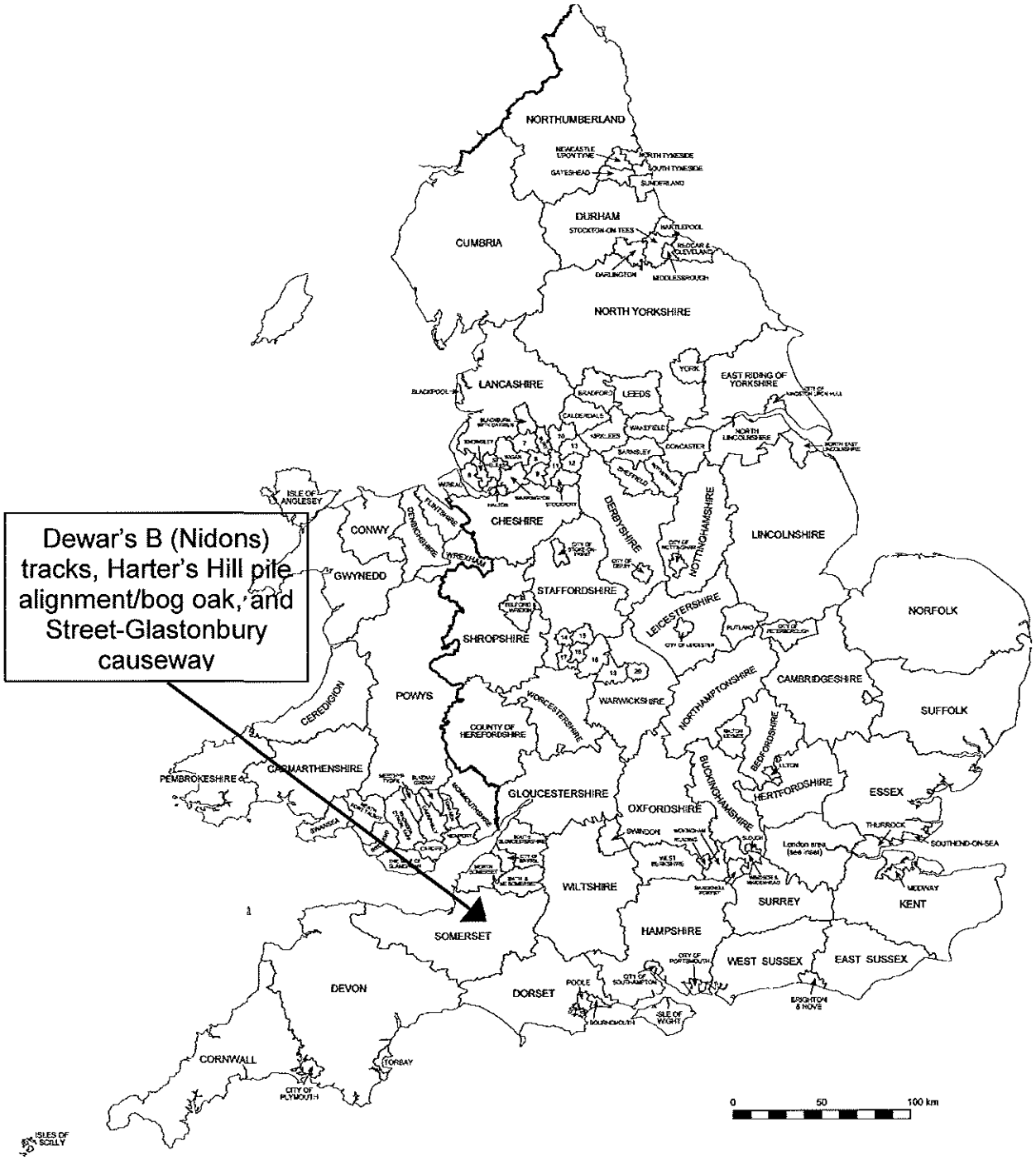


Figure 2 Location of the three sites in Somerset

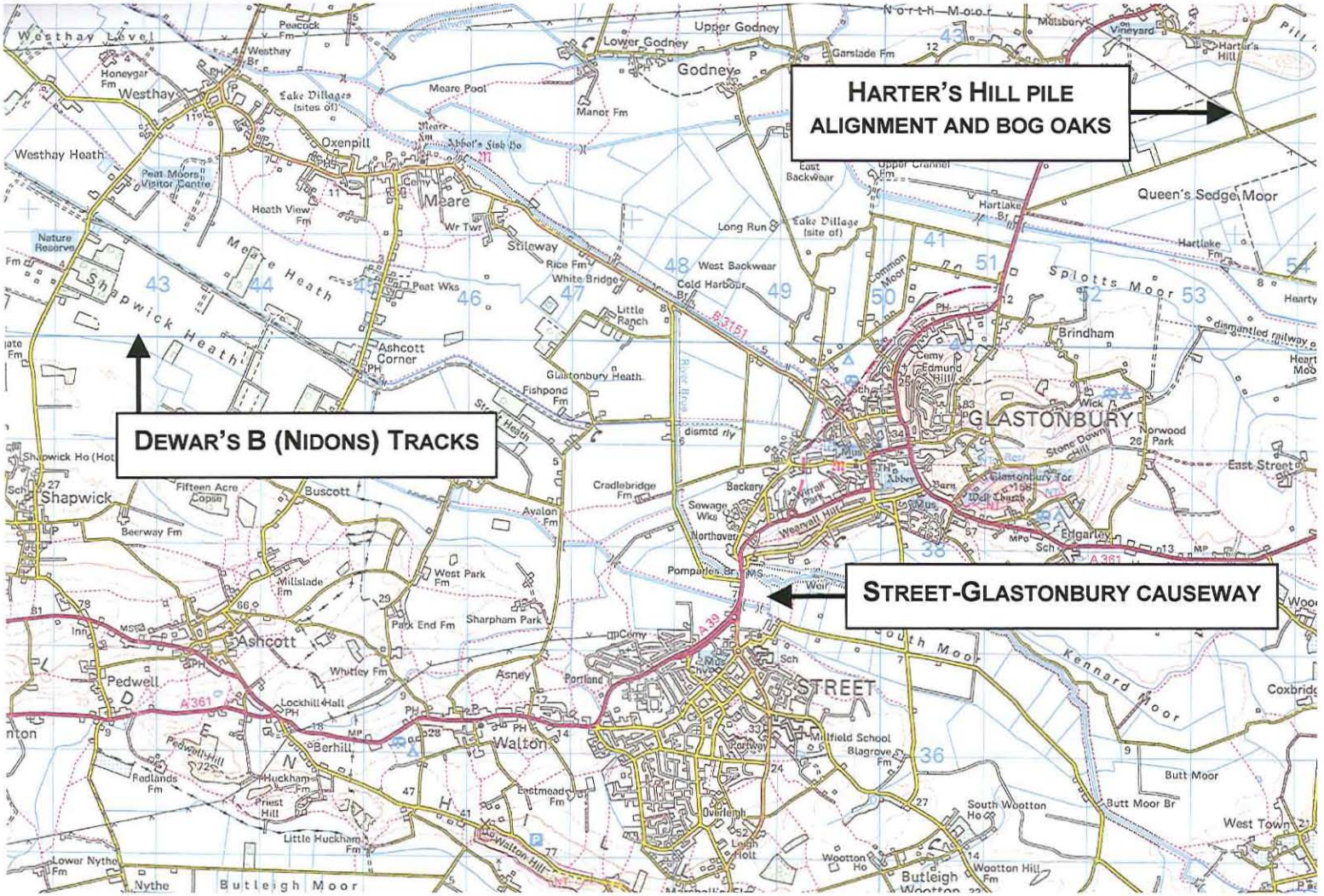


Figure 3 Diagram showing the similarity between the ring sequences derived from samples **16** and **17** from Dewar's B (Nidons) tracks. These two timbers are thought to have been derived from the same-tree

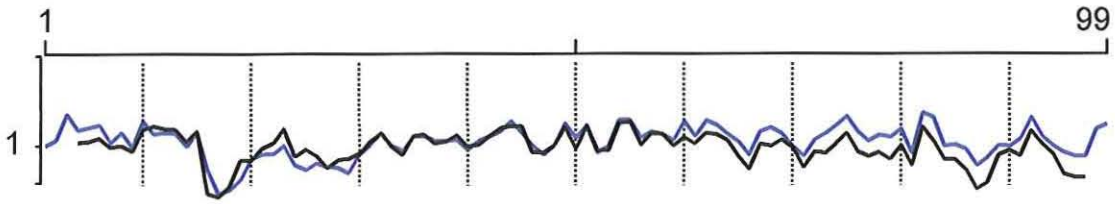


Figure 4 Bar diagram showing the relative positions of the all of the dated sequences from Harter's Hill analyses, including the possible bog oak **1997-99**, and their felling dates.

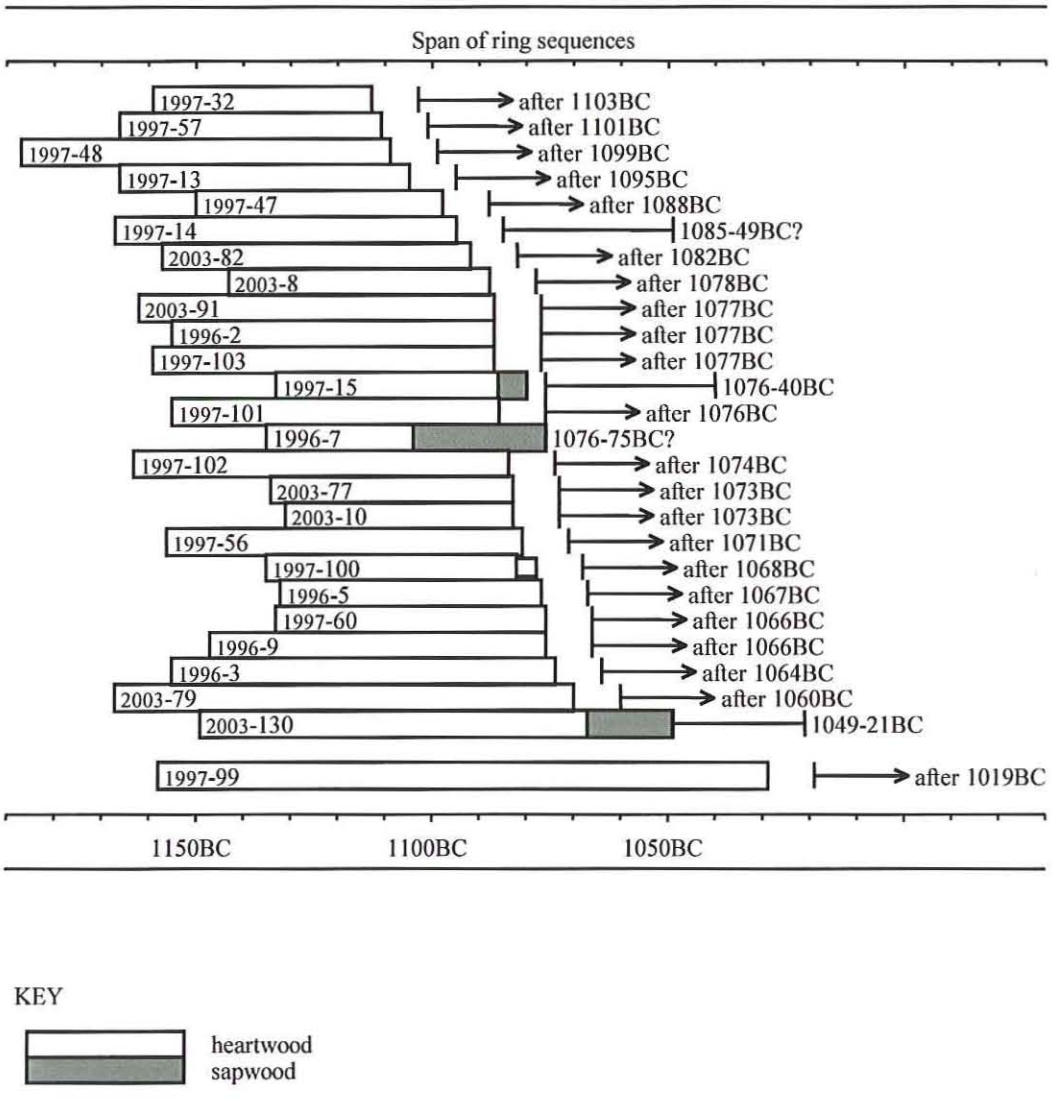


Figure 5 Bar diagram showing the relative positions of the dated sequences included in the Street-Glastonbury causeway site master sequence **STC-T3**

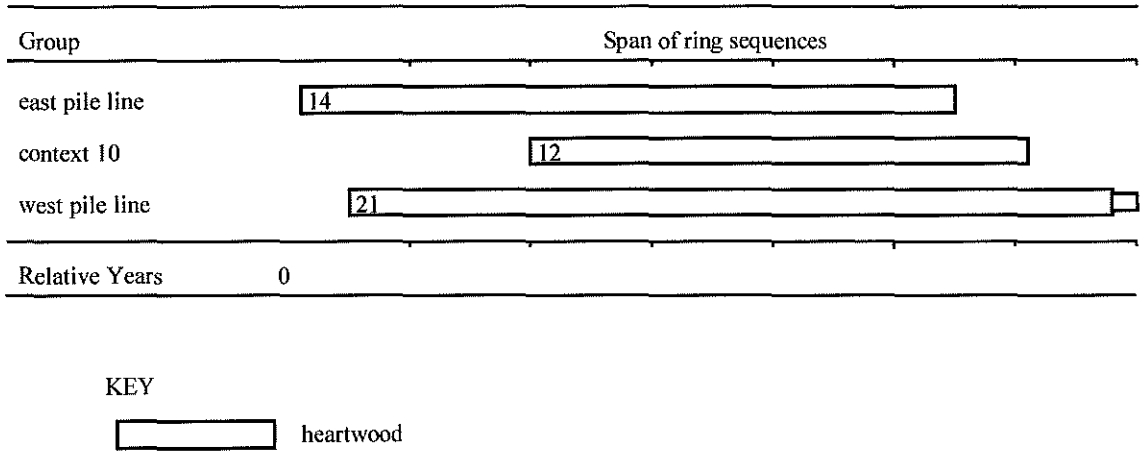
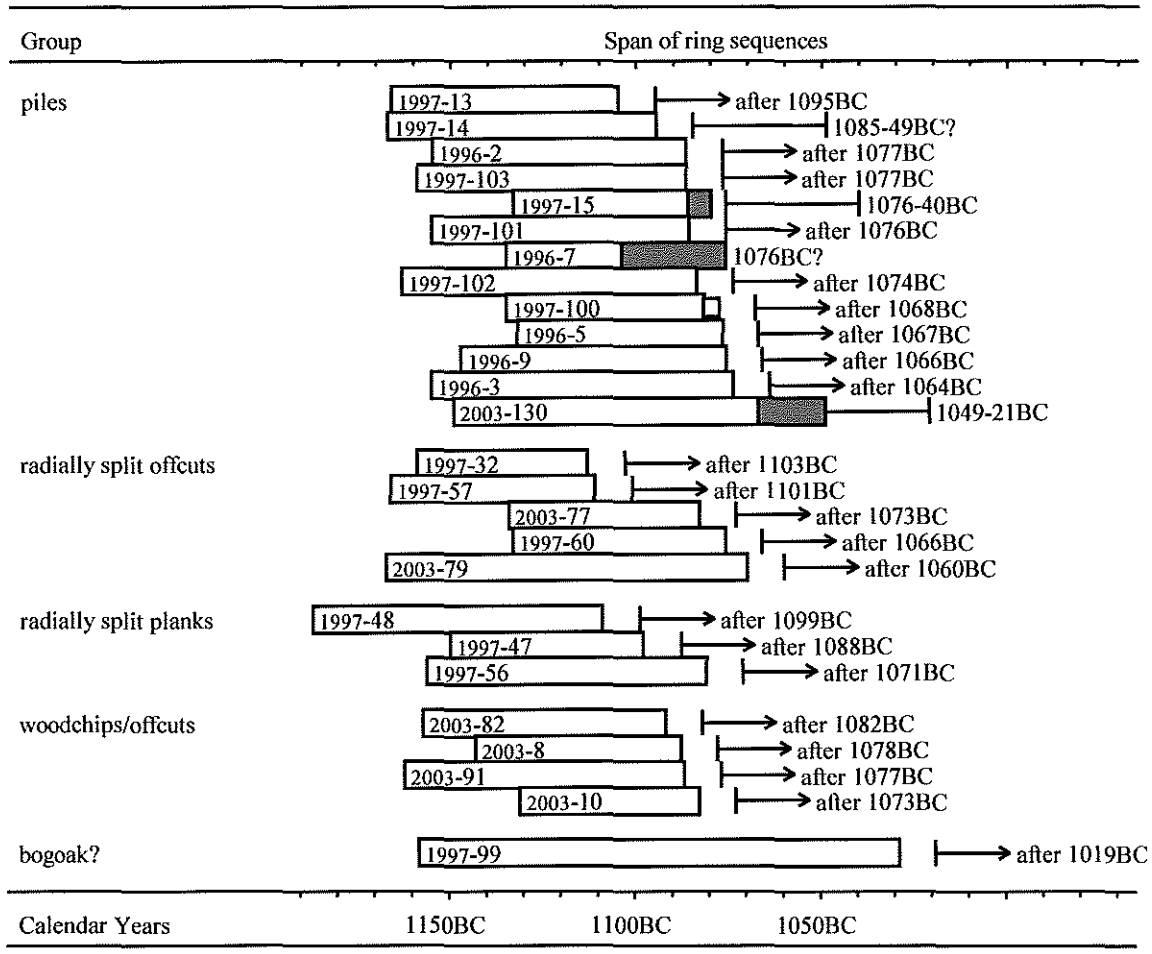


Figure 6 Bar diagram showing the relative positions of the all of the dated sequences from Harter's Hill analyses, including the possible bog oak **1997-99**, and their felling dates sorted by element type.



KEY

heartwood
sapwood

Table 1 Details of the samples

Number of rings - total number of measured rings including both heartwood and sapwood; *+nn* - indicates presence of unmeasured rings; *H* – indicates unmeasured rings are heartwood
Sapwood rings – number of measured sapwood rings only; hs – indicates presence of heartwood/sapwood transition; ?hs – indicates possible presence of heartwood/sapwood transition; ?b – indicates probable presence of bark edge
ARW – average ring width in millimetres

Wood number	Location/Description	Number of rings	Sapwood rings	ARW	Cross-section type	Cross-section dimensions (mm)	Date of measured sequence	Comments
Dewar's B (Nidons) tracks								
16	?trackway	99	-	1.12	quartered	110 x 70	-	same tree as 17
17	?trackway	94	-	0.99	quartered	90 x 55	-	same tree as 16
Harter's Hill pile alignment								
1996-2	pile	69	-	1.63	whole	230 x 190	1155-1087BC	-
1996-3	pile	82	-	1.32	whole	200 x 190	1155-1074BC	-
1996-5	pile	56	-	2.00	whole	215 x 210	1132-1077BC	-
1996-7	pile	60	28 ?b	1.40	whole	170 x 160	1135-1076BC	-
1996-9	pile	72	-	1.88	whole	215 x 200	1147-1076BC	-
1997-12	pile	63	hs	1.87	whole	180 x 175	-	-
1997-13	pile	62	-	1.50	whole	275 x 185	1166-1105BC	-
1997-14	pile	73	?hs	1.34	whole	195 x 150	1167-1095BC	-
1997-15	pile	54	6	1.51	whole	160 x 135	1133-1080BC	-
1997-32	radially split offcut	47	-	1.55	quartered	75 x 50	1159-1113BC	-
1997-47	radially split plank	53	-	2.30	quartered	130 x 75	1150-1098BC	-
1997-48	radially split plank	79	-	1.42	quartered	110 x 65	1187-1109BC	-
1997-50	radially split offcut	<40	-	-	quartered	55 x 25	-	rejected
1997-56	radially split plank	76	-	1.75	plank: radial	140 x 40	1156-1081BC	-
1997-57	radially split offcut	56	-	1.60	plank: tangential	105 x 45	1166-1111BC	-

Table 1 (continued)

Wood number	Location/Description	Number of rings	Sapwood rings	ARW		Cross-section dimensions	Date of measured sequence	Comments
1997-60	radially split offcut	58	-	1.39	plank: radial	80 x 10	1133-1076BC	-
1997-100	pile	54	-	1.36	whole	140 x 120	1135-1082BC	-
1997-101	pile	70	-	1.77	whole	200 x 165	1155-1086BC	-
1997-102	pile	80	-	1.45	whole	185 x 165	1163-1084BC	-
1997-103	pile	73	-	1.27	whole	150 x 125	1159-1087BC	-
2003-1	woodchip/offcut	<40	-	-	plank: radial	50 x 0.5	-	rejected
2003-8	woodchip/offcut	56	-	1.00	plank: radial	70 x 20	1143-1088BC	-
2003-10	woodchip/offcut	49	-	1.57	plank: radial	80 x 10	1131-1083BC	-
2003-14	woodchip/offcut	<40	-	-	plank: radial	80 x 15	-	rejected
2003-62	woodchip/offcut	<40	-	-	-	-	-	rejected, fragmented
2003-70	woodchip/offcut	<40	-	-	plank: radial	35 x 0.5	-	rejected
2003-77	radially split offcut	52	-	1.37	plank: radial	75 x 30	1134-1083BC	-
2003-78	half split	<40	-	-	quartered	50 x 30	-	rejected
2003-79	radially split offcut	98	-	0.98	plank: radial	95 x 15	1167-1070BC	-
2003-82	woodchip/offcut	66	-	0.83	plank: tangential	60 x 20	1157-1092BC	-
2003-91	woodchip/offcut	76	-	0.88	plank: tangential	60 x 20	1162-1087BC	-
2003-102	radially split offcut	c50-		-	plank: radial	45 x 20	-	rejected, outer rings crushed
2003-128	stake	71	-	0.59	quartered	80 x 40	-	-
2003-130	pile	101	18	0.97	whole	200 x 160	1149-1049BC	-
2003-132	stake	56	-	0.84	quartered	50 x 25	-	

Table 1 (continued)

Wood number	Location/Description	Number of rings	Sapwood rings	ARW	Cross-section type	Cross-section dimensions	Date of measured sequence	Comments
Harter's Hill pile bog oaks								-
99	?bog oak?	130	-	0.57	quartered	80 x 75	1158-1029BC	-
2003-131	bog oak	148	-	1.52		230 x 170	-	-
Street-Glastonbury causeway								
4	context 5, horizontal offcut	<40	-	-	quartered	40 x 40	-	rejected
6	context 10, horizontal offcut	77	-	1.05	plank: radial	80 x 30	-	-
11	context 10, horizontal offcut	71	-	1.01	quartered	80 x 60	-	-
12	context 10, horizontal offcut	42	-	1.09	plank: tangential	50 x 15	-	-
14	east pile line, radial pile	55	-	1.04	quartered	65 x 60	-	-
15	east pile line, radial pile	60+*2H*	-	1.77	plank: tangential	110 x 35	-	-
16	east pile line, radial pile	67	-	1.51	quartered	105 x 55	-	-
17	east pile line, radial pile	40	-	1.13	quartered	50 x 30	-	-
19	east pile line, radial pile	80	-	1.41	quartered	110 x 40	-	-
21	west pile line, intermediate pile	64+*2H*	-	0.74	quartered	50 x 30	-	rings distorted by crushing
22	west pile line, radial pile	51	-	1.25	quartered	65 x 60	-	rings distorted by crushing

Table 2 Matrix showing the *t*-values obtained between the matching ring sequences from Dewar's B (Nidons) tracks included in the site master chronology **DEW-S2**

	17
16	14.79

Table 3 Ring width data from the undated site master chronology **DEW-S2**

Ring widths (units of 0.01mm)

100	110	173	118	122	129	101	112	94	143
131	130	129	103	127	54	42	47	66	78
90	95	118	77	80	79	69	73	71	86
105	125	98	88	118	120	106	108	115	96
105	118	132	147	133	95	87	101	143	105
142	90	95	153	155	108	125	122	105	135
111	140	133	116	95	76	115	118	118	98
76	100	106	123	146	109	96	104	98	117
79	158	136	89	90	80	59	67	93	95
99	147	110	94	75	70	70	135	145	

Table 4 Matrix showing the *t*-values obtained between all of the dated samples from Harter's Hill including the possible bog oak **1997-99**. – indicates *t*-values of less than 3.00

	1996-3	1996-5	1996-7	1996-9	1997-13	1997-14	1997-15	1997-32	1997-47	1997-48	1997-56	1997-57	1997-60	1997-100	1997-101	1997-102	1997-103	2003-8	2003-10	2003-77	2003-79	2003-82	2003-91	2003-130	1997-99
1996-2	4.67	4.88	3.60	3.54	-	4.20	3.75	3.15	4.73	-	3.79	-	4.51	3.70	-	4.29	4.05	4.84	4.35	4.20	-	4.95	-	3.82	4.87
1996-3		6.01	3.03	5.06	6.15	6.12	4.58	3.11	4.36	4.69	5.07	-	4.57	6.40	4.68	6.12	7.03	4.19	4.39	3.81	3.83	4.94	4.34	5.35	3.87
1996-5			4.10	5.58	3.03	4.35	-	-	5.44	-	3.60	-	4.80	6.04	3.33	3.65	5.13	4.40	3.86	-	3.92	5.49	4.50	4.87	3.87
1996-7				3.74	-	3.62	3.10	-	4.64	-	3.09	-	3.19	4.20	3.15	3.67	3.95	-	-	4.18	-	3.55	4.22	3.73	4.17
1996-9					5.29	4.44	-	-	4.33	-	4.80	-	5.69	4.21	3.74	3.77	-	3.29	-	3.11	3.04	3.88	3.19	5.94	-
1997-13						4.17	-	-	3.39	3.47	3.30	3.44	-	-	-	3.11	-	-	-	-	4.01	4.05	3.12	3.33	-
1997-14							4.85	-	4.07	5.56	4.01	-	3.56	-	3.07	3.68	5.28	4.31	4.09	3.79	3.08	5.52	4.18	4.15	3.49
1997-15								-	-	-	-	-	-	-	3.97	4.48	4.09	4.19	3.99	3.81	3.46	4.14	3.27	4.77	3.08
1997-32									-	3.21	-	-	-	-	4.09	4.00	-	4.57	-	-	5.67	3.62	-	-	3.16
1997-47										-	3.89	-	4.19	3.40	-	3.89	4.07	3.67	4.81	4.09	-	3.80	4.28	3.04	4.84
1997-48											4.52	6.26	-	-	-	3.44	3.00	5.28	3.70	4.16	3.05	3.46	3.13	4.14	-
1997-56												5.04	4.69	4.11	-	3.54	4.81	3.12	7.34	4.03	-	3.47	-	5.03	-
1997-57													-	4.72	-	-	-	3.88	-	-	-	-	-	3.11	-
1997-60														5.70	-	4.14	5.32	-	-	-	-	3.54	-	5.08	-
1997-100															3.16	3.45	5.96	3.75	3.70	-	4.41	3.03	-	4.36	-
1997-101																4.36	3.87	4.49	-	-	4.80	4.23	4.34	-	4.42
1997-102																	4.96	4.27	3.53	4.38	3.50	5.12	5.52	4.05	5.22
1997-103																		3.48	5.20	4.14	3.07	4.95	3.82	4.78	-
2003-8																			5.34	3.95	5.52	4.37	-	5.43	4.03
2003-10																				4.73	3.21	4.92	-	4.64	-
2003-77																					-	4.10	3.69	4.49	3.90
2003-79																						4.89	3.82	3.15	-
2003-82																							7.85	4.00	4.10
2003-91																								3.24	3.09
2003-130																									-

Table 5 Ring width data from the site master chronology **HH-T25**, dated 1187-1049 BC inclusive

Date	Ring widths (units of 0.01mm)									
1187BC				217	238	284	292	320	289	199
	122	197	245	231	203	252	214	172	169	173
	119	135	196	224	241	193	239	225	268	154
	234	250	194	185	143	180	226	186	196	112
1150BC	147	132	195	121	116	123	138	148	148	137
	98	130	104	92	102	152	156	157	176	211
	149	153	140	126	149	99	113	132	179	163
	140	111	111	106	134	133	146	154	145	131
	176	154	125	78	110	167	157	139	162	104
1100BC	88	135	132	141	141	135	117	131	111	95
	109	103	120	134	151	118	145	143	177	154
	164	141	123	111	141	98	122	98	106	128
	129	95	73	85	80	76	100	74	78	48
	45	66	78	87	105	108	86	69	65	103
1050BC	86	89								

Table 6 Dating the site master chronology **HH-T25**, 1187-1049 BC inclusive. Example *t*-values with some relevant reference chronologies

Area	Reference chronology	Date span	*t*-value
England	England 2 (Hillam pers comm)	1804-323BC	4.77
Cambridgeshire	Flag Fen basin (Neve 1999)	1406-937BC	4.63
Kent	Swalecliffe (Masefield *et al* 2003)	1432-1085BC	4.48
Somerset	Skinners Wood (Hillam 1993)	1162-983BC	5.18
Somerset	Greylake (Howard pers comm)	1131-1062BC	7.96
Ireland	Mid1000 (Brown pers comm)	1336-886BC	3.53
Wales	Caldicot (Hillam 1997)	1169-990BC	6.30
Wales	Goldcliff boat (Hillam and Groves 2003)	1139-1027BC	4.72

Table 7 Ring width data from bog oak, **1997-99**, dated 1158-1029 BC inclusive

Date	Ring widths (units of 0.01mm)									
1158BC			100	61	54	74	68	71	84	88
1150BC	65	37	81	57	47	81	63	60	52	46
-	69	99	86	60	62	83	65	84	81	61
-	58	39	51	66	73	40	57	73	74	66
-	34	42	63	54	69	52	57	43	40	26
-	78	71	57	41	37	64	57	47	40	37
1100BC	35	51	61	60	56	41	37	37	38	25
-	47	59	43	43	56	35	40	46	74	51
-	46	42	49	59	40	45	49	58	53	44
-	48	45	34	44	56	58	57	67	62	48
-	67	50	56	83	54	44	47	43	41	64
1050BC	70	72	53	65	64	64	61	52	83	62
-	48	51	34	61	56	68	62	50	59	50
-	72	56								

Table 8 Matrix showing the *t*-values obtained between the matching ring sequences from the Street-Glastonbury causeway included in the site master chronology **STC-T3**

	14	**21**
12	6.35	7.96
14		7.73

Table 9 Ring width data from the undated site master chronology **STC-T3**

Ring widths (units of 0.01mm)

223	240	239	160	214	207	145	139	142	147
111	131	149	132	163	102	99	73	63	111
155	123	88	60	67	56	50	58	81	78
92	64	69	91	77	80	69	69	42	56
55	52	138	171	97	56	51	54	51	57
55	58	83	97	86	106	135	100	87	122
58	55	47	73	67	117	92	66		