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Oxford Dendrochronology Laboratory
Report 2017/57

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM HENDRE FAERDREF, CYNWYD, MERIONETH

(SJ 047 385)

Summary

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In 1586-98 the open hall had a stack inserted at the western, or lower end of the hall, presumably in association with an inserted floor, although nothing of this remains.

In, or shortly after, 1682/83 a kitchen was constructed to the north west of the cruck hall. Presumably it was constructed to the north of an existing service end, although this may have involved reconstructing the north wall of the cruck service end. More than a century later, in or shortly after 1794, the service end of the cruck range was reconstructed to form a parlour, in line with the 1682/83 kitchen wing to the north, forming a cross wing.

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The Dendrochronological Dating of Timbers from Hendre Faerdref, Cynwyd, Merioneth (SJ 047 385)

BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies. These include chronologies made by colleagues in other countries, most notably areas such as modern Poland, which have proved to be the source of many boards used in the construction of doors and chests, and for oil paintings before the widespread use of canvas.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

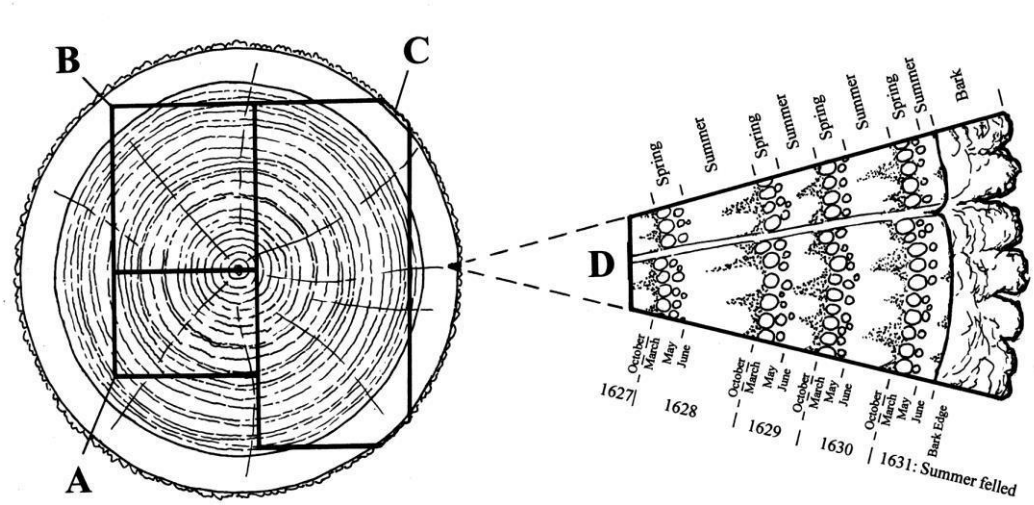
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value in oak studies. Higher values are usually found with matching pine sequences. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 11 – 41 (Miles 1997).



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997, 42)

Hendre Faerdref (Coflein entry by Richard Suggett)

NPRN 422043

A multi-period upland farmhouse of medieval origin and considerable interest. The upper part of the medieval house survives as the rear wing of the present house. This early house is of considerable interest as the upper end of a peasant hall-house. Three cruck-trusses survive defining the hall (single bay) and inner-room of a timber-framed hall-house. The passage bay is now within the later house and the outer bay has been lost. In the later C17th the medieval house was re-fronted by a substantial three-unit storeyed house built across the slope. This house retains its historic three-unit plan with a central service-room and entry flanked by kitchen (left) and parlour (formerly with boarded floor and fireplace at the back of the hall stack). The kitchen may have had a mural stair to the right of the fireplace and retains its framed partition. This house is substantial and the principal chamber over the parlour was painted with an C18th(?) net-and-floral pattern which survived under later wallpaper. The phasing may be summarised:

1. *c.* 1500-50: a timber-walled, cruck-framed peasant hall-house resembling the neighbouring house at Llanerch (NPRN 421847), tree-ring dated 1502.

2. *c.* 1575-1625. Inserted fireplace within the hall with entry cruck to hall surviving at the back of the fireplace. The fireplace is notable for the massive orthostatic stone jambs. Replacement of timber walling with stone walls.

3. *c.* 1675-1700. Medieval house re-fronted by stone-built storeyed house of three-unit type with central entry and service-room. The dating is suggested both by the developed plan and the well-defined ogee-stopped beams. The passage bay of the medieval house became the parlour of the new house. The entry to the hall alongside the inserted fireplace seems to have been blocked at this stage with the old house becoming an outside kitchen/dairy (a cheese press still survives).

4. C19th modernisation of kitchen and parlour.

SAMPLING

Nineteen samples were taken from sixteen timbers in November 2017. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled with the prefix **hfl**, with samples 1-6 from the cruck hall, samples 11 - 19 from the western down-slope range of both later phases, and sample 20 from the fireplace lintel between the stack at the west end of the cruck hall. The samples were polished with progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. Measurements and subsequent analysis were carried out using programmes written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker, as well as DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

The locations and details of the samples are described in Table 1, and illustrated in the site sketch (Fig 1).

The first samples taken were from the cruck hall. Cramped site conditions and height issues hindered access, hence only six timbers were sampled. Bark edge was successfully sampled from the two purlins on the north side, but despite several attempts, the complete sapwood from the north blade of the open truss cruck truss was in too poor a condition to be able to be retained complete. However, the three radii sampled from this timber were first combined together to form the same-timber mean **hfl01** with 95 rings. This was successfully cross-matched with the other five timbers, one with only 34 rings, to form the 149-ring site master **HFLx1** (Table 2a). Each sample was individually cross-matched with the reference chronologies to confirm the correct position within the site master, with the short-ringed sample **hfl03** having several *t*-values of 5+ and 6+ clearly distinguishing this matching position above any other possible date. The site master, spanning the years 1354-1502, matched with an outstanding *t*-value of 9.8 with Llanerch, just next door, of exactly the same date. Other excellent matches were had with local chronologies from Merioneth and Denbighshire (Table 3a).

Two timbers retained bark edge, purlins **hfl05** and **hfl06**. Both were found to have been felled in the winter of 1502/03. The north cruck to the open truss (**hfl01**) produced a felling date range of 1498-1505, and the collar to the open truss (**hfl04**) gave a felling date range of 1497-1527, both entirely consistent with the 1502/03 felling dates from the purlins.

Samples **hfl11 - hfl19** were taken from various elements of the western cross-wing. The framing here did not appear to be of one consistent phase and was not logically arranged, so a variety of timbers were sampled on both levels, with the hope that the dendrochronology would help to sort out the phasing. Two groups of timbers were found. The first was composed of three samples, **hfl 11**, **14**, and **15** (Table 2b). All three dated timbers retained bark edge. A transverse beam (**hfl11**) produced a precise felling date of winter 1682–83, as did the west principal rafter (**hfl14**) of the truss on the northern side of the staircase. The opposing principal rafter (**hfl15**) was thought that it might have originated from the same tree as **hfl14**, as both were halved trees, but this did not match the other principal rafter (Table 2b) and it was found to have been felled two years earlier, during the winter of 1680/81. These were combined to form the second site master **HFLx2** with 115 rings. This was compared with the reference chronologies and was found to date, spanning the years 1568-1682 (Table 3b). Again matches were excellent, the best being a t = 8.2 with Nantclwyd House in nearby Ruthin.

The second group consisted of samples **hfl12**, **13** and **19**. Only one timber retained bark edge, a ceiling joist **hfl13**. This was found to be felled in the spring of 1794. The other two timbers produced felled date ranges consistent with this.

The second group found in the parlour section of the west range was composed of three timbers, the axial beam **hfl12**, a joist adjacent (**hfl13**), and a principal rafter above (**hfl19**). All three matched together as shown in Table 2c, and were combined to form the 86-ring third site master **HFLx3**. This matched with the reference chronologies, spanning the years 1708-1793 (Table 3c). The matches were lower and with more distant locations than for the other site chronologies due to the paucity of C18th chronologies, but nevertheless gave strong and consistent matches.

Three other timbers from this range were sampled but failed to date conclusively. The tiebeam to the truss associated with the 1680s principal rafters was in two sections, both appearing to be re-used timbers. These matched each other and the mean **hfl1617m** was produced. This failed to date conclusively, or to match with the other undated sample **hfl18**. All three samples exhibited narrow bands of rings, possibly associated with pollarding of the trees. It was hoped that they might have been re-used from the end of the west end of the cruck range, but this study failed to confirm this.

The final sample was taken from the fireplace stack between the cruck hall and the parlour range to the west (**hfl20**). This had 177 rings and what appeared to be complete sapwood under the numerous coats of limewash. However, on inspection under the microscope the outer part of the timber had been shaved. Nevertheless, the timber dated to span the years 1409-1585 (Table 3d). As the bark edge was present on the timber, a felling date range was produced of 1586-98. As with the first site master, excellent matches were found in Merioneth, Denbighshire, and Montgomeryshire.

The relative positions of overlap of the dated samples are shown in Fig 2, along with their actual felling dates, or interpreted likely felling date ranges.

In conclusion, four phases of construction were identified. The first is the cruck range, of which only the two-bay all survives. This was dated to the winter of 1502/03, exactly the same date as the neighbouring cruck hall house at Llanerch, and it is tempting to imagine that both were constructed one after the other by the same master carpenter.

In 1586-98 the open hall had a stack inserted at the western, or lower end of the hall, presumably in association with an inserted floor, although nothing of this remains.

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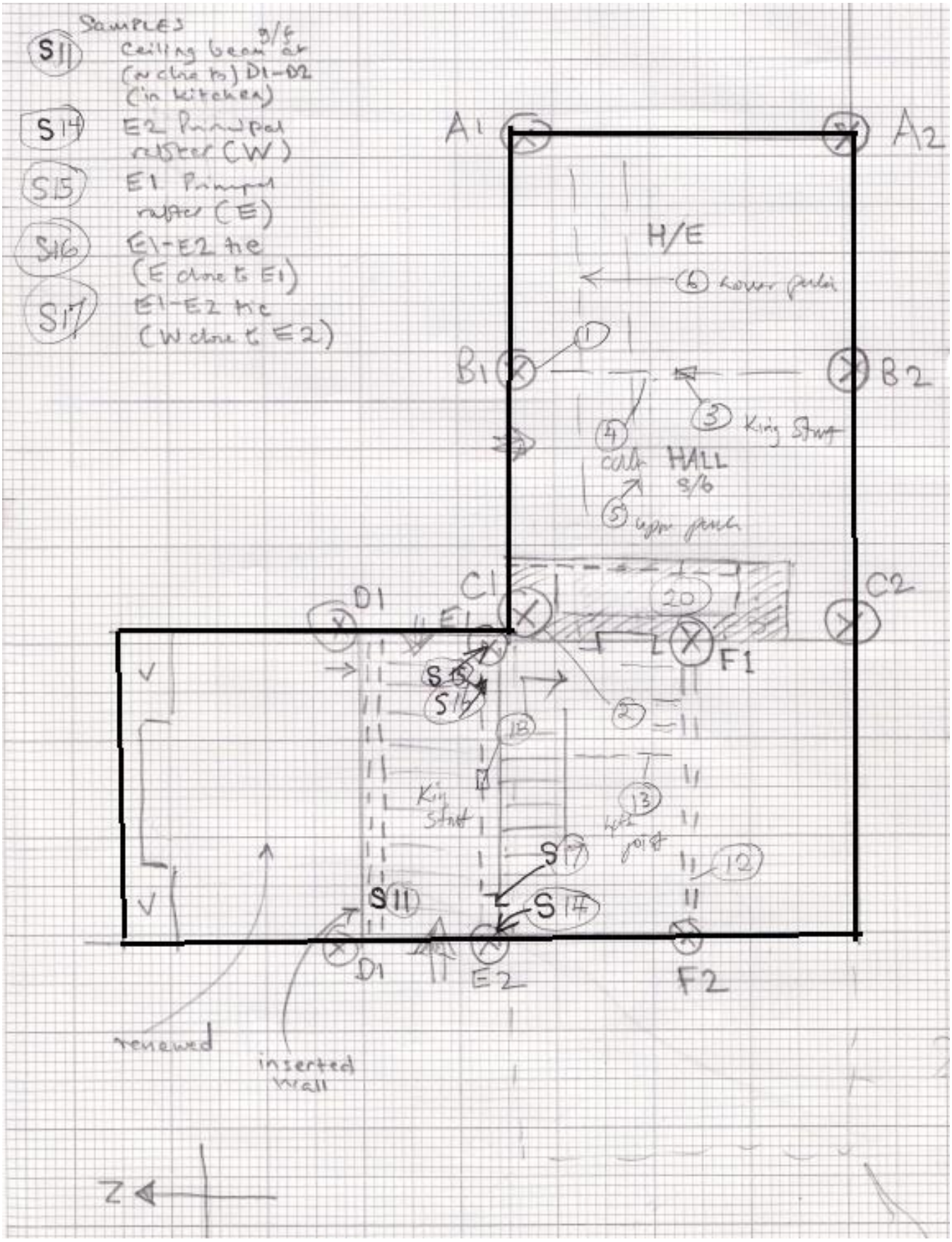

Figure 1: Field sketch showing the locations of the samples (Martin Cherry, Tony Scharer and DM)

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Table 1: Details of samples taken from Hendre Faerdref, Cynwyd.

Sample number	Timber and position	Date of series	H/S boundary date	Sapwood complement	No of rings	Mean width (mm)	Std devn (mm)	Mean sens	Felling date range
Cruck Range									
hfl01ai	North centre cruck, open truss	*1420–1449*			*30*	*1.62*	*0.75*	*0.23*	
hfl01aii	*ditto*	*1445–1485*	*1482*	*3 +13¼C NM*	*41*	*1.38*	*0.48*	*0.23*	
hfl01a	Mean of **01ai** and **01aii**	*1420–1485*	*1482*	*3 +13¼C NM*	*66*	*1.49*	*0.64*	*0.23*	
hfl01b	*ditto*	*1391–1461*			*71*	*1.92*	*0.77*	*0.26*	
hfl01c	*ditto*	*1432–1481*	*1481*	*H/S*	*50*	*1.27*	*0.53*	*0.19*	
*** hfl01**	Mean of **01a**, **01b** and **01c**	1391–1485	1482	3 +13¼C NM	95	1.75	0.74	0.21	1498–1505
*** hfl02**	North west cruckblade	1354–1455			102	1.96	0.89	0.23	
*** hfl03**	King strut, open truss	1440–1473			34	2.43	1.07	0.34	
*** hfl04**	Collar, open truss	1398–1489	1486	3	92	1.49	0.50	0.20	1497–1527
*** hfl05**	North upper purlin	1445–1502	1485	17C	58	2.00	0.76	0.26	Winter 1502/03
*** hfl06**	North lower purlin	1404–1502	1474	28C	99	1.26	0.58	0.27	Winter 1502/03
***** = component of site master **HFLx1**		**1354–1502**			**149**	**1.79**	**0.73**	**0.20**	
hfl20	Inserted fireplace lintel	1409–1585	1557	28	177	1.14	0.70	0.35	1586–98
West range, north end (kitchen)									
† hfl11	North transverse beam	1588–1682	1646	36C	95	2.01	1.04	0.25	Winter 1682/83
† hfl14	West principal rafter	1629–1682	1663	19C	54	2.88	1.25	0.22	Winter 1682/83
† hfl15	East principal rafter	1568–1680	1652	28C	113	1.84	1.37	0.26	Winter 1680/81
hfl16	East end tiebeam	-	-	H/S	43	3.02	0.56	0.17	
hfl17	West end tiebeam	-	-	H/S	63	1.58	1.08	0.29	
hfl1617m	Mean of **16** and **17**	-	-	H/S	63	2.05	0.88	0.26	
hfl18	Strut	-	-	H/S	66	1.24	0.87	0.34	
† = component of site master **HFLx2**		**1568–1682**			**115**	**2.30**	**1.10**	**0.24**	

Continued overleaf

Table 1 continued: Details of samples taken from Hendre Faerdref.

West range, south end (parlour)									
hfl12a	South transverse beam	*1710–1774*	*1774*	*H/S*	*65*	*1.82*	*0.86*	*0.25*	
hfl12b	*ditto*	*1710–1787*	*1761*	*16*	*78*	*1.57*	*0.80*	*0.24*	
ψ hfl12	Mean of **12a** and **12b**	1710–1787	1768	19	78	1.63	0.80	0.22	1788–1809
ψ hfl13	4th joist from east, middle bay	1712–1793	1778	15¼C	82	1.13	0.60	0.26	Spring 1794
ψ hfl19	West principal rafter	1708–1774	1774	H/S	67	1.69	0.70	0.28	1785–1815
ψ = component of site master **HFLx3**		**1708–1793**			**86**	**1.42**	**0.52**	**0.22**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; ¼C = complete sapwood, felled the following spring; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured.

Table 2a: Cross-matching between the dated samples in site master **HFLx1** (maximum number of years of overlap for **03** is 34)

t-values					
Sample	**hfl02**	**hfl03**	**hfl04**	**hfl05**	**hfl06**
hfl01	6.1	3.3	4.1	2.4	5.1
hfl02		2.1	5.8	1.4	2.4
hfl03			2.4	2.7	5.3
hfl04				3.0	4.5
hfl05					5.2

Table 2b: Cross-matching between dated samples in the site master **HFLx2**

t-values		
Sample	**hfl14**	**hfl15**
hfl11	4.0	5.0
hfl14		1.0

Table 2c: Cross-matching between dated samples in the site master **HFLx3**

t-values		
Sample	**hfl13**	**hfl19**
hfl12	3.0	4.0
hfl13		6.8

Table 3a: Dating evidence for the site chronology **HFLx1** **AD 1354–1502** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
North Wales	North Wales Master Chronology	(Bridge 2016)	**NWALES**	1306–1758	149	9.2
Northern England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440–1742	149	8.5
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	149	8.2
Site Chronologies						
Merioneth	Llanerch, Cynwyd	(Bridge *et al* 2017)	LLANRCH1	1370–1502	133	9.8
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	115	9.4
Denbighshire	Rose and Crown, Gwyddelwern	(Miles and Worthington 2000)	GWYDWN	1411–1571	92	8.9
Merioneth	Gwernbraichdwr, Llandderfel	(Bridge *et al* 2016)	GWRNBRDW	1404–1585	99	8.4
Merioneth	Rhydywernen, Llanfor	(Bridge *et al* 2015)	RHYDYWRN	1403–1530	100	8.2
Denbighshire	Glas Hirfryn,	(Bridge *et al* 2014)	GHN	1404–1557	99	8.1
Staffordshire	Biddulph Old Hall	(Miles *et al* 2005)	BIDDULPH	1404–1524	98	8.1
Denbighshire	Coed-y-Foel, Derwen	(Bridge *et al* 2016)	COEDYFL	1436–1511	67	8.1
Montgomeryshire	Trefrechan barn	(Miles *et al* 2004)	TREFECHN	1423–1606	80	7.9

Table 3b: Dating evidence for the site chronology **hfl20** **AD 1409–1585** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
North Wales	North Wales Master Chronology	(Bridge 2016)	**NWALES**	1306–1758	177	8.1
Northern England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440–1742	177	7.6
Site Chronologies						
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	177	9.2
Montgomeryshire	Peniarth-Uchaf, Meifod	(Miles and Haddon-Reece 1996)	PENIARTH	1385–1550	142	8.3
Denbighshire	Ucheldref Rhug, Corwen	(Miles et al 2010)	DENBY4	1373–1597	177	8.1
Merioneth	Hendre Faerdreff	This report	HFLx1	1354–1502	94	8.1
Denbighshire	Rose and Crown, Gwyddelwern	(Miles and Worthington 2000)	GWYDWN	1411–1571	161	8.0
Montgomeryshire	Ty Mawr, Castell Caereinion	(Miles and Haddon-Reece 1996)	TYMAWR1	1346–1459	51	7.9

Table 3c: Dating evidence for the site chronology **HFLx2** **AD 1568–1682** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
England	Southern Central England	(Wilson *et al* 2012)	**SCENG**	663–2009	115	7.4
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	115	6.3
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	115	5.8
Site Chronologies						
Denbighshire	Nantclwyd House, Ruthin	(Miles *et al* 2005)	NHRE	1563–1662	95	8.2
Shropshire	Stokesay Castle	(Miles and Worthington 1997)	STOKE5	1463–1662	95	7.9
Shropshire	Forester's Lodge, Upper Millichope	(Miles and Haddon-Reece 1995)	FORESTR2	1515–1633	66	7.5
Oxfordshire	Old Estate Yard, Mapledurham	(Miles *et al* 2005)	MDMYARD	1525–1624	57	7.0
Worcestershire	Hartlebury Castle Chapel Roof	(Tyers 2008)	HARTCHPL	1399–1678	111	6.9
Shropshire	Golding Farmhouse	(Miles and Haddon-Reece 1994)	GOLDING	1491–1666	99	6.7
Herefordshire	Wigmore Abbey	(Tyers 2002)	WIGALL46	1055–1729	115	6.7
Herefordshire	St Mary's Church, Pembridge	(Tyers 1999)	PBT_C	1559–1668	101	6.7
Oxfordshire	Manor Farm, Stanton St John	(Miles and Worthington 1998)	STNSTJN3	1533–1637	70	6.6

Table 3d: Dating evidence for the site chronology **HFLx3** **AD 1708–1793** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	86	5.2
England	Southern Central England	(Wilson *et al* 2012)	**SCENG**	663–2009	86	4.8
Site Chronologies						
London	Eastcote House, Hillingdon	(Arnold and Howard 2012)	ECTASQ03	1720–1820	74	5.9
Devon	Buckland, Yelverton	(Morgan unpublished)	BUCKLAND	1677–1799	86	5.8
Shropshire	Old Smithy, Mainstone	(Bridge and Miles 2015)	SMITHY	1722–1804	72	5.3
Devon	Leigh Barton, Churchstow	(Groves 2006)	LBC-E	1672–1783	76	5.1
Oxfordshire	Oriel College Tennis Court	(Miles and Haddon-Reece 1994)	ORIEL1	1534–1776	69	5.1
Montgomeryshire	Ty Mawr, Castell Caereinion	(Miles and Worthington 2001)	TYMAWR4	1707–1808	86	5.0
Cambridgeshire	Great Gransden Windmill	(Bridge 2015)	GRANSDEN	1703–1836	86	4.9
Carmarthenshire	Aberglasney House, Llandeilo	(Miles and Worthington 1999)	ABRGLSNY	1689–1770	63	4.9
Buckinghamshire	Mill Pond planks, Stowe	(Miles *et al* 2003)	STOWE5	1712–1891	82	4.8

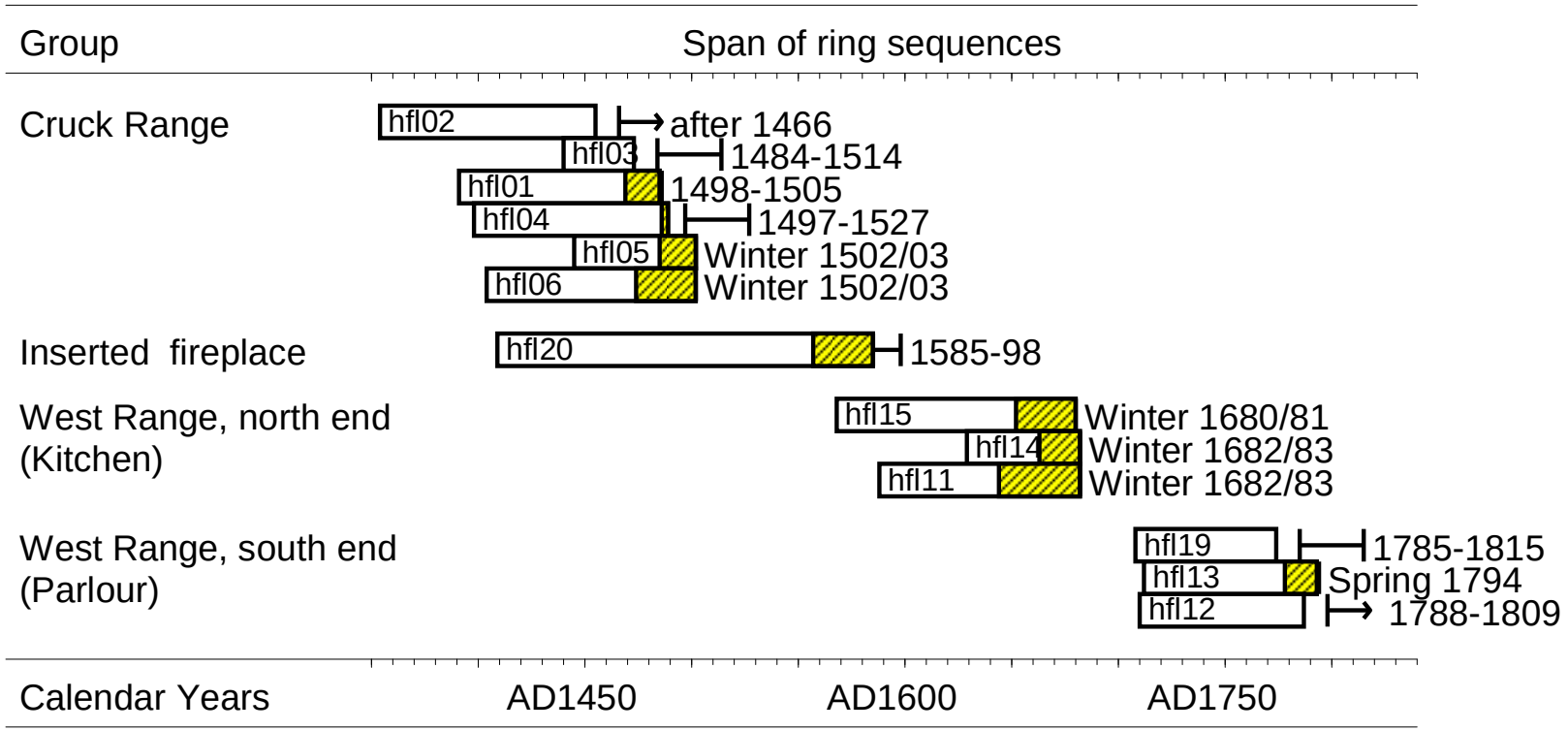

Figure 2: Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges. White sections represent heartwood rings and yellow hatched sections represent sapwood.