Oxford Dendrochronology Laboratory
Report 2012/25

THE TREE-RING DATING OF BRYNMAENLLWYD, TRAWSFYNYDD, MEIRIONNYDD (NGR SH 705 332)

Summary
Nine timbers were sampled from this property. Dendrochronology has identified two phases of work. Certainly, the house in its present form dates from the 1665, or within a year or two afterwards. However, the earlier group of timbers might suggest that the fireplace beam and the north end and south end tiebeam relate to an earlier phase of building dating from about 1588 which was then partly reconstructed in or shortly after 1665, reusing some timbers such as the purlin.

Authors: Dr D. Miles FSA and Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

July 2012

100 CBHC RCAHMW

A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

The Tree-Ring Dating of Brynmaenllwyd, Trawsfynydd, Meirionnydd (NGR SH 705 332)

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.

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.

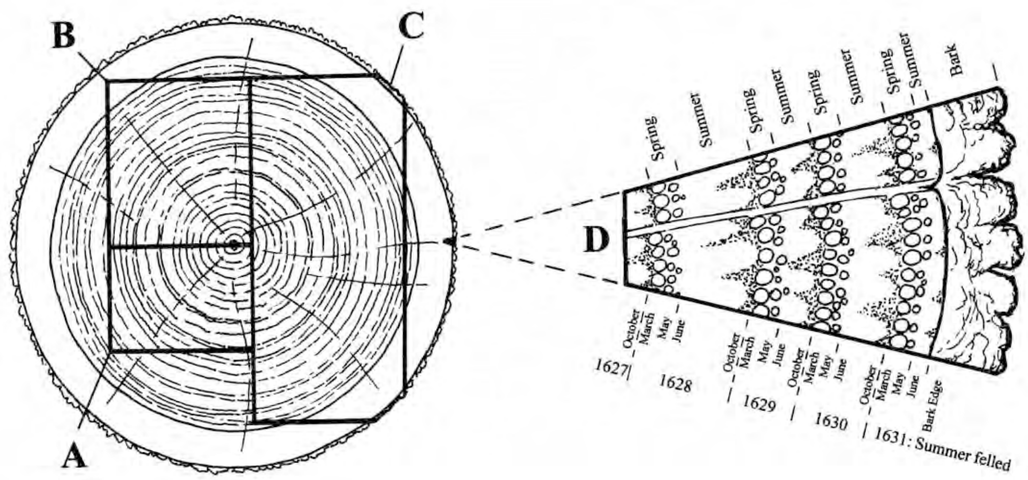
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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. 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 1997a).



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 1997a, 42)

BRYNMAENLLWYD, TRAWSFYNYDD

Brynmaenllwyd is a rubble-walled upland farmhouse of one-and-a-half storeys with an agricultural building in range. The farmhouse is of Snowdonian type with the characteristic central doorway and end chimneys. The architectural detail is consistent with a C17th building date but the downslope siting suggests that the present house may be a reconstruction of an earlier range. This was confirmed by dendrochronology of the roof trusses. The principal rafters are of later seventeenth-century date but the trusses reused some late-sixteenth-century timbers (purlin and tie-beam). The fireplace beam was of uncertain date (after 1549) but may belong to the earlier phase. NPRN 417311. RFS/RCAHMW/July 2012.

SAMPLING

Sampling took place in January 2012. All the samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were numbered using the prefix **bgu**. The samples were removed for further preparation and analysis. Cores were mounted on wooden laths and then these were polished using progressively finer grits down to 400. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer allowing the measurement of ring-widths to the nearest 0.01 mm using programs written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004) was also used.

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1.

Brynmaenllwyd is a long house of with four bays, with trusses of slightly different forms. The principal rafters are variable in size, suggesting some reuse of timber. A total of nine timbers were sampled, some requiring multiple cores to obtain complete sapwood which was situated at awkward angles for access.

Initially all multiple samples from the same timbers were combined to form same-timber means. Two samples (**traw9a** and **traw9b**) were taken from one tiebeam as a result of the core separating in many segments due to a series of cup, or ring shakes. The mean ring width was exceptionally narrow for this timber, with a mean-ring width of only 0.85mm, with the last 100 years of growth having a mean ring width of only 0.15mm. Considerable time and effort was required to reconcile the two sequences, and the last decade of **traw9a** was completely unmeasurable. Nevertheless, eventually both radii were successfully measured and combined (t = 8.5 with 183 years overlap) to form the same-timber mean **traw9** with an exceptional 204 rings.

Multiple samples (**traw1a – f**) taken from the east principal rafter of the middle truss (T2) were found to match the west principal rafter from the same truss (**traw2**) so well that it was concluded that both originated from the same parent tree (Table 2a). Visually, the two timbers were not obviously evident that they originated from the same parent tree. But on the basis of the statistical cross-matching they were combined to form the 197-ring same-tree mean **traw12**. Conversely, samples **traw3** and **traw4** visually matched with similar characteristics from the two sawn faces of the tree, the two sequences only matched with a t-value of 4.21. Nevertheless, on the visual evidence of the timber the two sequences were combined to form the 65-year same-tree mean **traw34**. These two mean sequences were then used in the subsequent analysis.

The same-tree mean **traw12** was compared with all other samples and means and no conclusive matches were found. Therefore, this was then compared with the dated reference chronologies and was found to date absolutely, spanning the years 1468-1664. As sample 1468-1664 **traw2** retained complete sapwood, it was found to have been felled in the winter of 1664/5. Although sample **traw1f** had the final ring of sapwood missing, it too could be ascribed a felling date of winter 1664/5 given that it was from the same parent tree as **traw2**.

Four other samples were found to match together (Table 2b): lower purlin **traw5**, the south tiebeam from the end truss **traw7**, the mantel beam **traw8**, and the north end tiebeam **traw9**. These were all combined into the 207-year site master **TRAWSFYN** which dated, spanning the years 1381-1587. The purlin **traw5** had complete sapwood and was felled in the spring of 1588, and the north end tiebeam, despite having such narrow distorted sequences, matched and was found to have been felled in the winter of 1584/5. This tree may have died standing, as the tree had gone into terminal decline at least a century earlier, and might have been actually felled some years later, possibly when **traw5** when it was felled in 1588. The south end tiebeam gave a felling date range of 1550-1580, and again with the outermost heartwood rings having a mean ring width of less than 1mm might well have had an extended felling date range, and could well be contemporary with **traw5** and **traw7**. The south fireplace beam had a last measured ring date of 1538 with no evidence of sapwood, therefore it might date from the *circa* 1588 phase of timbers, or the 1664/5 phase. The tiebeam to the middle truss **traw6** had only 28 rings and a mean ring width of 3.46mm failed to date.

Dendrochronology has identified two phases of work. Certainly, the house in its present form dates from the 1665, or within a year or two afterwards. However, the earlier group of timbers (Figure 1) might suggest that the fireplace beam and the north end and south end tiebeam relate to an earlier phase of building dating from about 1588 which was then partly reconstructed in or shortly after 1665, reusing some timbers such as the purlin.

ACKNOWLEDGEMENTS

This study was commissioned by the owners, Michael and Paula Burnett. The work was co-ordinated by the North-West Wales Dendrochronology Project, led by Margaret Dunn (who kindly supplied the photograph used on the cover of this report). Richard Suggett of the RCAHMW provided the description of the building.

REFERENCES

Arnold, A. J., Howard, R. E. and Litton, C. D. (2004) *Tree-ring analysis of timbers from Dacre Hall, Lanercost Priory, Brampton, near Carlisle, Cumbria*, **Centre for Archaeology Report**, 48/2004.

Arnold, A. J., Howard, R. E. and Litton C. D. (2005), *Tree-ring analysis of timbers from the Church of All Saints, Main Street, Fenton, South Kesteven, Lincolnshire*, **Centre for Archaeology Report**, 46/2005.

Baillie, M. G. L. (1977) The Belfast Oak Chronology to A.D. 1001, **Tree Ring Bulletin**, 37, 1-12.

Baillie, M.G.L. and Pilcher, J.R. (1973) *A simple cross-dating program for tree-ring research*. **Tree Ring Bulletin**, 33, 7-14.

Bridge, M. C. (1988) The dendrochronological dating of buildings in southern England, **Medieval Archaeology**, 32, 166-174.

English Heritage (1998) *Guidelines on producing and interpreting dendrochronological dates,* **English Heritage, London.**

Fletcher, J. M. (1980) Tree-ring dates, **Vernacular Architecture**, 11, 32-38.

Miles, D. (1997a) The interpretation, presentation, and use of tree-ring dates, **Vernacular Architecture**, 28, 40-56.

Miles, D. H. (1997b) Working compilation of 58 reference chronologies centred around Wales by various researchers, unpublished computer file WALES97, Oxford Dendrochronology Laboratory.

Miles, D. H. and Worthington, M. J. (2002) Tree-ring dates, **Vernacular Architecture**, 33, 81-102.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2003) Tree-ring dates, **Vernacular Architecture**, 34, 109-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2006) Tree-ring dates, **Vernacular Architecture**, 37, 118-132.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2009) Tree-ring dates, **Vernacular Architecture**, 40, 122-128.

Miles, D. H., Bridge, M. C., Suggett, R. and Dunn, M. (2011) Tree-ring dates, **Vernacular Architecture**, 42, 109-116.

Nayling, N. (2001) *Tree-ring analysis of timbers from Lower Brockhampton Gatehouse, near Bromyard, Herefordshire*, **Centre for Archaeology Report**, 98/2001.

Tyers, I. (1996) *Tree-ring analysis of the tower of St John the Baptist Church, Mamble, Hereford and Worcester*, **Anc Mon Lab Rep**, 22/96.

Tyers, I. (1999) *Tree-ring analysis of the Bell Tower of the church of St Mary, Pembridge, Herefordshire*, **Anc Mon Lab Rep,** 1/99.

Tyers, I. (2004) *Dendro for Windows Program Guide 3rd edn*, **ARCUS Report,** 500b**.**

Tyers, I. and Boswijk, G. (1998) *Tree-ring analysis of oak timbers from Dore Abbey, Abbey Dore, Herefordshire*, **Anc Mon Lab Rep**, 18/98.

Table 1: Details of samples taken from Brynmaenllwyd, Trawsfynydd, Meirionnydd.

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
traw1a	East principal rafter, middle truss (T2)	*1468-1577*	-	-	*110*	*1.68*	*0.38*	*0.20*	
traw1b	*ditto*	*1479-1536*	-	-	*58*	*2.05*	*0.33*	*0.17*	
traw1c	*ditto*	*1520-1558*	-	-	*39*	*2.27*	*0.57*	*0.20*	
traw1d	*ditto*	*1562-1603*	-	-	*42*	*1.39*	*0.31*	*0.22*	
traw1e	*ditto*	*1590-1644*	*1643*	*1*	*55*	*1.12*	*0.29*	*0.18*	
traw1f	*ditto*	*1596-1663*	*1643*	*20*	*68*	*0.99*	*0.29*	*0.17*	
traw2	West principal rafter, middle truss (T2)	*1566-1664*	*1645*	*19C*	*99*	*1.13*	*0.27*	*0.18*	*Winter 1664/65*
traw12	Same tree mean **traw1** and **traw2**	1468-1664	1644	20C	197	1.50	0.51	0.18	Winter 1664/65
traw3	East principal rafter, south end truss	-	-	*13C*	*65*	*2.63*	*1.09*	*0.32*	-
traw4	West principal rafter, south end truss	-	-	*11+3C NM*	*55*	*2.91*	*1.30*	*0.30*	-
traw34	Same tree mean of **traw3** and **traw4**	-	-	14C	65	2.76	1.04	0.27	-
* **traw5**	East lower purlin, south bay	1429-1587	1556	31¼C	159	0.80	0.41	0.20	Spring 1588
traw6	Tiebeam, middle truss (T2)	-	-	H/S	28	3.46	0.84	0.23	
* **traw7**	Tiebeam, south end truss	1463-1539	1539	H/S	77	1.56	0.44	0.17	1550–1580
* **traw8**	Mantelbeam, south end	1405-1538	-	-	134	1.04	0.49	0.23	After 1549
traw9a	Tiebeam, north end truss	*1389-1571*	*1535*	*36*	*183*	*0.82*	*0.74*	*0.24*	
traw9b	*ditto*	*1381-1584*	*1535*	*49C*	*204*	*0.87*	*0.70*	*0.24*	
* **traw9**	Same timber mean of **traw9a** and **traw9b**	1381-1584	1535	49C	204	0.85	0.72	0.20	Winter 1584/85
* = included in site master **TRAWSFYN**		**1381-1587**			**207**	**1.04**	**0.58**	**0.17**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; ¼C = complete sapwood, felled the following spring; ½C = complete sapwood, felled the following autumn; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured

A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

Table 2a: Cross-matching between the components of the same timber mean **traw12**

	t-values					
Sample	**traw1b**	**traw1c**	**traw1d**	**traw1e**	**traw1f**	**traw2**
traw1a	8.6	7.3	*	*	*	*
traw1b		*	*	*	*	*
traw1c			*	*	*	*
traw1d				*	*	14.2
traw1e					11.3	10.8
traw1f						8.6

* overlap less than 20 rings

Table 2b: Cross-matching between the dated components of the site master **TRAWSFYN**

	t-values		
Sample	**traw7**	**traw8**	**traw9**
traw5	2.6	4.4	3.6
traw7		6.1	4.6
traw8			6.3

A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

Table 3a: Dating evidence for the site master **TRAWSFYN AD 1381–1587** against dated reference chronologies.
Regional multi-site chronologies are shown in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355-1604	207	8.9
Wales	Pengwern Old Hall	(Miles *et al* 2003)	PENGWERN	1353-1521	141	8.1
Wales	Plas ym Mhenrhos, Penrhos	(Miles et al forthcoming)	PLASMNRS	1413-1607	175	7.6
Wales	Parc Llanfrothen	(Miles *et al* 2006)	BDGLRT22	1386-1669	202	7.3
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ01	1350-1504	124	7.3
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	207	7.2
Wales	Bodloesygad, Ffestiniog	(Miles *et al* forthcoming)	BODLSYGD	1368-1560	180	7.0
Wales	St Brothen's Church, Llanfrothen	(Miles *et al* 2006)	BDGLRT16	1410-1495	86	7.0
Wales	Ty-mawr, Nantmor	(Miles *et al* 2006)	BDGLRT3	1425-1528	104	6.9
Wales	Cae'nycoed-uchaf, Maentwrog	(Miles *et al* 2006)	BDGLRT17	1407-1592	181	6.9
Wales	St Gwyddelan's Church, Dolwyddelan	(Miles *et al* 2011)	STGWYD	1360-1467	87	6.9
Wales	Beddgelert	(Nayling pers comm)	BEDD_T6	1302-1529	149	6.8
Herefordshire	King's Arms, Michaelchurch, Escley	(Miles *et al* 2006)	MLCHRCH4	1370-1497	207	6.7
Wales	Y Gesail Gyfarch, Dolbenmaen	(Miles *et al* 2006)	BDGLRT6	1384-1609	204	6.7

Table 3b: Dating evidence for the site sequence **traw12 AD 1468–1664** against dated reference chronologies.
Regional multi-site chronologies are shown in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Gloucestershire	Swan House, Blakeney	(Miles *et al* 2009)	SWANHS	1386-1628	161	8.8
Ireland	Belfast Master Chronology	(Baillie 1977)	**BELFAST**	1001-1970	197	7.6
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	197	7.3
Herefordshire	Dore Abbey	(Tyers and Boswijk 1998)	DORE2	1363-1612	145	7.1
Wales	Plas Tirion, Llanrwst	(Miles *et al* forthcoming)	TIRION1	1418-1545	78	7.0
Wales	Parc Llanfrothen	(Miles *et al* 2006)	BDGLRT22	1386-1669	197	6.7
Wales	Lower Cill, Berriew, Montgomeryshire	(Miles *et al* 2006)	BERRIEW	1428-1583	116	6.6
Somerset	Market Place, Shepton Mallet	(Miles and Worthington 2002)	SHPTNMLT	1518-1677	147	6.5
Lincolnshire	Fenton Church	(Arnold *et al* 2005)	FENASQ02	1434-1617	150	6.4
Herefordshire	Little Brockhampton Gatehouse	(Nayling 2001)	LBG-T10	1368-1543	76	6.3
Wales	Oxwich Castle	(Miles *et al* 2006)	OXWICH	1459-1630	163	6.3
Worcestershire	Mamble	(Tyers 1996)	MAMBLE_B	1348-1582	115	6.1
Herefordshire	St Mary's Church, Pembridge	(Tyers 1999)	PBT_C	1559-1668	106	6.0
Worcestershire	Bailiff's House, Bewdley	(Fletcher 1980)	BEWDLEY2	1430-1600	133	5.9

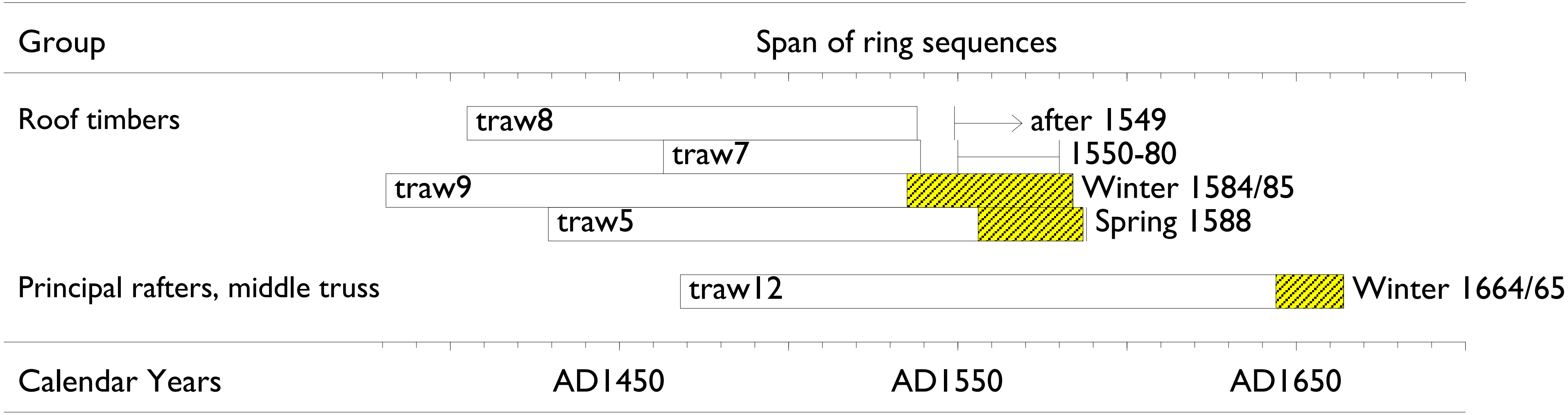


Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).