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Please note that these reports are being updated as part of an ongoing programme of revision. Older reports sometimes refer to the old names of the Group. Between 2005 and 2012 also known as The Snowdonia Dendrochronology Project, then the N W Wales Dendrochronology Project and then the Dating Old Welsh Houses Group.

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Oxford Dendrochronology Laboratory
Report 2015/56

THE DENDROCHRONOLOGICAL DATING OF GWERNBRAICHDWR, LLANDDERFEL, MAERDY, MERIONETH (SH 947 422)

Summary

Two precise felling dates of **Spring 1552 and Winter 1553/54** were found from timbers in the main range, consistent with the expected late C16th date attributed to this primary phase, and it is likely that these timbers were from that primary phase and were re-used when the whole house was remodelled. The crucks at the east end of the building, along with the timbers from the north wing, south wing (porch), stair post and floor did not give precise felling dates, but the likely felling date ranges are consistent with a date of **1611** that has been previously noted carved on a lintel, but is no longer legible.

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A project supported by Dating Old Welsh Houses, in collaboration with the Royal Commission on Ancient and Historic Monuments in Wales

The Dendrochronological Dating of Gwernbraichdwr, Llandderfel, Maerdy, Merioneth (SH 997 422)

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.

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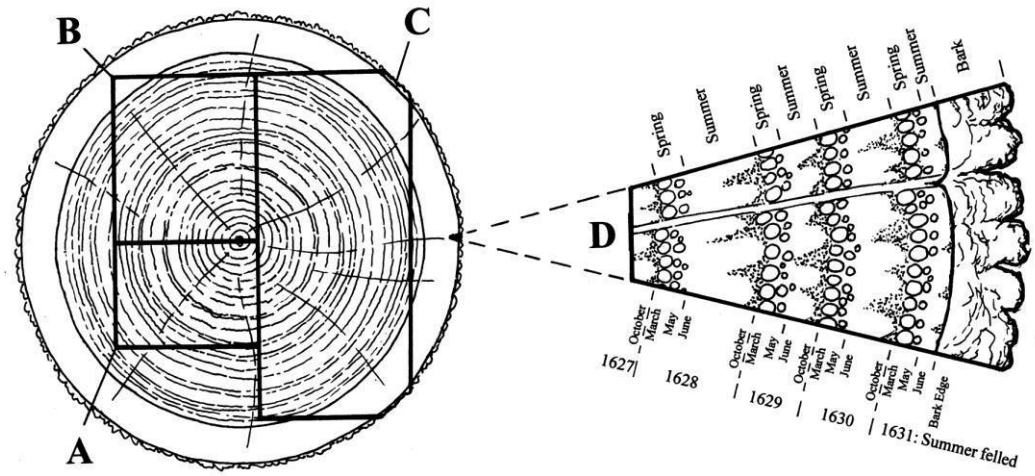
Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are 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 1997a, 42)

GWERNBRAICHDWR

Extract from Coflein, NPRN 28454:

Gwernbrychdwr is a large stone-built, three-unit, storeyed house of regional lobby-entry plan-type with a central back-to-back fireplace. The fireplace heats hall and outer kitchen; twin inner-rooms lie beyond the post-and-panel at the upper end of the hall. The projecting porch, which incorporates a stone stair reached internally from the hall, belongs structurally to the first building phase. The rear parlour wing, screened from the hall by a further post-and-panel partition, is oddly angled and appears to be an addition. The roof of six bays has collar-beam trusses with principal rafters having cruck-like curved feet. Earlier investigators noted a date of 1611 cut into the window frame of the hall or inner-room on the front elevation. This possibly dates the construction or modernization of the house. Peter Smith suggests that the house may follow the footprint of a medieval hall-house. Reused crucks are noted in the barn but it is unlikely that they are of domestic origin. The Lloyds of Gwernbrychdwr were patrons of the poets. For a plan and description of the house, see Peter Smith, 'Houses c. 1415 - c. 1642' in J. &

Ll. Beverley Smith, History of Merioneth, Volume II: The Middle Ages (Cardiff, 2001), pp. 456, 498.
R.F. Suggett/RCAHMW/December 2015.

SAMPLING

Samples were taken in September 2015. The locations of the samples are described in Table 1, and illustrated in Fig 2. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **gbdr**) and 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 DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples are given in Table 1. A number of the cores had large numbers of rings, and looked superficially very good from a dendrochronological point of view, but after preparation they were seen to have rapid growth declines, and continuous series of very narrow rings, not all of which could be readily distinguished. This was the case with **gbdr02** (Fig 1) where only the inner rings could be satisfactorily dated, the later narrow-ringed section being incapable of being resolved, although the approximate number of rings, and presence of complete sapwood enabled a felling date range to be derived.

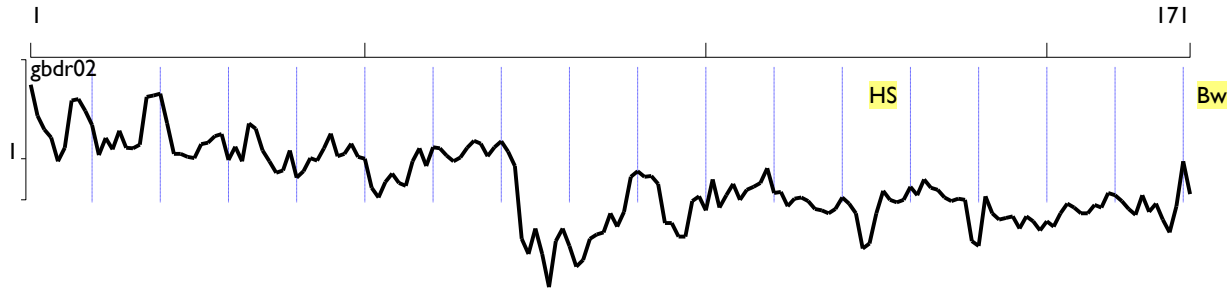


Figure 1: Plot of the ring width series for sample **gbdr02** as measured, showing the rapid decline in growth rate around year 72. Despite having complete sapwood, the outer rings could not be dated, and an edited series using only the inner rings was dated, allowing a narrow range of felling date to be estimated from the approximate number of rings. *y*-axis is width (mm) plotted on a logarithmic scale.

Cross-matching between the sequences was generally low (Table 2), the result of the 'sensitive' nature of the ring series (i.e. having high year-to-year variability) and the relatively short overlaps of some series. However, individual components dated well against the reference material, and the final 182-year site chronology, **GWRNBRDW**, gave very strong matching (Table 3) to site chronologies from North Wales and the neighbouring English counties.

The interpretation of the results is not immediately straightforward – although in the context of what is known or thought about the development of the site, it is perhaps a little easier to understand. The relative positions of overlap of the dated timbers are shown in Fig 3. The primary phase of the main open hall cruck building was thought to be of late C16th origin. Two samples gave actual felling dates in this period – a purlin and a cruck blade being found to have been made from trees felled in Spring

1552 and Winter 1553/54 respectively. It seems reasonable to suggest therefore

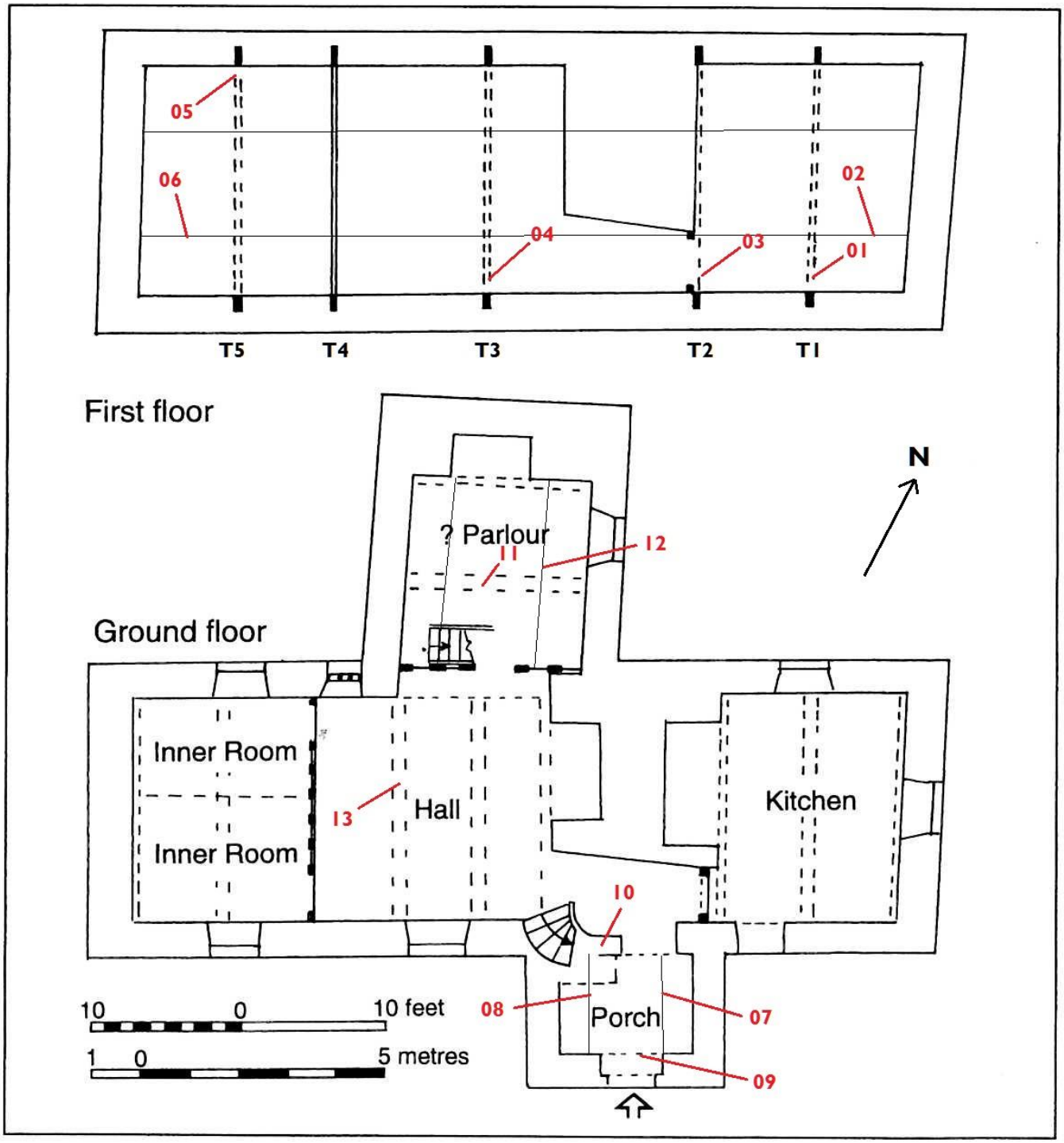


Figure 2: Plan of the house, showing the approximate positions of the samples taken for dendrochronology (based on a plan supplied by R. Suggett, RCAHMW)

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that the construction date for this primary phase was **1554**, or within a year or two after this date. These were incorporated into the remodelled house along with other cruck blades which date to the remodelling.

The remaining samples from the north wing, the south wing (porch), the stair post and the floor, could all be contemporaneous, and although no actual felling dates could be determined, the likely felling date ranges obtained would be consistent with a date of **1611** which was noted some years ago carved on a lintel, but is no longer legible.

ACKNOWLEDGEMENTS

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Table 1: Details of samples taken from Gwernbraichdwr, Llandderfel.

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
* **gbdr01**	South cruck, truss 1	1432–1563	1563	h/s	132	0.97	0.58	0.21	1574–1604
* **gbdr02e**	South purlin, east-most bay	1443–1512	-	-	70	1.29	0.54	0.21	after 1523
* **gbdr03**	South cruck, truss 2	1432–1491	-	-	60	2.67	0.84	0.27	after 1502
* **gbdr04i**	South cruck, truss 3 (inner rings)	1418–1496	-	-	79	1.09	0.35	0.26	-
gbdr04ii	*ditto* (outer rings)	-	-	h/s	57	0.97	0.49	0.25	after 1565
* **gbdr05**	North cruck, truss 5	1463–1553	1528	25C	91	2.07	0.96	0.23	Winter 1553/54
* **gbdr06**	South purlin, west-most bay	1484–1551	1530	21¼C	68	1.74	0.59	0.19	Spring 1552
* **gbdr07**	East purlin, south wing	1502–1585	1585	h/s	84	1.25	0.54	0.17	1596–1626
* **gbdr08e**	West purlin, south wing	1500–1576	*c*1600	-	77 (+*c*33[9]NM)	1.17	0.35	0.17	1609–1619
* **gbdr09**	Lintel over door opening, Grd Flr	1404–1565	1565	h/s	162	0.93	0.64	0.21	1576–1606
* **gbdr10**	Post in mid-bay supporting stairs	1503–1575	1575	h/s	73	0.98	0.48	0.20	1586–1616
gbdr11	East-west ceiling beam in north wing	1406–1564	1564	h/s (+38NM)	159	0.93	0.51	0.18	1602–1612
* **gbdr12e**	East purlin, north wing	1488–1533	*c*1569	-	46 (+*c*78[42])	1.73	0.73	0.20	1611–1621
* **gbdr13e**	West ceiling beam, central Grd Flr	1510–1559	*c*1581	-	50 (+*c*44[22])	2.43	1.07	0.17	1603–1615
* = included in site master **GWRNBRDW**		**1404-1585**			**182**	**1.35**	**0.49**	**0.16**	

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

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Table 2. Cross-matching between the individual series from Gwernbraichdwr (values over 3.5 are significant)

t-values												
	gbdr02e	**gbdr03**	**gbdr04i**	**gbdr05**	**gbdr06**	**gbdr07**	**gbdr08e**	**gbdr09**	**gbdr10**	**gbdr11**	**gbdr12e**	**gbdr13e**
gbdr01	2.8	4.9	3.0	2.8	3.7	2.5	1.9	3.0	3.6	4.3	3.3	4.7
gbdr02e		3.7	4.6	2.9	\	\	\	3.9	\	4.1	\	\
gbdr03			7.0	\	\	\	\	3.9	\	3.8	\	\
gbdr04i				1.8	\	\	\	2.6	\	3.8	\	\
gbdr05					3.7	3.2	2.9	3.9	1.4	3.2	2.6	2.2
gbdr06						2.9	2.1	1.4	2.3	3.2	3.6	1.0
gbdr07							3.2	2.2	4.1	3.4	0.5	1.9
gbdr08e								2.1	3.9	4.2	0.0	3.0
gbdr09									1.2	4.8	2.0	1.6
gbdr10										4.1	0.0	5.3
gbdr11											2.3	4.9
gbdr12e												\

\ = no calculation made, overlap under 30 years; 0.0 = zero, or negative correlation

Table 3: Dating evidence for the site sequence **GWRNBRDW** **AD 1404–1585** against dated reference chronologies

County or region	***Chronology name***	***Reference***	***File name***	***Spanning***	***Overlap (yrs)***	***t-value***
Regional Chronologies						
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	182	9.8
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	182	9.3
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	182	9.1
Northern England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440–1742	182	8.9
Wales/borders	Hillside oaks	(Siebenlist-Kerner 1978)	**GIERTZ**	1341–1636	182	8.9
Site Chronologies						
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	182	10.3
Montgomeryshire	St Idloes Church, Llanidloes	(Miles *et al* 2003)	LNYDLOS2	1384–1593	182	9.0
Shropshire	Porch House, Bishops Castle	(Miles and Worthington 2000)	PORCHBC	1416–1564	149	8.8
Denbighshire	Glas Hirfryn,	(Bridge *et al* 2014)	GHN	1404–1557	154	8.5
Staffordshire	Biddulph Old Hall	(Miles *et al* 2005)	BIDDULPH	1404–1524	120	8.4
Shropshire	Brookgate Farm	(Miles and Haddon-Reece 1993)	BROOKGT	1362–1611	182	8.4
Denbighshire	Ty Mawr, Druid, Corwen	(Miles *et al* 2010)	DENBY1	1440–1583	144	8.4
Merioneth	Rhydywernen, Llanfor	(Bridge *et al* 2015)	RHYDYWRN	1403–1530	127	8.2

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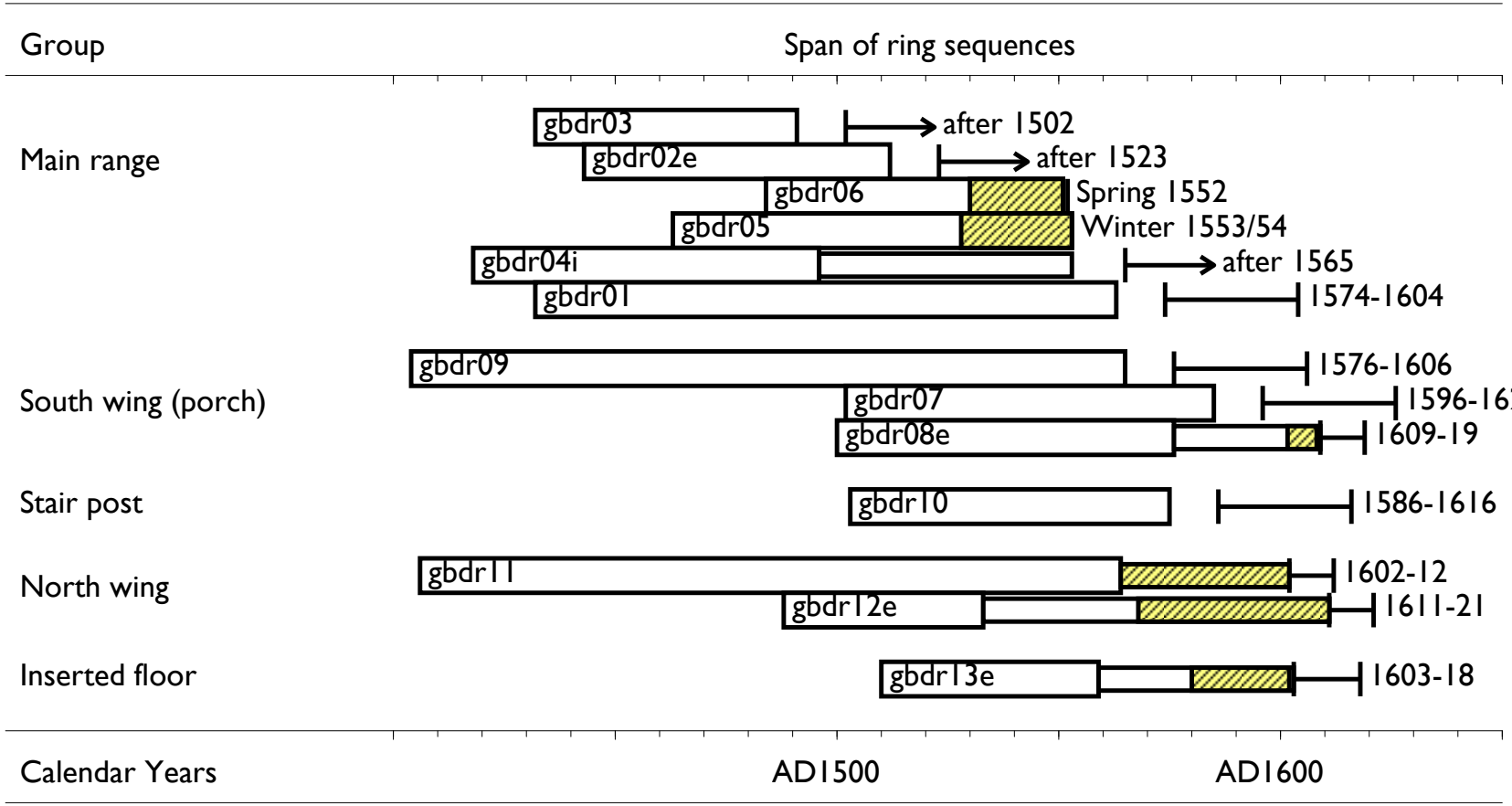

Figure 3: Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges. White sections represent heartwood rings and yellow hatched sections represent sapwood, narrow bars represent additional undated rings..