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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.

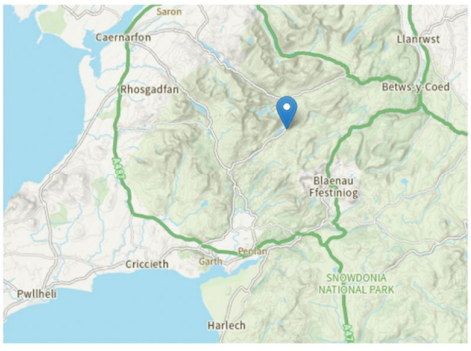
New reports will be added from time to time. Keep an eye on our website for updates.

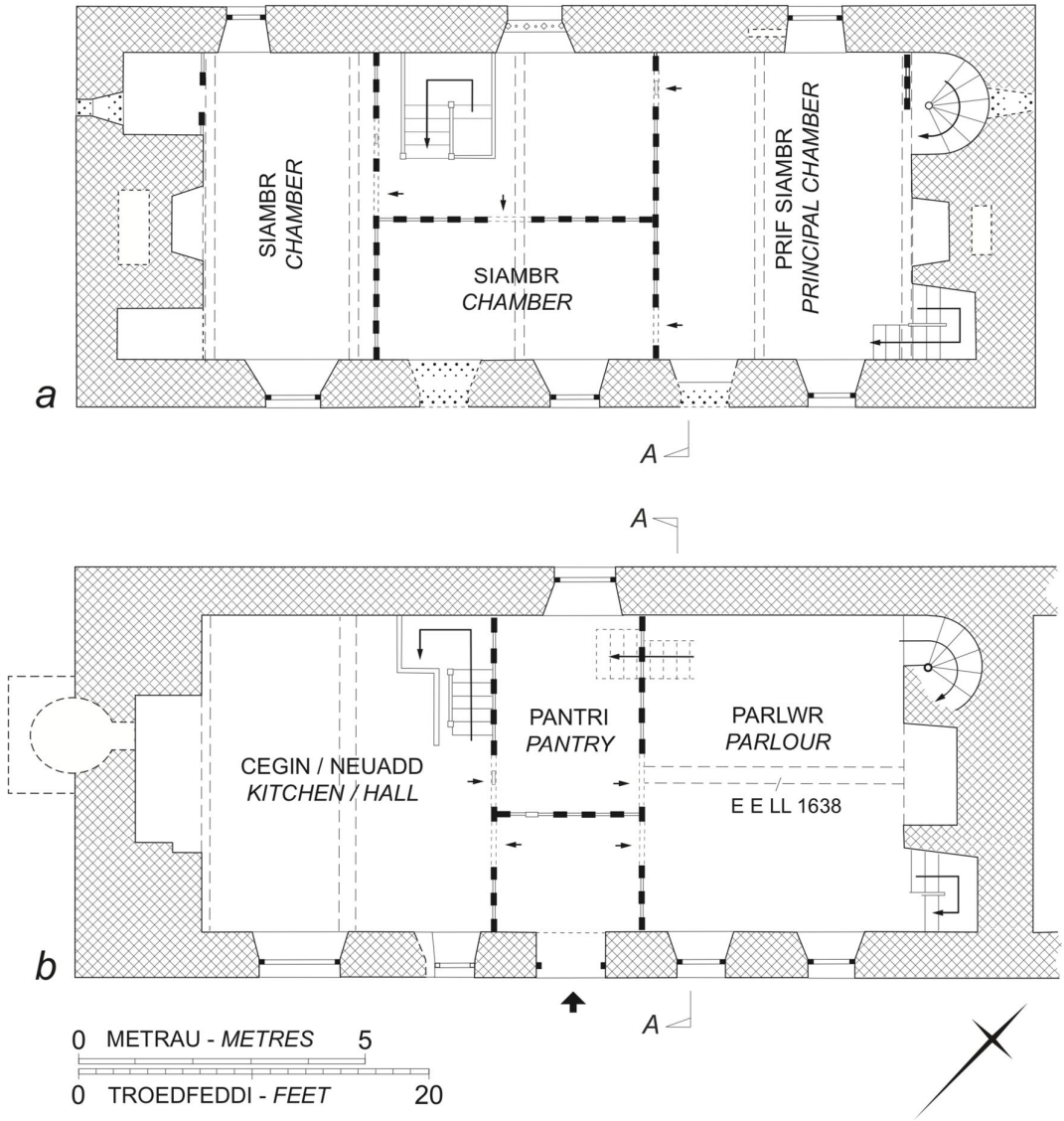
TREE-RING DATING OF
HAFOD LWYFOG
NANTGWYNANT
(CAERNARFONSHIRE)
GWYNEDD

(NGR SH 6526 5225)

The tree-ring analysis was commissioned by Beddgelert Historical Society as part of a community grant from the Snowdonia National Park and carried out in 2005 by Professor Nigel Nayling of the University of Wales, Trinity St David (Lampeter), who holds the copyright and his full report appears below. Dating was commissioned by the Beddgelert Historical Society.

1 SUMMARY





(a) Upper floor and (b) ground floor plans adapted to reflect its layout in 1638 when it was rebuilt and the original roof timbers re-set.
Reproduced from Richard Suggett and Margaret Dunn, *Discovering the Historic Houses of Snowdonia* (2014), 212-17 © RCAHMW

Hafod-lwyfog is a 'a modernised mid-sixteenth century Snowdonian gentry house'. The original house may have been of Snowdonian plan, with a large passage bay. The roof timbers of this house had a felling range of **1541-60** and were re-used when the house was reconstructed in **1638** by Evan Lloyd (dated beam), creating a central service room as is evident in the plan above. It is of interest that most twentieth century historians stated that the dated beam referred to the erection of the building rather than listen to local people who said that it had been erected over 80 years earlier, as was indicated by the dendrochronology results. The house is noted as having a remarkably well-preserved interior.

Hafod-lwyfog is situated in a hollow at about 150 metres above O.D. set across the slope and cut into it. It formed part of the Nanhwynan estate, which belonged to Aberconwy Abbey: John Wynn of Gwydir had been the abbey's steward and was well placed to lease most of the property including this holding. Evan Lloyd, esquire (1600-78), a kinsman of the Wynn

dynasty, who served as High Sheriff, rebuilt the house in an up-to-date fashion with ovolo-moulded beams to both parlour and principal chamber.

Hafod-lwyfog is fully discussed in Richard Suggett and Margaret Dunn, *Discovering the Historic Houses of Snowdonia* (2014), 108-13 with plans, elevations and photographs. The tree-ring analysis was carried out in 2005 by Professor Nigel Nayling of the University of Wales, Trinity St David (Lampeter) and his full report appears below. In addition, readers are referred to the house history by Margaret Dunn, which contains further details and references.

A full set of images (and a calendar of documents in the National Monuments Record) is available on https://coflein.gov.uk/en/site/26578/images?term=Hafod%20Lwyfog

RCAHMW National Primary Reference Number (NPRN): 26578

2 TECHNICAL DATA

The following summary of technical data regarding Hafod-lwyfog is taken from *Vernacular Architecture*, 46, 116 https://doi.org/10.1080/03055477.2015.1123413
The abbreviation 'h/s' indicates the presence of the heartwood-sapwood boundary. Readers are advised to refer to the following section.

***Felling date range*: 1541–50**

Collar 1519(15+22NM); principal rafters (2/3) 1516(h/s); 1517(h/s?); undated: joists.

See, attached, N. Nayling, 'Tree-Ring Analysis of Timbers from Selected Buildings in the Beddgelert Area, North Wales', University of Wales, Lampeter, Dendrochronology Report 2005.

3 BACKGROUND TO DENDROCHRONOLOGY (Dan Miles)

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.

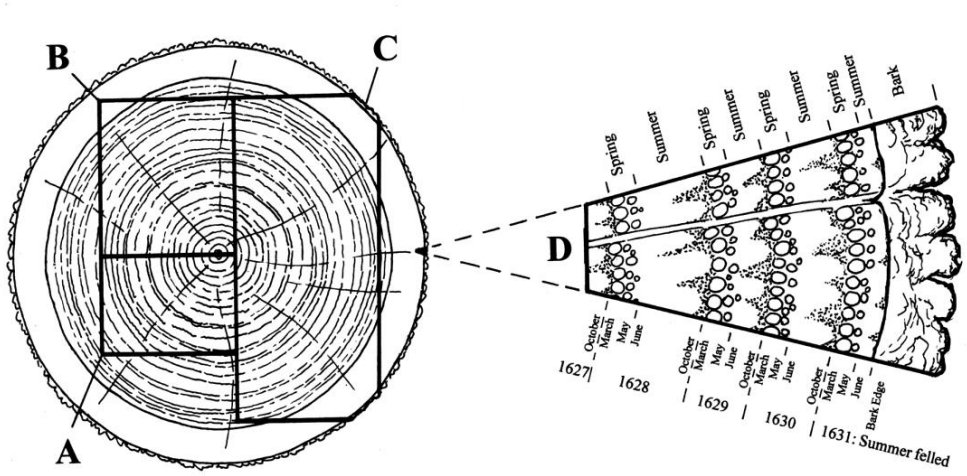
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's t-test. The t-test compares the actual difference between two means in relation to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



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.

Notes compiled by Martin Cherry, May 2022, from material generated by the North-west Wales Tree-ring Dating Project. The origins of this programme of dating lay with the Beddgelert Historical Society under the direction of Margaret Dunn (see the 'About Us' page.) This report should be read in conjunction with the other reports in this section.

The full tree-ring dating report is appended below.

Dec. 05

University of Wales Lampeter, Dendrochronology Report 2005

Tree-Ring Analysis of Timbers from Selected Buildings in the Beddgelert Area, North Wales

Nigel Nayling

Summary

The results of analysis of samples taken from three buildings in the Beddgelert area are presented. Difficulties were encountered with some of the buildings having been constructed from timbers with relatively few rings which limited their dating potential.

Dating of both blades of a cruck at Gwastad Annas indicate felling in AD 1508. A bressumer beam, with possible heartwood/sapwood interface, located over an apparently inserted fireplace, has been dated to an estimated felling date range of AD 1539-75?

Three timbers from roof trusses in Hafod Lwyfog (a collar and two principal rafters) have been dated suggesting felling of the timber for construction of the roof in the date range AD 1541- AD 1550.

Samples taken from joists and one beam in the ground floor ceiling at Hafod Rhisgl did not date. Apparently reused timbers in trusses of a nearby barn were inspected but rejected for sampling because of the limited number of rings present.

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Introduction

This document is an archive report on the tree-ring analysis of oak timbers from selected buildings from the Beddgelert area of North Wales. Analysis of these buildings was undertaken at the request of Margaret Dunn acting as Secretary of the Beddgelert Historical Society.

It is beyond the dendrochronological brief to describe individual buildings in detail or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the buildings, elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition.

Methodology

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (1998). Details of the samples taken from individual buildings are given in the short text sections for each building, where their respective results are also discussed.

Timbers with more than 50 annual rings and some survival of the original sapwood or bark-edge were sought. The dendrochronological sampling programme attempted to obtain cores from as broad a range of timbers, in terms of structural element types, scantling sizes, and carpentry features, as was possible within the terms of the request whilst also meeting health and safety requirements. Recovered cores were sanded with progressively finer sand paper to reveal the ring sequence. The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported 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, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions. Timbers originally derived from the same parent tree generally have *t*-values greater

than 10.0. Lower values from timbers obviously derived from the same parent tree (e.g. on morphological grounds) are however quite common. It is the visual similarity in medium term growth trends of the samples that is the critical factor in determining 'same tree' origin.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These and any remaining unmatched ring sequences were tested against a range of reference chronologies, using the same matching criteria of high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* 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 which are missing. This *tpq* may be many decades prior to the real felling date. 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 estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 1998). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

Details of individual samples for each building are given in Table 1, the computer correlations between cross-matched timbers are shown in Table 2, and computer correlations between a six timber mean constructed from cross-matched timbers from Gwastad Annas and Hafod Lwyfog, and previously dated site masters (and one regional

chronology) given in Table 3. The dating and interpretation of the absolutely dated samples is shown graphically in Figure 1. The location of individual samples is given in Figures 2-4

Gwastad Annas

The number of suitable timbers available was very limited. Two cruck blades, truncated some time in the past, were both sampled by taking thin slices from their exposed ends (samples 01 and 02, Table 1). Two samples were taken from apparently later features including a bressumer beam over an inserted (?) fireplace (sample 04), and the collar of a roof truss over the fire (sample 03) (Figure 2). The samples from the cruck blades and that from the bressumer beam proved suitable for analysis and have all dated, cross-matching against each other and timbers from Hafod Lwyfog.

Dating of both cruck blades indicate felling in AD 1508. The bressumer beam, with possible heartwood/sapwood interface, located over an apparently inserted fireplace, has been dated to an estimated felling date range of AD 1539-75?

Hafod Rhisgl

Four samples were taken from quartered joists and a single beam in the ground floor ceiling (Table 1, Figure 3). None of these samples had more than 100 rings, and none cross-matched with each other, or samples from the other buildings investigated in this study. The nearby barn, containing reused timbers in its roof trusses which might have come from the historic building known to have stood at Wenallt were not sampled as the timbers had insufficient rings to merit sampling and analysis.

Hafod Lwyfog

Samples were taken from timbers forming the roof trusses (samples 01-02, 04-05), or from *in situ* joists or fragments of joists held in store (samples 03, 06-09) (Table 1, Figure 4). Results from the joists were disappointing with none dating. Three of the four samples from roof timbers (01, 04 and 05) cross-matched with each other and timbers from Gwastad Annas (Table 2). Absolute dating of two of the sampled principal rafters indicates felling of the parent trees in the felling date range AD 1527-62. Dating of a collar (01) allows this to be refined to AD 1541-50.

Acknowledgements

The sampling and analysis programme was funded by the Beddgelert Historical Society with assistance from the Snowdonia National Park. I am grateful to all the owners and occupiers who have assisted the survey. Margaret Dunn, secretary of the Beddgelert Historical Society not only instigated the project but arranged access and provided hospitality to the author and David Sables who provided sampling assistance. Thanks are due to Richard Suggett and Geoff Ward of the Royal Commission on Ancient and Historical Monuments of Wales for access to unpublished drawings of Hafod Lwyfog.

Figure 1 Bar diagram showing the chronological positions of the dated timbers. The estimated felling periods are also shown. The dated tree-ring series are grouped as crucks from Gwastad Annas (Gwastad A), the bressumer beam over the presumed inserted fireplace (Gwasta B), and dated roof timbers from Hafod Lwyfog

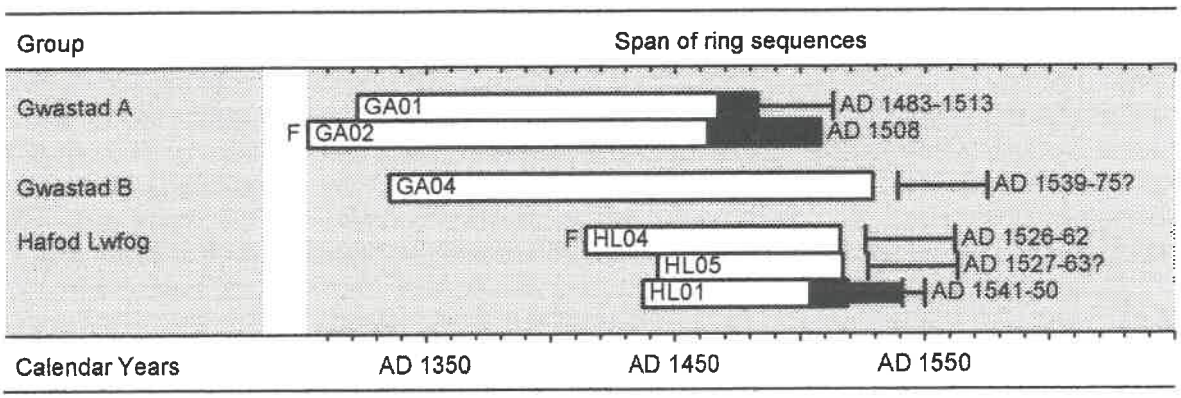

Figure 2 Plan of Gwastad Annas indicating location of samples. After RCAHMW 1960, Fig 28

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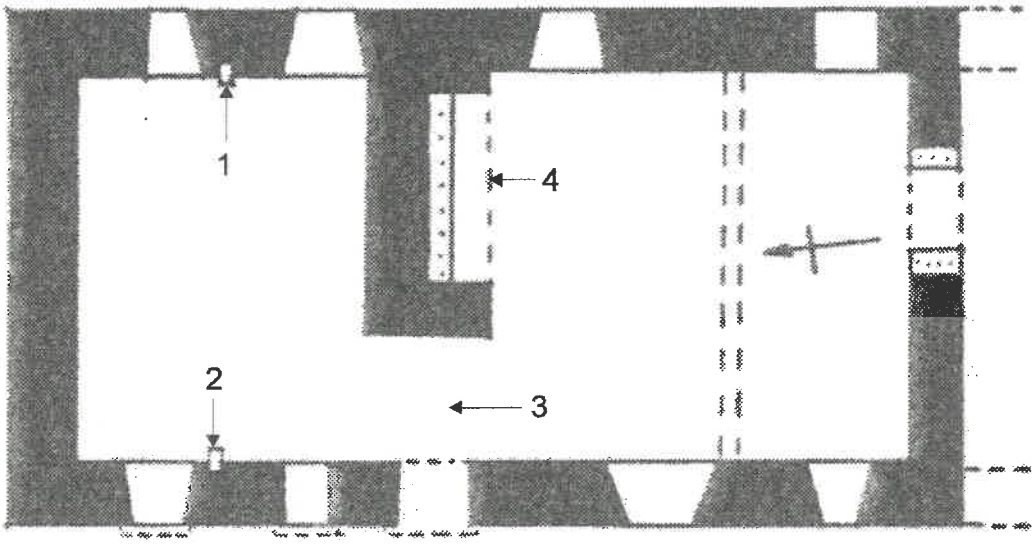
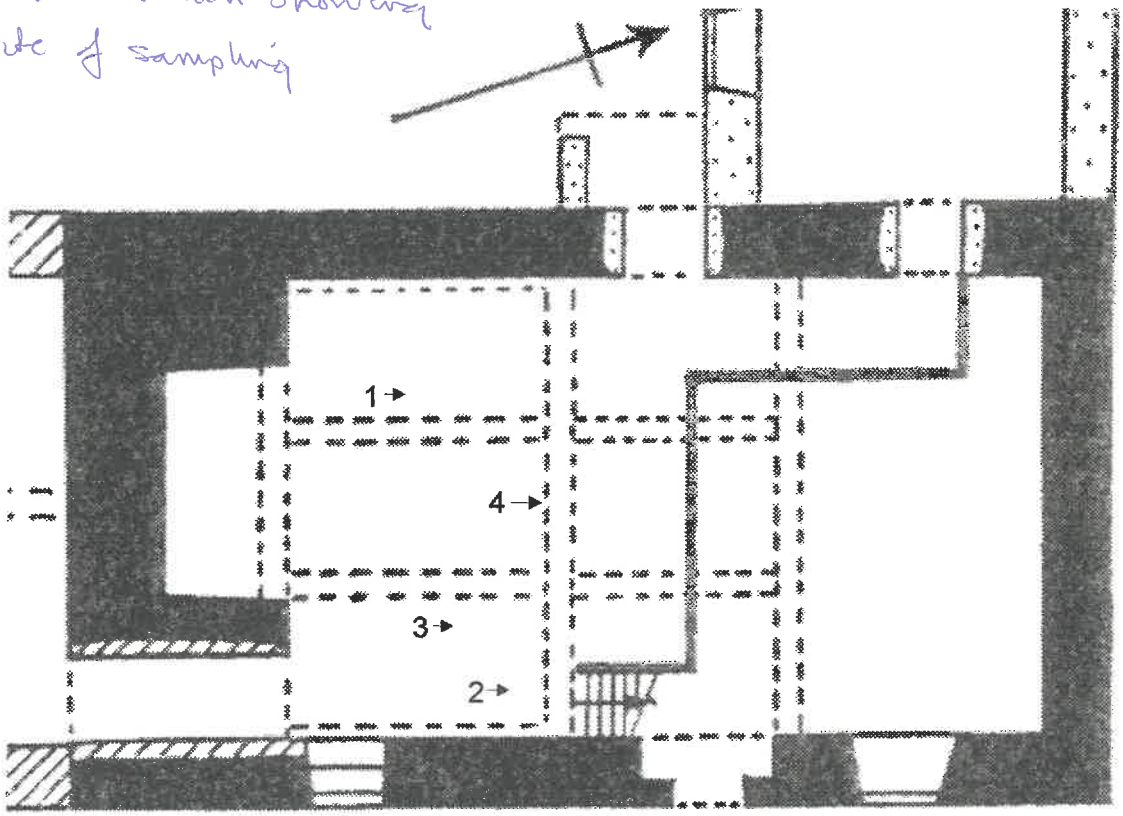


Elevation showing site of sampling

Fig 1. F =
Solid black =

Figure 3 Plan of Hafod Rhisgl indicating location of samples. After RCAHMW 1960, Fig 26 NGR SH 65545284 5m Scale

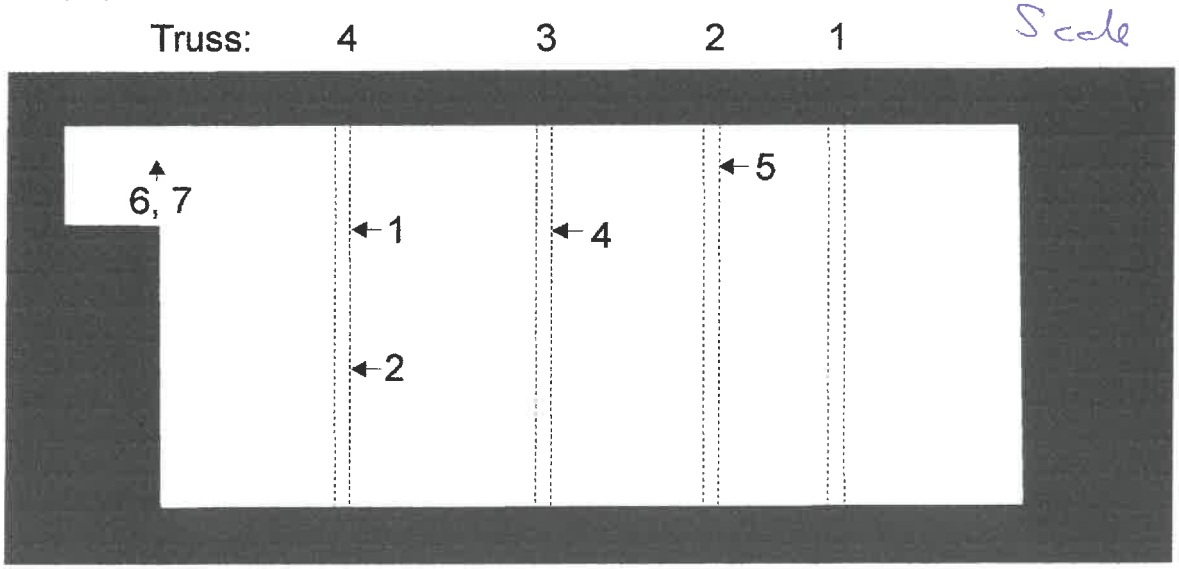
Elevation showing site of sampling



Scale

Figure 4 Plan of Hafod Lwyfog indicating location of samples and position of numbered trusses. After RCAHMW 1960, Fig 24 and unpublished

NGR SH 65265225 5m North Scale



Elevation showing site of sampling

Table 1 List of samples

Gwastad Annas

Sample	Origin of core	Cross-section (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	Truncated eastern cruck blade. Slice sample. Sapwood poorly preserved	310 x 170	162	16	0.89	AD 1322-AD 1483	AD 1483-1513
02	Truncated western cruck blade. Slice sample	340 x 145	207	45+B	0.72	AD 1302-AD 1508	AD 1508
03	Collar from truss over bressumer beam. Badly fragmented and few rings. Unmeasured	250 x 100	-	-	-	Unmeasured	Undated
04	Bressumer beam	415 x 365	195	+HS?	1.19	AD 1335-AD 1529	AD 1539-75?

Hafod Rhisgl

Sample	Origin of core	Cross-section (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	Quartered joist in ground floor ceiling	140 x 135	-	-	-	Unmeasured	Undated
02	Quartered joist in ground floor ceiling	115 x 110	60	HS	1.58	Undated	-
03	Quartered joist in ground floor ceiling	125 x 114	67	HS	1.55	Undated	-
04	Girding beam in ground floor ceiling	340 x 310	86	HS	1.38	Undated	-

Hafod Lwfog

Sample	Origin of core	Cross-section (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	Collar, southernmost roof truss (4)	295 x 145	83	15+22s	1.88	AD 1437-AD 1519	AD 1541-50
02	Eastern principal rafter, truss 4	280 x 125	87	+HS	1.32	Undated	-
03	Moulded joist. Slice sample	102 x 97	131	2	0.96	Undated	-
04	Western principal rafter, truss 3	295 x 125	103	+HS	1.56	AD 1414-AD 1516	AD 1526-62
05	Western principal rafter, truss 2	375 x 130	75	+?HS	2.12	AD 1443-AD 1517	AD 1527-63?
06	Joist in SW corner	110 x 102	74	-	1.53	Undated	-
07	Joist, 5th in from SW corner	104 x 95	51	-	1.82	Undated	-
08	Chamfered joist? from store	98 x 95	57	29+Bw	1.91	Undated	-
09	Joist? from dairy (from store)	125 x 95	103	-	0.74	Undated	-

Table 2 *t*-value matrix for cross-matched samples from Gwastad Annas and Hafod Lwfog used in construction of area mean \ = overlap < 15 years, - = t-values less than 3.00,* = empty triangle

Samples	HL05	HL04	GA01	GA02	GA04
HL01	3.32	-	3.94	3.40	-
HL05	*	7.03	-	3.20	-
HL04	*	*	-	3.27	3.36
GA01	*	*	*	8.48	4.41
GA02	*	*	*	*	5.52

Table 3 Dating the mean sequence BEDD_T6, AD 1302- AD 1529 inclusive: *t*-values with independent reference chronologies

Reference chronology	*t*-values
Bronyffynnon, 24 Bridge Street, Denbigh (Nayling 2001)	5.01
Llangelynin Church, Gwynedd (Nayling 2003)	6.35
Llyn Peris Boat, Gwynedd (Nayling 1999)	5.47
Penrhyn Fish Weir, Bangor (Nayling 2000a)	6.68
Belfast (Baillie 1977)	6.36
Bedstone Manor Farm, Salop (Miles *et al* 1995)	6.27
Apethorn Fold Farmhouse, Greater Manchester (Tyers 1999)	5.28
Stayley Hall, Stalybridge, Greater Manchester (Nayling 2000b)	5.36

Table 4 The tree-ring width data for the mean sequence BEDD_T6, dated to AD 1302-AD 1529 inclusive

Date	Ring widths (0.01mm)										Number of timbers									
AD 1302		31	46	51	58	107	137	140	101	92		1	1	1	1	1	1	1	1	1
-	90	115	99	118	141	117	161	183	190	197	1	1	1	1	1	1	1	1	1	1
-	179	98	104	97	107	95	114	127	170	94	1	2	2	2	2	2	2	2	2	2
-	101	110	64	91	133	108	165	180	174	168	2	2	2	2	3	3	3	3	3	3
-	156	189	159	165	168	124	127	125	198	156	3	3	3	3	3	3	3	3	3	3
AD 1351	204	152	160	152	148	133	154	140	111	94	3	3	3	3	3	3	3	3	3	3
-	102	103	125	151	110	141	173	91	97	125	3	3	3	3	3	3	3	3	3	3
-	113	109	89	86	109	84	88	88	107	86	3	3	3	3	3	3	3	3	3	3
-	92	114	95	128	105	116	67	72	67	71	3	3	3	3	3	3	3	3	3	3
-	93	86	77	67	85	81	71	81	88	89	3	3	3	3	3	3	3	3	3	3
AD 1401	85	72	123	97	87	78	70	76	71	62	3	3	3	3	3	3	3	3	3	3
-	55	76	101	123	114	113	169	143	116	141	3	3	3	4	4	4	4	4	4	4
-	135	100	142	150	142	156	142	137	143	131	4	4	4	4	4	4	4	4	4	4
-	124	151	128	124	131	120	150	163	116	107	4	4	4	4	4	4	5	5	5	5
-	97	120	146	148	150	113	116	127	137	112	5	5	6	6	6	6	6	6	6	6
AD 1451	110	137	135	178	118	133	185	182	147	152	6	6	6	6	6	6	6	6	6	6
-	151	114	165	114	111	114	131	140	106	75	6	6	6	6	6	6	6	6	6	6
-	80	97	113	109	129	140	93	114	107	94	6	6	6	6	6	6	6	6	6	6
-	112	69	100	130	167	121	148	98	89	100	6	6	6	5	5	5	5	5	5	5
-	96	63	69	86	136	165	183	146	122	158	5	5	5	5	5	5	5	5	5	5
AD 1501	126	99	135	154	150	153	92	123	145	130	5	5	5	5	5	5	5	5	4	4
-	135	157	131	121	132	117	93	100	110	59	4	4	4	4	4	4	3	2	2	1
-	68	77	61	60	73	61	55	59	51		1	1	1	1	1	1	1	1	1	

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