Oxford Dendrochronology Laboratory
Report 2011/20

# THE TREE-RING DATING OF DUGOED, PENMACHNO, BETWS-Y-COED, CONWY (CAERNARFORNSHIRE) (NGR SH 8062 5218)


## Summary

Dugoed is a down-slope two-unit Snowdonian house with cross-passage and projecting end chimney. The projecting end chimney and absence of a mural stair can be features of early Snowdonian houses, and the date of 1516/17 is the earliest dated house of this type found on Snowdonia. A parlour wing added on the N side has a mural stair and was dated to 1594. Plan and description in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), pp. 174. Dating commissioned by The National Trust Wales in association with the North West Wales Dendrochronology Project and RCAHMW. NPRN 26415.



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July 2011


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 Dugoed, Penmachno, Betws-y-Coed, Conwy (Caernarfonshire) (NGR SH 8062 5218)**

## 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.

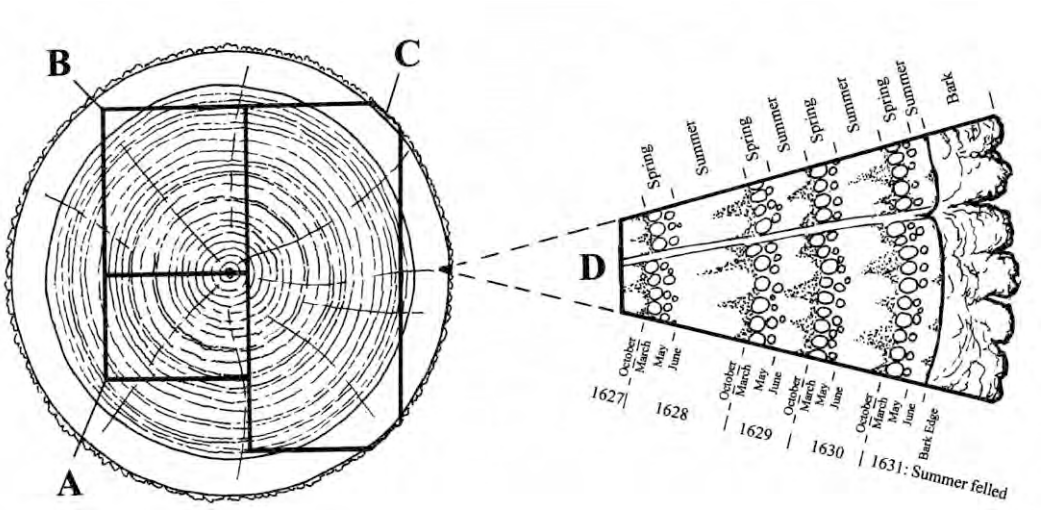
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence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

## DUGOED

Dugoed is a down-slope two-unit Snowdonian house with cross-passage and projecting end chimney. The projecting end chimney and absence of a mural stair can be features of early Snowdonian houses. A parlour wing added on the N side has a mural stair. Plan and description in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), pp. 174. Dating commissioned by The National

Trust Wales in association with the North West Wales Dendrochronology Project and RCAHMW. NPRN 26415.

## SAMPLING

Sampling took place in January 2011. 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 **dug**. 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 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. The ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. Subsequent analyses were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

## RESULTS AND DISCUSSION

Details of the samples, and their locations, are given in Table 1.

Two samples were taken from the main range of the house, one from a transverse beam (**dug1**) and an axial beam (**dug2**) with 103 and 84 rings respectively. These matched together with a *t*-value of 4.75.

Three samples (**dug12**, **dug13**, **dug14**) were taken from the roof trusses of the north wing of the house, and these all matched with the two samples from the main range of the house. Therefore all five samples were combined to form the 197-ring site master **DUGOED**. This dated, spanning the years 1397-1593.

A sample from a replacement transverse beam downstairs within the north wing (**dug11**) failed to date due to having only 52 rings.

Both ceiling beams to the main phase of the house dated, and as they both retained complete sapwood, they producing precise felling dates of winter 1515/16 and winter 1516/17 respectively for samples **dug1** and **dug2**. This makes Dugoed the earliest Snowdonian house yet identified.

One of the timbers, a purlin (**dug12**), from the north wing also retained complete sapwood, giving a felling date of spring 1594. Another purlin and a principal rafter also dated, but these only retained the heartwood/sapwood boundary. These produced felling date ranges of 1556-86 and 1562-92. Whilst these felling date ranges are slightly earlier than the 1594 date for sample **dug12**, they were most likely contemporary with sample **dug12**, which had over 64 sapwood rings, higher than the average of 11-41 for Wales. It is therefore likely that these other two samples had similarly higher sapwood rings counts thus accounting for the disparity, and the outermost heartwood rings did show a distinct narrowing towards the heartwood/sapwood transition. Therefore, the north wing was probably constructed during 1594 or a year or two afterwards.

**Table 1:** Details of samples taken from Dugoed, Penmachno, Betws-y-Coed,

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| **South Range** | | | | | | | | | |
| * dug1 | East transverse beam, Ground Flr | 1413-1515 | 1476 | 39C | 103 | 1.70 | 1.02 | 0.21 | Winter 1515/16 |
| * dug2 | Middle longitudinal beam, Grd Flr | 1433-1516 | 1492 | 24C | 84 | 1.62 | 0.70 | 0.21 | Winter 1516/17 |
| **North Wing** | | | | | | | | | |
| dug11 | Transverse beam, Ground Floor | undated | - | 12?C | 52 | 2.31 | 0.74 | 0.18 | unknown |
| * dug12 | West upper purlin, South bay | 1424-1593 | 1529 | 64¼C | 170 | 1.14 | 0.98 | 0.20 | Spring 1594 |
| * dug13 | West lower purlin, middle bay | 1397-1545 | 1545 | H/S | 149 | 1.65 | 1.04 | 0.19 | 1556–86 |
| * dug14 | West principal rafter, south truss | 1443-1551 | 1551 | H/S | 109 | 1.90 | 1.20 | 0.27 | 1562–92 |
| * = included in site mean **DUGOED** | | **1397-1593** | | | **197** | **1.40** | **1.10** | **0.20** | |

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

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**Table 2:** Cross-matching between dated samples

| Sample | dug2 | dug12 | dug13 | dug14 |
|---|---|---|---|---|
| **dug1** | 4.8 | 3.1 | 5.9 | 3.6 |
| **dug2** | | 0.8 | 2.8 | 4.4 |
| **dug12** | | | 5.4 | 4.1 |
| **dug13** | | | | 4.4 |

**Table 3:** Dating evidence for the site master **DUGOED** **AD 1397–1593** against dated reference chronologies, regional chronologies in **bold**

| *County or region:* | *Chronology name:* | *Short publication reference:* | *File name:* | *Spanning:* | *Overlap (yrs):* | *t-value:* |
|---|---|---|---|---|---|---|
| Wales | St Gwyddelan's Church, Dolwyddelan | (Miles *et al* 2011) | STGWYD | 1360-1467 | 71 | 7.4 |
| Wales | Gwernfyda Llanllugan | (Miles and Haddon-Reece 1996) | GWRNFYDA | 1410-1551 | 142 | 7.2 |
| Wales | Dylasau Isaf, Caernarfonshire | (Miles *et al* 2011) | DYLASAU1 | 1412-1592 | 181 | 7.0 |
| Wales | Plas Mawr House | (Miles and Haddon-Reece 1996) | PLASMWR2 | 1360-1578 | 182 | 6.5 |
| Shropshire | Alcaston Hall | (Miles and Worthington 1998) | ALCASTON | 1389–1556 | 160 | 6.4 |
| Shropshire | 25 Kempton | (Miles and Haddon-Reece 1996) | kemp1 | 1362-1476 | 80 | 6.1 |
| Wales | Derwyn-bach, Dolbenmaen | (Miles *et al* 2006) | BDGLRT15 | 1385-1548 | 152 | 6.1 |
| Durham | Unthank Hall, Stanhope | (Howard *et al* 2001) | STANHOPE | 1386-1592 | 196 | 6.1 |
| Manchester | Stayley Hall | (Nayling 2000) | STAY20 | 1387-1565 | 169 | 6.0 |
| Herefordshire | Church House, Allensmore | (Miles *et al* 2006) | CHAM | 1357-1551 | 155 | 5.9 |
| Wales | St Mary's, Abergavenny | (Miles and Worthington 1999) | ABERGVNY | 1349–1482 | 86 | 5.8 |
| Wales | Gorllwyn-uchaf, Dolbenmaen | (Miles *et al* 2006) | BDGLRT2 | 1437-1532 | 96 | 5.8 |
| Wales | Rose and Crown, Gwydwn | (Miles and Worthington 2000) | GWYDWN | 1411-1571 | 161 | 5.7 |

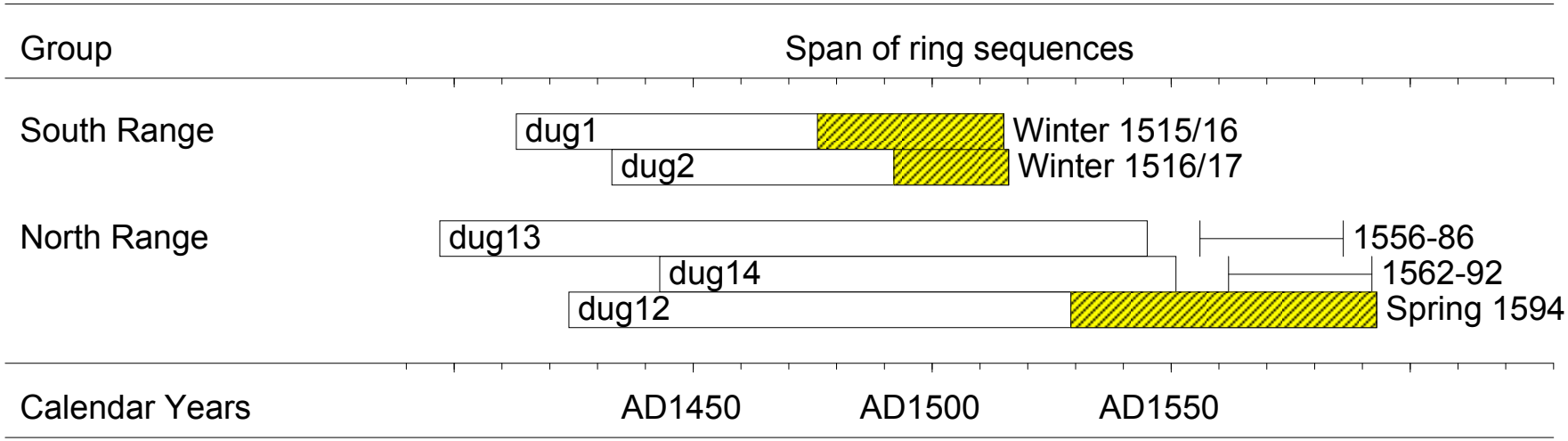


**Figure 1:** Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

## ACKNOWLEDGEMENTS

This study was funded by the National Trust and co-ordinated by Margaret Dunn of the North-West Wales Dendrochronology Project, (who supplied the cover photograph), with support by the Royal Commission on Ancient and Historic Monuments of Wales – with thanks to Richard Suggett. We are especially grateful to the tenants, Mr and Mrs Ken Lloyd, for graciously allowing us access to sample.

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