Oxford Dendrochronology Laboratory
Report 2013/25

THE TREE-RING DATING OF OAK TIMBERS AT NORTH PARK FURNACE, FERNHURST WEST SUSSEX

(NGR: SU 878 283)

Summary

Three timbers were sampled, each of which had been converted into beams and subsequently eroded, so showed no signs of sapwood on their outer surfaces. One had a short ring sequence (41 rings measured) and could not be dated. The other two, both from the left bank, each had 132-year sequences which were firmly dated, one to the period 1334-1465 and one to 1406-1537. It is actually possible that these timbers are contemporaneous, though there is insufficient evidence at present. The earliest likely felling date, adding the minimum likely number of sapwood rings, for one timber is 1474, and for the other is 1546.

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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.

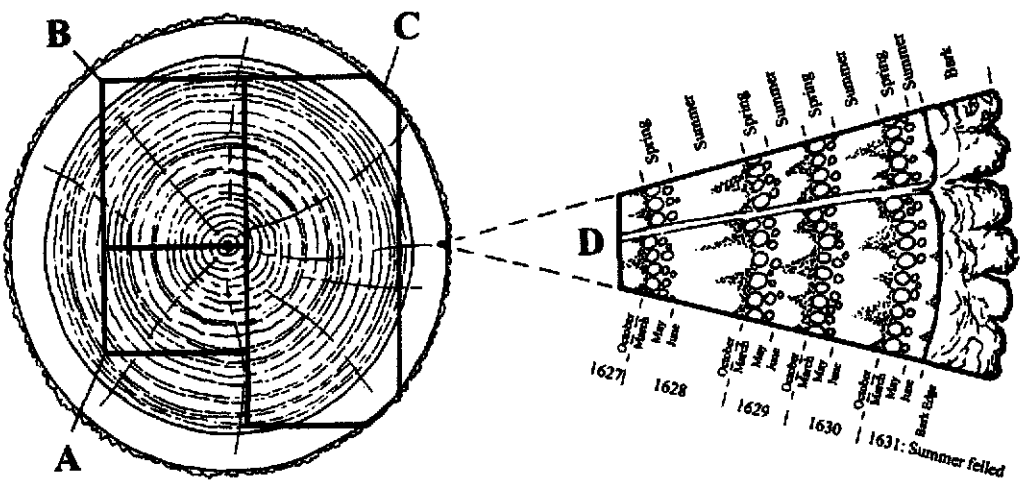
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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 9 – 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)

FERNHURST FURNACE

This site, which is about 1km west of the village of Fernhurst, is one of the finest preserved of the many medieval iron furnaces of the Weald, and is a Scheduled Monument, requiring Schedule VI consent for work on it. The most comprehensive descriptions of the site, its context, and excavation works are to be found in Magilton *et al* (2003), published by Chichester District Council. A number of oak timbers remain below the sluice, four being readily visible at the time of sampling, though others could be detected under the surface of the water. The continuous wet/dry cycles and movement of the water poses problems with the timbers erosion. It was therefore decided that cutting a slice from three of the exposed timbers was a good opportunity to maximise the information from these timbers before they deteriorate further, with the possible option to further sample other timbers at a later stage if it is felt necessary.

RESULTS AND DISCUSSION

Details of the timbers sampled and basic characteristics of the ring series are shown in Table 1. Figures 1 & 2 show the site at the time of sampling, with four timbers being visible, whilst others are recorded at the site (see Fig 6) and were detected under the water level. The decision was taken on-site not to sample the timber nearest the sluice on the left bank as this was the timber appeared to be the least vulnerable to erosion, and would be available if necessary at a later date. Sample FFN01 comes from a timber on the left bank (as one looks downstream) that comes out to the remains of a wall. This turned out to have few rings (41 measured) as was not dated.

The remaining samples (see Figs 4, 5 & 6) did have sufficient numbers of rings and were dated. The lack of sapwood and the loss of the outer parts of the trees used when the timbers were converted and their subsequent erosion make the interpretation of the results a little difficult. The downstream timber (FFN02) yielded a 132-year sequence that dated very firmly to the period 1406_1537 (Table 2a). The minimum likely number of sapwood rings for this area (nine) mean that felling of the tree is likely to have been after 1546, but there is no indication of how many rings may have been lost. The third sample came from the upstream timber not far from 02, and this also yielded a 132-year sequence, this time dated firmly to the period 1334–1465 (Table 2b). Again there is no indication of how many rings may have been lost in conversion and subsequent erosion, the earliest likely felling date being 1474 (1465 plus a minimum 9 rings). It is quite possible that both these timbers are actually contemporaneous, and indeed the rings that do overlap between the two samples (Fig 7) do have very similar growth patterns.

This exercise has been useful in that it does rule out the possibility that the timbers were from a much earlier building nearby, and it gives some indication of the age of the timbers, though this is necessarily limited in the absence of sapwood. Further timbers may show a grouping in the dates of the outer rings which may indicated the likely felling dates, but it seems likely that the trees used were felled on purpose for this structures found on the site, and a late 16th century origin is indeed possible.

The timber, not surprisingly, is almost certainly of local origin.

ACKNOWLEDGEMENTS

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Figure 1: *Photograph of the site showing the right bank with timbers* in situ

Figure 2: *Photograph of the left bank with view of the timbers* in situ

Figure 3: *Photograph of the timber* FFN01 *showing the upper part of the timber removed*

Figure 4: *Photograph of sample* FFN02 *after removal. Note the areas of rot showing the gradual degradation of the timber*

Figure 5: *Photograph of timber* FFN03 *after sampling*

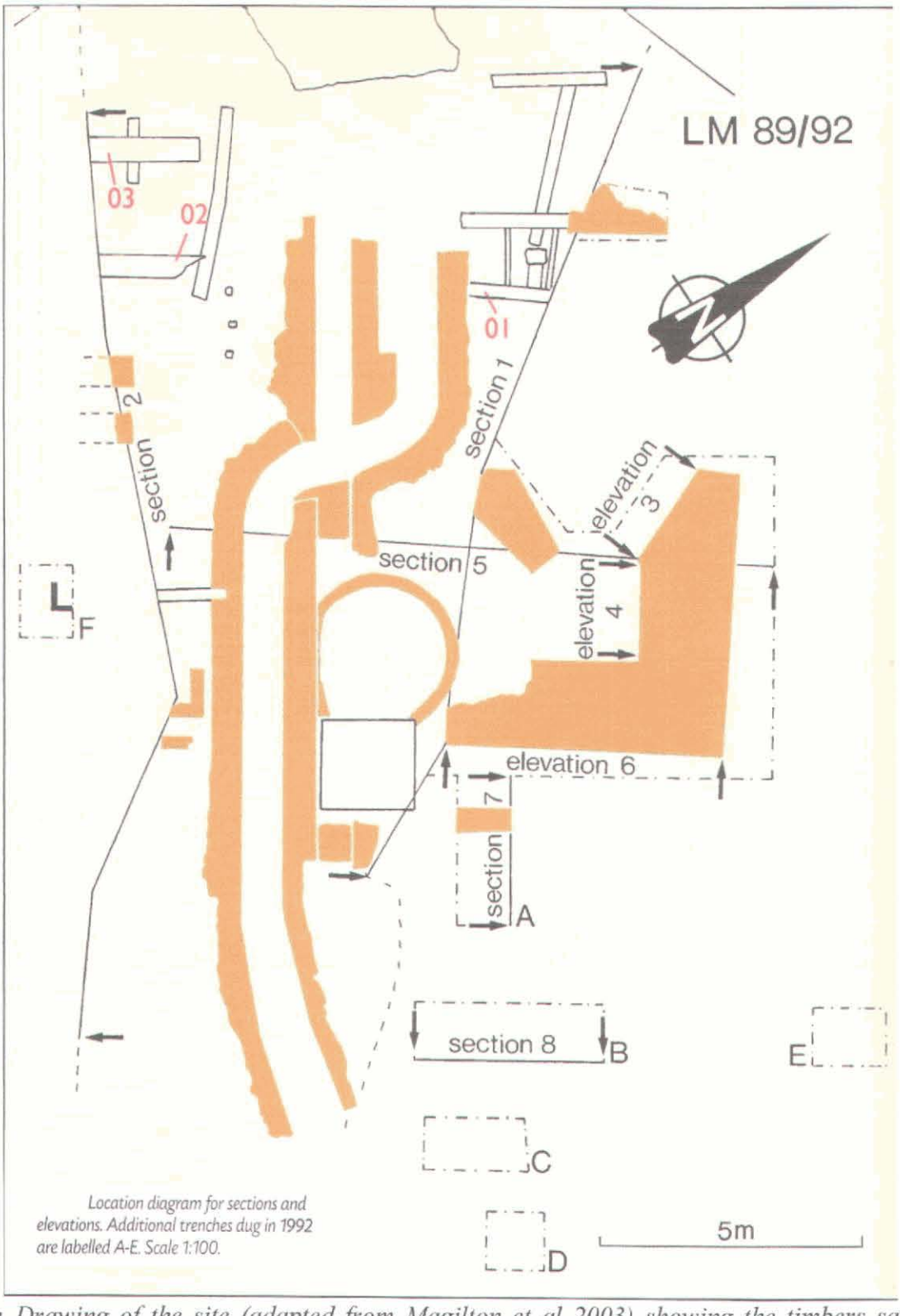

Figure 6: *Drawing of the site (adapted from Magilton et al 2003) showing the timbers sampled for dendrochronology*

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Table 1: Details of samples taken from Fernhurst Furnace, West Sussex

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
FFN01	East-most visible timber on left bank	undated	-	-	41	3.82	1.04	0.24	unknown
FFN02	East-most visible timber on right bank	1406-1537	-	-	132	1.46	0.99	0.20	after 1546
FFN03	West-most timber on right bank	1334-1465	-	-	132	1.70	0.86	0.28	after 1474

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

Table 2a: Dating evidence for the site sequence **FFN02 AD 1406–1537** against dated reference chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
REGIONAL CHRONOLOGIES						
Southern England	Southern England Master	(Bridge 1998)	**SENG98**	944–1790	132	7.3
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	132	6.1
London	London Master Chronology	(Tyers pers comm)	**LONDON**	413–1728	132	5.7
INDIVIDUAL SITE CHRONOLOGIES						
Hampshire	Burhunt Barn	(Bridge *et al* 2013)	BURHUNT	1377–1506	101	6.6
Hampshire	Mary Rose 'original' timbers	(Bridge and Dobbs 1996)	ORIGINAL	1334–1503	98	6.5
Oxfordshire	Greys Court, Rotherfield Greys	(Miles *et al* 2009)	GREYSCTA	1319–1618	132	6.5
Hampshire	Hambledon Church	(Bridge 2006)	HAMBLDN1	1269–1346	56	6.4
Hampshire	Church Farm, Barton Stacey	(Miles and Worthington 2002)	BRTNSTCY	1381–1539	132	6.3
Hampshire	Franklin Farm, Dean	(Bridge *et al* 2010)	FRANKLN2	1398–1520	115	6.2
Warwickshire	Guildhall, Stratford-on-Avon	(Arnold *et al* 2006)	SUABSQ02	1377–1502	97	6.1
Gloucestershire	Swan House, Blakeney	(Miles *et al* 2009)	SWANHS	1386–1628	132	6.0
Hampshire	St Olaf's Pond Cottage, Wonston	(Miles and Worthington 1997)	STOLAFS	1376–1535	130	6.0

Table 2b: Dating evidence for the site master **FFN03 AD 1334–1465** against dated reference chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
REGIONAL CHRONOLOGIES						
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	132	7.0
Southern England	Southern England Master	(Bridge 1998)	**SENG98**	944–1790	132	5.8
England	Southern Central England	(Wilson *et al* 2012)	**SCENG**	663–2009	132	5.4
Kent	Kent Master Chronology	(Laxton and Litton 1989)	**KENT88**	1158–1540	132	5.2
INDIVIDUAL SITE CHRONOLOGIES						
Hampshire	Rye Cottage, Mapledurwell	(Miles and Worthington 1999)	RYECOTT1	1317–1486	132	6.7
West Sussex	St Andrew's Church, Ford	(Bridge 2000)	FORD	1286–1511	132	6.2
Hampshire	Great Barn, Old Basing	(Bridge 1997)	BOBROOF	1347–1535	119	6.1
Oxfordshire	The Stores, East Hendred	(Miles and Worthington 1999)	EHENDRD1	1353–1472	113	6.1
Sussex	Warhams, Rudgwick	(Miles *et al* 2009)	WARHAM3	1342–1606	124	5.9
West Sussex	Bosham Church Spire	(Miles and Worthington 1999)	BOSHAM	1303–1405	72	5.8
Hampshire	Strete Farm, N. Warnborough	(Miles and Worthington 2002)	STRETEFM	1332–1505	132	5.7
Hampshire	Castlebridge Cottages, N.Warnborough,	(Miles and Worthington 1997)	CSTLBRDG	1347–1532	119	5.4
Hampshire	Southwick Barn	(Miles and Worthington 1998)	SWKBARN	1362–1493	104	5.3

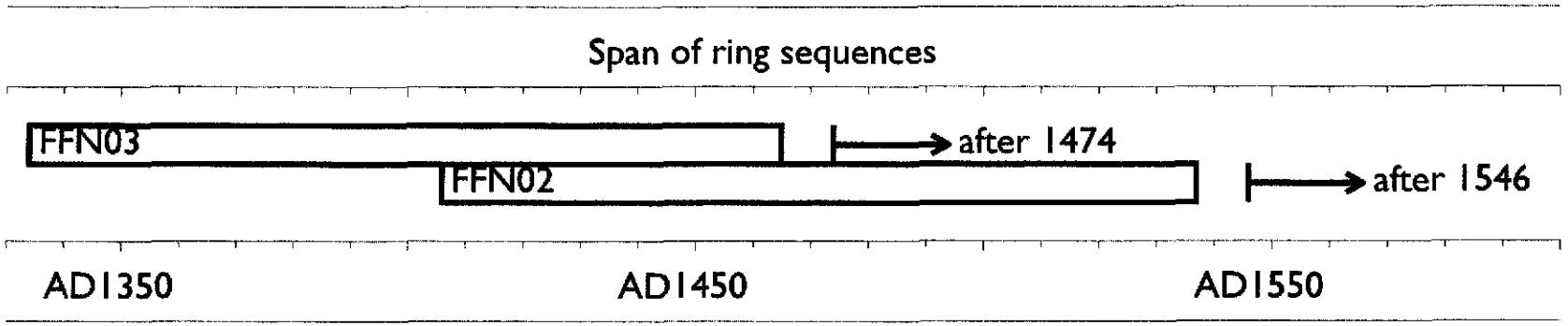

Figure 7: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling dates.