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# TREE-RING ANALYSIS OF TIMBERS FROM SAUNDERS WHARF, HEDSOR WHARF, BOURNE END, NEAR TAPLOW, BUCKINGHAMSHIRE

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**Summary**

**Core samples were obtained from nine different oak timbers in the building known as Saunders Wharf, at Hedsor Wharf, in Berkshire. Analysis and dating by dendrochronology reflects the complicated nature of the building, as evidenced by the structural evidence for the re-use of old beams, in that timbers with different felling dates have been found.**

**One timber, reused as a strut, is from a tree that was probably growing as early as the mid-twelfth century. Whilst the exact felling date of this tree cannot be determined because it is missing its outermost rings, it is likely to have been cut some time after *ca* 1230. Another single timber, re-used as a collar, has felling date estimated to lie in the range 1450 – 75.**

**There is, however, a small group of timbers, principal rafter, purlins, which were felled in 1561. Given that these timbers appear to be primary it is possible that these represent the approximate construction date of the original building as a whole. No other timbers with later felling dates have been identified. It is probable that the timbers here dated represent the building referred to in a document of 1573 which cites a lease of Ralph Hawtrey to Thomas Saunders of a wharf '*called the "New Wharf", with a house thereon lately builded, and adjoining the Thamys side'.***

## Introduction

As a whole Hedsor Wharf at Bourne End, near Taplow, in Buckinghamshire (SU 904 860), is an extensive collection of very fine late-eighteenth or very early-nineteenth century brick buildings comprising a substantial main house, a smaller, though still large, ancillary building, greenhouses, an enclosed garden, and surroundings acres, all picturesquely set on the north bank of the river Thames. Currently undergoing conservation and repair, the site has an extended history, with finds and archaeological excavations in the nineteenth and twentieth centuries demonstrating the presence of some prehistoric and Roman remains (Baynes 1921 and Branigan 1967).

In the medieval period the area was for a long time being particularly concerned with the trade by river of tiles downstream to London, of especial note being those supplied during the major rebuilding works at Windsor Castle during the fourteenth century (Hope 1908). To facilitate the development of this trade a series of wharf buildings appear to have been built at Hedsor to allow transports to load cargoes; hence the site name Hedsor 'Wharf'.

Although now clad in brick and extended, the two principal buildings of the site (see Fig 1), the main house and the adjacent ancillary building, known as 'Saunders Wharf', with which this report is particularly concerned, appear to have originally been timber-framed. Within both buildings can be found substantial quantities of timber, especially to Saunders Wharf which retains timbers to its lower floors.

## The Saunders Wharf building

Judging by the brief survey made at the time of sampling, it seems that Saunders Wharf was originally a two bay structure formed by three principal rafter with tiebeam and collar trusses. Possibly unusual for this part of England (it is certainly more common in north-east England) the principal rafters are reduced in size at collar level. The roof trusses are supported by main wall posts from which spring braces to the tiebeams, with queen struts rising from the tiebeams to the collars (Fig 2). The trusses support single purlins to each roof slope, these in turn supporting the 8 – 10 replacement common rafters of each bay (Fig 3).

Despite there being virtually none now, it would appear that as originally formed there might have been windbraces, either straight or curved, between the principal rafters of each truss and the purlins. In some cases there are mortices in principal rafters and purlins where the ends of these members would have been housed. Some of the purlins, however, and some of the principal rafters too, do not have such mortices, or have mortices to one side or face only, but not the other. The east principal rafter of truss II, for example, has a mortice on its north face for a wind brace, but not on its south face, although the east purlin to the south of truss II (running in to truss III) does have mortices at both ends as if to receive windbraces.

It would seem possible that all three trusses might have been closed by partition walls, at least in the roof-space. Almost all the principal rafters have two or three small holes on their under-faces which would have taken staves or small poles (Fig 4). In some instances the tiebeams and / or the collars have shallow grooves to

receive the ends of the staves. Withies or laths would have been woven between the staves to form a wattle screen which might then have been plastered with mud daub mixed possibly with straw or horse hair.

It is not possible to determine whether or not the closed partitioning of the middle truss, truss II, extended through from the roof space and down to the first and ground floors, but by comparison with other buildings it is probably unlikely. It is probable, however, that the end trusses, trusses 1 and III, and the front and back walls, were filled with close-set stud posts. The underside of truss 1, and parts of the wall plates to each side, appear to have small mortices which would have held such studs. In this instance it is not possible to determine what the gaps between the stud posts would have been filled with. The most common method was to use short stave pieces (though occasionally stone was used), which would then be plastered with mud daub.

Some of the timbers show evidence of their conversion from raw trees, such as cut, chop, and saw marks, or evidence of their carpentry, such as scribed making-out lines for some of the joints. There also appear to be a series of assembly marks. These appear to run from 'I' at the south to possibly 'III' at the north (the front of the building is taken to be facing west, towards the river). However, not all timbers appear to have assembly marks on them (Fig 5).

The features seen at Saunders Wharf, the form of the framing with its close-set timber studding, the braces, the collars and queen posts, etc, and the size and setting of the timbers, would suggest a building highly typical of those seen all over south-central and south-eastern England between the early-sixteenth and later-seventeenth century (as one moves further south and west close-set studding dies out in favour of square panels). However, anomalies such as the redundant mortices or joint beds and the differences in timber size, would lead to the conclusion that some of the timbers have been replaced, or that some have been re-used from other buildings. The east purlin between trusses II and III almost certainly has as this has no mortices at all and is not oak, like all the other timbers, but is a conifer. The west principal rafter of truss II has also almost certainly been replaced; this has no mortices either, no assembly marks, and is of a different size to the other principals.

Saunders Wharf has been altered and extended since its original construction. The earliest extension may have been the construction of a third, possibly timber-framed, bay to the south, in-line with the original two-bay building. There are some timbers in the roof of this third bay but they are generally of softwood, or, where they are oak, unsuitable for analysis in that they have insufficient rings for reliable dating. The building appears to have been subsequently extended to both the west, or river frontage, and the east, or rear, so that the original timber-framed two-bay building is now heavily encased within later work (fig 6).

On stylistic grounds, therefore, it would seem that Saunders Wharf is typical of the sixteenth or seventeenth century. However, and perhaps not unexpectedly for a building of its likely age, while it has undergone some alteration, and while its builders may have availed themselves of reclaimed timbers, there are some beams in the building which are primary and probably belong to the original construction phase.

**Sampling**

Sampling and analysis by tree-ring dating of timbers within Saunders Wharf were commissioned by Anthony Jaggard FSA of John Stark & Crickmay Partnership, Architects, Consultants and Planning Supervisors of Dorchester. This was done on behalf of the owner of Hedsor Wharf, Mrs Josie Rowland, out of personal interest and as part of a general enquiry into the background history and development of the site whilst conservation and repairs were underway, this making the timbers especially accessible. It was hoped that tree-ring analysis might indicate the dates at which certain timbers had been felled and, if possible, establish a likely primary construction date for the building as a whole.

Thus, from the material available a total of nine core samples was obtained. All samples were taken from the roof timbers in the belief that, although there was evidence for some reuse of material here, this area had been relatively less disturbed than the lower levels, and might more likely represent the primary construction phase of the building. The roof timbers, furthermore, contained beams which appeared to be more suitable for tree-ring analysis in having sufficient rings for reliable analysis and in having timbers which retained complete sapwood; such timbers, it was hoped, would demonstrate a precise year of felling.

Each sample was given the code HDS-A (for Hedsor, site "A") and numbered 01 – 09, its position, and other relevant information about the timber, being carefully recorded. The position of these samples were marked on sketch plans made at the time of sampling, which were later worked-up to those reproduced here as Figure 6a/b. Details of the samples are given in Table 1. In these figures, and in Table 1, the trusses and frames have been numbered from site south to site north following what appears to be the numbering system found on the timbers themselves. These appear to show truss I as being at the south end, truss II in the middle, and truss III to the north end. Individual timbers are identified on an east – west basis as appropriate.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to firstly thank the owner of Hedsor Wharf for taking such an interest in the building and for generously funding tree-ring dating. We would also like to thank Anthony Jaggard and Tony Ward for commissioning the work and for their on-site tour and discussion. Finally, we would like to thank the staff of Simms Construction who were at all times most understanding and helpful and whose cooperation during sampling could not be improved upon.

## Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees, the most frequently used building timber in England) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March – September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically influenced pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of

them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth-ring pattern of the tree. The pattern of a short period of growth, 20, 30 or even 40 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 54 years or so. In essence, a short period of growth, anything less than 54 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal of tree-ring dating is that, until the early- to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland, or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimeter. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which *is* known. When the growth-ring sequence of a sample “cross-matches” repeatedly at the same date span against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a “*t*-value”; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phase of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a “site chronology”. As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for satisfactory analysis.

## Analysis

Each of the nine samples obtained from Saunders Wharf was prepared by sanding and polishing and their annual growth-ring widths were measured. The growth-ring widths of the nine samples were compared with each. At a minimum value of *t*=3.5 a single group of four samples could be formed, the individual samples cross-matching with each other at the relative positions as shown in the bar diagram, Figure 7. The four cross-matching samples were combined at these off-set positions to form site chronology HDSASQ01, this having an overall length of 101 rings. Site chronology HDSASQ01 was then satisfactorily dated by repeated and consistent cross-matching with a number of relevant reference chronologies for oak as spanning the years 1461 to 1561. The evidence for this dating is given in the *t*-values of Table 2.

Site chronology HDSASQ01 was then compared with the remaining five ungrouped samples but there was no further satisfactory cross-matching. Each of the five ungrouped samples was then compared individually to the full range of reference chronologies for oak, this indicating cross-matches and dates for two individual samples, HDS-A04 and A09. Sample HDS-A04, which has 58 rings, has a first and last ring date of 1157 and 1214, while sample HDS-A09, which has 54 rings, has a first and last ring date of ring date of ring date of 1382 and 1435, see Tables 3 and 4. The three remaining ungrouped samples, HDS-A03, A05, and A07 cannot be dated.

## Interpretation

Analysis by dendrochronology has produced a single site chronology, HDSASQ01, comprising 4 samples, its 101 rings dated as spanning the years 1461 to 1561. Two samples in this site chronology, HDS-A01 and A02, from the two principal rafters of truss 1, retain complete sapwood, denoted by 'C' in Table 1 and the bar diagrams. This means that they each have the last ring produced by the trees represented before they were felled. In both cases the last complete sapwood ring, and thus the felling, is the same at 1561. The relative positions of the heartwood/sapwood boundaries on the other two samples in this site chronology, HDS-A06 and A08 (which are missing only their outer sapwood rings), would suggest that they too represent timbers which were felled in 1561.

There are also two other samples which have been dated individually. The earliest, HDS-A4, has a first ring date of 1157. Given that the sample does not quite include the centre ring of the beam, this would suggest that the tree originally felled for this timber began growing about 1150, during the reign of Stephen, the last Norman King of England. The last ring on sample HDS-A04 is dated to 1214. Unfortunately, the sample does not retain the heartwood/sapwood boundary (it has been heavily trimmed of its outer rings) and it is thus not possible to indicate when the tree was felled except to say it is unlikely to be before about 1230.
The second individually dated sample, HDS-A09, is from the collar of truss 3, which clearly shows evidence for reuse by way of the redundant mortices on its upper face. Sample HDS-A09 has a first ring date of 1382 and a last ring date of 1435. The sample retains the heartwood/sapwood boundary which means it is missing only its outer 15 to 40 sapwood rings. This would suggest that the timber represented is likely

to have been felled between 1450 and 1475.

It is perhaps worth sounding a slight note of caution about the dating of these two individual samples. As described in the notes about tree-ring dating, above, it is usual to combine cross-matching samples together to make a site chronology. This gives added reliability and confidence to the results. The dating of single samples is always slightly more difficult as it is possible for an individual to produce a spurious cross-match. In this case, given that the *t*-values of the cross-matches seen in Tables 3 and 4 are high and consistent, and that there is structural evidence for the re-use of timber, the dating indicated cannot be rejected.

Judging by the values of the cross-match between some of the samples, particularly HDS-A01 and A02, it is likely that the two trees represented were growing adjacent to each other in the same copse or stand of woodland; samples HDS-A06 and A08 represent trees that were probably growing further apart. Where the source woodland for these four timbers was located cannot be deduced precisely from tree-ring analysis. It is likely, however, that it lay to the north and west of Hedsor, probably up-stream on the Thames. As can be seen from Table 2, four of the best cross-matches for the Hedsor samples are found against reference chronologies made up of material from Oxfordshire, particularly those from Newnham Murren and Nuffield.

The cross-matches for the other two individually dated samples appear to be more widespread, perhaps as a consequence of their being individuals rather than the composite data of two or more samples. The cross-matches may also represent the fact that the timbers have originated from more widely dispersed sources. There is, however, still a tendency for the best cross-matches to be found against southern and central English reference chronologies, reflecting their likely general source area.

## Conclusion

The analysis of the nine samples from Saunders Wharf would strongly suggest, therefore, that the building was originally constructed of timber felled in 1561; the form of the framing and other stylistic indicators would certainly be in keeping with such a date. Either at the time of construction, or during subsequent repairs or alterations, timbers with different felling dates have been used. One such timber is unlikely to have been felled before 1230; another timber was probably felled in the period 1450 – 75.

It is known from documentary sources that in 1556 Sir Edmund Peckham sold Hedsor Manor to Ralph Hawtrey, with the exception of '*one wharf with certain lands, tenements and hereditaments'*, which were sold to Richard Over. In 1573 Ralph Hawtrey sold the manor to Rowland Hynde, the deed citing a lease of Ralph Hawtrey to Thomas Saunders of a wharf '*called the "New Wharf", with a house thereon lately builded, and adjoining the Thamys side',* the site subsequently known as Saunders Wharf. It would seem probable that it was for this house that the timbers dated here were felled in 1561.

Table 1: Details of samples from Saunders Wharf, Hedsor Wharf, Bourne End, near Taplow, Buckinghamshire

| Sample number | Sample location | Total rings | *Sapwood rings | First measured ring date | Last heartwood ring date | Last measured ring date |
|---|---|---|---|---|---|---|
| HDS-A01 | East principal rafter, truss 1 | 101 | 31C | 1461 | 1530 | 1561 |
| HDS-A02 | West principal rafter, truss 1 | 100 | 40C | 1462 | 1521 | 1561 |
| HDS-A03 | Tiebeam, truss 1 | 54 | 3 | ------ | ------ | ------ |
| HDS-A04 | West queen post, truss 1 | 58 | no h/s | 1157 | ------ | 1214 |
| HDS-A05 | East purlin, truss 1 – 2 | 54 | 4 | ------ | ------ | ------ |
| HDS-A06 | West purlin, truss 1 – 2 | 57 | h/s | 1493 | 1549 | 1549 |
| HDS-A07 | West purlin, truss 2 – 3 | 65 | h/s | ------ | ------ | ------ |
| HDS-A08 | East principal rafter, truss 3 | 54 | h/s | 1487 | 1540 | 1540 |
| HDS-A09 | Collar, truss 3 | 54 | h/s | 1382 | 1435 | 1435 |

*h/s = the last ring on the sample is at the heartwood/sapwood boundary
C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the timber

Table 2: Results of the cross-matching of site chronology HDSASQ01 and relevant reference chronologies when the date of the first ring is 1461 and the last ring date is 1561

| Reference chronology | Span of chronology | *t*-value | |
|---|---|---|---|
| England, London | 413 – 1728 | 8.0 | ( Tyers and Groves 1999 unpubl ) |
| Upper House Farm, Nuffield, Oxon | 1431 – 1627 | 7.6 | ( Haddon-Reece *et al* 1990 ) |
| Pye Corner, Moulsford, Oxon | 1340 – 1558 | 7.4 | ( Alcock *et al* 1991 ) |
| Hall Farm, Newnham Murren, Oxon | 1412 – 1551 | 7.2 | ( Howard 2006 forthcoming ) |
| 26 Westgate Street, Gloucester | 1399 – 1622 | 7.1 | ( Howard *et al* 1998 ) |
| 53 The Causeway, Steventon, Oxon | 1437 – 1542 | 6.4 | ( Alcock *et al* 1989 ) |
| South-central England | 1458 – 1681 | 6.2 | ( Howard 2002 unpubl ) |
| East Midlands | 882 – 1981 | 5.7 | ( Laxton and Litton 1988 ) |

Table 3: Results of the cross-matching of sample HDS-A04 and relevant reference chronologies when the date of the first ring is 1157 and the last ring date is 1214

| Reference chronology | Span of chronology | *t*-value | |
|---|---|---|---|
| Great Coxwell Barn, Berks | 1082 – 1246 | 5.3 | ( Howard *et al* 1990 unpubl ) |
| Medbourne Manor, Medbourne, Leics | 1086 – 1287 | 5.2 | ( Howard *et al* 1999 ) |
| Angel Choir, Lincoln Cathedral | 904 – 1257 | 4.7 | ( Laxton and Litton 1988 ) |
| Southern England | 1083 – 1981 | 4.6 | ( Bridge 1988 ) |
| East Midlands | 882 – 1981 | 4.5 | ( Laxton and Litton 1988 ) |
| Stoneleigh Abbey, Stoneleigh, Warwicks | 1124 – 1339 | 4.5 | ( Howard *et al* 2000 ) |
| Worcester Cathedral | 1057 – 1285 | 4.4 | ( Arnold *et al* 2003 ) |
| Reading Waterfront, Berks | 1160 – 1407 | 4.4 | ( Groves *et al* 1997 ) |

Table 4: Results of the cross-matching of sample HDS-A09 and relevant reference chronologies when the date of the first ring is 1382 and the last ring date is 1435

| Reference chronology | Span of chronology | *t*-value | |
|---|---|---|---|
| Barn Grounds, Binfield, Oxon | 1353 – 1452 | 6.7 | ( Alcock *et a*l 1991 ) |
| Lacock Abbey, Lacock, Wilts | 1314 – 1448 | 5.6 | ( Esling *et al* 1990 ) |
| April Cottage, Rothley, Leics | 1343 – 1443 | 5.2 | ( Alcock *et al* 1990 ) |
| Anne Hathaway's Cottage, Stratford, Warwick | 1319 – 1462 | 4.9 | ( Alcock *et al* 1991 ) |
| Rooftree Cottage, Hoby, Leics | 1348 – 1441 | 4.6 | ( Alcock *et al* 1990 ) |
| England, London | 413 – 1728 | 4.1 | ( Tyers and Groves 1999 unpubl ) |
| Southern England | 1083 – 1981 | 3.7 | ( Bridge 1988 ) |
| East Midlands | 882 – 1981 | 3.7 | ( Laxton and Litton 1988 ) |

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