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Tree-Ring Analysis of Further Oak Timbers from the Belfry of All Saints Church, Doddinghurst, Essex

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Summary

Tree-ring analysis was undertaken of the belfry at All Saints Church, Doddinghurst, during AD 1996 (Tyers 1996). An updated tree-ring dating programme of further timbers in the belfry was initially commissioned by English Heritage in AD 2001 during a grant aided repair programme. Assessment of timbers accessible during the repair showed that no dendrochronologically useful timbers relating to the primary construction of the belfry would become accessible during this work. Subsequently the repairs removed elements of timbers which were themselves eighteenth- or nineteenth-century repairs to the belfry structure and samples of these were collected and analysed. The absence of surviving sapwood prevents precise felling or construction dates from being obtained from this material but it provides a useful addition to the tree-ring series for the county.

Keywords

Dendrochronology
Standing Building

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TREE-RING ANALYSIS OF FURTHER OAK TIMBERS FROM THE BELFRY OF ALL SAINTS CHURCH, DODDINGHURST, ESSEX

Introduction

This document is a technical archive report on the tree-ring analysis of two oak timbers from the base of the belfry of All Saints Church, Doddinghurst, Essex (NGR TQ 5893 9902). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. 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 on the building.

All Saints Church lies to the north of Church Road in the village of Doddinghurst. The village lies in the south-west corner of Essex, *c* 5km north of Brentwood (Figs 1 and 2). The belfry has been undergoing an English Heritage grant aided repair, designed to strengthen the bottom of the belfry where death watch beetle (*Xestobium rufovillosum* L) had potentially weakened both the original timbers and some intermediate repairs in the same area. The initial dendrochronological commission was to asses whether the temporary supporting structure, installed during the repairs, would allow sampling of material that it had not been possible to access during an earlier sampling programme on the belfry. This assessment identified that there was no further potential for sampling the *in-situ* timbers since they were derived from trees with too few rings for reliable analysis. Arrangements were made for any sections of timber that were going to be entirely replaced during the repairs to be retained. Fragments of the sole plates were retained and subsequently analysed and dated. The results of the analysis of this material is reported here.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The methodology used for this building was as follows.

Several fragments of timbers were collected from the church by Elphin Watkin and were supplied to the author. These pieces were returned to the laboratory and representative cross-sections of those assessed as suitable for analysis were cut from them by band-saw.

The ring sequences in the sections were revealed by sanding. The complete sequences of growth rings in the slices that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1999). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the 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 these positions are supported by satisfactory visual matching.

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: 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 (Tyers 1998a). These figures are applicable to oaks from England and Wales. 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, seasoning, 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

Two dendrochronologically useful timbers were collected, sectioned, and measured. One other timber was of no potential use. The timbers were assigned arbitrary labels **X**-**Z** inclusive. Samples **X** and **Y** were suitable for analysis. This material is known to be derived from the two large east-west aligned sole plates that support the belfry although the precise original location of each individual section is unknown (Table 1).

The tree-ring series from the two suitable timbers were measured and the resultant series were then compared with each other. These sequences were found to match together to form an internally consistent group (Table 2). A 99-year site mean chronology was calculated, named DODNG_XY. This site mean was then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well correlated position was identified for the DODNG_XY sequence. Table 3 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample by this process and their interpretation.

Figure 4 graphically shows the chronological position identified for each component sample. Appendix 1 lists the individual sample series.

Discussion

The 99-year chronology DODNG_XY is dated AD 1637 to AD 1735 inclusive. It was created from two timbers. Neither of the dated samples were complete to the original bark surface, or retain any sapwood, or the heartwood/sapwood boundary (Table 1). All the timbers are oak (*Quercus* spp).

The dates of the latest rings in each sample vary by nearly 30 years, sample **X** ends at AD 1735, whilst **Y** ends at AD 1706. However it seems most probable that they are a co-eval pair of timbers, dating from sometime after AD 1745.

Conclusion

Because of the complete absence of sapwood the tree-ring results from these *ex situ* timbers do not provide any precise dating evidence. The belfry includes graffiti in two areas indicating repair works occurred here in both AD 1790 and AD 1850 (David Andrews pers comm.). The tree-ring results cannot strictly exclude either date for the sole plates, and of course it is also possible that undocumented repairs occurred at other times. However they seem more likely to be derived from the earlier of these two dates simply because the growth rates of the samples (3-4mm/year average) would otherwise imply the sole plates were cut from the middles of trees more than 1.2m in diameter which would be extraordinarily wasteful.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. David Andrews and Dave Stenning from Essex County Council provided information about the graffiti on the timbers. Elphin Watkin kindly collected the off-cuts. Peter Marshall from English Heritage kindly put together the request documentation, and Cathy Groves provided useful discussion of the results and checked the data against the material from Bolsover Castle.

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Figure 1 Location of Doddinghurst within England and Wales.]

Figure 2 Location of All Saints Church, Doddinghurst (

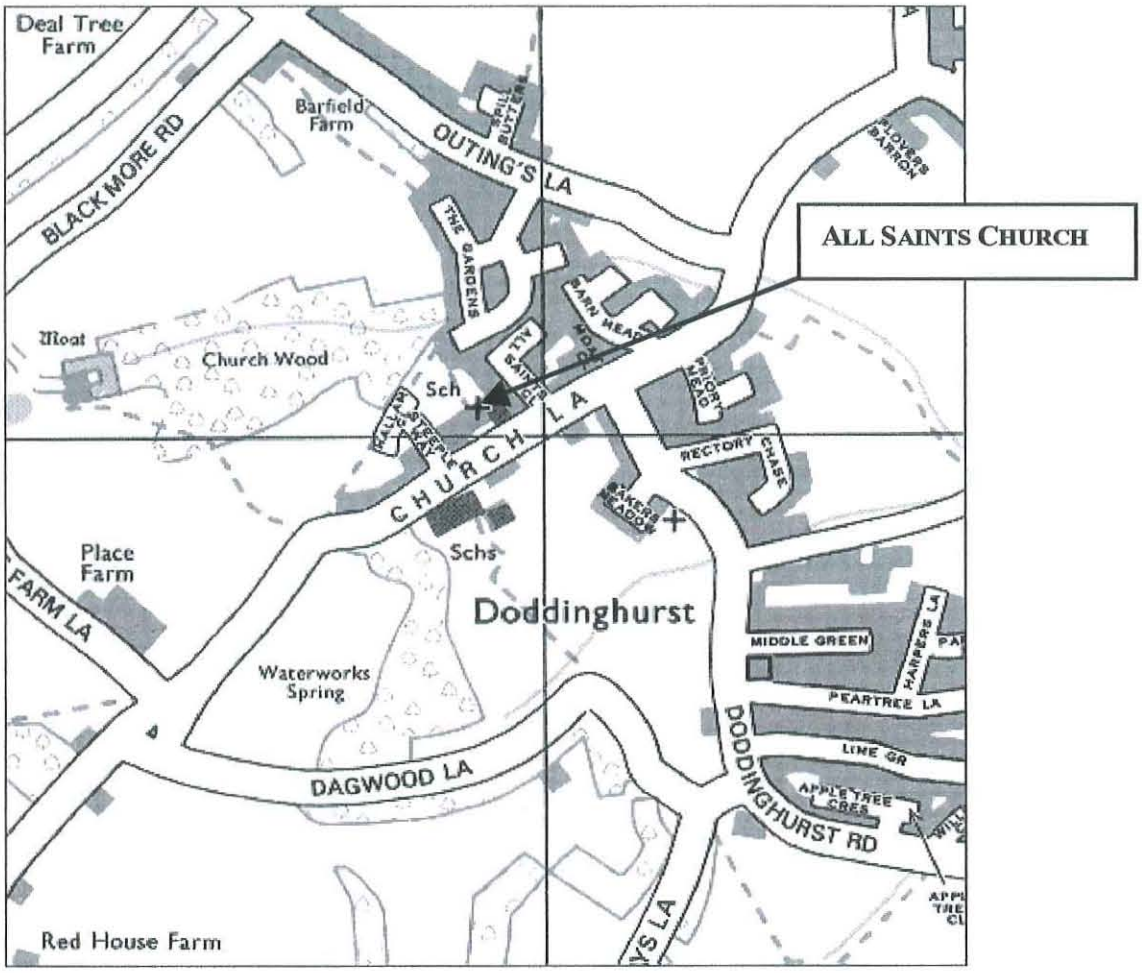


Figure 3 Elevation looking east of the belfry of All Saints Church, Doddinghurst, showing the sole plates (based on a drawing supplied by Elphin Watkin)

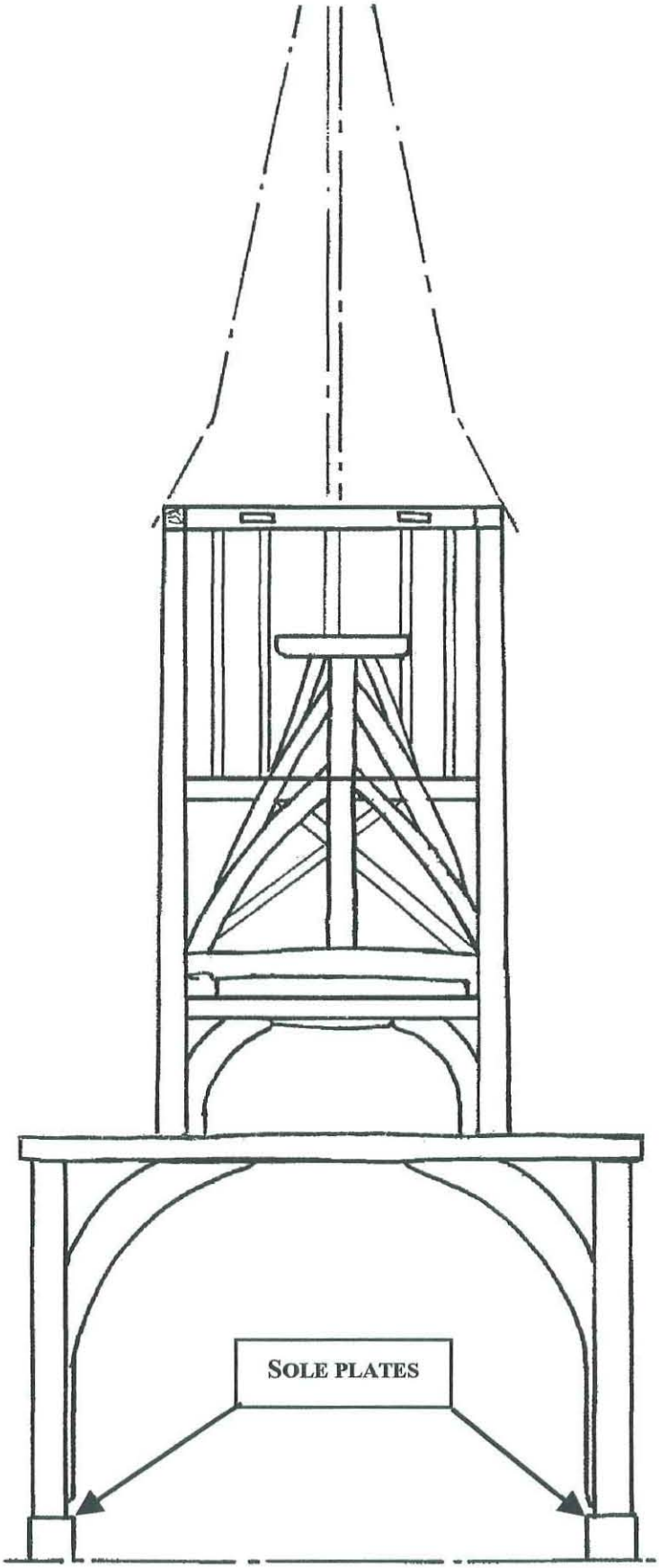
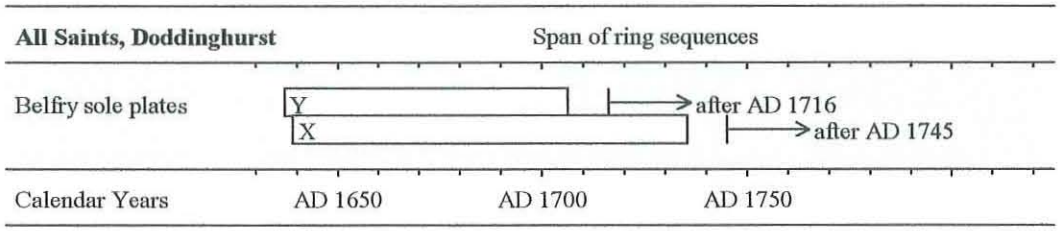


Figure 4 Bar diagram showing the chronological positions of the dated timbers from the belfry of All Saints Church, Doddinghurst. The estimated felling period for each sequence is also shown



KEY for figure 4

heartwood

Table 1 List of samples from timbers from the belfry of All Saints Church, Doddinghurst

Sample	Origin of section	Cross-section size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
X	Sole plate	*c* 600 x 550	97	-	3.22	AD 1639-AD 1735	after AD 1745
Y	Sole plate	*c* 600 x 550	70	-	4.11	AD 1637-AD 1706	after AD 1716
Z	Unknown origin	Unknown	< 50	-	-	Rejected	-

KEY for Table 1 Total rings = all measured rings. ARW = average ring width of the measured rings

Table 2

t-value matrix for the timbers forming the chronology DODNG_XY.

	Y
X	6.78

Table 3

Dating the mean sequence DODNG_XY, AD 1637-1735 inclusive. Example *t*-values with independent reference chronologies.

Area	Reference chronology	*t*-values
Buckinghamshire	Claydon House Middle Claydon (Tyers 1995)	6.04
Derbyshire	Riding School Bolsover Castle (Howard *et al* forthcoming)	4.27
Hampshire	Petersfield Causeway Brickworks Drying Shed (author unpubl)	4.13
Hertfordshire	Cromer Windmill (Tyers 1998b)	4.83
Kent	Scotts Barn Rainham (Bridge pers comm)	4.68
London	Royal Arsenal Woolwich (Tyers 2000)	5.07
Nottinghamshire, etc	East Midlands regional master (Laxton and Litton 1988)	5.00
Suffolk	Ballingdon Bridge Sudbury (Tyers 2002a)	5.33
Wiltshire	Savernake Forest Briffa (Briffa *et al* 1986)	4.44
Yorkshire, North	Hovingham Hall (Tyers 2002b)	4.74

Appendix 1 Ring width data for samples from All Saints Church, Doddinghurst, 100 = 1mm

DODNG_X

303	362	305	352	391	399	304	333	329	340
308	295	204	282	271	358	397	340	342	348
256	300	236	261	334	336	317	367	262	275
269	334	293	324	303	293	263	281	357	455
470	456	355	527	315	281	252	261	327	387
357	316	376	279	231	255	252	274	293	424
318	328	285	348	356	363	368	431	346	402
314	253	340	344	378	302	355	384	383	259
208	235	353	236	235	303	253	319	362	285
295	300	286	309	291	455	290			

DODNG_Y

403	518	515	487	507	575	551	487	557	570
537	509	423	416	356	430	374	491	545	475
515	527	418	523	433	539	557	496	483	455
407	414	411	475	420	437	483	543	436	414
429	433	472	467	403	516	327	268	283	281
293	304	314	314	316	268	252	246	252	271
323	420	257	300	239	250	265	303	301	285