The tree-ring analysis of 22 timber framed buildings in Coggeshall, Essex

Introduction

Coggeshall in Essex is *c.* 15km west of Colchester, & *c.* 9km east of Braintree. This report summarises the sampling and the tree-ring results from 20 timber framed properties in the centre of Coggeshall, mostly within, or surrounding, a triangle formed by East Street, Church Street & Swan Alley (Figure 1). This work was funded by the Coggeshall Heritage Society with a Heritage Lottery Grant as one component of a project titled '*Discovering Coggeshall*'. Sampling was undertaken on 108 *in-situ* timbers from 20 different properties. Dates were obtained from 62 of these samples, from 16 of the properties. In the period prior to the onset of the coring programme 5 slices of historic timbers had been collected during building works in 3 Coggeshall properties. These were also analysed, and dates were obtained from all 5. Three of these are from one of the subsequently cored buildings, with a sample each from 2

further buildings within the study area. These results are integrated into this report. Detailed drawings and descriptions of these buildings are being produced as part of the project and will ultimately be integrated with the tree-ring results.

Tree-ring dating

Tree-ring dating or dendrochronology is an independent dating technique that utilises the pattern of ring widths within a sample of timber to determine the calendar period during which the tree grew. From England there are a large number of oak (*Quercus*) ring-width reference chronologies against which new sequences can be tested. The geographical and temporal coverage of these ring-width reference chronologies is extensive and a series of strong regional chronologies can be produced for almost the entire area. If suitable ring sequences can be obtained, and these can be matched to reference chronologies, precise dates can be provided for buildings for which the date is either unknown or uncertain. It is not intended here to provide comprehensive details of the method as there is an extensive body of literature upon the subject. Details of the technique are given in Schweingruber (1988). The general methodology and working practises used are described in English Heritage (1998). A dendrochronological study is of greatest value when integrated with detailed building recording.

Several important aspects of the technique that need to be outlined:

Trees put their new growth on the outside of their trunk, just under the bark. The most recent rings are therefore those originally most near the outside of the tree. A series of tree-rings from a sample run from the oldest which are those nearer the centre through to the most recent which are nearer the outside.

It is necessary that enough annual growth rings are obtained from any one sample in order to be able to find reliable cross-correlation with other tree-ring sequences. For oak the minimum acceptable number of rings is widely held to be 50, although some

of the material from each building usually requires more than this number if dating is to be successful.

Since not all timbers contain datable sequences, it is appropriate to obtain samples from a number of apparently suitable timbers in any building for which a date is sought.

The date of the tree-ring sequence must not be confused with the date of usage of a tree. The felling year of a tree can only be determined by obtaining sequences that have complete sapwood and either bark or identifiable bark-edge. Such samples do not survive in every building. Many dendrochronological studies of buildings provide felling date ranges or a *terminus post quem* dates.

The date of felling of a tree is not necessarily the date of its use. Observations relating to the toolmarks and conversion distortions can be used to suggest timbers were cut and framed whilst green. However it remains possible that timbers were re-used and that this has not been identified during the recording and interpretation of any particular structure.

The standard method of reporting correlation between tree-ring sequences employed throughout European dendrochronology is by use of coefficients calculated using the CROS algorithm of Baillie and Pilcher (1973). This algorithm produces *t* values. A *t* value of between -3.0 and 3.0 is normally found for each non-matching position of overlap between any two sequences. Values of between 3.0 and 5.0 may reflect the correct dating position. Values between 5.0 and 10.0 are usually reliable indicators of synchronous sequences. Values of 10.0 and above are usually found between two sequences derived from the same tree. Reference chronologies are composite series mathematically constructed from many separate data series. Reference chronologies correlate more strongly than individual series.

The *t*-value tables lists examples of matches between a selective group of independent reference series and dated individual timbers (in 9 cases) or composite data sets (in 14

cases) from various phases from the 16 successfully dated buildings. These tables are intended to show that there is independent corroboration for the dating given here, the lists of chronologies, many from within Coggeshall and Cressing parishes, clearly indicates that these trees were originally derived in the vicinity of Coggeshall. These tables are not exhaustive, since these individual samples, and composite sequences match many other reference series, these tables do not necessarily list the highest correlations available for these sequences.

Methodology

This project involved the attempt to sample a range of building types, of a range of dates within the study area of Coggeshall. Not all timber framed buildings are equally suitable for tree-ring dating due to one or more of the following features: not all timbers contain sufficient rings – this limits their potential for reliable dendrochronological dating; not all contain surviving evidence for the original outer surfaces of the tree – this limits the precision of any results obtained; and not all buildings contain timbers that are accessible in the right directions and with appropriate working room around them to be successfully sampled. A large group of buildings in the study area were visited and assessed for their dendrochronological potential.

Each timber in each assessed building or part of building was carefully examined for indications of the numbers of rings present and the presence of sapwood and bark. Identification of timbers in buildings that appeared to have more than the minimum necessary number of rings, that is those in which more than fifty annual rings appeared to be present, provided an initial list of buildings that had the potential for sampling. The results of this assessment were reviewed to provide the shortlist of selected properties.

For the selected timbers within each of the selected properties the precise location of the sample was determined by factors such as the localised presence of either sapwood and bark-edge, and ease of access. The sampling locations were designed to maximise

the numbers of rings obtained and, wherever possible, included all the sapwood and the original bark-edge of the tree. Sampling was undertaken on the selected structural elements using a 17mm diameter hollow corer attached to an electric drill. Despite selecting positions that initially included sapwood and bark the resultant cores do not always retain these delicate structures, since sapwood that has been attacked by woodworm, or other pests, will often crumble during coring. There are mixed views as to whether core holes should be filled after sampling. Generally accepted practise in standing buildings is to fill core holes where aesthetic considerations require them, here most of the core holes in the sampled properties were filled.

In the laboratory the sequence of ring widths in each core were revealed by preparing a surface equivalent to the original horizontal plane of the parent tree with a variety of bladed tools and/or increasingly fine sand papers. The prepared surfaces were then assessed again to determine the suitability of each sample for analysis. The complete sequence of the annual growth rings in each of the suitable samples were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequence of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. Cross-correlation algorithms (e.g. Baillie & Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. These positions were checked using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences.

This initial analysis can obviously only date the rings present in the cores. The correct interpretation of those dates relies upon the nature of the final rings in the individual samples. 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 that may be 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. Alternatively, if bark-edge survives, then a felling date can be directly

utilised from the date of the last surviving ring. The sapwood estimates applied here 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 medieval and modern oaks from England (author unpubl.). 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 reuse of timbers and any repairs before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of any component of the structure.

Results

Coggeshall was visited over a number of occasions between March 2010 and May 2011. The assessments of many buildings were undertaken during this period, and timbers from 20 of the properties were selected for sampling, this being undertaken between April 2010 & May 2011. The initial assessment indicated that there was great diversity in the suitability of the timbers in Coggeshall for tree-ring analysis. There are significant differences in the growth rates, scantling sizes and tree-ages of the timbers used, usually within any one structure, and certainly across the settlement as a whole. Most of the apparently original structural timbers are oak (*Quercus* spp.).

A total of 108 timbers were selected for tree-ring sampling from 20 properties, representing about 2 dozen phases of construction. The sampling attempted to encompass as wide a range of elements as possible within each building, where less samples were taken, relatively fewer suitable timbers were accessible within the structure. After preparation and re-examination a total of 88 of the samples were found to be suitable for analysis, the remainder variously either having fragmented, contained too few rings, or were trees with aberrant anatomical features. 62 of the suitable samples were found to be datable, this overall level of success repeats the success rates seen at similar projects in Herefordshire, Worcestershire, & Norfolk. Over a number of previous years 5 slices of timbers were collected from building repairs etc., within the study area, 3 of these are from one of the subsequently cored

buildings, the other 2 are a single timber each from a further 2 properties. The tree-ring results of the analysis of this material is given here, the precise source of these samples within these properties is not always known.

The following sections discuss the results obtained from the sampling and analysis of each building as well as the dendrochronological interpretation of each successfully dated building, the buildings are arranged in street number order, doing odd and even numbered buildings separately, and arranged clockwise starting from Church Street. The samples were given a continuous number sequence that reflects the sequence of sampling within the project, they are not in the order the buildings are discussed here. For each building there is a very simplified wire-frame ground plan. These ground plans provide a very rough indication of the sampling locations and illustrate the building alignment. The project outputs will include descriptions and drawings for these buildings. The following 22 sections refer to a number of tables and diagrams that appear at the end of the report. These, whilst not of general interest, provide an archive of the dendrochronological work undertaken.

1 Church Street, TL 8504 2262

Sampling

Three samples numbered **86-88** were obtained from this property (Figure 2, Table 1).

Results

Two of these samples proved usable. The measured series do not match each other. The 2 individual series were compared with medieval and post-medieval oak sequences from throughout England and elsewhere in Europe. No consistent and reliable cross-matching was identified between these samples and independent reference chronologies.

Interpretation

No dating was obtained.

5/7 Church Street, TL 8506 2263

Sampling

Nine samples numbered **44-52** were obtained from this property, 2 from the western range of the building, 7 from the eastern range (Figure 3), 5 of the samples were from the exposed floor timbers of the eastern range (Table 2). Three of the samples were unsuitable for analysis.

Results

The 6 measured series were compared with each other, and 4 were found to cross-match consistently (Table 3). These are all from the floor of the eastern building. These series were combined into a 80-year composite series, which was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1374-1453 inclusive for the rings in the composite sequence (Figure 4, Table 4). No consistent and reliable cross-matching was identified between the other 2 usable samples from this property and independent reference chronologies.

Interpretation

The 4 datable samples include one which was complete to bark-edge and the analysis identifies this timber was felled in the spring of 1454 (Figure 4), whilst the others retain some sapwood and are compatible with this interpretation. The floor timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this part of this building occurred very shortly after the felling date identified for one of these timbers. No dating was obtained for the western range samples.

14/16 Church Street, TL 8509 2264

Sampling

Sampling was undertaken in the front roof in this property with 2 samples numbered samples **77** & **78** (Figure 5, Table 5).

Results

Both samples from the building contained enough rings for analysis. These series do not cross-match each other. The individual series were compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that both sequences matched a number of independent reference chronologies at single consistent positions. These positions were both checked visually and both appear to be reliable matches (Figure 6, Tables 6 & 7).

Interpretation

Both of the datable samples retain bark-edges, both were felled in winter, one in 1545/6, the other in 1588/9. The former is a principal rafter, the latter a purlin, perhaps suggesting this roof was modified some decades after its original construction. The sampled timberswere of very awkward access but they appeared to exhibit seasoning distortions indicating the timbers were first used whilst they were still green. It is therefore appropriate to assume original usage of these timbers occurred at these dates. The back range roof contained unsuitable material for analysis, the rest of the timbers in the front roof was difficult to access.

18 Church Street, TL 8510 2265

Sampling

Samples **9** & **10** were obtained from ceiling joists in the back bay of this property (Figure 7, Table 8). The other timbers in the building were mostly unsuitable since they were short-lived and fast grown.

Results

Both of these samples proved usable, the samples cross-match each other strongly (Table 9), suggesting they are derived from a single tree. They were combined to produce a single composite sequence of 94 years length. This composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1334-1427 inclusive for the composite series (Figure 8, Table 10).

Interpretation

The 2 dated samples include one which was complete to bark-edge and the analysis identifies this timber was felled in the spring of 1428 (Figure 8). These ceiling joists exhibit seasoning distortions indicating this material was prepared whilst these timbers were still green. It is therefore appropriate to assume construction of this part of the building occurred very shortly after the felling date identified for this timber.

30 Church Street, TL 8513 2268

Sampling

Six samples numbered **89-94** were obtained from this property. Five of the samples were obtained from the front range, with the other from a storey post of the rear range (Figure 9, Table 11).

Results

Four of the samples proved usable, 3 were found to cross-match each other (Table 12), and these were combined to produce a single composite sequence of 74 years length. This composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of this composite sequence to other oak reference chronologies indicates a date of 1271-1344 inclusive for the rings in the composite series (Figure 10, Table 13). The sample from the rear range, **#94**, contained a sequence which also matched at a single consistent position. This position was checked visually and it appears to be a reliable match. The correlation of this sequence to other oak reference chronologies indicates a date of 1461-1608 for the rings in this sample (Figure 10, Table 14).

Interpretation

The 3 samples from the front range are each complete to the edge of sapwood, adding the minimum and maximum expected number of missing sapwood rings indicates these were felled between 1353 & 1386 (Figure 10). The rear range sample is complete to bark-edge and was felled in the winter of 1608/9. Both groups exhibit seasoning distortions indicating they were prepared whilst the timbers were still green. It is therefore appropriate to assume construction of the front section of the building occurred during the felling period identified, and the rear section very shortly after the felling date identified for this timber.

40 Church Street, TL 8515 2271

A single offcut slice, possibly from the spere truss of this building, was supplied by David Andrews in 2006 (Table 15).

Results

The sample contained a reasonable number of rings, and the series obtained from this timber was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the sequence to other oak reference chronologies indicates a date of 1254-1377 inclusive for the rings in the series (Figure 11, Table 16).

Interpretation

The slice appeared to retain the heartwood/sapwood boundary. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from this timber suggests that it was felled between 1387 & 1423 (Figure 11).

9 East Street, TL 8507 2257

Sampling

Samples **70-73** were obtained from this property (Figure 12, Table 17). Most of the other structural timbers were short-lived and fast grown, the rear range included elm timbers.

Results

Two samples from the building proved usable. The measured series do not match each other. They were compared with medieval and post-medieval oak sequences from throughout England and elsewhere in Europe. No consistent and reliable cross-matching was identified between these samples and independent reference chronologies.

Interpretation

No dating was obtained.

11 East Street, TL 8508 2258

A single offcut slice was supplied by David Andrews in 2008 (Table 18).

Results

The sample contained a reasonable number of rings, and the series obtained from this timber was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the sequence to other oak reference chronologies indicates a date of 1315-1398 inclusive for the rings in the series (Figure 13, Table 19).

Interpretation

The slice retained some sapwood. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from this timber suggests that it was felled between 1404 & 1440 (Figure 13).

19 East Street, TL 8510 2259

Sampling

Samples **64-66** were obtained from the rear range of this property (Figure 14, Table 20). The other timbers in the building were mostly unsuitable since they were short-lived and fast grown.

Results

All of these samples proved usable, the samples cross-match each other (Table 21). They were combined to produce a single composite sequence of 68 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1330-1397 inclusive for the composite series (Figure 15, Table 22).

Interpretation

All 3 of the dated samples were complete to bark-edge and the analysis identifies each timber was felled in the summer of 1397 (Figure 15). These timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this part of the building occurred very shortly after the felling date identified for these timbers.

23 East Street, TL 8512 2259

Sampling

Samples **1**-**8** were obtained from this property (Figure 16, Table 23).

Results

All of these samples proved usable, the samples cross-match each other (Table 24). They were combined to produce a single composite sequence of 128 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1472-1599 inclusive for the composite series (Figure 17, Table 25).

Interpretation

Six of the 8 dated samples were complete to bark-edge and the analysis identifies 5 of these timbers were felled in the spring of 1599, with the remaining sample apparently a few weeks later in the summer of 1599 (Figure 15), such a difference may simply reflect natural variation in the onset of tree growth during this period. These timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this building occurred very shortly after the felling date identified for these timbers.

27/29 East Street, TL 8514 2259

Sampling

Samples **83-85** were obtained from this property (Figure 18, Table 26). The other timbers in the building were mostly unsuitable since they were short-lived and fast grown.

Results

All 3 of these samples proved usable. None of these samples cross-match each other. The individual series was compared with medieval and post-medieval oak sequences from throughout England. It was apparent that one of the sequences matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the sequence from sample **#85** to other oak reference chronologies indicates a date of 1344-1408 inclusive for the sample (Figure 19, Table 27). No consistent and reliable cross-matching was identified between the other samples and independent reference chronologies.

Interpretation

The dated sample was thought to be complete to the edge of sapwood. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from this timber suggests that it was felled between 1418 & 1454 (Figure 19). It is therefore appropriate to assume construction of this part of the building occurred during the felling period identified for this timber.

33 East Street, TL 8513 2262

Sampling

Samples **79-82** were obtained from this property (Figure 20, Table 28). The other timbers in the building were mostly inaccessible for coring, or short-lived and fast grown.

Results

All 4 of the samples from the building proved usable. Three of them cross-match each other (Table 29), and were combined to produce a single composite sequence of 120 years length. This composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the sequence to other oak reference chronologies indicates a date of 1312-1431 inclusive for the rings in the composite series (Figure 21, Table 30).

Interpretation

Two of the datable samples were complete to bark-edge, but unfortunately the analysis identifies these timbers was felled in different years, the winters of 1428/9 and 1431/2 respectively (Figure 21). Although the timbers in the building exhibit seasoning distortions which appear to indicate they were prepared whilst they were still green, it is clear from the results that something has either been modified or that re-used or stored timber has been used. At present it is not clear how to interpret this result, although it seems clear this property dates from the second quarter of the 15th century.

6 & 6B East Street, TL 8504 2255

Sampling

Samples **31-43** were obtained from this complex group of properties (Figure 22, Table 31). Unfortunately the timbers in 6, 6B and 6C East St were mostly short-lived and fast grown.

Results

Twelve of the samples proved usable. Two of which cross-match each other (Table 32), and this pair and 2 of the other individual series each matched a number of independent reference chronologies at single consistent positions (Tables 33-35, Figure 23).

Interpretation

One of the dated samples retains bark-edge, and this was felled in the spring of 1441. This is a wall plate from 6B, and the other dated timber from 6B is from a joist below it, and this incomplete sample produces a compatible date. The timbers in this area exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this part of 6B East St occurred shortly after the felling date identified for the wall plate.

The other 2 datable samples are from the southern range of 6, one from a wall plate and the other from a window frame. Both retained sapwood, or heartwood/sapwood boundary. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from each of these timbers suggests either that they are of slightly different date, 1464-1497, and 1484-1520 respectively, or that they are the product of a single construction phase, dated between 1484 & 1497 (Figure 23). These timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this part of 6 East St occurred in the second half of the 15th century.

8 East Street, TL 8505 2255

Sampling

Samples **25-30** were obtained from 2 different parts of this property, this was during repairs following a fire in the building. Five samples were obtained from the southern range, the remaining sample was from the front range (Figure 24, Table 36). Unfortunately the front range timbers were mostly short-lived and fast grown.

Results

Four samples from the building proved usable, 3 of which, all from the rear range, cross-match each other (Table 37), with 2 storey posts evidently derived from a single tree. These 3 series were combined to produce a single composite sequence of 82 years length. The other measured sample, which is from a front range storey post, does not cross-match with this composite sequence. The composite series, and the unmatched individual series were compared with medieval and post-medieval oak sequences from throughout England, and elsewhere in Europe. It was apparent that the composite sequence matched a number of independent reference chronologies at a consistent position. This position was checked visually and appears to be a reliable match. The composite sequence matches oak reference chronologies at 1537-1618 inclusive (Figure 25, Table 38). No consistent and reliable cross-matching was identified between the front range sample from this property and independent reference chronologies.

Interpretation

All 3 of the dated samples were complete to bark-edge and the analysis identifies these timbers were felled in the winter of 1618/9 (Figure 25). These timbers exhibit seasoning distortions indicating the rear range was prepared from timbers which were still green. It is therefore appropriate to assume construction of this part of the building occurred very shortly after the felling date identified for these timbers.

10 East Street, TL 8506 2256

Sampling

Samples **53-60** were obtained from this property (Figure 26, Table 39), this included one timber from the inserted floor (that runs into 12 East Street?). The other timbers in the property were unsuitable as they were short-lived and fast grown.

Results

Five of these samples proved usable, 4 of which, all from the west range, cross-match each other (Table 40). These 4 series were combined to produce a single composite sequence of 77 years length. The other measured sample, which is from the inserted floor, does not cross-match with this composite sequence. The composite series, and the unmatched individual series were compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a consistent position. This position was checked visually and appears to be a reliable match. The composite sequence matches oak reference chronologies at 1320-1386 inclusive (Figure 27, Table 41). The floor joist cross-matched at a position identifying its sequence dates to 1469-1550 inclusive (Figure 27, Table 42).

Interpretation

Two of the western range samples were complete to bark-edge and the analysis identifies these timbers were felled in the winter of 1386/7 (Figure 27). These timbers exhibit seasoning distortions indicating the west range was prepared from timbers that were still green. It is therefore appropriate to assume construction of this part of the building occurred very shortly after the felling date identified for these timbers. The inserted floor joist retained some sapwood. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from this timber suggests it was felled between 1552 & 1588 (Figure 27). This timber also exhibits seasoning distortions indicating it was prepared whilst the timber was still green.

14 East Street, TL 8507 2256

Sampling

Timbers in this property were cored on 2 separate occasions with samples **11-20** obtained from the roof of the front range, and samples **61-63** obtained from the rear range (Figure 28). In 2009 3 timber offcuts were supplied by David Andrews (these were possibly sillbeams from the eastern wall?).

Results

15 of these samples or offcuts were suitable for analysis (Table 43). 13 of these series cross-match each other (Table 44). They were combined to produce a single composite sequence of 135 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1300-1434 inclusive for the composite series (Figure 29, Table 45).

Interpretation

One of the 13 dated samples was complete to bark-edge and the analysis identifies this timber was felled in the spring of 1435, this was a tiebeam, 11 of the remaining samples retain either sapwood or edge of sapwood and these are all likely to be contemporaneous (Figure 29). These timbers exhibit seasoning distortions indicating this material was prepared whilst they were still green. It is therefore appropriate to assume construction of the front half of this building occurred very shortly after the felling date identified for these timbers. No dating was obtained from the rear range.

16 East Street, TL 8508 2256

Sampling

Four samples were obtained from the roof of this property numbers **21-24** (Figure 30, Table 46).

Results

All 4 of these samples were suitable for analysis. All of these series cross-match each other (Table 47). They were combined to produce a single composite sequence of 83 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1553-1635 inclusive for the composite series (Figure 31, Table 48).

Interpretation

Two of the 4 dated samples were complete to bark-edge and the analysis identifies these timbers were felled in the spring of 1636, both of the remaining samples retain either sapwood or edge of sapwood and these are likely to be contemporaneous (Figure 31). These timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this building occurred very shortly after the felling date identified for these timbers.

18 East Street, TL 8509 2256

Sampling

Samples **67-69** were obtained from this property (Figure 32, Table 49). The other timbers in the building were mostly unsuitable since they were short-lived and fast grown.

Results

All 3 of these samples proved usable. 2 of the samples cross-match each other (Table 50), and were combined to produce a single composite sequence of 118 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1240-1357 inclusive for the composite series (Figure 33, Table 51). No consistent and reliable cross-matching was identified between the other usable sample from this property and independent reference chronologies.

Interpretation

The dated sample are both studs from the 1st floor. Both retained sapwood, or heartwood/sapwood boundary. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from each of these timbers suggests that they are the product of a single construction phase, dated between 1361 & 1393 (Figure 33). The timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this part of the building occurred between the dates identified for these timbers.

14/15 Market Hill, TL 8502 2258

Sampling

Three samples numbered **74-76** were obtained from this property (Figure 34, Table 52). The other timbers in the building were mostly inaccessible for coring, or short-lived and fast grown.

Results

Two of the samples from the building proved usable. These samples may cross-match each other, although this is by no means certain. The 2 individual series were compared with medieval and post-medieval oak sequences from throughout England and elsewhere in Europe. No consistent and reliable cross-matching was identified between these samples and independent reference chronologies.

Interpretation

No dating was obtained.

9 Market End, TL 8500 2254

Sampling

Samples **104-108** were obtained from this property (Figure 35, Table 53). The timbers in the roof were somewhat difficult to access.

Results

Four samples proved usable. These samples cross-match each other (Table 54), and were combined to produce a single composite sequence of 193 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at a single consistent position. This position was checked visually and appears to be a reliable match. The correlation of the composite sequence to other oak reference chronologies indicates a date of 1230-1422 inclusive for the rings in the composite series (Figure 36, Table 55).

Interpretation

Two of the datable samples retained sapwood. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from each of these timbers suggests, assuming they are the product of a single construction phase, that they were felled between 1422 & 1448 (Figure 36). These timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this building occurred between the dates identified for these timbers.

7 West Street, TL 8492 2253

Sampling

Samples **95-98** were obtained from this property, this was during repairs following a fire in the building (Figure 37, Table 56). The other timbers in the building were mostly inaccessible for coring or unsuitable.

Results

Three samples obtained from this building proved usable, all of which cross-match each other (Table 57). These were combined to produce a single composite sequence of 172 years length. The composite series was compared with medieval and post-medieval oak sequences from southern & eastern England. It was apparent that the composite sequence matched a number of independent reference chronologies at consistent positions. This position was checked visually and appears to be a reliable match (Figure 38, Table 58), dating the composite sequence matches to 1222-1393 inclusive.

Interpretation

Two of the samples were complete to the sapwood edge, the fire having removed most of the sapwood. Adding the minimum and maximum expected numbers of sapwood rings that are likely to be missing from both of these timbers suggests, assuming they are the product of a single construction phase, that they were felled between 1403 & 1429 (Figure 38). The timbers exhibit seasoning distortions indicating they were prepared whilst they were still green. It is therefore appropriate to assume construction of this building occurred between the dates identified for these timbers.

18/20 Stoneham Street, TL 8499 2269

Sampling

Samples **99-103** were obtained from this property (Figure 39, Table 59). The other timbers in the building were mostly inaccessible for coring, or short-lived and fast grown.

Results

Three samples from the building proved usable, however none cross match each other. The 3 individual series were compared with medieval and post-medieval oak sequences from throughout England and elsewhere in Europe. No consistent and reliable cross-matching was identified between these samples and independent reference chronologies.

Interpretation

No dating was obtained.

Discussion

The sampling and analysis of buildings in Coggeshall reported here obtained dates from 16 of the 20 cored buildings. An overview is shown in Figure 40.

The dated buildings from the *Discovering Coggeshall* study area cover a period of nearly 3 centuries; the front range of 30 Church St may be as early as 1353, whilst 16 East St dates to 1636. Within that however there appear to be 3 distinct groupings each about a century in length.

The results indicate that 15 of the dated buildings, or phases of buildings, fall within the period 1353-1454, some are dated with more precision than others depending on the survival of sapwood and bark-edges. Another 7 fall in the period 1545-1636. That leaves just 2 dated timbers from the entire project that were used between 1454 and 1545; both are from the rear range of 6 East St, and both were probably used during the second half of the 15th century, although it is currently not clear (to me) if they represent 1 or 2 phases of construction.

Whether this reflects a pattern common to the rest of Coggeshall, or only relates directly to the study area, and whether the pattern results from a bias due to consistent differences of the suitability of timbers from different periods are significant questions. Further discussion is perhaps needed about whether the undated buildings & phases that were sampled within the study area, and also the rejected buildings, may themselves fall mostly into specific periods. This might make the observable pattern something to do with a shortfall of datable timbers being used in buildings in Coggeshall at certain periods, alternative possibilities are that there was less construction during this period, poorer survival of buildings of this period, or that there was a problem with woodland exploitation or availability of longer lived timbers during this period.

Acknowledgements

The analysis reported here was commissioned by the Coggeshall Heritage Society. I would particularly like to thank Alan and June Willis for their unfailing hospitality. David Andrews, Mike Meadows, Richard Shackle, Dave Stenning, John Walker, Brenda Watkin & Elphin Watkin all provided discussions & practical assistance. The sampling in Coggeshall was greatly facilitated by the owners and occupiers of the selected properties.

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Figure 1 Coggeshall, Essex showing the approximate location of the 20 sampled buildings, and the 2 additional buildings with *ex-situ* timbers discussed in this report. Reproduced from Explorer® 1:25 000 scale sheet 195 by permission of Ordnance Survey® on behalf of The Controller of Her Majesty's Stationery Office. ©Crown copyright 2006. All rights reserved. Licence number 100046590. Not to scale.

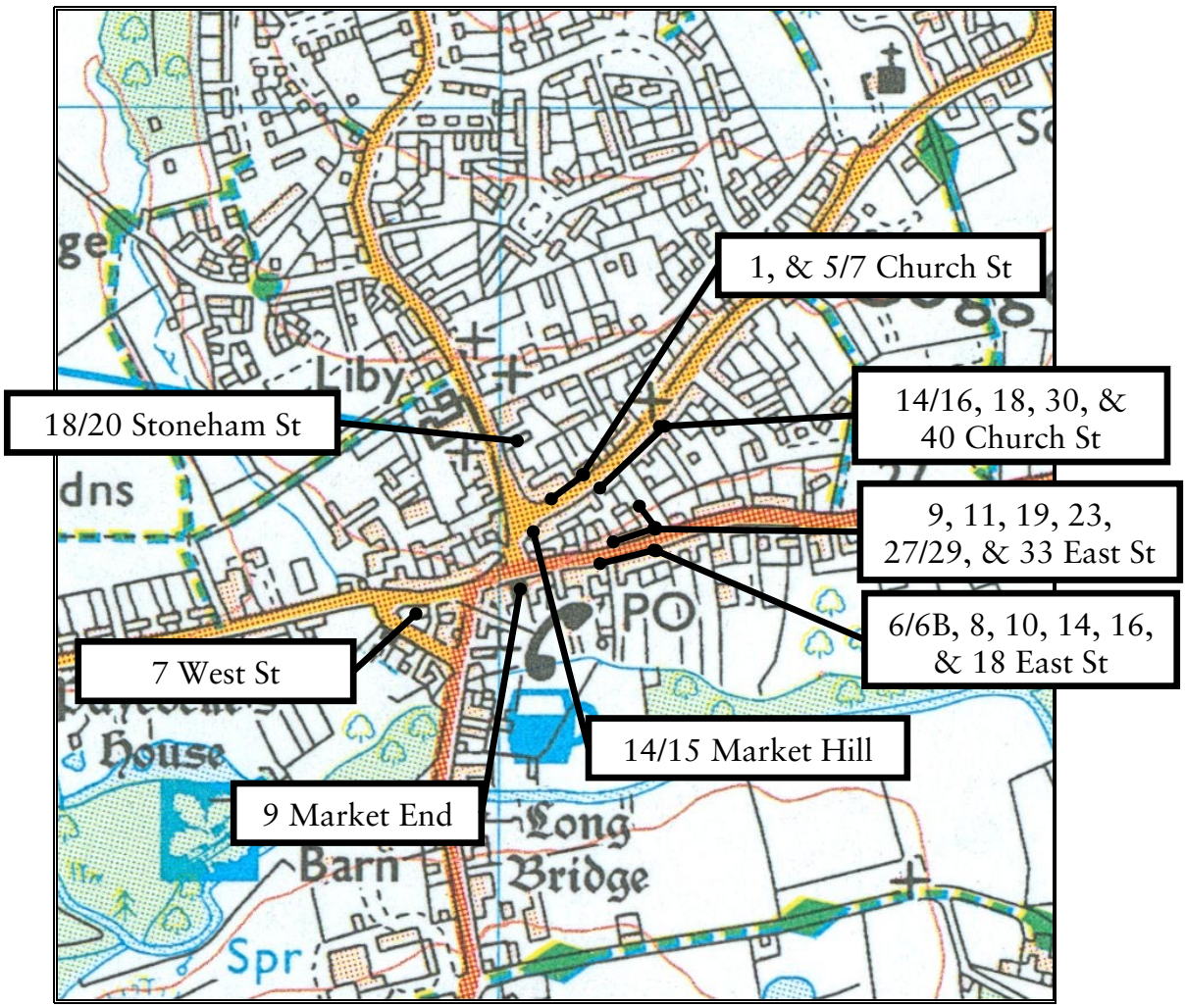

Figure 2 A sketch plan of 1 Church St. The numbers with arrows show the approximate location of each sampled timber.

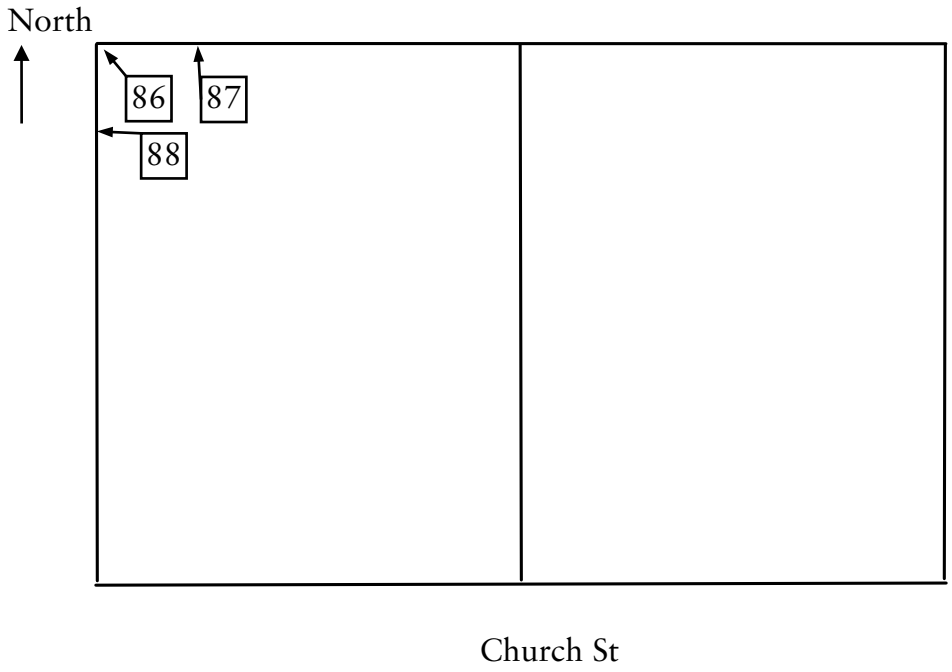

Table 1 List of samples from 1 Church St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
86	corner post	43	9	3.98	undated	-
87	wall plate	55	15+Bw	2.14	undated	-
88	tiebeam	-	-	-	unmeasured	-

KEY: Figure 2 shows the approximate location of the sampled timbers. AGR Average Growth Rate mm/year, +Bw = winter felled

Figure 3 A sketch plan of 5/7 Church St. The numbers with arrows show the approximate location of each sampled timber.

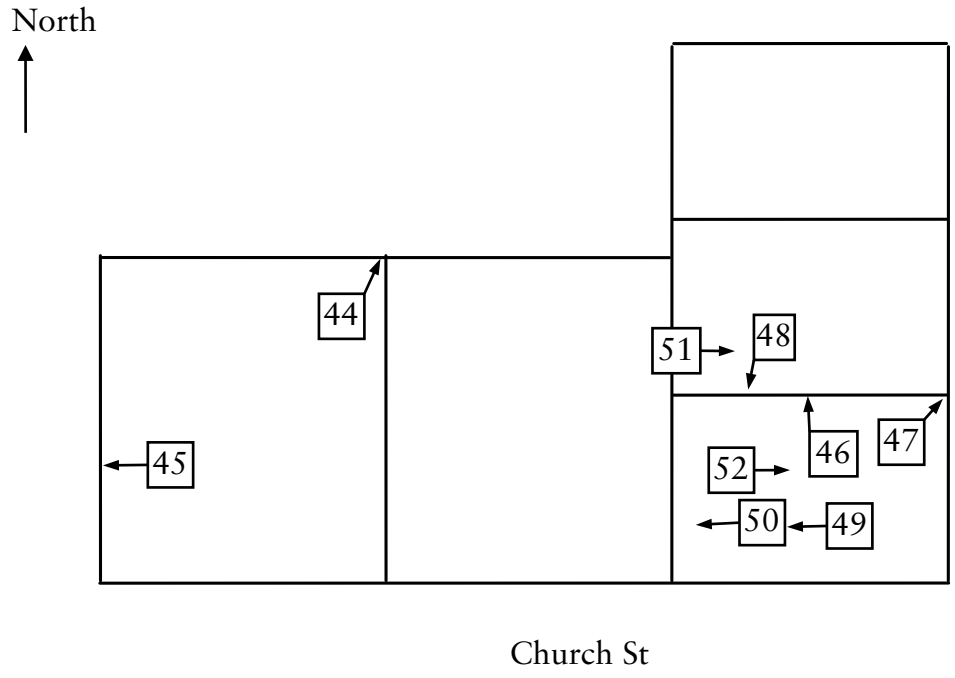

Figure 4 Bar diagram showing the relative & absolute positions of the dated material from 5/7 Church St. White bars are heartwood, hatched bars are sapwood. The interpreted felling date and felling date ranges are also shown.

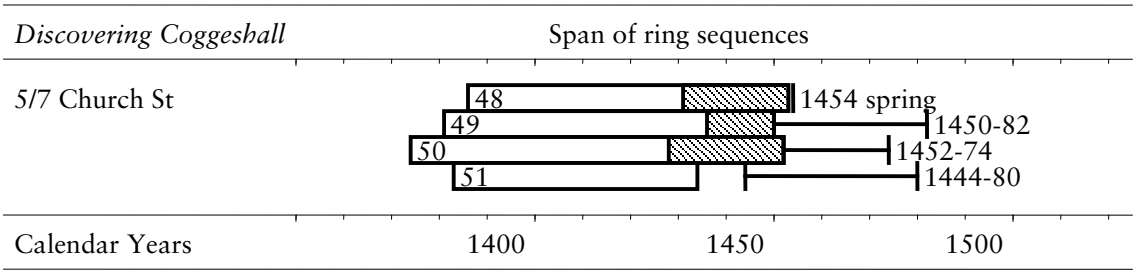

Table 2 List of samples from 5/7 Church St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
44	storey post	-	-	-	unmeasured	-
45	tiebeam	64	18+sB	2.06	undated	-
46	tiebeam	-	-	-	unmeasured	-
47	storey post	61	2	1.98	undated	-
48	girding beam	68	22+sB	2.07	1386-1453	1454 spring
49	joist	70	14	2.90	1381-1450	1450-82
50	joist	79	24	2.40	1374-1452	1452-74
51	joist	52	H/S	2.68	1383-1434	1444-80
52	joist	-	-	-	unmeasured	-

KEY: Figure 4 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S heartwood/sapwood boundary, +sB = bark-edge with an incomplete annual ring indicating the tree was felled in the spring after the final measured ring.

Table 3 Correlation *t*-values between the dated samples from 5/7 Church St. – correlation *t*-value less than 3.0

	49	**50**	**51**
48	-	4.93	4.50
49		-	3.36
50			3.85

Table 4 Illustrative correlation *t*-values between the mean sequence constructed from the 4 dated samples from 5/7 Church St and a number of independent oak reference chronologies.

Reference chronology	5/7 Church St., 4 cores 1374-1453
London, Hays Wharf (Tyers 1996a; b)	7.22
Essex, Thaxted Church (Tyers 1990)	6.36
Essex, Normans Hall outbuilding Wakes Colne (Tyers *et al* 2003)	5.26
Bedfordshire, Chicksands Priory (Howard *et al* 1998)	5.24
Essex, Cann Hall Clacton (Tyers 1998a)	5.14

Figure 5 A sketch plan of 14/16 Church St. The numbers with arrows show the approximate location of each sample.

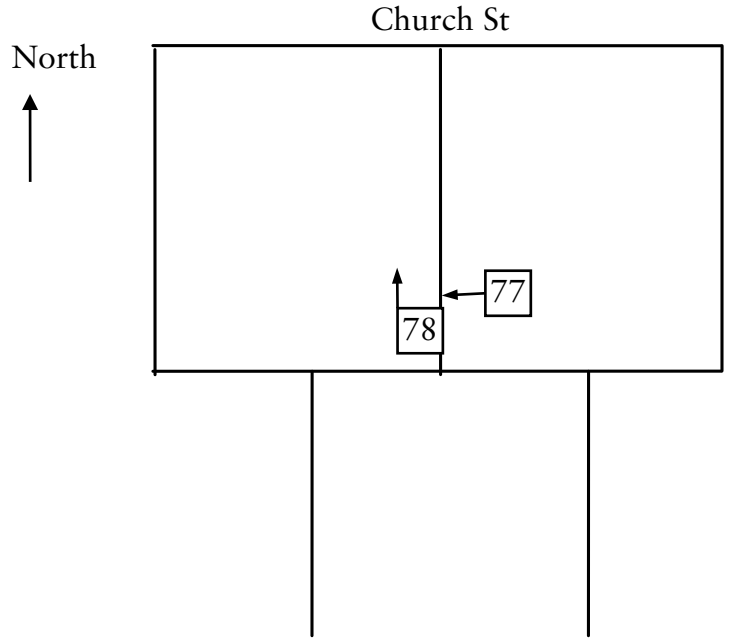

Figure 6 Bar diagram showing the relative and absolute positions of the dated material from 14/16 Church St. White bars are heartwood, hatched bars are sapwood. The interpreted felling date range for each timber is also shown.

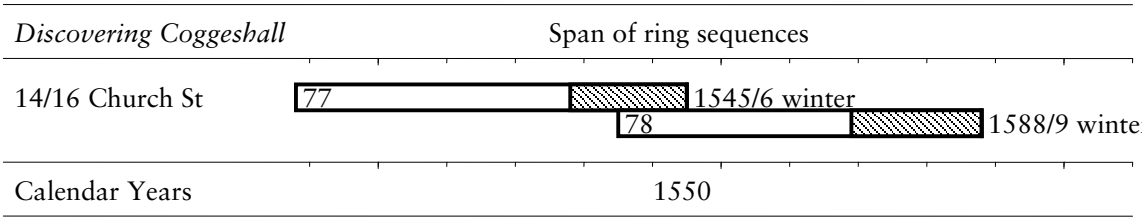

Table 5 List of samples from 14/16 Church St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
77	principal rafter	58	17+Bw	1.31	1488-1545	1545/6 winter
78	purlin	54	19+Bw	2.10	1535-1588	1588/9 winter

KEY: Figure 5 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +Bw = bark edge winter felled.

Table 6 Illustrative correlation *t*-values between the sequence from core #77 from 14/16 Church St and a number of independent oak reference chronologies.

Reference chronology	14/16 Church St #77 1488-1545
London, Osterley Park Stables (Tyers 2009)	7.33
Essex, Beeleigh Abbey nr Maldon (Tyers 2002)	5.97
Essex, Coggeshall Paycockes (Tyers 2006)	5.92
Bedfordshire, Chicksands Priory (Howard *et al* 1998)	5.91
Essex, Cressing Temple Farmhouse (Tyers 1995a)	5.85

Table 7 Illustrative correlation *t*-values between the sequence from core #78 from 14/16 Church St and a number of independent oak reference chronologies.

Reference chronology	14/16 Church St #78 1535-1588
Essex, Cressing Temple Granary (Andrews *et al* 1994)	8.66
Essex, Cressing Temple Farmhouse (Tyers 1995a)	7.29
Essex, Cressing Hungry Hall (Tyers 1997b)	7.19
Essex, Moyns Park Birdbrook (Tyers 1999a)	6.45
London, Hays Wharf (Tyers 1996a; b)	5.83

Figure 7 A sketch plan of 18 Church St. The numbers with arrows show the approximate location of each sampled timber.

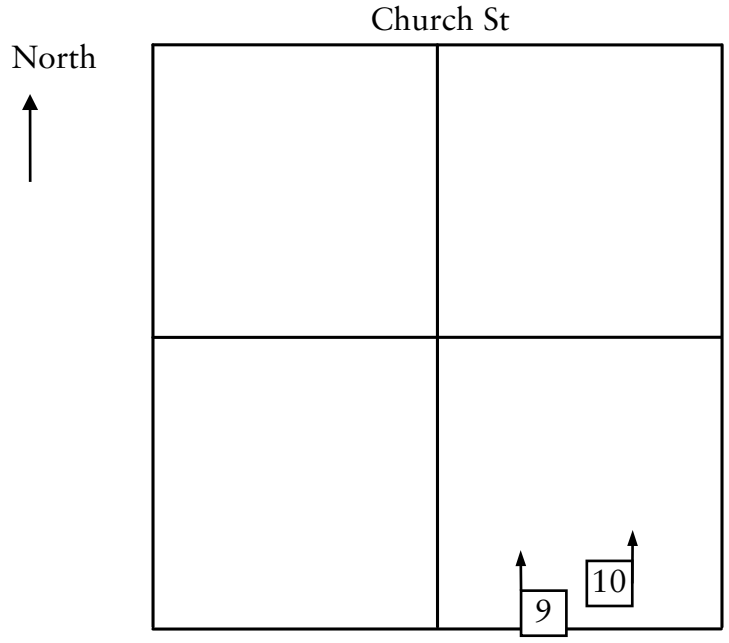

Figure 8 Bar diagram showing the relative and absolute positions of the dated material from 18 Church St. White bars are heartwood, hatched bars are sapwood. The felling date or calculated felling date range for each timber is also shown.

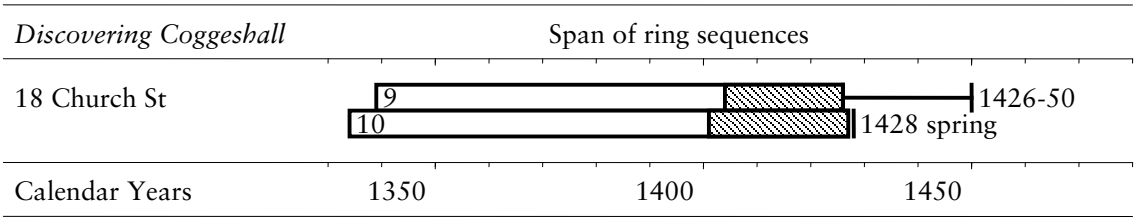

Table 8 List of samples from 18 Church St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
9	joist	88	22	1.88	1339-1426	1426-50
10	joist	94	26+sB	1.69	1334-1427	1428 spring

KEY: Figure 7 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary +sB = bark-edge with a additional partial ring indicating the tree was felled in following spring.

Table 9 Correlation *t*-value between the 2 dated samples from 18 Church St.

	10
9	12.58

Table 10 Illustrative correlation *t*-values between the mean sequence constructed from the 2 dated samples from 18 Church St and a number of independent oak reference chronologies.

Reference chronology	18 Church St., 2 cores 1334-1427
London, Upminster Tithe Barn (Tyers 1997c)	7.08
Essex, Coggeshall 14 East St (this report)	6.67
Essex, Cann Hall Clacton (Tyers 1998a)	5.98
Essex, Coggeshall Paycockes (Tyers 2006)	5.95
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	5.66

Figure 9 A sketch plan of 30 Church St. The numbers with arrows show the approximate location of each sampled timber.

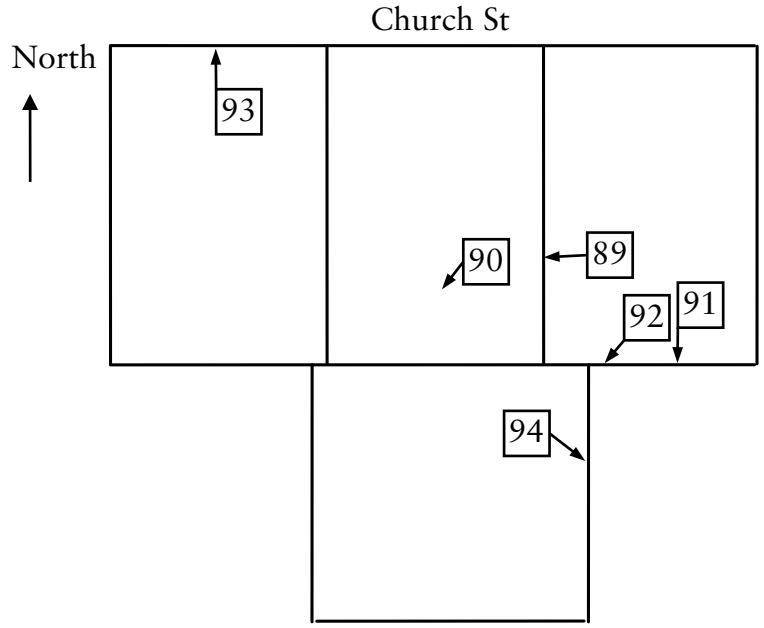

Figure 10 Bar diagram showing the relative and absolute positions of the dated material from 30 Church St. White bars are heartwood, hatched bars are sapwood. The felling date or calculated felling date range for each timber is also shown.

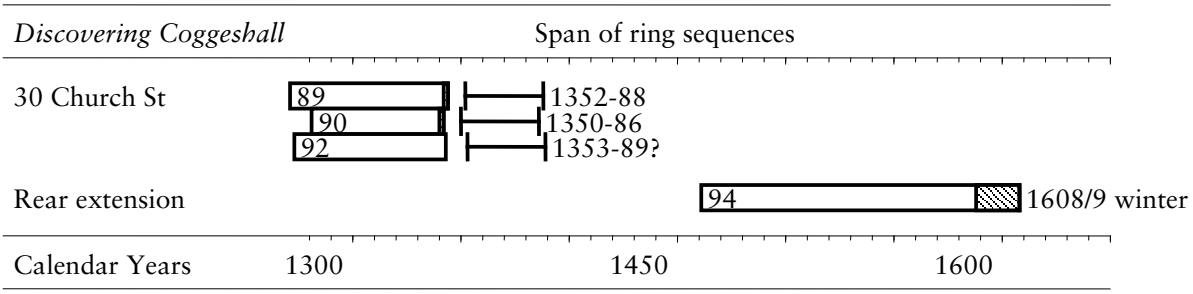

Table 11 List of samples from 30 Church St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
89	tiebeam	74	2	1.53	1271-1344	1352-88
90	common rafter	62	2	2.04	1281-1342	1350-86
91	common rafter	-	-	-	unmeasured	-
92	wall post	71	?H/S	2.24	1273-1343	1353-89?
93	wall plate	-	-	-	unmeasured	-
94	rear storey post	148	20+Bw	1.58	1461-1608	1608/9 winter

KEY: Figure 9 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, ?H/S possible heartwood/sapwood boundary, +Bw = bark-edge with a complete annual ring indicating the tree was felled in winter.

Table 12 Correlation *t*-values between 3 of the dated samples from 30 Church St.

	90	**92**
89	3.00	4.57
90		4.34

Table 13 Illustrative correlation *t*-values between the mean sequence constructed from 3 of the dated samples from 30 Church St and a number of independent oak reference chronologies.

Reference chronology	30 Church St., 3 cores 1271-1344
Essex, Blackmore Church (Bridge pers comm.)	7.51
Essex, Forest Cottage Hatfield Broad Oak (Tyers *et al* 2003)	6.96
Essex, St Martins Colchester chancel (Tyers 1998b)	6.20
Essex, Widdington Priors Hall Barn (Tyers 2000)	6.19
Essex, Navestock Church (Tyers 1999b)	5.80

Table 14 Illustrative correlation *t*-values between the sequence from the sample **#94** from 30 Church St and a number of independent oak reference chronologies.

Reference chronology	30 Church St **#94** 1461-1608
Essex, Coggeshall Paycockes (Tyers 2006)	10.59
London, Osterley Park Stables (Tyers 2009)	10.56
Essex, Beeleigh Abbey nr Maldon (Tyers 2002)	8.82
Essex, Cressing Temple Farmhouse (Tyers 1995a)	8.55
London, Hays Wharf (Tyers 1996a; b)	7.41

Figure 11 Bar diagram showing the dating position of the offcut from 40 Church St. White bar is heartwood. The calculated felling date range for this timber is also shown.

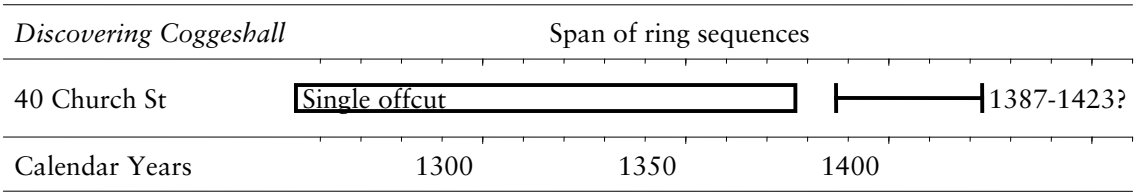

Table 15 Sample from 40 Church St.

Sample	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
offcut	Spere Truss?	124	?H/S	1.65	1254-1377	1387-1423?

KEY: AGR Average Growth Rate mm/year, ?H/S = possible heartwood/sapwood boundary.

Table 16 Illustrative correlation *t*-values between the sequence from the offcut from 40 Church St and a number of independent oak reference chronologies.

Reference chronology	40 Church St offcut 1254-1377
Essex, Coggeshall 7 West St (this report)	9.58
Essex, Coggeshall 9 Market End (this report)	7.38
Essex, St Martins Colchester chancel (Tyers 1998b)	6.81
London, Hays Wharf (Tyers 1996a; b)	6.42
Essex, Navestock Church (Tyers 1999b)	5.97

Figure 12 A sketch plan of 9 East St. The numbers with arrows show the approximate location of each sample.

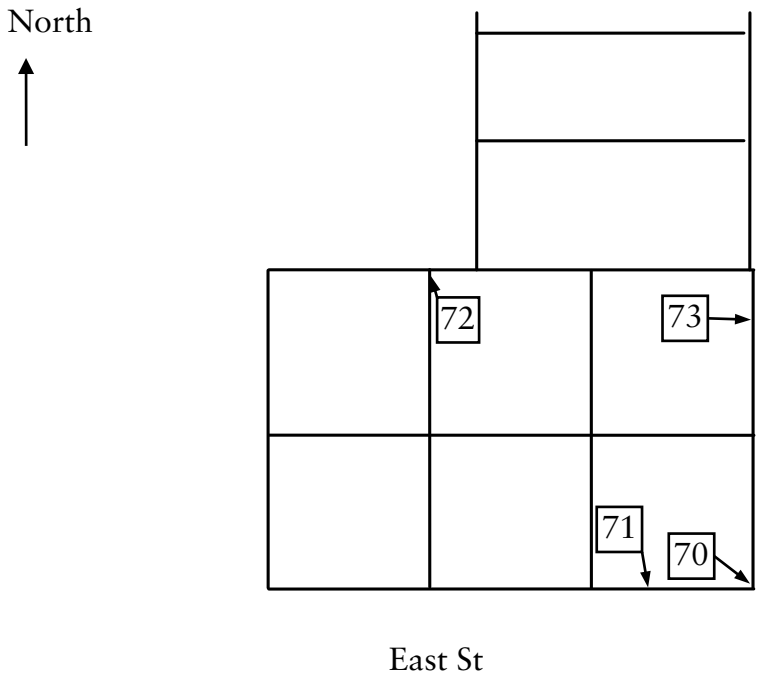

Table 17 List of samples from 9 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
70	storey post	50	19	1.87	undated	-
71	top plate	-	-	-	unmeasured	-
72	storey post	-	-	-	unmeasured	-
73	stair midrail	90	39+?B	1.15	undated	-

KEY: Figure 12 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +?B = possible bark-edge.

Figure 13 Bar diagram showing the calendar position of the offcut from 11 East St. White bar is oak heartwood, hatched bar is sapwood. The interpreted felling date range is also shown.

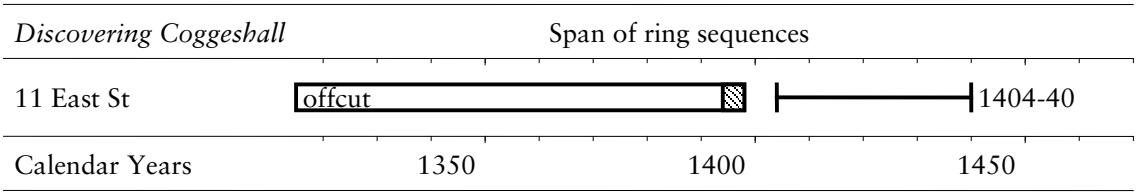

Table 18 Sample from 11 East St.

Sample	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
offcut	?	84	4	1.42	1315-1398	1404-40

KEY: AGR Average Growth Rate mm/year

Table 19 Illustrative correlation *t*-values between the sequence from the offcut from 11 East St and a number of independent oak reference chronologies.

Reference chronology	11 East St offcut 1315-1398
Essex, Coggeshall 33 East St (this report)	8.02
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	6.65
Essex ,Cressing Temple Granary (Andrews *et al* 1994)	6.13
Essex, Cressing Temple Wheat Barn (Tyers 1995a)	5.82
Essex, Coggeshall 19 East St (this report)	5.74

Figure 14 A sketch plan of 19 East St. The numbers with arrows show the approximate location of each sampled timber.

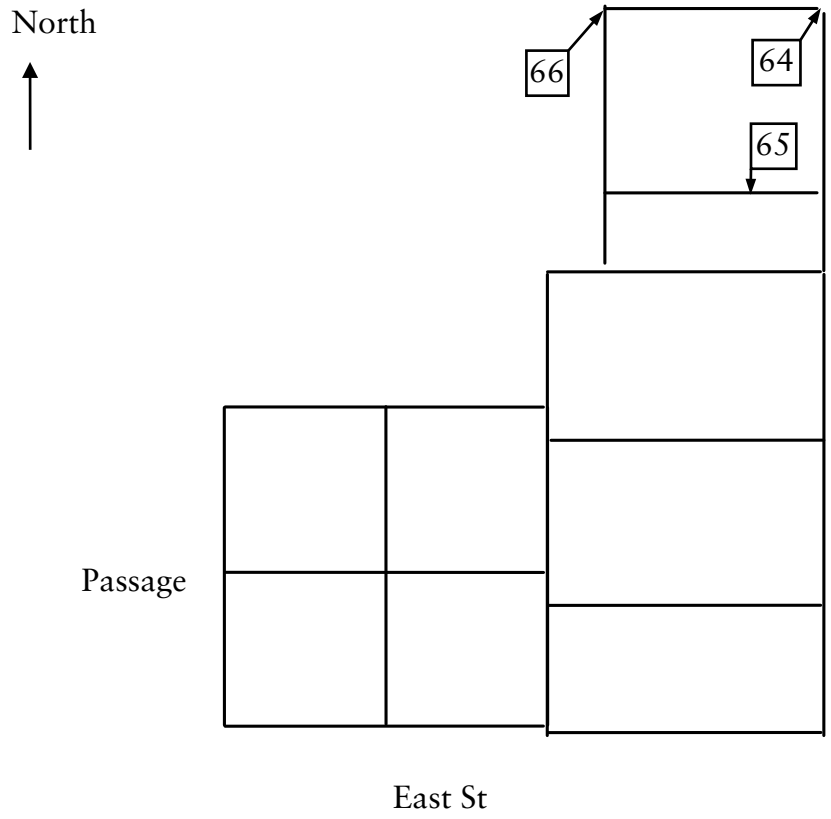

Figure 15 Bar diagram showing the dating positions of the material from 19 East St. White bars are heartwood, hatched bars are sapwood. The felling dates are also shown.

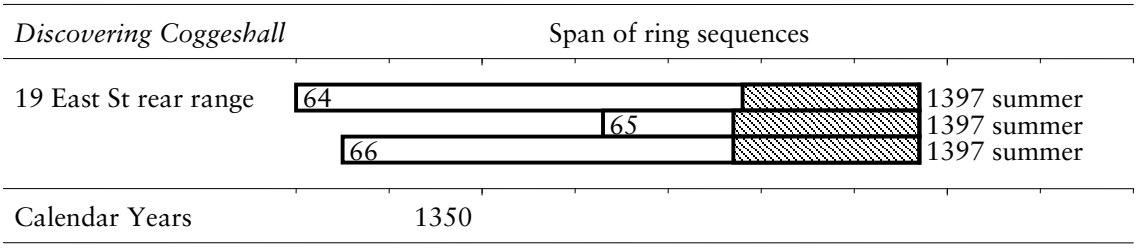

Table 20 List of samples from 19 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
64	storey post	68	19+Bs	1.69	1330-1397	1397 summer
65	tiebeam	35	20+Bs	1.33	1363-1397	1397 summer
66	storey post	63	20+Bs	2.10	1335-1397	1397 summer

KEY: Figure 14 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +Bs = bark-edge with an incomplete annual ring indicating the tree was felled in the summer of the final measured ring.

Table 21 Correlation *t*-values between the 3 dated samples from 19 East St.

	65	**66**
64	3.32	3.23
65		4.84

Table 22 Illustrative correlation *t*-values between the mean sequence constructed from the 3 dated samples from 19 East St and a number of independent oak reference chronologies.

Reference chronology	19 East St., 3 cores 1330-1397
Essex, Coggeshall 33 East St (this report)	7.74
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	7.23
Essex, Coggeshall 9 Market End (this report)	6.58
Essex, Coggeshall 11 East St (this report)	5.74
Essex, Coggeshall 7 West St (this report)	5.45

Figure 16 A sketch plan of 23 East St. The numbers with arrows show the approximate location of each sample.

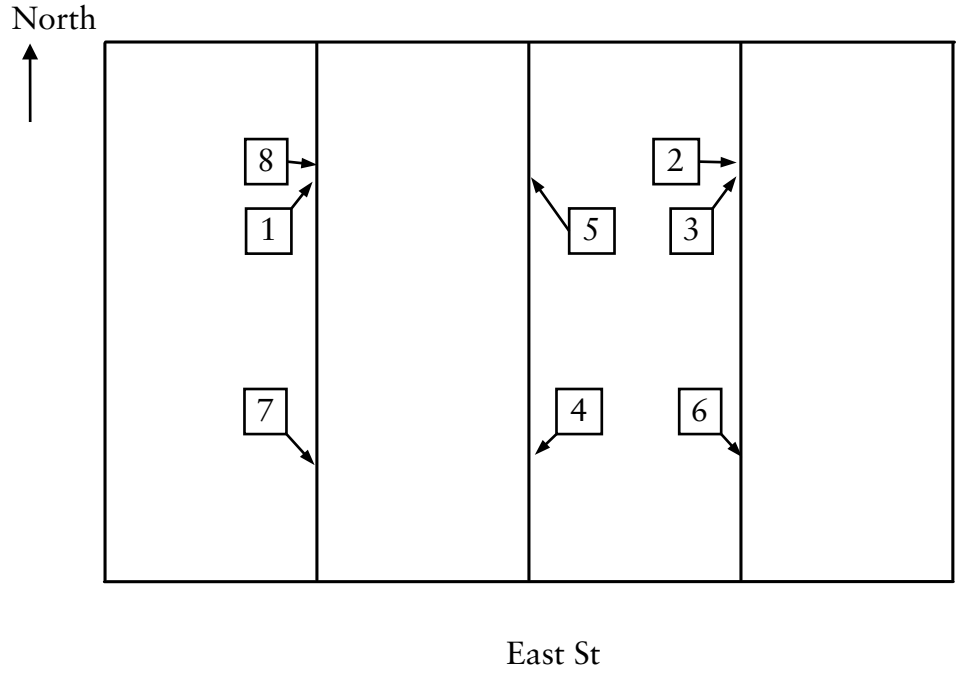

Figure 17 Bar diagram showing the relative and absolute positions of the dated material from 23 East St. White bars are heartwood, hatched bars are sapwood. The interpreted felling date or felling date range for each timber is also shown.

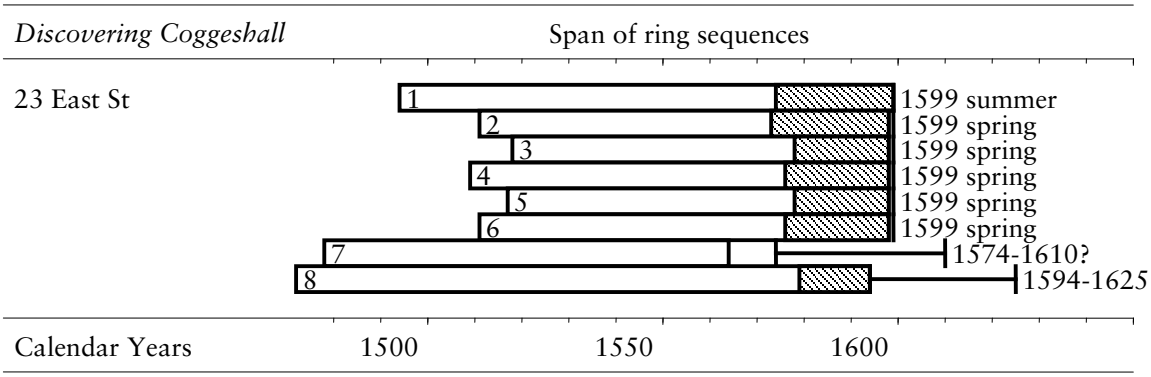

Table 23 List of samples from 23 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
1	storey post	106	25+Bs	1.23	1494-1599	1599 summer
2	tiebeam	88	25+sB	1.13	1511-1598	1599 spring
3	principal rafter	81	20+sB	1.23	1518-1598	1599 spring
4	principal rafter	90	22+sB	1.13	1509-1598	1599 spring
5	principal rafter	82	20+sB	1.10	1517-1598	1599 spring
6	principal rafter	88	22+sB	1.10	1511-1598	1599 spring
7	principal rafter	87	?H/S	1.57	1478-1564	1574-1610?
8	tiebeam	123	15	1.03	1472-1594	1594-1625

KEY: Figure 16 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, ?H/S = possible heartwood/sapwood boundary, +sB = bark-edge with an incomplete annual ring indicating the tree was felled in the spring after the final measured ring. +Bs = bark-edge with an incomplete annual ring indicating the tree was felled in the summer of the final measured ring.

Table 24 Correlation *t*-values between the 8 dated samples from 23 East St.

	2	**3**	**4**	**5**	**6**	**7**	**8**
1	6.75	3.63	5.08	5.35	4.79	5.17	6.45
2		7.07	9.88	5.72	7.53	10.03	5.85
3			13.97	10.06	11.47	10.69	3.42
4				13.28	12.69	15.83	4.95
5					13.05	9.66	3.61
6						8.90	4.39
7							4.89

Table 25 Illustrative correlation *t*-values between the mean sequence constructed from the 8 dated samples from 23 East St and a number of independent oak reference chronologies.

Reference chronology	23 East St., 8 cores 1472-1599
Essex, Moyns Park Birdbrook (Tyers 1999a)	10.03
Essex, Cressing Temple Farmhouse (Tyers 1995a)	9.45
London, Osterley Park Stables (Tyers 2009)	9.20
Essex, Beeleigh Abbey nr Maldon (Tyers 2002)	8.33
Essex, Coggeshall Paycockes (Tyers 2006)	8.19

Figure 18 A sketch plan of 27/9 East St. The numbers with arrows show the approximate location of each sampled timber.

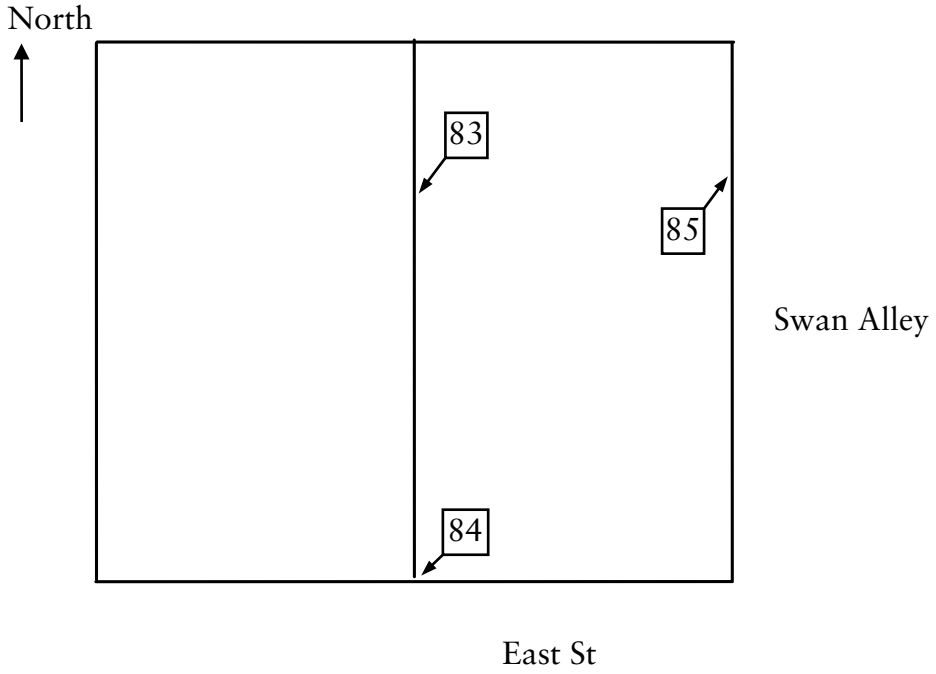

Figure 19 Bar diagram showing the position of the dated sample from 27/9 East St. White bar is heartwood. The calculated felling date range is also shown.

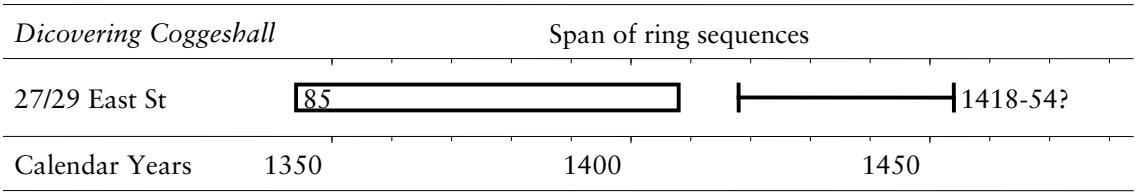

Table 26 List of samples from 27/9 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
83	storey post	46	16+Bw	2.70	undated	-
84	corner post	45	14	3.24	undated	-
85	centre post	65	?H/S	1.67	1344-1408	1418-54?

KEY: Figure 18 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, ?H/S = possible heartwood/sapwood boundary +Bw = bark-edge with a complete annual ring indicating the tree was felled in winter.

Table 27 Illustrative correlation *t*-values between the sequence from sample #85 from 27/9 East St and a number of independent oak reference chronologies.

Reference chronology	27/9 East St **#85** 1344-1408
Essex, Coggeshall 33 East St (this report)	7.31
Essex, Widdington Priors Hall Barn (Tyers 2000)	5.21
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	4.74
Essex, Coggeshall 9 Market End (this report)	4.33
Essex, Coggeshall 19 East St (this report)	4.20

Figure 20 A sketch plan of 33 East St. The numbers with arrows show the approximate location of each sampled timber.

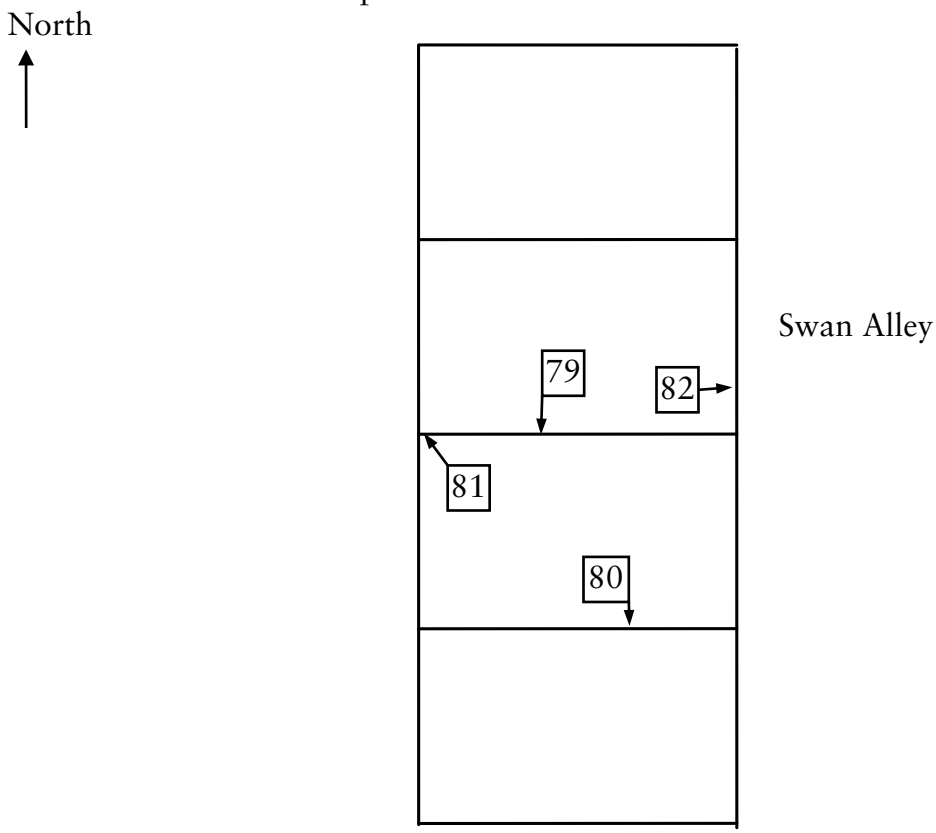

Figure 21 Bar diagram showing the relative and absolute positions of the dated material from 33 East St. White bars are heartwood, hatched bars are sapwood. The felling date or calculated felling date range for each timber is also shown.

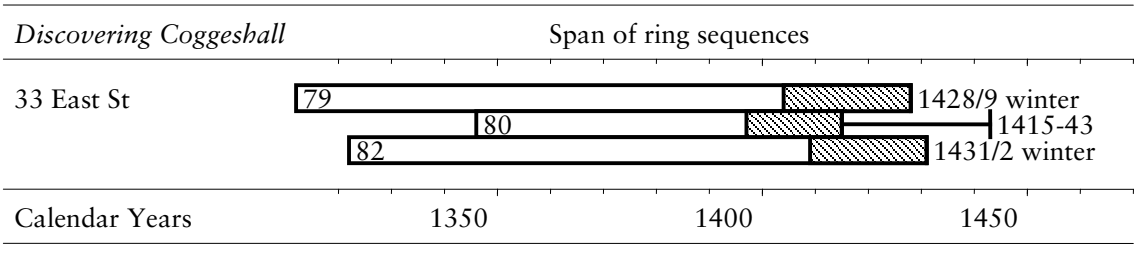

Table 28 List of samples from 33 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
79	tiebeam	117	24+Bw	1.25	1312-1428	1428/9 winter
80	tiebeam	70	18	1.09	1346-1415	1415-43
81	storey post	50	8	2.50	undated	-
82	midrail	110	22+Bw	1.15	1322-1431	1431/2 winter

KEY: Figure 20 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +Bs = bark-edge with an incomplete additional annual ring indicating the tree was felled in spring following the end of the measured sequence.

Table 29 Correlation *t*-values between the 3 dated samples from 33 East St.

	80	82
79	5.53	6.02
80		6.32

Table 30 Illustrative correlation *t*-values between the mean sequence constructed from the 3 dated samples from 33 East St and a number of independent oak reference chronologies.

Reference chronology	33 East St., 3 cores 1312-1431
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	8.64
Essex, Coggeshall 11 East St offcut (this report)	8.02
Essex, Coggeshall 19 East St (this report)	7.74
Essex, Coggeshall 27/9 East St #85 (this report)	7.31
London, Hays Wharf (Tyers 1996a; b)	7.30

Figure 22 A sketch plan of 6 & 6B East St. The numbers with arrows show the approximate location of each sampled timber.

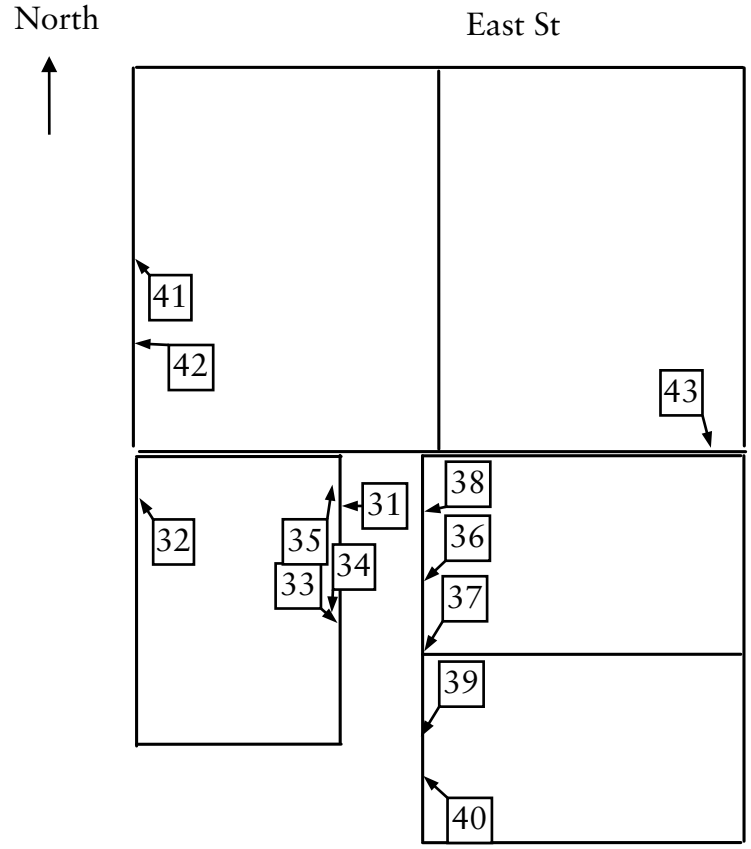

Figure 23 Bar diagram showing the relative positions of the matched material from 6 & 6B East St. White bars are heartwood, hatched bars are sapwood, narrow hatched bars represent detached sapwood fragments of these cores. The calculated felling date range for each timber is also shown.

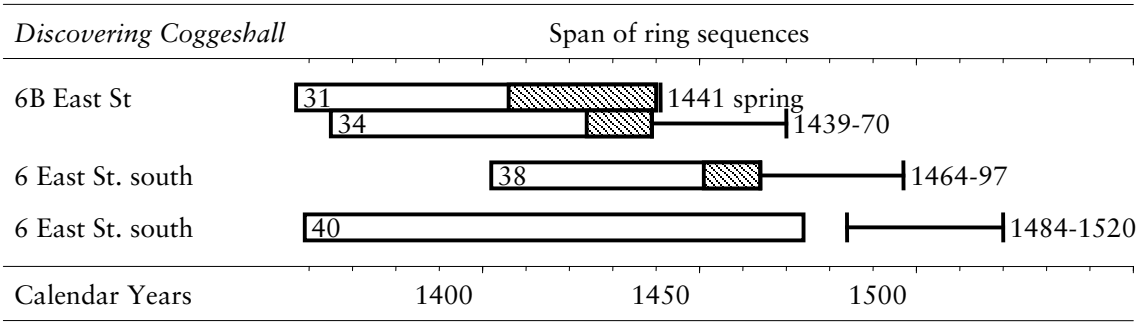

Table 31 List of samples from 6 & 6B East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
31	wall plate	84	34+sB	1.16	1357-1440	1441 spring
32	stud	50	-	1.70	undated	-
33	stud	-	-	-	unmeasured	-
34	joist	75	15	1.79	1365-1439	1439-70
35	joist	64	26+Bw	1.62	undated	-
36	stud	64	22+sB	1.53	undated	-
37	storey post	50	4	1.24	undated	-
38	wall plate	63	13	1.98	1402-1464	1464-97
39	window post	80	1	1.70	undated	-
40	window post	116	H/S	1.43	1359-1474	1484-1520
41	wall post	55	15+sB	2.38	undated	-
42	wall plate	59	12+sB	2.78	undated	-
43	wall plate	45	2	2.50	undated	-

KEY: Figure 22 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary, +Bw = bark-edge with a complete annual ring indicating the tree was felled in winter, +sB = bark-edge with an incomplete additional annual ring indicating the tree was felled in the spring following the end of the measured sequence.

Table 32 Correlation *t*-values between 2 of the dated samples from 6B East St.

	34
31	4.85

Table 33 Illustrative correlation *t*-values between the mean sequence constructed from 2 of the dated samples from 6B East St and a number of independent oak reference chronologies.

Reference chronology	6 East St **#31+#34** 1357-1440
Essex, Cressing Temple Barley Barn (Tyers 1992a)	5.42
Essex, Coggeshall 5/7 Church St (this report)	4.83
Essex, Coggeshall 14 East St (this report)	4.40
Essex, Nether Hall Roydon (author unpubl)	4.29
Essex, Thaxted Guildhall (Tyers & Hibberd 1993)	4.21

Table 34 Illustrative correlation *t*-values between the sequence from sample **#38** from 6 East St and a number of independent oak reference chronologies.

Reference chronology	6 East St **#38** 1402-1464
Essex, Coggeshall Paycockes (Tyers 2006)	5.06
Essex, Priors Hall Outbuilding Widdington (Tyers 2001)	5.05
London, Barking Eastbury Manor (Tyers 1997a)	4.78
Essex, Cressing Temple Barley Barn (Tyers 1992a)	4.51
Essex, Cann Hall Clacton (Tyers 1998a)	4.43

Table 35 Illustrative correlation *t*-values between the sequence from sample **#40** from 6 East St and a number of independent oak reference chronologies.

Reference chronology	6 East St **#40** 1359-1474
Essex, Coggeshall Paycockes (Tyers 2006)	6.04
Essex, Coggeshall 40 Church St offcut (this report)	5.11
Essex, Cressing Temple Wheat Barn (Tyers 1992a)	5.02
Essex, Coggeshall 11 East St offcut (this report)	4.77
London, Hays Wharf (Tyers 1996a; b)	4.54

Figure 24 A sketch plan of 8 East St. The numbers with arrows show the approximate location of each sample.

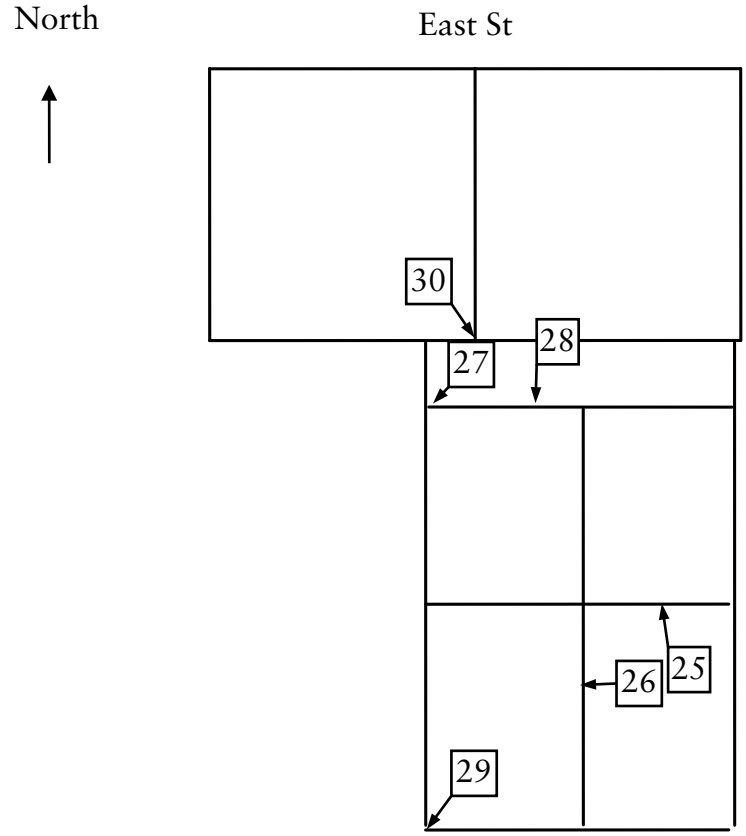

Figure 25 Bar diagram showing the relative and absolute positions of the dated material from 8 East St. White bars are heartwood, hatched bars are sapwood. The felling dates for each timber are also shown.

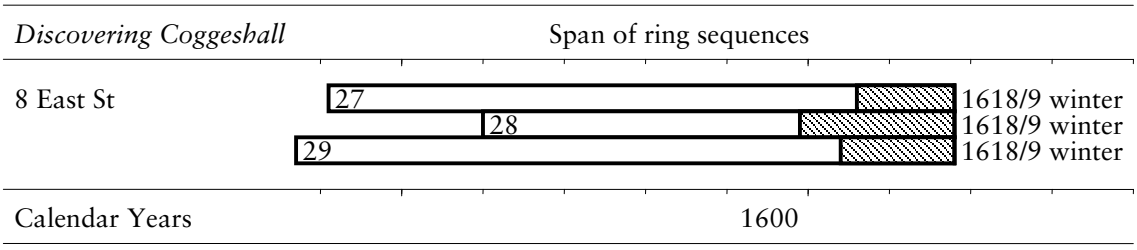

Table 36 List of samples from 8 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
25	mid rail	-	-	-	unmeasured	-
26	mid rail	-	-	-	unmeasured	-
27	storey post	78	12+Bw	2.33	1541-1618	1618/9 winter
28	mid rail	59	19+Bw	2.25	1560-1618	1618/9 winter
29	storey post	82	14+Bw	2.02	1537-1618	1618/9 winter
30	jowled storey post	62	18+sB	2.72	undated	-

KEY: Figure 24 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary, +Bw = bark-edge with a complete annual ring indicating the tree was felled in winter, +sB = bark-edge with an incomplete additional annual ring indicating the tree was felled in the spring following the end of the measured sequence.

Table 37 Correlation *t*-values between the 3 dated samples from the 8 East St.

	28	**29**
27	4.87	10.34
28		3.72

Table 38 Illustrative correlation *t*-values between the sequence from the composite sequences constructed from the 3 dated samples from 8 East St and a number of independent oak reference chronologies.

Reference chronology	8 East St., 3 cores 1537-1618
Essex, Cressing Temple Granary (Andrews *et al* 1994)	9.09
Essex, Coggeshall 23 East St (this report)	7.59
Essex, Coggeshall 14-16 Church St #78 (this report)	7.35
Essex, Coggeshall 30 Church St #94 (this report)	6.93
Essex, Cressing Temple Farmhouse (Tyers 1995a)	6.80

Figure 26 A sketch plan of 10 East St. The numbers with arrows show the approximate location of each sampled timber.

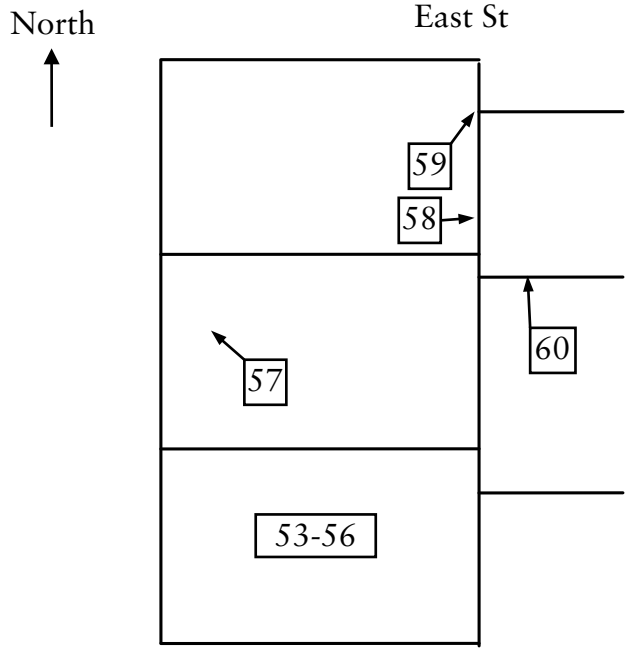

Figure 27 Bar diagram showing the calendar position of the dated sample from 10 East St. White bar is oak heartwood. The interpreted felling date range is also shown.

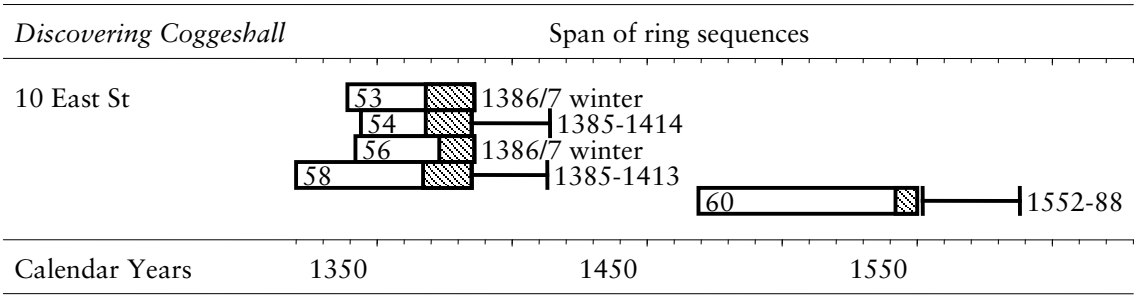

Table 39 List of samples from 10 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
53	common rafter	48	18+Bw	1.57	1339-1386	1386/7 winter
54	common rafter	42	17	1.48	1344-1385	1385-1414
55	common rafter	-	-	-	unmeasured	-
56	common rafter	45	13+Bw	2.83	1342-1386	1386/7 winter
57	common rafter	-	-	-	unmeasured	-
58	stud	66	18	2.18	1320-1385	1385-1413
59	jetty post	-	-	-	unmeasured	-
60	floor joist	82	8	1.70	1469-1550	1552-88

KEY: Figure 26 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +Bw = bark-edge with a complete annual ring indicating the tree was felled in the winter of the final measured ring.

Table 40 Correlation *t*-values between the dated samples from 10 East St. – correlation *t*-value less than 3.0

	54	**56**	**58**
53	5.80	5.35	-
54		5.64	4.41
56			-

Table 41 Illustrative correlation *t*-values between the composite sequence constructed from 4 of the dated samples from 10 East St and a number of independent oak reference chronologies.

Reference chronology	10 East St., 4 cores 1320-1386
London, Upminster Tithe Barn (Tyers 1997c)	8.28
Essex, Normans Hall Wakes Colne (Tyers *et al* 2003)	7.77
Essex, Cann Hall Clacton (Tyers 1998a)	6.20
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	6.13
Essex, Coggeshall 33 East St (this report)	5.96

Table 42 Illustrative correlation *t*-values between the sequence from sample **#60** from 10 East St and a number of independent oak reference chronologies.

Reference chronology	10 East St., **#60** 1469-1550
Essex, Moyns Park Birdbrook (Tyers 1999a)	7.15
London, Osterley Park Stables (Tyers 2009)	7.12
Essex, Cressing Temple Farmhouse (Tyers 1995a)	6.83
Essex, Coggeshall 23 East St (this report)	6.24
Essex, Coggeshall Paycockes (Tyers 2006)	6.13

Figure 28 A sketch plan of 14 East St. The numbers with arrows show the approximate location of each sampled timber.

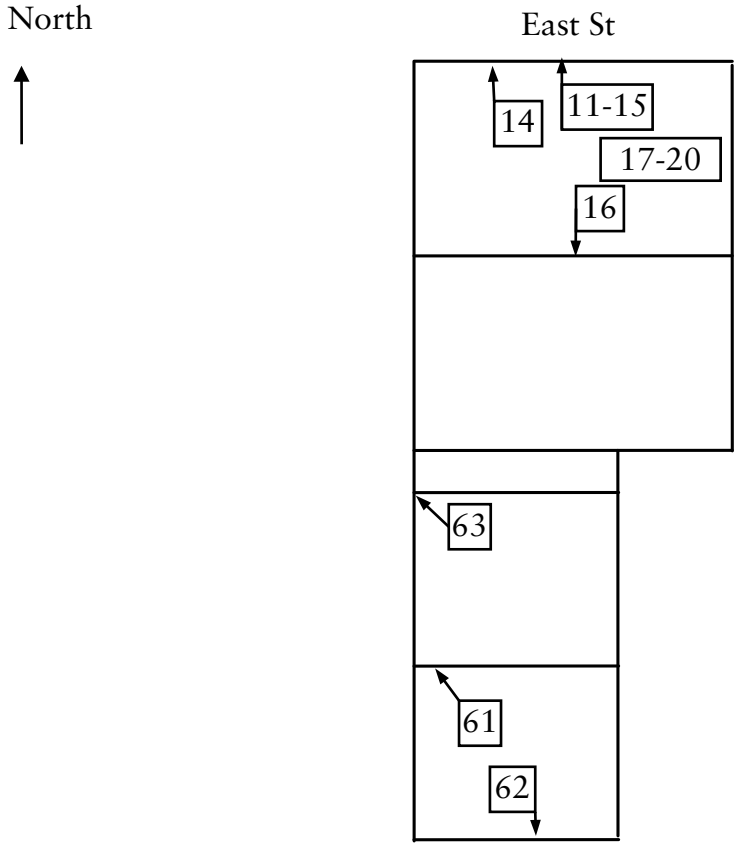

Figure 29 Bar diagram showing the relative and absolute positions of the dated material from 14 East St. White bars are heartwood, hatched bars are sapwood. The felling dates and interpreted felling date ranges are also shown.

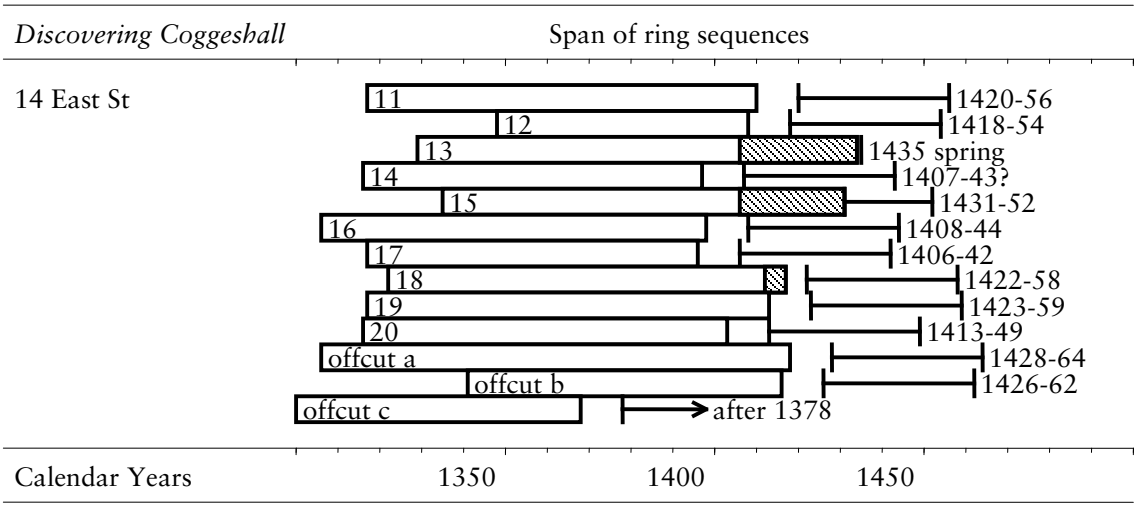

Table 43 List of samples from 14 East St.

Core/ Slice	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
11	gable stud	94	H/S	1.41	1317-1410	1420-56
12	gable stud	61	H/S	1.71	1348-1408	1418-54
13	gable stud	106	28+sB	1.33	1329-1434	1435 spring
14	tiebeam	82	?H/S	1.79	1316-1397	1407-43?
15	gable stud	97	25	1.41	1335-1431	1431-52
16	tiebeam	93	H/S	1.60	1306-1398	1408-44
17	collar	80	H/S	1.06	1317-1396	1406-42
18	common rafter	96	5	1.31	1322-1417	1422-58
19	common rafter	97	H/S	1.16	1317-1413	1423-59
20	common rafter	88	H/S	0.96	1316-1403	1413-49
61	tiebeam	93	H/S	1.66	undated	-
62	tiebeam	-	-	-	unmeasured	-
63	storey post	87	H/S	1.40	undated	-
a	offcut	113	H/S	1.42	1306-1418	1428-64
b	offcut	76	H/S	1.94	1341-1416	1426-62
c	offcut	69	-	2.29	1300-1368	after 1378

KEY: Figure 28 shows the location of the sampled timbers. ?H/S = possible heartwood/sapwood boundary, H/S = heartwood/sapwood boundary, +sB = bark-edge with an incomplete annual ring indicating the tree was felled in the spring after the final measured ring.

Table 44 Correlation *t*-values between the 13 dated samples from 14 East St. – correlation *t*-value less than 3.0

	12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**a**	**b**	**c**
11	3.98	8.03	6.46	10.41	3.54	4.98	4.69	6.08	3.15	7.96	5.81	4.30
12		4.19	4.38	4.79	4.20	-	6.47	5.87	4.89	3.65	4.79	3.45
13			4.55	7.69	3.28	-	6.40	4.89	3.31	6.07	6.34	3.48
14				5.02	4.86	5.57	4.66	6.19	4.31	7.63	9.47	5.77
15					-	-	6.00	5.09	3.85	6.57	6.82	4.21
16						3.73	5.81	5.46	5.55	3.88	3.86	5.52
17							-	4.54	4.15	4.28	3.45	3.70
18								9.61	4.99	5.88	7.20	4.51
19									4.90	6.65	5.97	3.93
20										-	3.53	4.72
a											10.74	4.69
b												6.10

Table 45 Illustrative correlation *t*-values between the mean sequence constructed from the 13 dated samples from 14 East St and a number of independent oak reference chronologies.

Reference chronology	14 East St., 10 cores + 3 offcuts 1300-1434
Essex, Cressing Temple Barley Barn (Tyers 1992a)	8.77
London, Upminster Tithe Barn (Tyers 1997c)	7.30
Essex, Widdington Priors Hall Barn (Tyers 2000)	6.85
Essex, Coggeshall 18 Church St (this report)	6.67
Essex, Cressing Temple Wheat Barn (Tyers 1992b)	6.60

Figure 30 A sketch plan of 16 East St. The numbers with arrows show the approximate location of each sample.

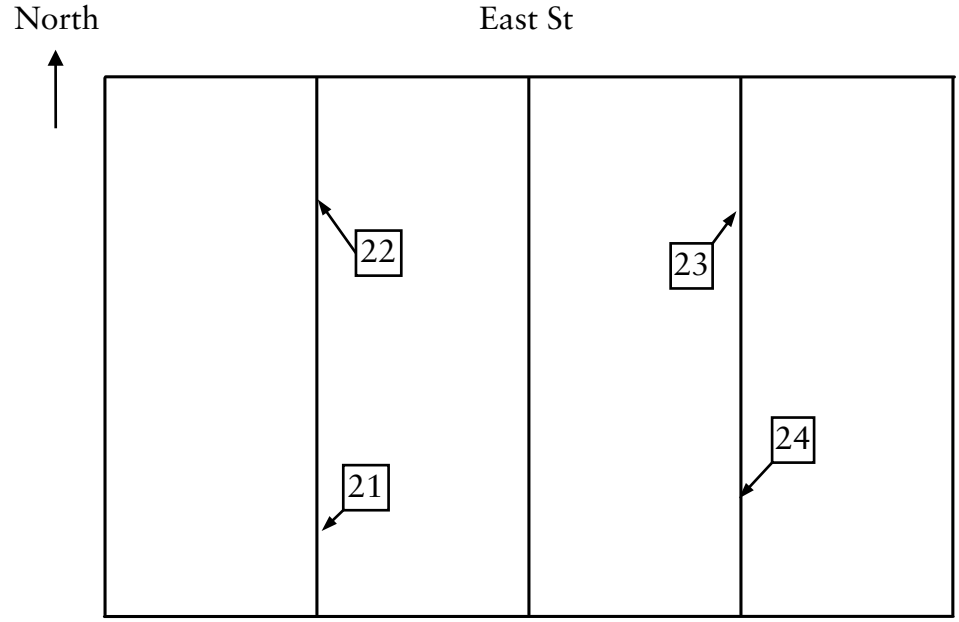

Figure 31 Bar diagram showing the relative and absolute positions of the dated material from 16 East St. White bars are heartwood, hatched bars are sapwood. The interpreted felling date range for each timber is also shown.

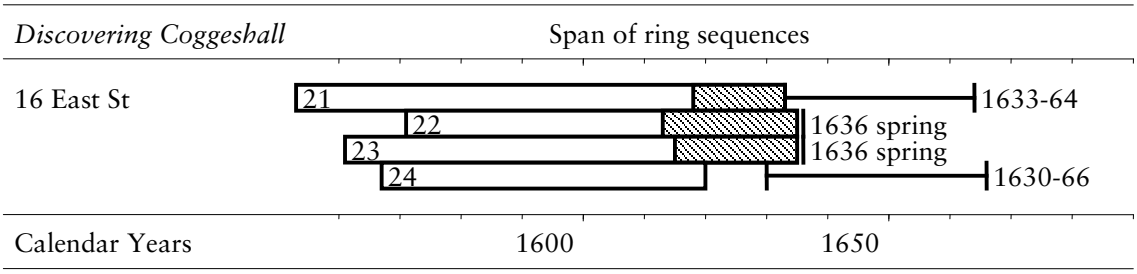

Table 46 List of samples from 16 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
21	principal rafter	81	15	2.38	1553-1633	1633-64
22	principal rafter	65	22+sB	1.90	1571-1635	1636 spring
23	principal rafter	75	20+sB	1.52	1561-1635	1636 spring
24	principal rafter	54	H/S	2.62	1567-1620	1630-66

KEY: Figure 30 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary, +sB = bark-edge with an incomplete annual ring indicating the tree was felled in the spring after the final measured ring.

Table 47 Correlation *t*-values between the dated samples from 16 East St.

	22	**23**	**24**
21	6.32	10.97	6.91
22		6.03	6.20
23			6.68

Table 48 Illustrative correlation *t*-values between the mean sequence constructed from the 4 dated samples from 16 East St and a number of independent oak reference chronologies.

Reference chronology	16 East St., 4 cores 1553-1635
Suffolk, Ipswich, Isaac Lord (Bridge 1999)	7.10
Cambridgeshire, Sutton-in-the-Isle Bellframe (Tyers 1995b)	5.35
Essex, Cressing Temple New House (Tyers 1997b)	4.62
Essex, Coggeshall 8 East St (this report)	4.36
Essex, Cressing Temple Granary (Andrews *et al* 1994)	4.35

Figure 32 A sketch plan of 18 East St. The numbers with arrows show the approximate location of each sampled timber.

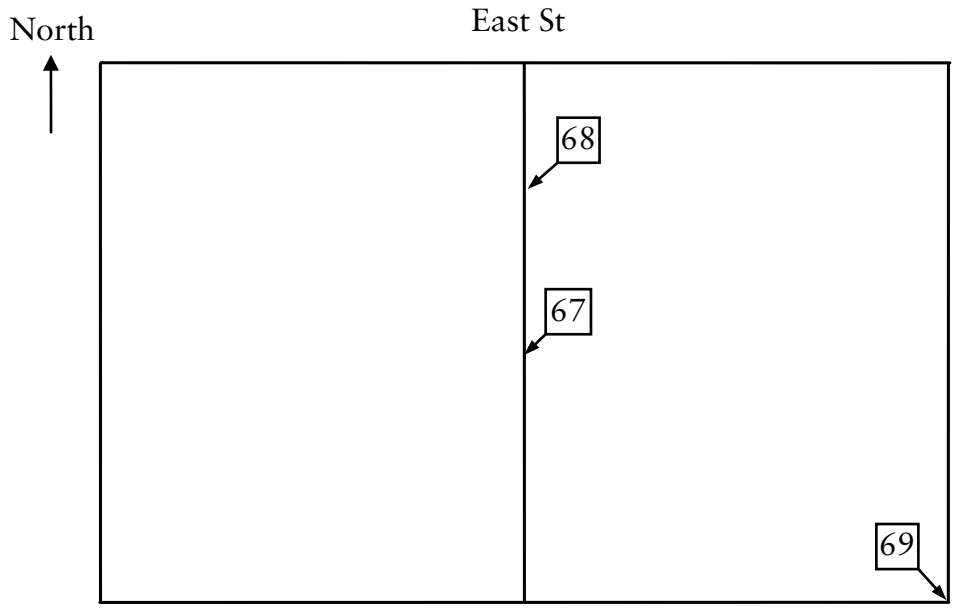

Figure 33 Bar diagram showing the relative and absolute positions of the dated material from 18 East St. White bars are heartwood, hatched bars are sapwood. The felling date or calculated felling date range for each timber is also shown.

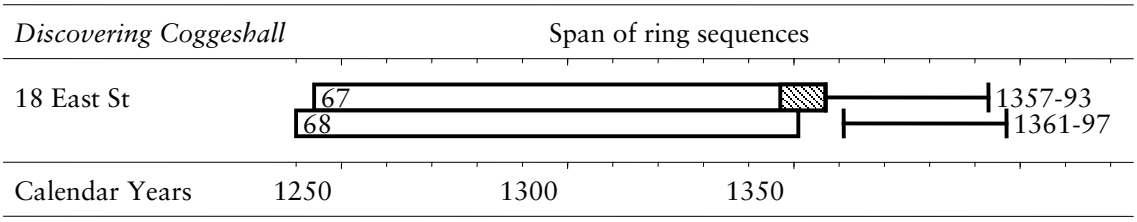

Table 49 List of samples from 18 East St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
67	stud	114	10	1.34	1244-1357	1357-93
68	stud	112	H/S	1.52	1240-1351	1361-97
69	storey post	87+56	37	1.20	undated	-

KEY: Figure 32 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary.

Table 50 Correlation *t*-value between the 2 dated samples from 18 East St.

	68
67	6.15

Table 51 Illustrative correlation *t*-values between the mean sequence constructed from the 2 dated samples from 18 East St and a number of independent oak reference chronologies.

Reference chronology	18 East St., 2 cores 1240-1357
Essex, Normans Hall Wakes Colne (Tyers *et al* 2003)	6.99
London, Hays Wharf (Tyers 1996a; b)	5.86
Essex, St Martins Colchester chancel (Tyers 1998b)	5.69
Essex, Coggeshall 7 West St (this report)	5.42
Essex, Navestock Church (Tyers 1999b)	5.35

Figure 34 A sketch plan of 14/15 Market Hill. The numbers with arrows show the approximate location of each sampled timber.

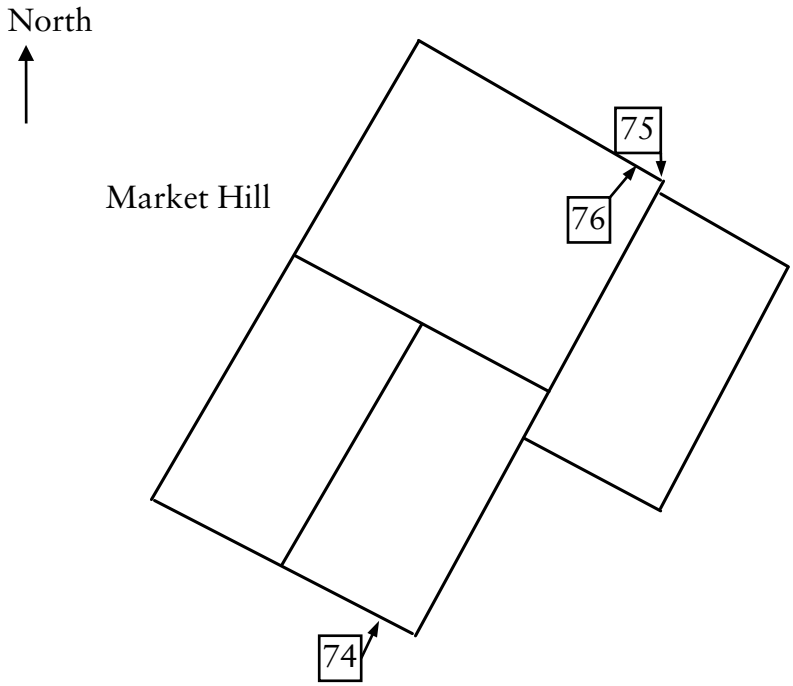

Table 52 List of samples from 14/15 Market Hill.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
74	girt	-	-	-	unmeasured	-
75	storey post	58	16+Bw	3.65	undated	-
76	girt	52	14+Bw	2.68	undated	-

KEY: Figure 34 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, +Bw = bark-edge with an complete annual ring indicating the tree was felled in winter at the end of the measured sequence.

Figure 35 A sketch plan of 9 Market End. The numbers with arrows show the approximate location of each sampled timber.

Figure 36 Bar diagram showing the relative positions of the matched material from 9 Market End. White bars are heartwood, hatched bars are sapwood, narrow hatched bars represent detached sapwood fragments of these cores. The calculated felling date range for each timber is also shown.

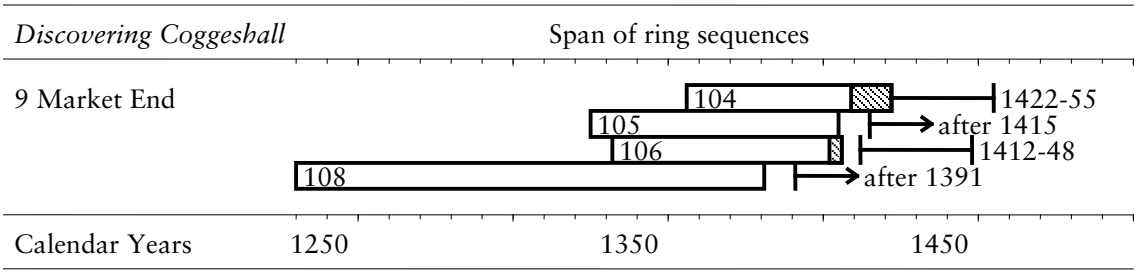

Table 53 List of samples from 9 Market End.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
104	G floor girt	67	13	2.74	1356-1422	1422-55
105	G floor joist	81	-	1.76	1325-1405	after 1415
106	G floor girt	75	4	2.90	1332-1406	1412-48
107	storey post	-	-	-	unmeasured	-
108	crown post	152	-	1.14	1230-1381	after 1391

KEY: Figure 35 shows the location of the sampled timbers. AGR Average Growth Rate mm/year.

Table 54 Correlation *t*-values between the 4 dated samples from 9 Market End. – correlation *t*-value less than 3.0

	105	**106**	**108**
104	3.43	3.15	-
105		-	3.09
106			-

Table 55 Illustrative correlation *t*-values between the mean sequence constructed from the 4 dated samples from 9 Market End and a number of independent oak reference chronologies.

Reference chronology	9 Market End, 4 cores 1230-1422
Essex, Coggeshall 7 West St (this report)	11.67
Bedfordshire, Chicksands Priory (Howard *et al* 1998)	8.37
Essex, Coggeshall 40 Church St offcut (this report)	7.38
Essex, Netteswellbury Barn Harlow (Tyers 1997b)	7.35
Essex, Coggeshall 33 East St (this report)	6.57

Figure 37 A sketch plan of 7 West St. The numbers with arrows show the approximate location of each sample.

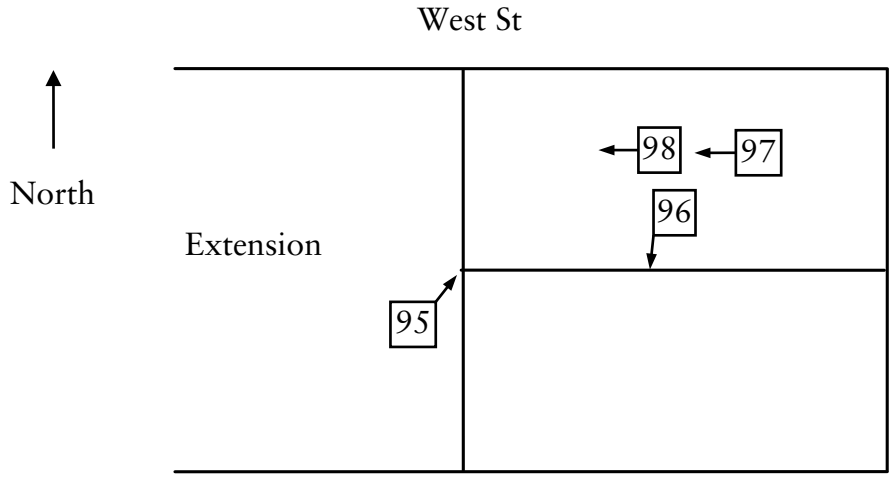

Figure 38 Bar diagram showing the relative and absolute positions of the dated material from 7 West St. White bars are heartwood. The interpreted felling date ranges for each timber are also shown.

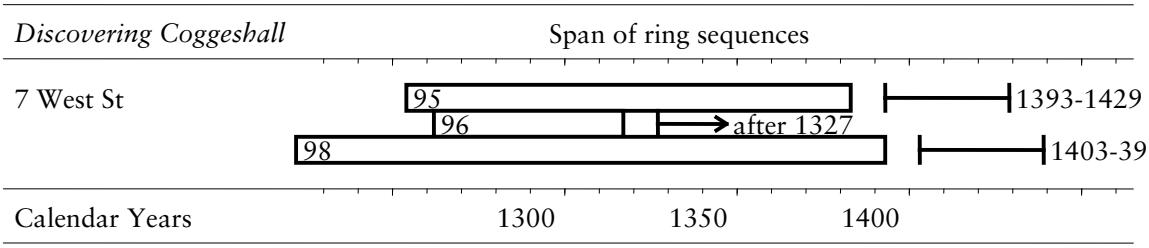

Table 56 List of samples from 7 West St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
95	storey post	130	H/S	1.24	1254-1383	1393-1429
96	girt	56+*	-	1.39	1262-1317	after 1327
97	joist	-	-	-	unmeasured	-
98	joist	172	H/S	1.15	1222-1393	1403-39

KEY: Figure 37 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary. * Core 96 fragmented badly and this is the inner part of this timber.

Table 57 Correlation *t*-values between the 3 dated samples from 7 West St.

	96	**98**
95	7.34	6.25
96		7.93

Table 58 Illustrative correlation *t*-values between the composite sequence constructed from the 3 dated samples from 7 West St and a number of independent oak reference chronologies.

Reference chronology	7 West St., 3 cores 1222-1393
Essex, Coggeshall 9 Market End (this report)	11.67
Essex, Coggeshall 40 Church St offcut (this report)	9.58
Essex, Navestock Church (Tyers 1999b)	8.71
Essex, St Martins Colchester chancel (Tyers 1998b)	8.51
Essex, Normans Hall Wakes Colne (Tyers *et al* 2003)	8.28

Figure 39 A sketch plan of 18/20 Stoneham St. The numbers with arrows show the approximate location of each sample.

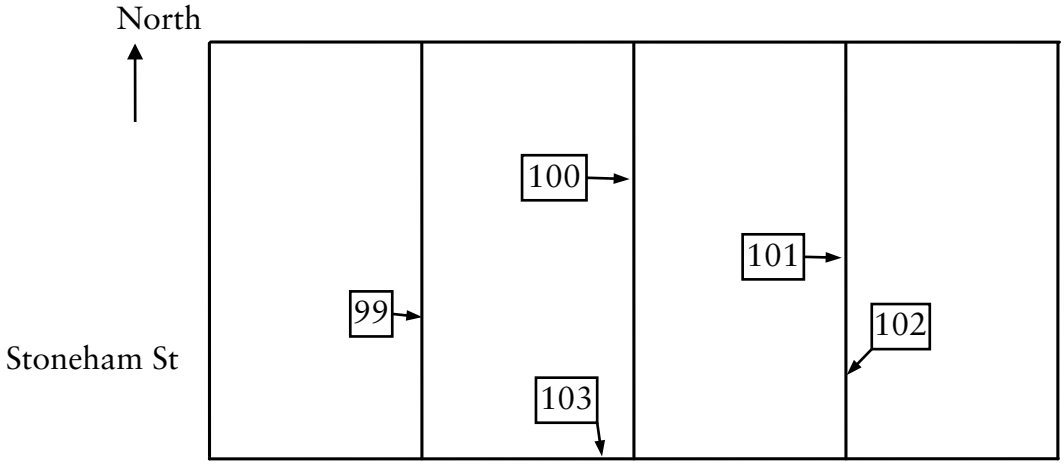

Table 59 List of samples from 18/20 Stoneham St.

Core	Origin of sample	Total rings	Sap rings	AGR	Date of sequence	Interpretation
99	tiebeam	-	-	-	unmeasured	-
100	tiebeam	52	H/S	3.34	undated	-
101	tiebeam	57	17	1.59	undated	-
102	queen strut	55	19	1.60	undated	-
103	wall plate	-	-	-	unmeasured	-

KEY: Figure 39 shows the location of the sampled timbers. AGR Average Growth Rate mm/year, H/S = heartwood/sapwood boundary.

Figure 40 Summary bar diagram showing the chronological distribution of dated samples from the project. There is a clear difference between the number of samples obtained that date from before and after *c.* 1465, with no single timber located that entirely cross the period 1455-1480, although this 'gap' is well covered by Paycockes samples.