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THE BELLFRAME
CHURCH OF ST MARTIN
NORTH LEVERTON
NOTTINGHAMSHIRE

SURVEY, RECORDING, AND TREE-RING ANALYSIS OF TIMBERS

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SUMMARY

Dendrochronological analysis undertaken on samples taken from timbers of the bellframe at this church resulting in the construction of a single site sequence.

Site sequence NBFCSQ01, contains nine samples and spans the period AD 1596–1710. Interpretation of the sapwood suggests felling of dated timbers occurred in AD 1708/1710, with construction likely to have followed shortly after.

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INTRODUCTION

The Grade I listed parish church of St Martin is located in the village of North Leverton in north Nottinghamshire (Figs 1 & 2). Thought to date back to the twelfth century the church underwent comprehensive restoration in the nineteenth century. It consists of nave, south aisle, chancel, west tower, and south porch (http://southwellchurches.nottingham.ac.uk/north-leverton/hintro.php).

The Bell frame

Originally for four bells (the side pit has been removed), the extant frame is for three bells and is of double jack-braced design (Pickford, Group 6.D; Figs 3–5). It sits on three base beams, which run from the north to south walls and at each end sit on timbers which are on the off-sets along the north and south walls. The cut-outs in the top sills by the bearings are for the headstock hoops to fall into in the event of gudgeon failure.

It was built in one phase and was thought to date from the recasting of either the treble (AD 1694) or tenor bells (AD 1718; AD 1661). All joints are mortise and tenon joints, pegged with oak pegs.

The Bells

The inscriptions:

1(i). GOD [46] SAVE [46] HIS CHVRCH [46] 1718 [46]

(ii). [50] repeated

2(i). GOD SAVE THE KING 1661

(ii). [53]

3(i). GOD [46] SAVE [46] HIS [46] CHVRCH [46] RM [46] IS [46] 1694 [46] (ii). [50] repeated

The treble and tenor bells are the work of William Noone of Nottingham and the second is by George I Oldfield using his less common badge with the rounded G.

Badge numbers are taken from the Church Bells of Nottinghamshire.

Physical data:

	Diameter(cm)	Weight	Note
Treble.	69.5	c3.5cwt	-
2.	73.5	c4.5cwt	1080 Hz
Tenor.	79.5	c6cwt	1005 Hz

PRINCIPLES OF TREE-RING DATING

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

Secondly, because the weather over any number of consecutive years is unique, so too is the growth pattern of the tree. The pattern of a short period of growth, 20 or 30 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

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

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

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

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

SAMPLING STRATEGY

A total of nine samples were taken from various timber elements of this bellframe. Each sample was given the code NBF-C and numbered 01–09. The location of all samples was noted at the time of sampling and has been marked on Figures 6–11. Further details can be found in Table 1.

ANALYSIS & RESULTS

All nine samples were prepared by sanding and polishing and their growth-ring width measured. These growth-ring widths were then compared with each other following Laboratory procedures, resulting in all nine samples matching to form a single group.

These nine samples were then combined with each other at the relevant offset positions to form NBFCSQ01, a site sequence of 115 rings (Fig 12). This site sequence was compared against a series of relevant oak chronologies where it was found to match at a first-ring date of AD 1596 and a last-measured ring date of AD 1710. The evidence for this dating is given by the *t*-values in Table 2.

INTERPRETATION

The estimate that 95% of mature oak trees from this region have between 15 and 40 sapwood rings has been used when calculating felling date ranges.

Nine samples have been successfully dated, three of which (NBF-C04, NBF-C07, and NBF-C08) have complete sapwood. Samples NBF-C07 and NBF-C08 have the last-measured ring (and hence felling) date of AD 1708, whereas NBF-C04 was felled slightly later, in AD 1710. The other six samples all have the heartwood/sapwood boundary ring, the date of which is in all cases broadly contemporary and suggestive of a single felling. The average heartwood/sapwood boundary ring date is AD 1690, allowing an estimated felling date to be calculated for the six timbers represented to within the range AD 1707–30 (allowing for sample NBF-C09 having a last-measured ring date of AD 1706 with incomplete sapwood). One of these samples, NBF-C03, has the last-measured ring date of AD 1708 and so must have been felled after this date, but could have been felled in AD 1710. The rest of the timber could have been felled in either AD 1708 or AD 1710.

DISCUSSION

Tree-ring analysis has shown that the bellframe at St Martin's Church contains timber felled in AD 1707–30 with at least two beams known to date to AD 1708 and one to AD 1710. These results suggest construction occurred in the early-eighteenth century and utilised timber sourced either as the result of an extended period of felling over a couple of years or incorporating stockpiled timber. It is possible that the frame dates to the casting of the AD 1718 tenor bell. Alternatively, it may be that the frame is a couple of years earlier than the bell and increased ringing due to the new frame caused the tenor bell to crack necessitating the casting of a new one.

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Table 1: Details of samples taken from the bellframe at the Church of St Martin, North Leverton, Nottinghamshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
NBF-C01	Top cill, truss D	80	h/s	1602	1681	1681
NBF-C02	Top cill, truss C	89	01	1602	1689	1690
NBF-C03	Top cill, truss B	113	12	1596	1696	1708
NBF-C04	Top cill, truss F	104	23C	1607	1687	1710
NBF-C05	Top cill, truss F	75	12	1629	1691	1703
NBF-C06	Top cill, truss E	95	15	1611	1690	1705
NBF-C07	East lower strut, truss D	103	30C	1606	1678	1708
NBF-C08	East brace, truss C	103	21C	1606	1687	1708
NBF-C09	South strut, truss F	87	09	1620	1697	1706

**h/s = the heartwood/sapwood boundary ring is the last-measured ring on the sample

C = complete sapwood retained on sample, last-measured ring is the felling date

Table 2: Results of the cross-matching of site sequence NBFCSQ01 and relevant reference chronologies when the first-measured ring date is AD 1596 and the last-measured ring date is AD 1710

Reference chronology	*t*-value	Span of chronology	Reference
Bolsover Castle (Riding School), Derbyshire	9.4	AD 1494–1744	Howard *et al* 2005
Bretby Hall, Bretby, Derbyshire	9.3	AD 1494–1719	Howard *et al* 1999
Sinai Park, Burton-on-Trent, Staffordshire	8.9	AD 1227–1750	Tyers 1997
Wren Wing, Easton Neston, Northamptonshire	6.8	AD 1468–1686	Arnold *et al* 2008
Highfield, Langham, Rutland	6.8	AD 1556–1681	Arnold and Howard 2007 unpubl
North Scarle (bellframe), Lincolnshire	6.3	AD 1602–1716	Arnold and Howard 2010
Kenilworth Castle Gatehouse, Warwickshire	6.1	AD 1623–1727	Arnold and Howard 2007

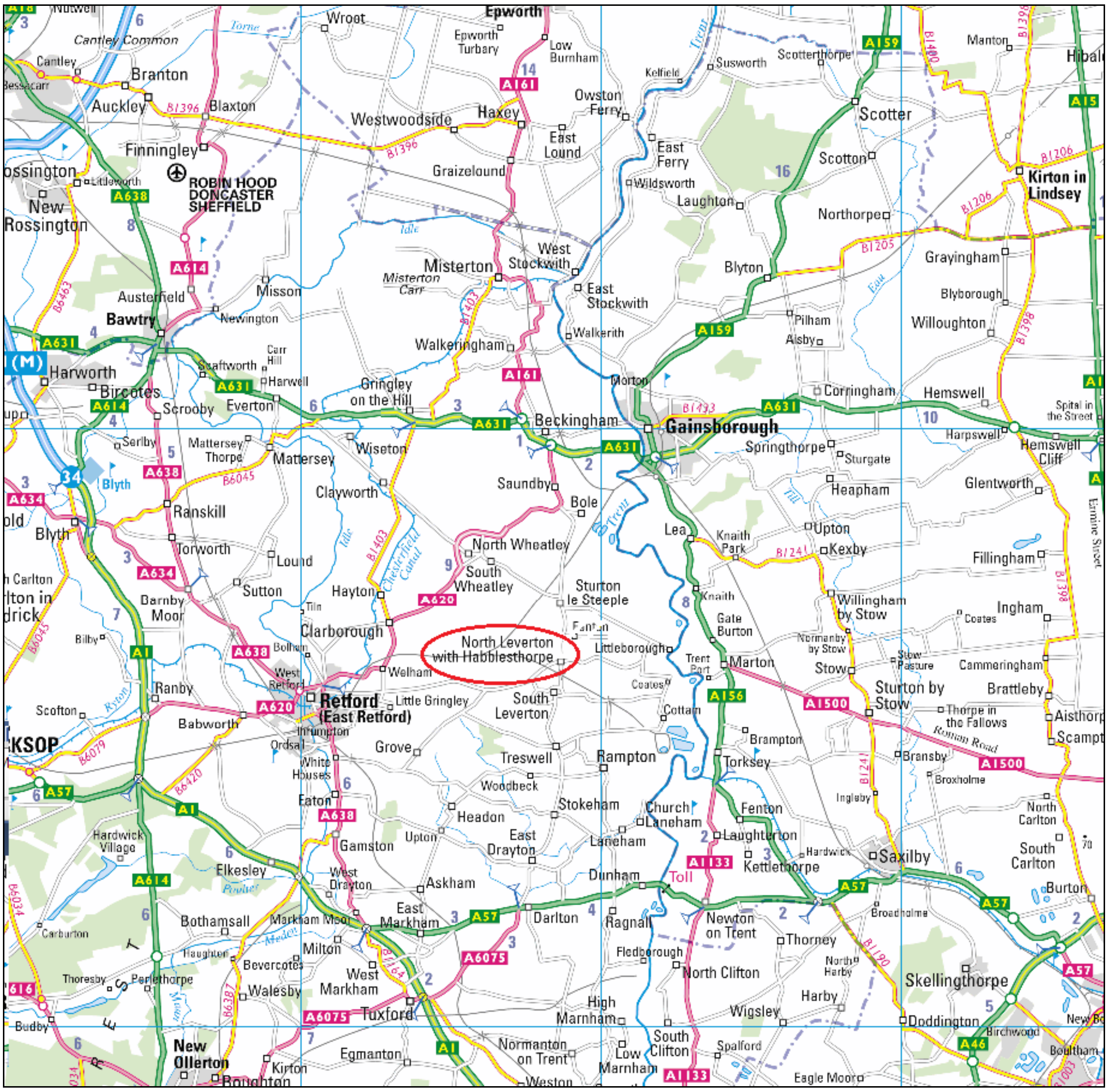

Figure 1: Map to show the general location of North Leverton, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright

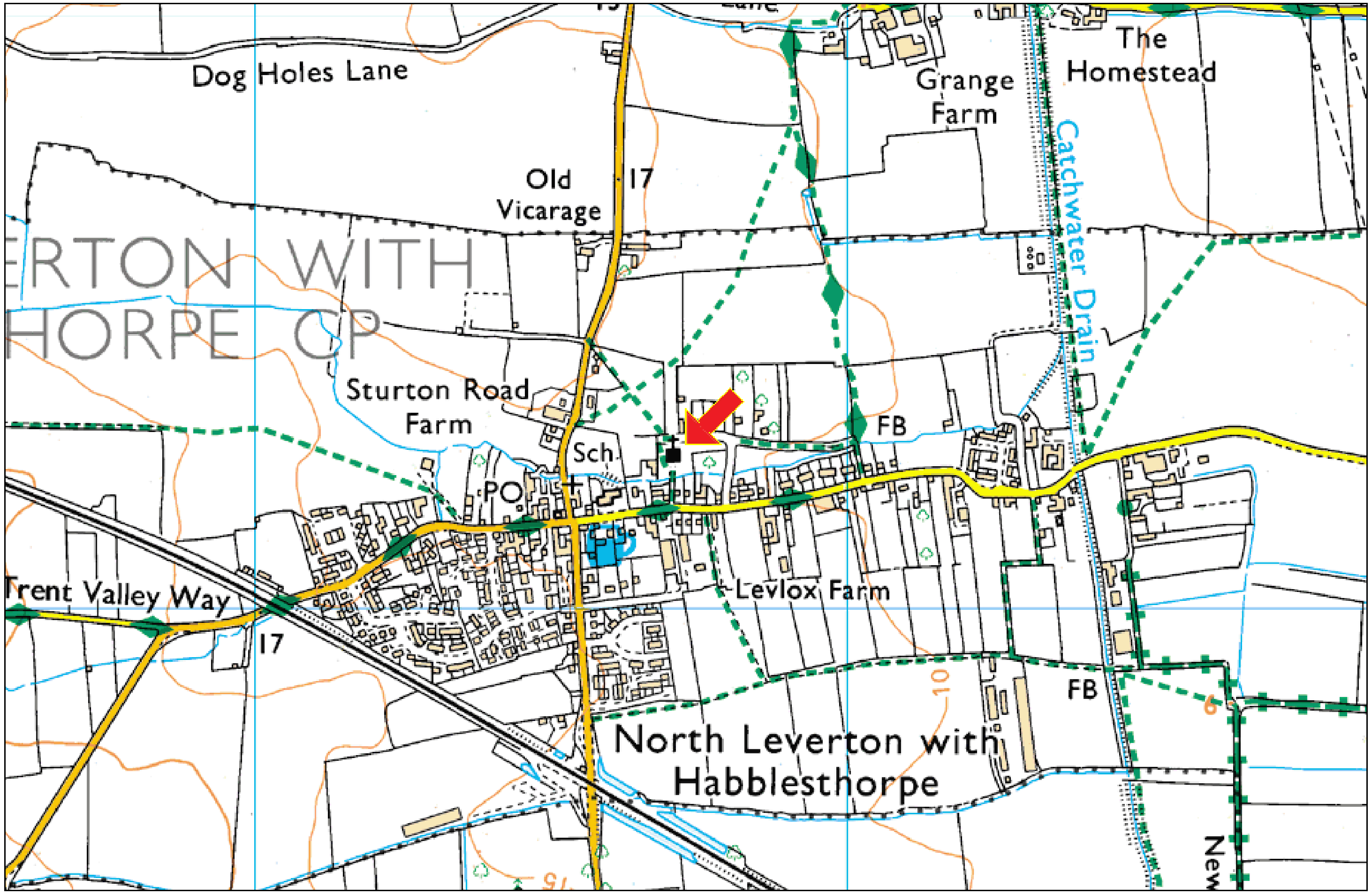

Figure 2: Map to show the location of Church of St Martin, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 3: Bellframe (Dr Chris Brooke)

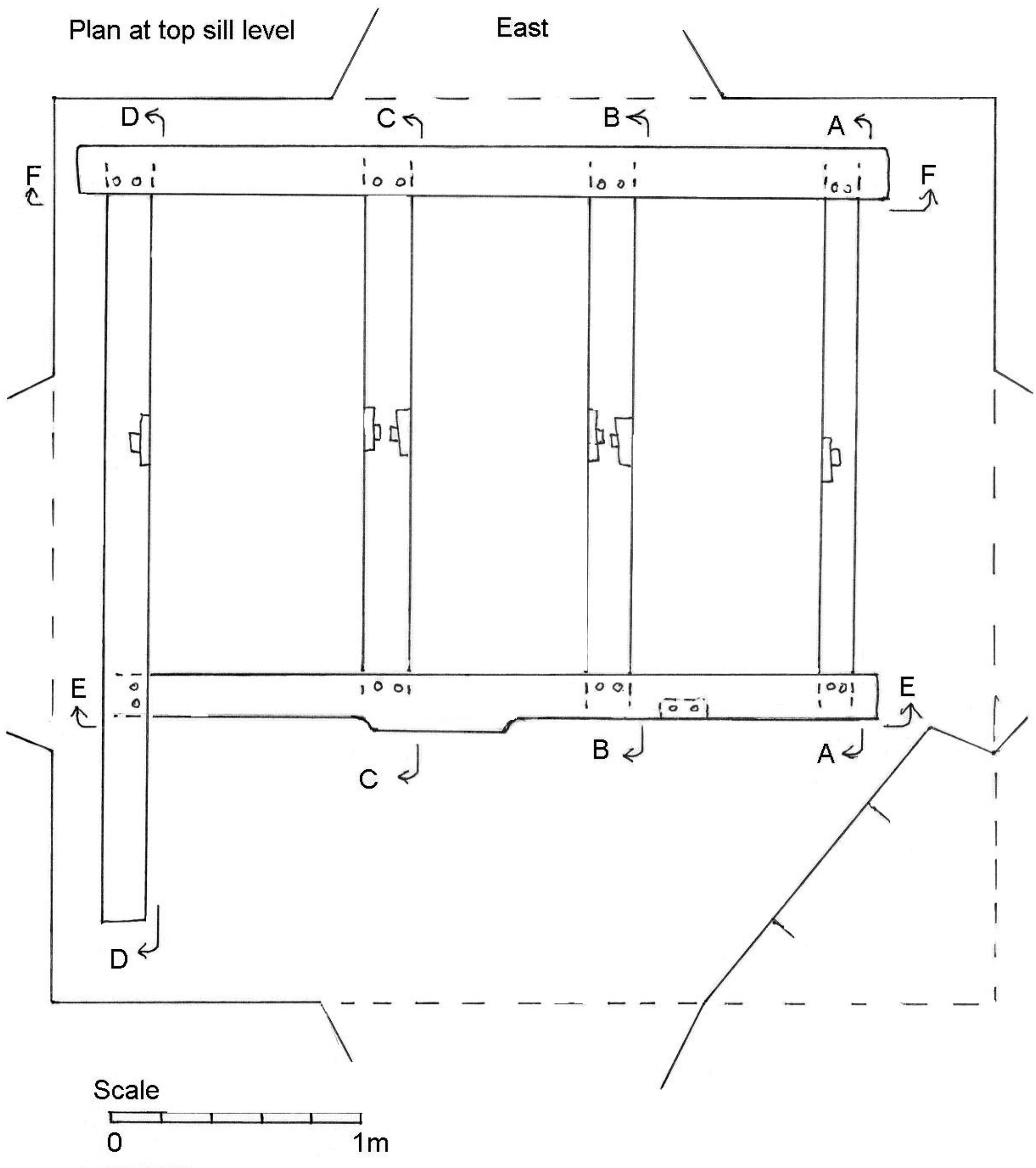

Figure 4: Plan, showing truss labelling (George Dawson)

Figure 5: Truss A

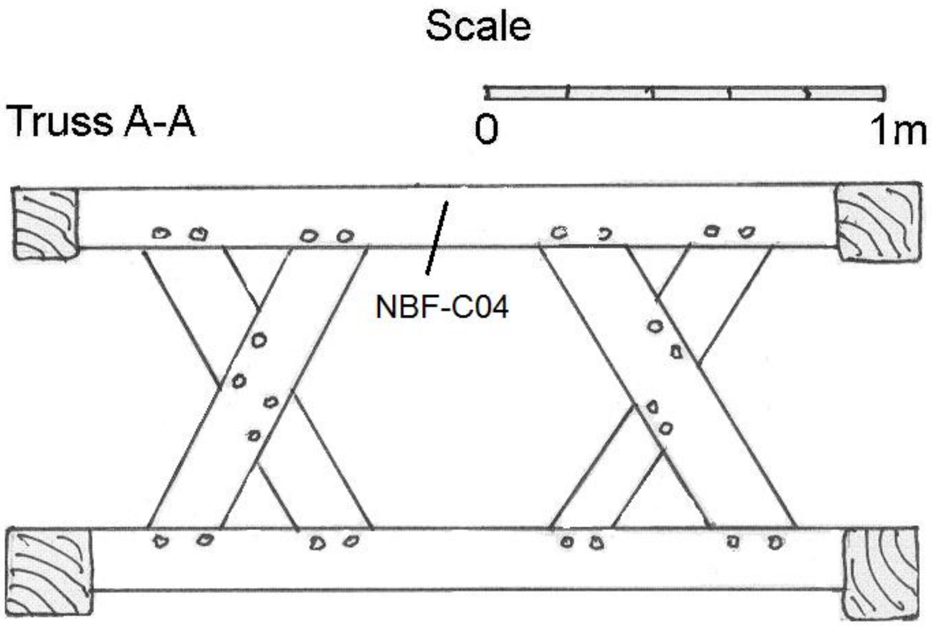

Figure 6: Truss A, showing the location of sample NBF-C04

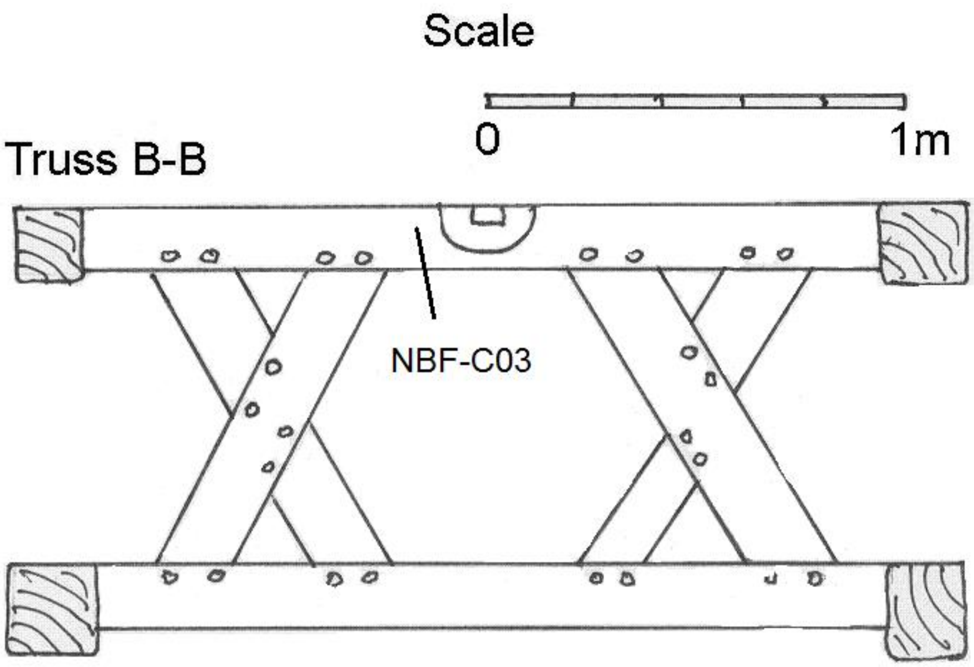

Figure 7: Truss B, showing the location of sample NBF-C03 (George Dawson)

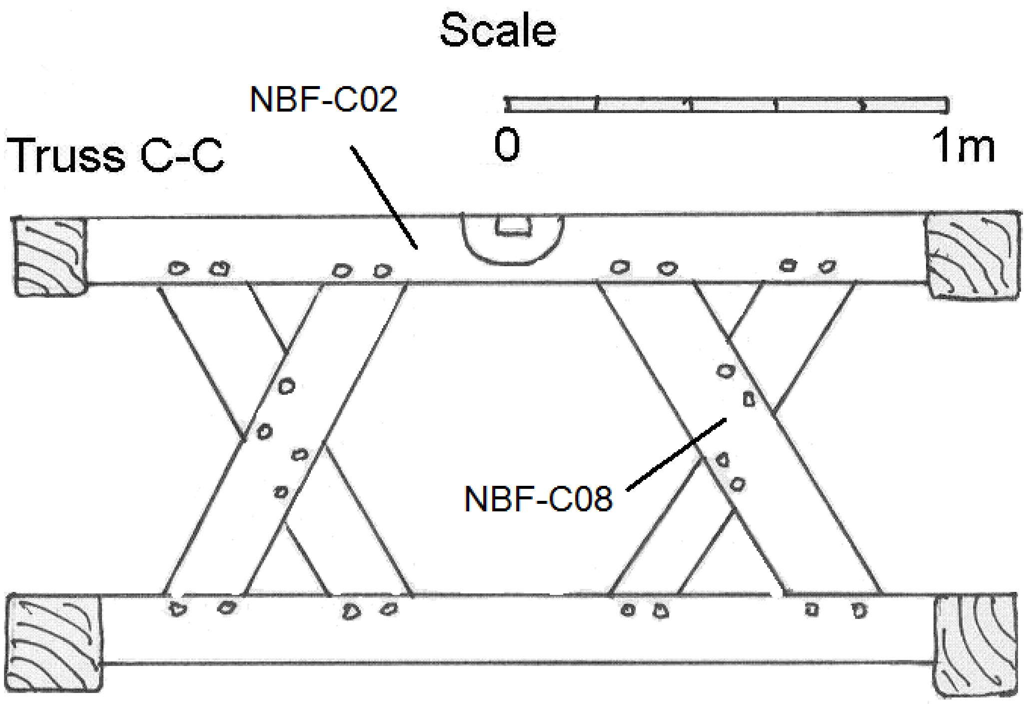

Figure 8: Truss C, showing the location of samples NBF-C02 and NBF-C08 (George Dawson)

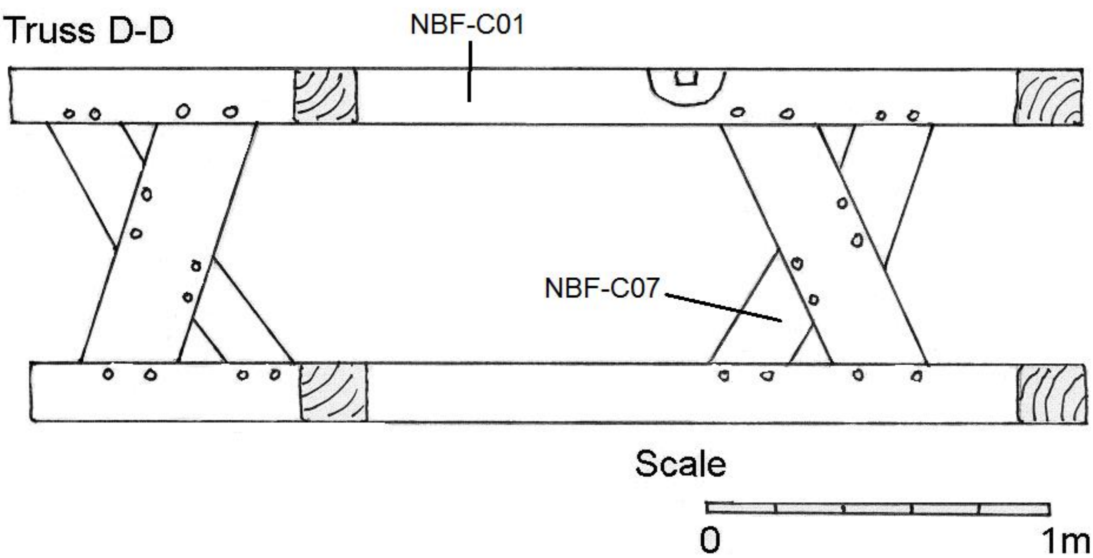

Figure 9: Truss D, showing the location of samples NBF-C01 and NBF-C07 (George Dawson)

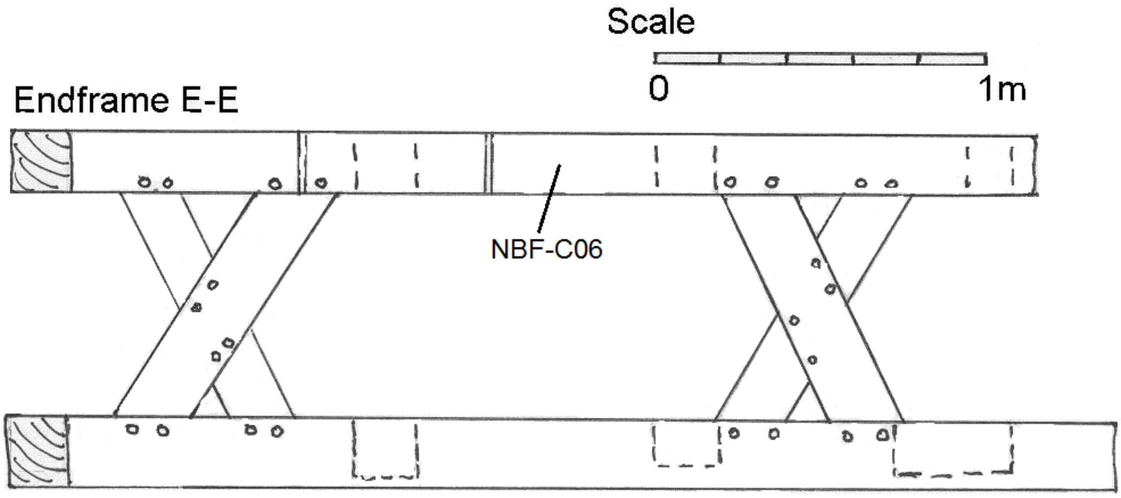

Figure 10: Truss E, showing the location of sample NBF-C06 (George Dawson)

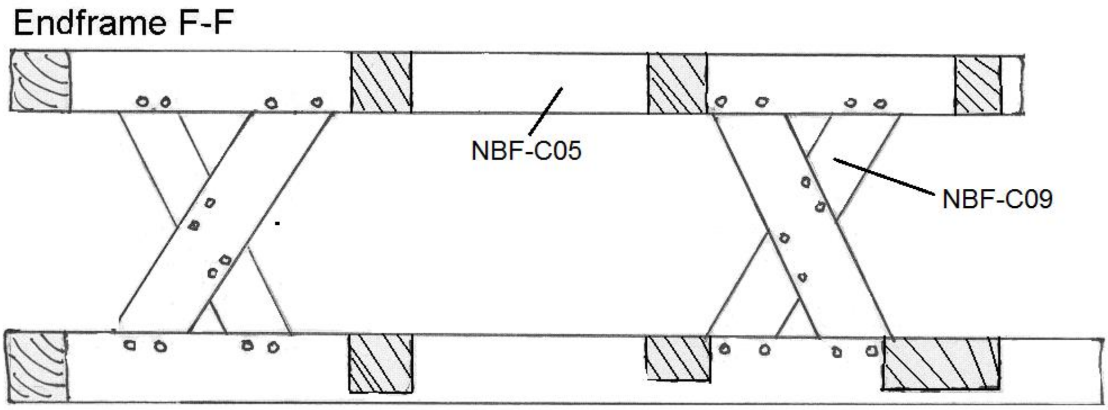

Figure 11: Truss F, showing the location of sample NBF-C05 and NBF-C09 (George Dawson)

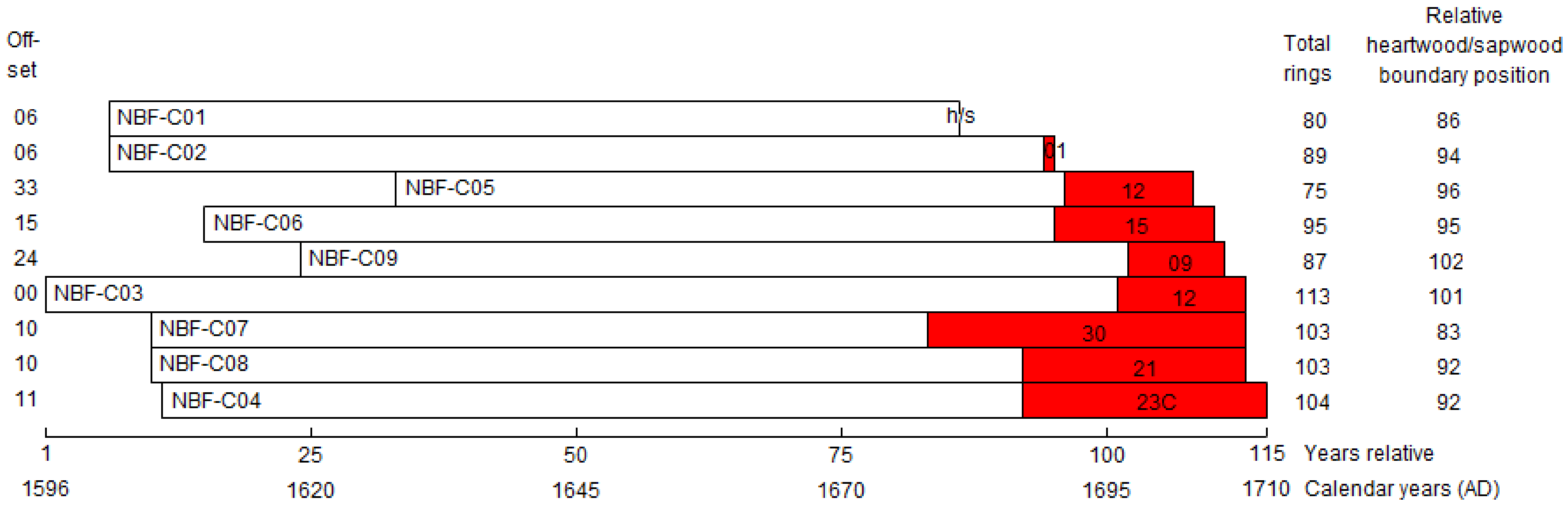

Figure 12: Bar diagram of samples in site sequence NBFCSQ01

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

NBF-C01A 80
141 201 204 98 145 179 200 218 260 236 245 289 189 169 183 173 162 128 105 97
154 125 119 151 153 171 136 237 179 151 262 179 125 171 126 149 151 107 159 167
91 108 120 141 160 134 178 152 108 156 82 106 120 168 149 129 121 101 164 94
87 106 85 103 78 122 83 101 58 89 65 61 98 61 68 106 94 85 86 71
NBF-C01B 80
157 197 201 101 148 184 198 215 250 247 239 288 189 164 181 174 154 137 111 97
152 122 117 151 159 164 142 247 185 142 264 179 117 162 118 153 153 101 151 189
104 111 137 141 161 137 185 154 105 164 78 105 113 163 158 125 118 114 162 98
85 110 90 104 77 122 85 90 65 94 64 58 101 60 69 102 95 87 97 78
NBF-C02A 89
549 748 760 476 513 564 496 345 291 297 375 312 283 322 281 210 236 267 218 149
243 130 109 76 72 70 60 65 39 30 29 19 24 21 23 28 42 42 86 118
61 75 62 47 102 52 52 48 74 59 45 41 176 239 289 249 244 155 234 154
149 227 194 192 217 223 184 241 275 224 336 211 184 222 181 181 210 222 113 152
201 160 163 149 263 276 205 156 141
NBF-C02B 89
538 746 742 469 513 568 493 349 296 305 380 280 270 322 284 212 231 241 183 171
228 135 102 84 65 69 56 63 42 31 25 17 19 27 26 22 45 40 86 124
58 75 65 48 99 51 55 50 72 62 48 39 174 237 291 255 243 156 221 144
154 214 196 191 211 219 191 239 267 232 331 216 178 223 187 177 192 218 106 154
209 174 180 141 245 286 203 138 159
NBF-C03A 113
525 519 398 459 418 430 357 447 412 283 329 279 213 146 170 203 237 206 174 192
201 192 211 176 180 192 250 234 160 139 163 217 214 243 152 84 109 101 78 75
62 65 83 59 94 104 74 76 65 51 67 51 53 55 49 45 58 59 108 176
190 155 191 176 220 157 162 182 154 186 129 152 230 268 257 236 162 223 202 200
203 230 178 257 210 230 256 268 268 167 283 388 389 259 165 190 140 232 220 227
255 214 235 241 289 317 173 217 304 237 297 369 231
NBF-C03B 113
536 512 396 451 407 418 404 411 434 281 304 293 220 163 176 201 239 199 182 199
194 196 194 192 185 182 237 231 166 146 169 214 204 253 152 77 108 108 86 80
59 71 72 62 97 99 74 77 64 51 71 55 50 59 53 48 54 63 111 170
192 157 190 176 221 158 160 181 156 193 126 155 231 272 255 232 163 215 208 195
200 219 188 251 224 221 256 261 256 167 283 394 383 254 178 192 139 243 216 237
271 219 240 240 295 292 175 226 305 240 286 373 238
NBF-C04A 104
435 379 340 428 381 371 426 352 416 333 302 250 291 263 223 338 220 223 233 234
199 202 263 152 89 180 113 97 151 175 170 148 82 132 149 156 122 167 138 203
201 257 169 106 125 79 77 58 86 73 59 94 79 114 77 72 116 101 122 94
111 95 113 88 103 87 72 89 89 72 120 122 99 107 76 91 69 107 89 106
116 87 86 71 82 105 86 99 74 77 95 86 94 90 95 100 106 151 91 97

103 139 106 85
NBF-C04B 104
434 379 339 431 389 368 428 357 409 330 291 257 308 255 221 335 231 228 228 243
201 204 258 149 96 178 108 102 152 177 163 150 77 137 152 150 120 154 150 200
223 240 174 105 112 85 78 58 90 72 63 92 80 112 76 80 114 105 131 95
123 93 116 77 109 86 78 90 86 67 120 127 98 99 73 103 69 103 88 111
119 87 83 67 87 91 90 89 83 75 91 97 78 88 101 96 117 140 68 90
115 142 97 81
NBF-C05A 75
292 143 154 202 140 105 160 265 189 186 128 254 242 129 164 236 320 297 209 343
215 142 71 74 61 178 322 333 148 129 195 218 125 131 148 148 150 200 172 189
153 197 152 140 135 113 111 107 160 158 226 166 147 206 140 100 101 181 170 135
121 82 167 101 51 42 48 44 57 94 90 148 102 128 96
NBF-C05B 75
292 147 151 201 144 101 160 267 194 187 129 251 226 113 159 233 317 302 208 338
233 138 76 69 64 170 319 337 143 127 177 217 127 124 130 130 129 183 175 192
165 229 146 140 145 108 109 111 158 161 218 168 160 206 133 100 105 175 174 127
121 86 168 97 50 49 46 46 59 89 94 142 100 128 100
NBF-C06A 95
334 286 304 248 291 324 231 237 210 191 166 226 208 182 186 218 271 215 278 249
173 192 144 104 135 146 177 160 113 145 187 144 157 221 206 178 186 176 154 96
104 79 66 44 50 31 46 56 58 80 82 54 90 47 95 66 54 68 75 76
95 73 59 89 62 51 93 68 84 85 51 62 46 56 61 74 91 84 74 49
60 77 82 70 55 58 63 70 63 46 50 38 51 66 66
NBF-C06B 95
331 284 318 242 287 329 219 238 229 193 166 223 203 186 184 231 262 207 280 243
170 188 144 106 140 147 174 160 114 147 187 144 160 232 196 190 184 175 153 99
104 79 73 58 52 45 52 52 55 88 84 59 88 48 99 63 67 67 79 71
96 76 59 82 67 56 93 74 82 84 47 65 42 59 66 66 89 84 72 52
63 79 71 65 64 49 74 71 54 59 54 44 44 69 69
NBF-C07A 103
210 178 188 193 151 145 187 190 177 257 279 151 142 85 96 112 179 162 127 159
164 152 161 239 182 115 129 110 72 92 103 145 120 85 132 151 96 96 110 129
124 82 105 63 36 51 29 24 51 81 71 64 43 33 78 61 42 77 56 69
67 85 70 68 58 73 69 51 109 71 59 94 85 83 103 87 138 90 125 132
160 119 115 147 96 119 156 185 118 109 116 140 141 101 128 126 102 131 106 46
71 68 89
NBF-C07B 103
209 175 183 188 191 140 186 188 175 241 300 145 136 88 108 100 159 171 124 164
166 153 161 280 179 108 136 109 74 87 93 131 119 92 127 151 98 95 116 129
128 85 106 56 41 50 31 25 52 89 66 48 51 44 65 67 37 77 54 76
64 85 68 70 59 72 71 51 114 63 60 99 82 84 101 90 139 90 129 135
158 121 116 149 92 116 157 182 126 106 112 144 141 104 130 121 102 139 104 42
77 66 94
NBF-C08A 103
298 356 212 280 269 301 271 246 193 196 228 189 213 184 218 149 225 223 181 210
152 173 166 199 182 139 154 145 109 134 99 93 97 103 128 127 113 113 122 146

172 166 194 176 118 115 77 91 119 179 129 113 108 99 136 117 98 131 114 148
137 140 157 127 146 132 121 90 148 145 88 136 136 143 180 120 142 103 103 107
139 147 114 103 95 103 128 125 113 91 86 97 109 97 104 97 78 79 109 55
61 76 99

NBF-C08B 103

299 352 229 265 276 294 268 263 193 195 224 191 214 184 223 145 226 217 180 218
146 175 167 198 181 141 149 146 117 129 113 96 90 100 128 126 119 112 127 138
176 165 190 154 119 116 75 82 134 181 134 117 104 102 132 121 99 128 125 149
138 138 152 139 145 134 117 86 155 155 87 140 142 136 182 122 140 107 101 107
140 147 109 107 85 110 130 131 117 86 94 94 107 94 107 94 75 93 103 58
52 74 77

NBF-C09A 87

262 153 195 253 255 291 301 164 181 293 163 206 231 134 103 100 143 157 146 101
116 153 119 151 247 412 311 193 420 188 160 173 142 123 217 191 253 175 188 227
167 132 196 206 351 281 365 321 252 273 219 285 218 208 257 191 201 308 253 256
266 273 401 244 220 167 256 201 165 222 171 234 187 121 150 187 145 211 169 170
312 264 180 173 296 190 175

NBF-C09B 87

258 155 195 259 257 297 298 166 181 292 165 204 242 130 104 99 140 154 151 97
111 154 117 161 238 410 306 187 419 191 156 176 135 126 227 195 247 176 187 227
161 133 197 205 353 281 363 325 253 289 201 292 218 206 261 192 198 305 260 255
255 264 393 251 223 161 260 204 165 225 174 237 184 120 149 188 145 203 175 171
316 268 179 168 295 198 166