

**Dendrochronological Analysis of
Rural Plains,
Mechanicsville, Hanover County,
Virginia**



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Introduction

This is the final report on the dendrochronological analysis of the structure known as the *Rural Plains*, located at 7273 Studley Road (Route 606), Mechanicsville, Hanover County, Virginia, 23116. The house is currently owned by Richmond National Battlefield Park, a unit of the National Park Service. Rural Plains is listed on both the Virginia Landmarks Register and The National Register of Historic Places.

In an effort to confirm the construction history of this building, architectural historian Dr. Camille Wells, acting on behalf of the NPS, requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of its structural timbers.

Together with Dr. Wells and Richmond National Battlefield Park Superintendent Cynthia McLeod, Callahan visited the house on 20 November 2006, and collected wood core samples for the dendrochronological analysis of the timbers. Of the 12 samples acquired and analyzed, all were of pine (*Pinus* sp.). Every effort was made on site to locate bark or waney edges on the sampled timbers in order to ascertain an absolute cutting date, or dates, of the trees used in the construction.

Dendrochronological Analysis

Dendrochronology is the science of analyzing and dating annual growth rings in trees. Its first significant application was in the dating of ancient Indian pueblos of the southwestern United States (Douglass 1921, 1929). Andrew E. Douglass is considered the "father" of dendrochronology, and his numerous early publications concentrated on the application of tree-ring data to archaeological dating. Douglass established the connection between annual ring width variability and annual climate variability which allows for the precise dating of wood material (Douglass 1909, 1920, 1928; Stokes and Smiley 1968; Fritts 1976; Cook and Kariukstis 1990). The dendrochronological methods first developed by Douglass have evolved and been employed throughout North America, Europe, and much of the temperate forest zones of the globe (Edwards 1982; Holmes 1983; Stahle and Wolfman 1985; Cook and Callahan 1992, Krusic and Cook 2001). In Europe, where the dendrochronological dating of buildings and artifacts has long been a routine professional support activity, the success of tree-ring dating in historical contexts is noteworthy (Baillie 1982; Eckstein 1978; Bartholin 1979; Eckstein 1984).

The wood samples collected from the Rural Plains were processed in the Tree-Ring Laboratory by Dr. Edward Cook following well-established dendrochronological methods. The samples were carefully glued onto grooved mounts and sanded to a high polish to reveal the annual tree rings clearly. The rings widths were measured under a microscope to a precision of ± 0.001 mm. The cross-dating of the obtained measurements utilized the COFECHA computer program (Holmes 1983), which employs a sliding correlation to identify probable cross-dates between tree-ring series. In all cases, the robust non-parametric Spearman rank correlation coefficient was used for determining cross-dating. Experience has shown that for trees growing in the northeastern United States, this method of cross-dating is superior to the traditional skeleton plot technique (Stokes and Smiley 1968). It is also very similar to the highly successful CROS program employed by, for instance, Irish dendrochronologists to cross-date European tree-ring series (Baillie 1982).

COFECHA is used to first establish internal, or relative, cross-dating amongst the individual timbers from the site. This step is critically important because it locks in the relative positions of the timbers to each other, and indicates whether or not the dates of those specimens with outer bark rings are consistent. Subsequently, the internally cross-dated series are each

compared with independently established tree-ring master chronologies compiled from living trees and dated historical tree-ring material. All of the "master chronologies" are based on completely independent tree-ring samples.

In the Rural Plains study, regional composite master dating chronologies from living trees and historical structures in the Middle Atlantic region were referenced primarily. All dating results were verified finally by comparison with independent dating masters from surrounding areas in Maryland, New Jersey, Virginia and central Pennsylvania. In each case, the datings as reported here were verified as correct.

Results and Conclusions

The results of the dendrochronological dating of the Rural Plains timbers are summarized in **Table 1** and **Figure 1**. A total of 12 pine samples were analyzed in the laboratory, with all 12 samples providing firm dendrochronological dates.

To achieve these datings required attention during analysis to the previously recorded structural context of the samples (see **Table 1**). The contextual association of samples from within the house, the redundancy of the indicated relative cross-datings, and the eventual existence of bark/waney edges demonstrating cutting year, provides the essential constraints necessary for establishing cross-dating, both within a site and with absolute chronological masters.

The strength of the cross-dating of the samples is indicated by the Spearman rank correlations in the seventh column ("CORREL") of **Table 1**. These statistical correlations, produced by the COFECHA program, indicate how well each sample cross-dates with the mean of the others in the group. The individual correlations vary slightly in statistical strength, but all are in the range that is expected for correctly cross-dated timbers from buildings in the eastern United States. Of the 12 samples that cross-dated well between themselves, and also dated well against the local pine historical dating masters (see **Table 1**, column 6), 8 had verifiable bark edge at the time of laboratory analysis. Microscopically in the laboratory, all 8 of these were determined to have complete growth rings in their cutting year. Some of remaining samples exhibited bark edge surfaces before extraction, yet lost their outermost sections due to surface degradation caused by insects and/or moisture. Estimated ring loss has been taken into account when employing these samples in the chronological analysis of the site.

From the datings that were achieved, there emerged strong evidence of at least one intrinsic construction period for Rural Plains. The absolutely dated, bark-edged samples RPHCVA01, 02, 03, 07, 09, indicate a primary construction phase for the house some time after the end of the growth season 1723 (that is, the trees were cut during dormancy after the end of the growth season, late in the autumn of 1723 or immediately before the beginning of the growth season of the spring of 1724, i.e., approximately November 1723 through February 1724). Two other bark-edged samples (RPHCVA10 & 11, attic joists) were absolutely dated to 1725. A single sample (RPHCVA12) taken from a loose floorboard, not found *in situ* and lacking bark edge but probably including sapwood, dated to 1719, while another attic sample (RPHCVA08) without bark edge but including sapwood, dated to 1720. In conjunction, these results indicate that Rural Plains was probably built during 1724-26.

In a central causeway of the cellar used in modern times as a washroom, in the vicinity of the existent Greek Revival staircase, 3 samples (RPHCVA04, 05, 06) taken from joists indicate a renovation or structural "adjustment" likely undertaken in 1784-85.

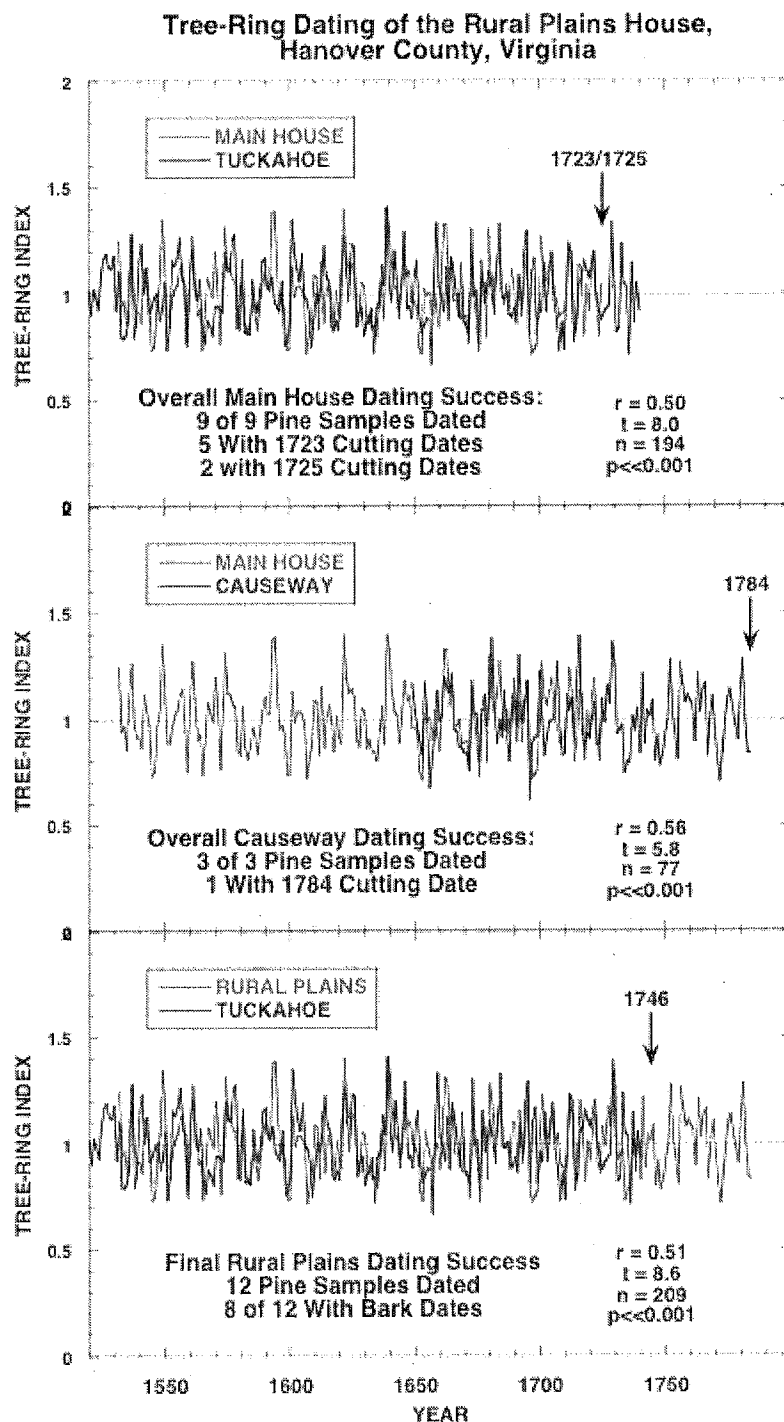
Close *in situ* inspection of the timbers indicated that the materials were utilized soon after cutting, in keeping with historical woodworking and carpentry techniques. Possible re-use of

older timbers in subsequent construction phases, although not evidenced, cannot be excluded. However, the chronological homogeneity of the dated samples makes eventual re-use of timbers of no germane consequence to the present dendrochronological analysis.

Table 1. Dendrochronological dating results for all samples taken from the Rural Plains House, Hanover County, Virginia. For WANEY, +BE means the bark edge was present and thought to be recovered at the time of sampling; -BE means that the bark edge was not recovered or was completely missing on the timber. SP refers to sapwood being recovered (+) or not (-). All correlations are Spearman rank correlations of each series against the mean of all of the others of the same pine species. If the outermost recovered +BE ring is completely formed, it is indicated as "comp", meaning that the tree was felled in the dormant season following that last year of growth.

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
RPHCVA01	Pine	Header 1, under hearth, SW corner room, cellar,	+BE	100	1624 1723 comp.	0.70
RPHCVA02	Pine	Header 2, under hearth, SW corner room	+BE	111	1613 1723 comp.	0.64
RPHCVA03	Pine	Joist, cellar, 2 nd fr partition wall, SW corner room, cellar	+BE	66	1658 1723 comp.	0.45
RPHCVA04	Pine	Joist, 2 nd fr S of staircase, causeway, modern wash room, cellar	+SP	111	1649 1759	0.62
RPHCVA05	Pine	Joist, 3 rd fr S of staircase, causeway, modern wash room, cellar	+BE	112	1673 1784 comp.	0.71
RPHCVA06	Pine	Joist, 5 th fr S of staircase, causeway, modern wash room, cellar	+SP	97	1658 1754	0.59
RPHCVA07	Pine	Attic, W side, rafter #2 fr N	+BE	76	1648 1723 comp.	0.76
RPHCVA08	Pine	Attic, E side, rafter #19 fr N	-BE, +SP	76	1645 1720	0.64
RPHCVA09	Pine	Attic, E side, rafter #20 fr N	+BE	71	1653 1723 comp	0.60
RPHCVA10	Pine	Attic, 11th joist fr S wall	+BE	49	1677 1725 comp.	0.64
RPHCVA11	Pine	Attic, 2 nd joist fr S wall	+BE	59	1667 1725 comp.	0.58
RPHCVA12	Pine	Floor board, unknown provenience, found loose in attic	-BE, +SP?	188	1532 1719	0.41

Figure 1. Comparisons of the cross-dated internal chronologies of the Rural Plains House, from two sections - "Main House" and "Causeway" - and their compiled mean, with an independently dated pine master chronology ending in 1746, from nearby Tuckahoe in Virginia. The Spearman rank correlations between the two Rural Plains masters and the Tuckahoe master ($r=0.50$ and 0.51) are highly significant ($p<<0.001$) with t -statistics of 8.0 and 8.6 . In addition, the two Rural Plains chronologies (middle plot) match each other with an $r=0.56$ and $t=5.8$ ($p<<0.001$).



The "r-factor" is the Spearman rank correlation coefficient, a measure of relative statistical agreement between two groups of measurements or data. It can range from +1 (perfect direct agreement) to -1 (perfect opposite agreement). The "t-value" is Student's distribution test for determining the unique probability distribution for "r", i.e. the likelihood of its value occurring by chance alone. As a rule, a $t=3.5$ has a probability of about 1 in 1000, or 0.001, of being invalid. Higher "t" values indicate increasingly stronger statistical certitude.

The t-statistic ($t=8.6$) associated with the third correlation between the two series ($r=0.51$) is statistically highly significant ($p \ll 0.001$) for a 209-year overlap. For that reason, there can be no doubt that the dates presented here for these sampled sections of the Rural Plains are very strongly valid, and that the statistical chance of the cross-dates being incorrect is much, much less than 1 in 1000.

Selected References

- Baillie, M.G.L. 1982. *Tree-Ring Dating and Archaeology*. Croom Helm, London and Canberra. 274 pp.
- Baillie, M.G.L. 1995. *A Slice Through Time: Dendrochronology and Precision Dating*. B.T. Batsford, Ltd., London
- Bartholin, T.S. 1979. "Provtagning för dendrokronologisk datering och vedanatometisk analys." *Handbook i archeologiskt fältarbete, häfte 2*. 1-15 Riksantikvarieämbetets dokumentationsbyrå, Stockholm.
- Cook, E.R. and Callahan, W.J. 1987. *Dendrochronological Dating of Fort Loudon in South-Central Pennsylvania*. Limited professional distribution.
- Cook, E.R. and Callahan, W.J. 1992. *The Development of a Standard Tree-Ring Chronology for Dating Historical Structures in the Greater Philadelphia Region*. Limited professional distribution.
- Cook, E.R. and L. Kariukstis, eds. 1990. *Methods of Dendrochronology: Applications in the Environmental Sciences*. Kulwer, The Netherlands.
- Douglass, A.E. 1909. Weather cycles in the growth of big trees. *Monthly Weather Review* 37(5): 225-237
- Douglass, A.E. 1920. Evidence of climate effects in the annual rings of trees. *Ecology* 1(1):24-32
- Douglass, A.E. 1928. Climate and trees. *Nature Magazine* 12:51-53
- Douglass, A.E. 1921. Dating our prehistoric ruins: how growth rings in trees aid in the establishing the relative ages of the ruined pueblos of the southwest. *Natural History* 21(1):27-30
- Douglass, A.E. 1929. The secret of the southwest solved by talkative tree-rings. *National Geographic Magazine* 56(6):736-770.
- Eckstein, D. 1978. Dendrochronological dating of the medieval settlement of Haithabu (Hedeby). In: *Dendrochronology in Europe*, (J. Fletcher, ed.) British Archaeological Reports International Series 51: 267-274
- Eckstein, D. 1984. *Dendrochronological Dating (Handbooks for Archaeologists, 2)*. Strasbourg, European Science Foundation.
- Eckstein, D. and Bauch, J. 1969. "Beitrag zur Rationisierung eines dendrokronologischen Verfahrens und zur Analyse seiner Aussagesicherheit." *Forstwissenschaftliches Centralblatt* 88, 230-250.
- Edwards, M.R. 1982. Dating historic buildings in lower Maryland through dendrochronology. In: *Perspectives in Vernacular Architecture*. Vernacular Architecture Forum.
- Fritts, H.C. 1976. *Tree Rings and Climate*. Academic Press, New York. 567 pp.
- Holmes, R.L. 1983. Computer assisted quality control in tree-ring dating and measurement. *Tree-Ring Bulletin* 43:69-78
- Krusic, P.J. and E.R. Cook. 2001. *The Development of Standard Tree-Ring Chronologies for Dating Historic Structures in Eastern Massachusetts: Completion Report*. Great Bay Tree-Ring Laboratory, May 2001, unpublished report.
- Stahle, D.W. and D. Wolfman. 1985. The potential for archaeological tree-ring dating in eastern North America. *Advances in Archaeological Method and Theory* 8: 279-302.
- Stokes, M.A. and T.L. Smiley. 1968. *An Introduction to Tree-Ring Dating*. University of Chicago Press, Chicago 110 pp.

Edward Cook was born in Trenton, New Jersey, in 1948. He received his PhD. from the Tucson Tree-Ring Laboratory of the University of Arizona in 1985, and has worked as a dendrochronologist since 1973. Currently director of the Tree-Ring Laboratory at the Lamont-Doherty Earth Observatory of Columbia University, he has comprehensive expertise in designing and programming statistical systems for tree-ring studies, and is the author of many works dealing with the various scientific applications of the dendrochronological method.

William Callahan was born in West Chester, Pennsylvania, in 1952. After completing his military service he moved to Europe, receiving his MA from the University of Stockholm in 1979. He began working as a dendrochronologist in Sweden in 1980 at the Wood Anatomy Laboratory at the University of Lund, and returned to the United States in 1998. A former associate of Dr. Edward Cook at the Tree-Ring Laboratory of Lamont-Doherty, he has extensive experience in using dendrochronology in dating archaeological artifacts and historic sites and structures.

Some regional historical dendrochronological projects completed by the authors:

Abraham Hasbrouck House, New Paltz, NY
 Carpenter's Hall, Philadelphia, PA
 Christ's Church, Philadelphia, PA
 Conklin House, Huntington, NY
 Customs House, Boston, MA
 Daniel Boone Homestead, Birdsboro, PA
 Daniel Pieter Winne House, Bethlehem, NY
 Ephrata Cloisters, Lancaster County, PA
 Fawcett House, Alexandria, VA
 Gadsby's Tavern, Alexandria, VA
 Gilmore Cabin, Montpelier, Montpelier Station, VA
 Gracie Mansion (Mayor's Residence), New York, NY
 Hanover Tavern, Hanover Courthouse, VA
 Harriton House, Bryn Mawr, PA
 Hollingsworth House, Elk Landing, MD
 Independence Hall, Philadelphia, PA

John Bowne House, Forest Hills, NY
 Log Cabin, Fort Loudon, PA
 Lower Swedish Log Cabin, Delaware County, PA
 Morris Jumel House, Jamaica, NY
 Old Swede's Church, Philadelphia, PA
 Panel Paintings, National Gallery, Washington, DC
 Pennock House & Barn, London Grove, PA
 Powell House, Philadelphia, PA
 Spangler Hall, Bentonville, VA
 St. Peter's Church, Philadelphia, PA
 Strawbridge Shrine, Westminster, MD
 Thomas & John Marshall House, Markham, VA
 Thomas Grist Mill, Exton, PA
 Varnum's HQ, Valley Forge, PA
 William Garrett House, Sugartown, PA
 Yew Hill, Fauquier County, VA