Dendrochronological Investigation at *Warehousen Farm South Barn*, Pine Plains, Dutchess County, New York

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February 2011

Introduction

This is a report on the results of the investigatory dendrochronological testing of the structure known as the *Warehousen Farm South Barn*, located on Hicks Hill Road, Pine Plains New York 12567 (Latitude: N41°58'28"/Longitude: W73°42'45").

In an effort to reveal some details of the construction history of this building, architectural historian Walter Wheeler of Hartgen Archeological Associates, Inc., Rensselaer, NY 12144, acting on behalf of clients, requested that dendrochronologists William Callahan and Dr. Edward Cook perform an investigatory analysis of some of its structural timbers.

Together with Mr. Wheeler and Dr Edward Cook, Callahan visited the house on 9 December 2010, and collected some wood core samples for the dendrochronological analysis of the timbers. Of the 4 samples retained and analyzed, 3 were of oak (Quercus sp.). The remaining sample (undated) is tentatively identified as either chestnut or ash. 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 Warehousen Farm South Barn 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 Warehousen Farm South Barn study, regional composite master dating chronologies from living trees and historical structures in the Hudson Valley region were referenced primarily. All dating results were verified finally by comparison with independent dating masters from surrounding areas in Virginia, Maryland, New Jersey and central Pennsylvania. In each case, the datings as reported here were verified as correct.

Results and Conclusions

The results of the investigatory dendrochronological testing of the Warehousen Farm South Barn timbers are summarized in **Table 1** and **Figure 1**. A total of 3 oak samples and 1 sample of an indeterminant species were analyzed in the laboratory, with all 3 of the oak samples providing firm dendrochronological dates. The fourth sample remains undated, likely due to its short ring series.

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.

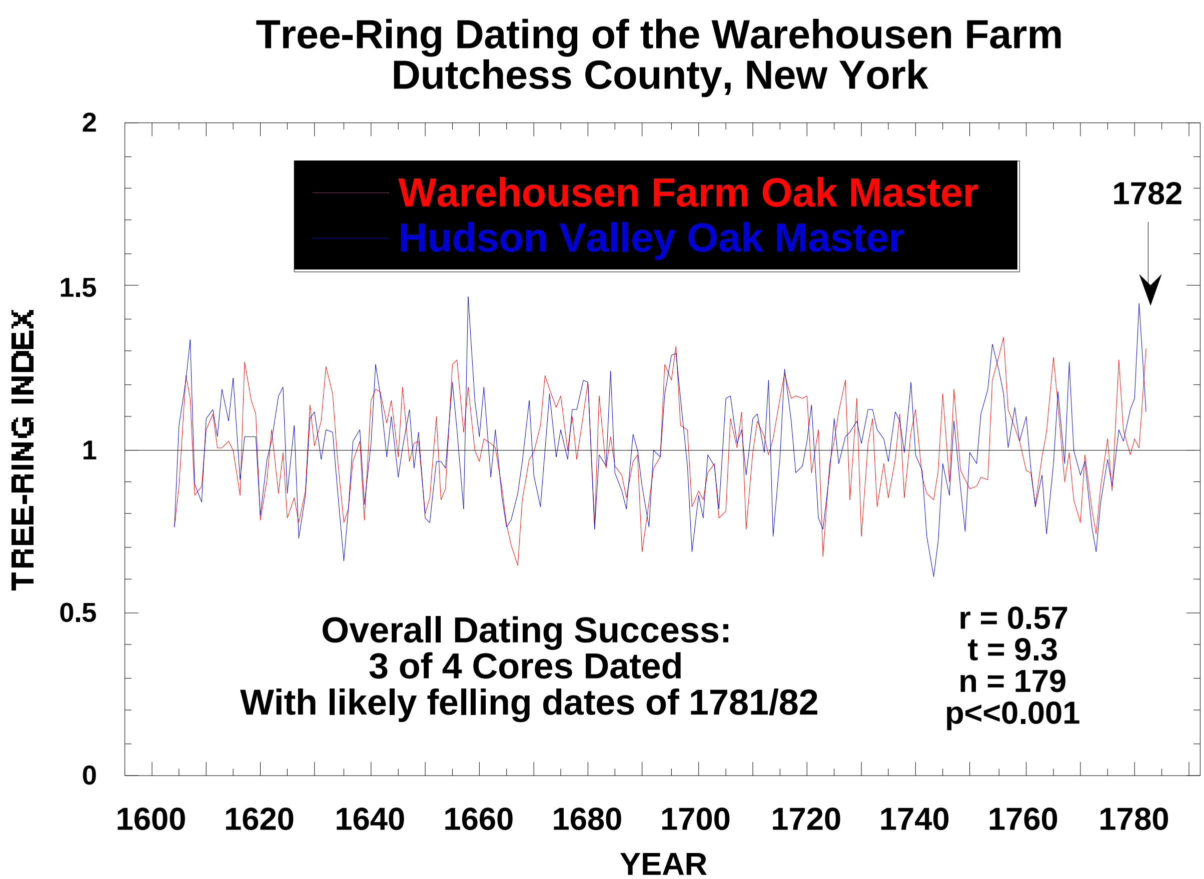
The strength of the cross-dating of the samples is indicated by the Spearman rank correlations in the seventh column (“CORREL”) of **Table 1**. These statistical correlations, produced by the COFECHA program, indicate how well each sample cross-dates with the mean of the others in the group. The individual 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.

The dated samples WHFDNY01 & 02, together with 04, all significant structural timbers, suggest a construction phase for the site in its present configuration of some time after the after the growth season 1782 (that is, after the end of the growth season, late in the autumn of 1782 or immediately before the beginning of the growth season of the spring of 1783, i.e., approximately November 1782 through February 1783). The dating of WHFDNY04, several decades earlier than the assorted datings, may represent an earlier structural unit, a re-used timber from an earlier configuration, or perhaps a re-used timber from another source. The determination of the wane edge of this sample was inconclusive in the field and laboratory, and the dating may merely represent an otherwise contemporary timber that lost a significant number of rings due to erosion or milling. In any case, this dating does not contradict an interpretation of the 1782/83 construction, and provides some redundant evidence for this construction phase.

Close *in situ* inspection of the timbers indicated that the materials were initially utilized soon after cutting, in keeping with historical woodworking and carpentry techniques. Possible re-use of the timbers in subsequent construction activities cannot be excluded absolutely.

Table 1. Dendrochronological dating results for the oak samples taken from the Warehousen Farm South Barn, Pine Plains, Dutchess County, New York. 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. If –BE, +SP refers to the likelihood that sapwood rings are present. If so, the outer date may be close to the cutting date. All correlations are Spearman rank correlations of each series against the mean of all of the others of the same 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. "Incomp" means that the outermost ring was not fully formed, meaning that the tree was felled during the spring/summer growing season.						
ID	**SPECIES**	**DESCRIPTION**	**WANEY**	**RINGS**	**DATING**	**CORREL**
WHFDNY01	Oak	South barn, post, 6th from west	-BE, +SP	122	1660 1781	0.43
WHFDNY02	Oak	South barn, post, 3rd from west	+BE	179	1604 1782	0.43
WHFDNY03	Chestnut or Ash?	South barn, beam, 1st from west	+BE	59	No Date	-.--
WHFDNY04	Oak	South barn, beam, 2nd from west	+BE?	106	1607 1712	0.50

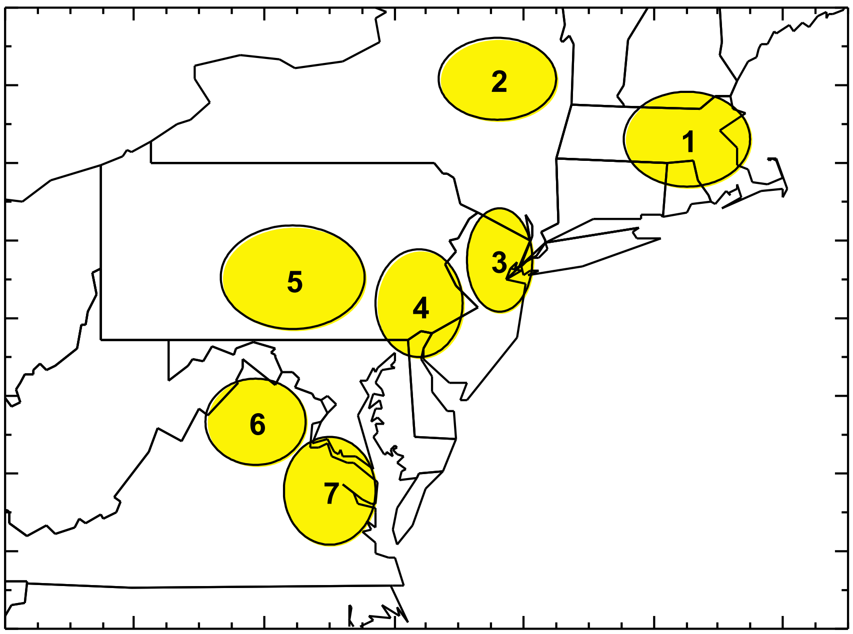
Figure 1. Comparison of the cross-dated oak master chronology for the Warehousen Farm South Barn against a historical oak dating master for the Hudson Valley of New York. The Spearman rank correlation between the series (r=0.57) is highly significant (p<<0.001) with an overlap of 179 years and a t-statistic of 9.3.

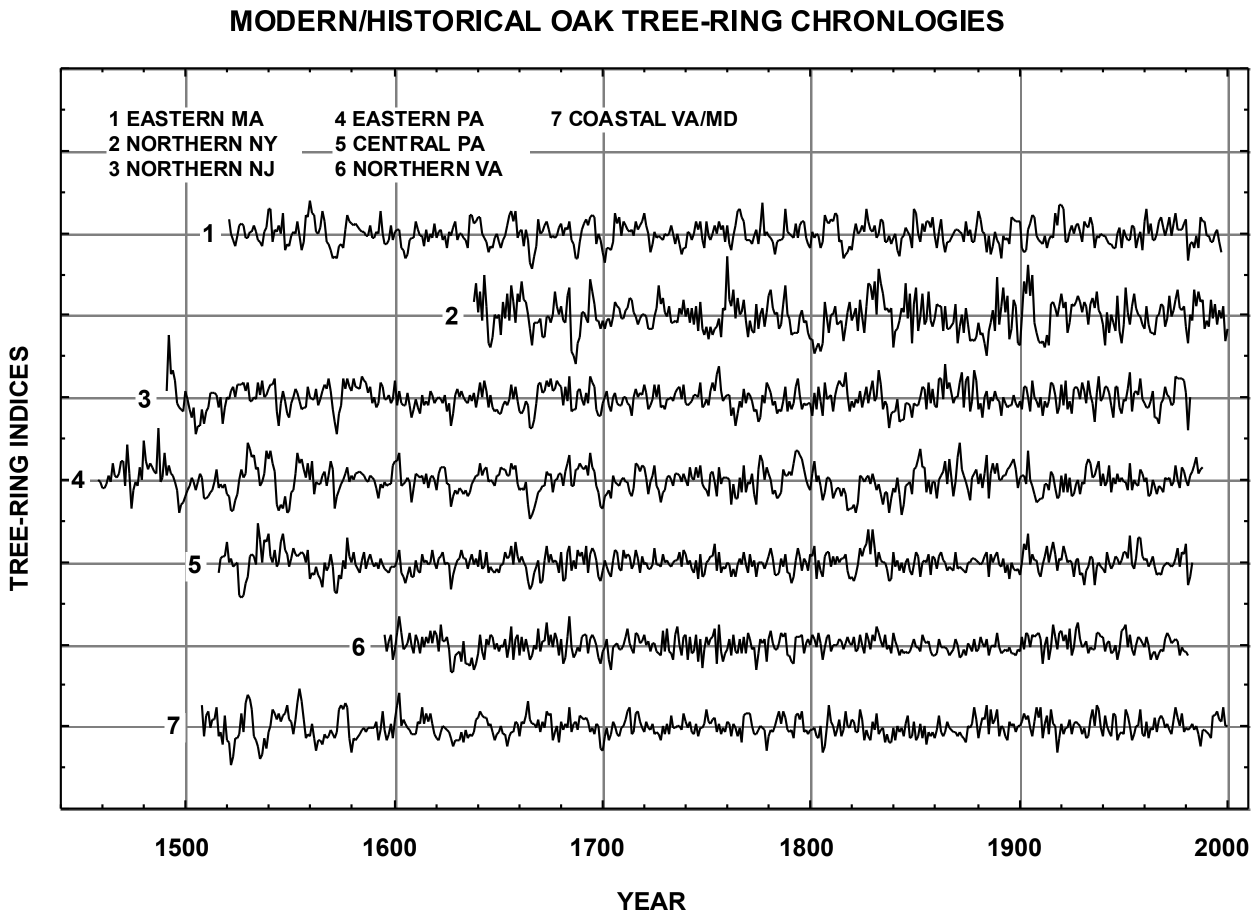


The "r-factor" is the Spearman rank correlation coefficient, a measure of relative statistical agreement between two groups of measurements or data. It can range from +1 (perfect direct agreement) to -1 (perfect opposite agreement). The "t-value" is Student's distribution test for determining the unique 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-statistics (t=9.3) associated with the correlation between the series (r=0.57) is statistically highly significant (p<<0.001) for a 179-year overlap. For that reason, there can be no doubt that the dates presented here for these sampled sections of the Warehousen Farm South Barn are very strongly valid, and that the statistical chance of the cross-dates being incorrect is much, much less than 1 in 1000.

MODERN/HISTORICAL OAK CHRONOLOGIES
REGIONAL LOCATIONS OF SAMPLES




MODERN/HISTORICAL OAK TREE-RING CHRONLOGIES
1 EASTERN MA
2 NORTHERN NY
3 NORTHERN NJ
4 EASTERN PA
5 CENTRAL PA
6 NORTHERN VA
7 COASTAL VA/MD
1
2
3
4
5
6
7
TREE-RING INDICES
1500
1600
1700
1800
1900
2000
YEAR

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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
Allen House, Shrewsbury, NJ
Belle Ilse, Lancaster County, VA
Bowne House, Queens, 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
Ditchley, Northumberland County, VA
Ephrata Cloisters, Lancaster County, PA
Fallsington Log House, Bucks 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
Marmion, King George County, VA
Merchant's Hope Church, Prince George County, VA

Morris Jumel House, Jamaica, NY
Frederick Muhlenberg House, Trappe, PA
Old Caln Meeting House, Thorndale, PA
Old Swede's Church, Philadelphia, PA
Panel Paintings, National Gallery, Washington, DC
Pennock House & Barn, London Grove, PA

Podrum Farm, Limekiln, PA
Powell House, Philadelphia, PA
Pyne House, Cape May, NJ
Radcliff van Ostrade, Albany, NY
Rippon Lodge, Prince William County, VA
Rural Plains, Hanover County, VA
Sabine Hall, Richmond County, VA
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
Thomas Thomas House, Newtown Square, PA
Tuckahoe, Goochland County, VA
Updike Barn, Princeton, NJ
Varnum's HQ, Valley Forge, PA
West Camp House, Saugerties, NY
Westover, Charles City County, VA
William Garrett House, Sugartown, PA
Yew Hill, Fauquier County, VA