A Dendrochronological Analysis
of the

Abraham & Maria LeFevre House

Gardiner, Ulster County, New York

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Introduction

This is the final report on the dendrochronological analysis of the Abraham & Maria LeFevre House, located on Forest Glen Road, Gardiner, Ulster County, New York. In an effort to confirm the construction history of this house, architectural historian Neil Larson of Larson Fisher Associates, PO Box 1394, Woodstock, NY, 12489, tele: 845-679-5054, requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of its structural timbers. Neil Larson was working on behalf of the present owners of the house, Raymond and Johanna Sokolov. Together with Mr. Larson, Callahan visited the house on 16 November, 2005, and collected wood core samples for the dendrochronological analysis of the timbers. Of the 12 samples acquired and analyzed, 8 were oak (Quercus sp.), 2 were tulip poplar - also known as yellow poplar - (Liriodendron sp.) and 2 were 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 Abraham & Maria LeFevre House 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 Abraham & Maria LeFevre House study, a regional composite master dating chronology from living trees and historical structures in the Hudson Valley region of New York state was referenced primarily. All dating results were verified finally by comparison with independent dating masters from surrounding areas in New York, New Jersey, Massachusetts 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 Abraham & Maria LeFevre House timbers are summarized in **Table 1** and **Figure 1**. A total of 8 oak, 2 tulip poplar and 2 pine samples were analyzed in the laboratory, with 7 of the 8 oak samples providing firm dendrochronological dates. None of the pine or tulip poplar samples was successfully dated, nor was the 8th oak sample.

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 sapwood and 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 oak 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 7 oak samples that cross-dated well between themselves, and also dated well against the local oak historical dating master (see **Table 1**, column 6), all had absolutely verifiable bark edge at the time of sampling.

From the datings that were achieved, there emerged evidence of (at least two) intrinsic construction periods that produced the Abraham & Maria LeFevre House. The dated samples, all of oak, indicate likely construction phases shortly after the end of the year 1758 - with very strong redundant evidence - and, much less evidentially, shortly after 1794 . Furthermore, two oak samples from the so-called "west cellar" produced absolute dates of 1740 and 1767, but these contrasting datings within the same structural context makes analysis of their chronological import speculative. Perhaps they are re-used timbers, and/or perhaps they represent renovations or repairs in the building.

Of the remaining samples: the undated oak timber gave an indication of a cross-date, but with so few rings and a weak t-correlation with the master chronologies this result is statistically unsustainable and therefore is ignored. The two coniferous samples (Pinus sp., likely "white pine") also remain undated. Although the physical integrity of the cores was good and they had a sufficient number of rings for dating they did not produce any cross-date with local masters or more southerly pine master chronologies. The two tulip poplar (Liriodendron sp.) samples from the first floor had too few rings to date. The wood anatomy of tulip poplar makes it notoriously difficult to measure and cross-date reliably even under the best of circumstances.

Table 1. Dendrochronological dating results for all samples taken from the Abraham & Maria LeFevre House, Gardiner, Ulster 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. 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. For example, +BE 1758 means cutting took place during the winter period of 1758 or into the pre-spring period of 1759

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
ALHGNY 01	Oak	East cellar, cellar joist, 2nd from east wall	+BE	174	1585 1758 comp	0.62
ALHGNY 02	Oak	East cellar, cellar joist, 3rd from east wall	+BE	209	1550 1758 comp	0.54
ALHGNY 03	Oak	Lintel over doorway through wall between east and west cellars	+BE	122	1637 1758 comp	0.55
ALHGNY 04	Oak	West cellar, cellar joist, 3rd from west wall	+BE	52	No Date	-.--
ALHGNY 05	Oak	West cellar, cellar joist, 1st from west wall	+BE	124	1617 1740 comp	0.63
ALHGNY 06	Oak	Kitchen, joist, 3rd from west wall, fireplace	+BE	106	1689 1794 comp	0.53
ALHGNY 07	Pine	Stairwell to 2nd floor, floor joist, west side of stairs	-BE	102	No Date	-.--
ALHGNY 08	Pine	Stairwell to 2nd floor, floor joist, east side of stairs	-BE	95	No Date	-.--
ALHGNY 09	Oak	2nd floor bedroom closet, south side, roof plate, south side	+BE	104	1655 1758 comp	0.63
ALHGNY 10	Tulip Poplar	East section, 1st floor, living room, ceiling joist, 6th from east wall	-BE	64	No Date	-.--
ALHGNY 11	Tulip Poplar	East section, 1st floor, living room, joist/lintel over doorway to mid-section	-BE	58	No Date	-.--
ALHGNY 12	Oak	West cellar, cellar joist, 2nd from west wall	+BE	133	1635 1767	0.4

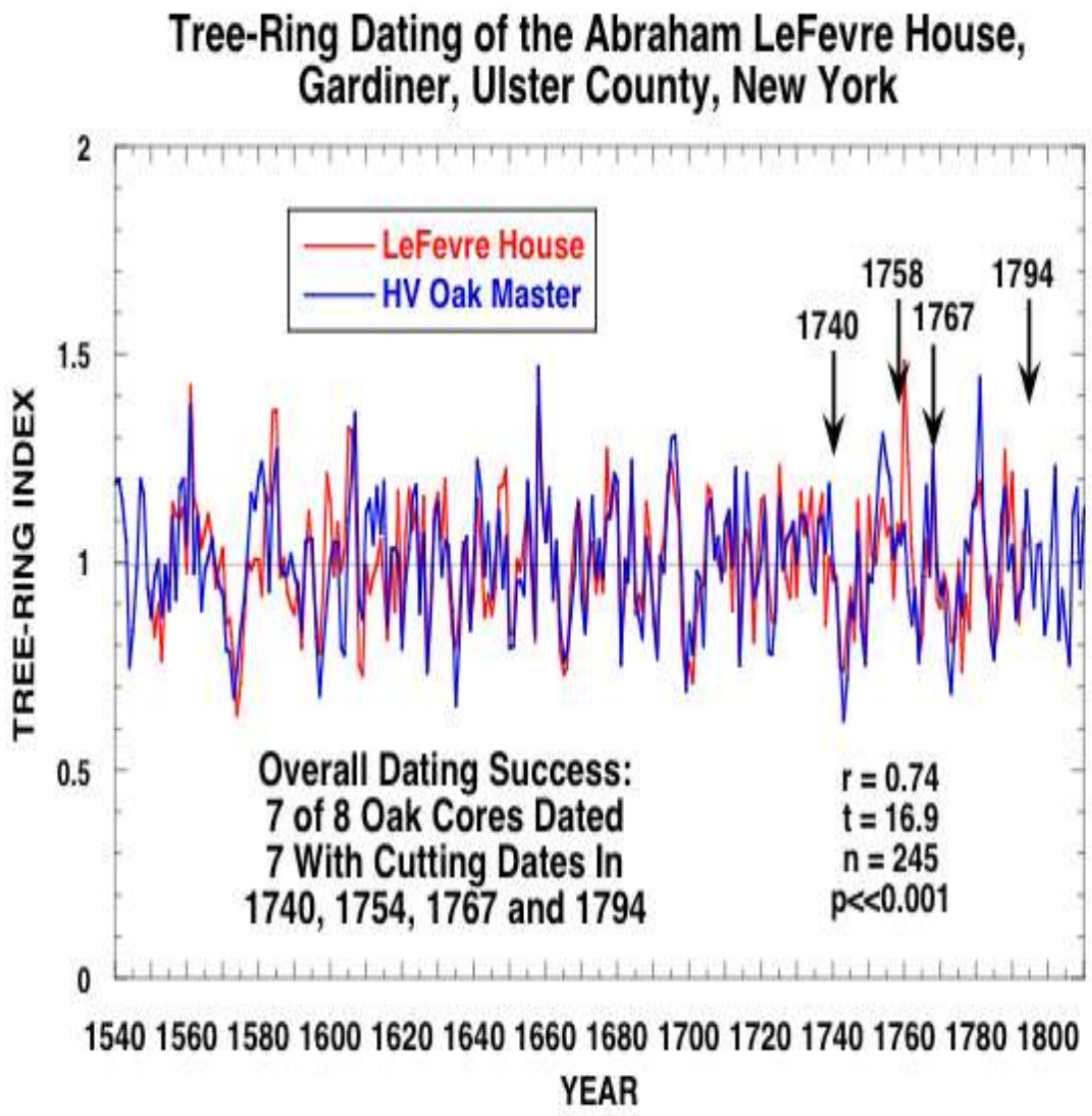

Figure 1. Comparison of the cross-dated oak master chronology for the Abraham & Maria LeFevre House with a locally derived historical oak dating master from the lower Hudson Valley, New York. The Spearman rank correlation between the series (r=0.74) is highly significant (p<<0.001) with an overlap of 245 years and a t-statistic of 16,9. Two apparent periods of construction are noted based on these analyses: 1758 and 1794. An absolute date of 1740 from the west cellar is more historically speculative, as is the 1767 date from the same structural unit within the house.

The "r-factor" is the Spearman rank correlation coefficient, a measure of relative agreement between two groups of measurements or data. It can range from -1 (perfect opposite agreement) to +1 (perfect direct 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=7.1) associated with the correlation between these two series (r=0.54) is highly significant ($p<<0.001$) for a 245-year overlap. For that reason, there can be no doubt that the dates presented here are very strongly valid, and that the statistical chance of the cross-dates being incorrect is much, much less than 1 in 1000.

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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. 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 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 Browne 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
Varnum's HQ, Valley Forge, PA
William Garrett House, Sugartown, PA
Yew Hill, Fauquier County, Virginia