A Dendrochronological Analysis of the Elting Memorial Library, New Paltz, Ulster County, New York.

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Introduction

This is the final report on a dendrochronological analysis of the Elting Memorial Library, which stands at 93 Main Street, New Paltz, Ulster County, New York 12561 (41°44'54" N 74°05'05" W). The Elting Library consists of an older stone structure with modern side-wings attached; the stone structure was originally called the Solomon Eltinge House after its owner, and is the subject of the present study. Located within the New Paltz Historic District, it is a public library governed by a board of directors, and operates as a member of the regional Mid-Hudson Library System.

In an effort to establish a more precise chronology of the old structure's history, Director of the Library John Giralico requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of selected representative structural timbers. Callahan and Cook visited the site on 10 June 2019, and collected samples for dendrochronological analysis. Of the 9 field samples taken, all 9 were deemed methodologically and conditionally of sufficient quality for submission for laboratory analysis. All of the submitted samples were of oak (Quercus sp.).

Every effort was made on site to locate bark or waney edges on the sampled timbers in order to ascertain the absolute cutting date, or dates, of the trees used in the construction. After the completion of this analysis, the core and cut samples and their associated measurement series will be permanently archived at the Tree Ring Research Laboratory, Lamont-Doherty Earth Observatory, Columbia University, under the sample reference numbers listed in Table 1, column 1.

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 Elting Library were processed in the Tree-Ring Laboratory by Dr. Edward Cook following well-established dendrochronological methods. The core samples were carefully glued onto grooved mounts and were sanded to a high polish to reveal the annual tree rings clearly; cut samples were similarly surfaced . 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 greatly superior to the traditional skeleton plot technique (Stokes and

Smiley 1968), now disused. 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 itself. 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, one or more internally cross-dated series are compiled from the individual site samples, and these are compared in turn with independently established tree-ring master chronologies compiled from living trees and dated historical tree-ring material. All of the regional "master chronologies" are based on completely independent tree-ring samples.

During the Elting Library study, species specific, regional composite master chronologies from living trees and historical structures from the Hudson Valley and Central New York state and other near-lying regions were referenced primarily. All dating results were verified finally by subsequent comparison with other independent dating masters from surrounding regions. In each case, the datings as reported here were confirmed as correct.

Results and Conclusions

To achieve these datings required attention during analysis to the previously recorded structural context of the samples (see **Table 1**, column 3). The contextual association of samples from within the structure, 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 outermost ring on a waney, bark-edged sample identifies the absolute cutting year. Absence of the bark edge (interchangeably called the wane) on a sample indicates that the outermost extant ring is not the year of cutting, but some identifiable year preceding the cutting. In the absence or loss of wane, field observations of wood anatomical factors often permit close approximation of the number of missing rings, and thus reasoned estimation of the cutting date. In particular the presence of sapwood, a physiologically active wood found immediately within the bark on the outer portion of the trunk, is an indication that the original wane was near.

The results of the dendrochronological dating of the timbers collected from the cellar under the older section of the Elting Library are summarized in **Table 1** and **Figure 1**. A total of 9 samples from 8 timbers, all oak, were analyzed in the laboratory, with all 9 samples providing firm dendrochronological dates. Note that two of the samples were collected from a single timber (EMLUNY08 & 09), this done in order to assure the presence of a bark-edged wane representing the cutting date (see **Table 1**). This redundancy secured an absolute cutting date for the timber based on a confirmed bark-edge surface, the original attempt wasn suspected of having lost the wane during extraction.

Of the 9 oak samples that cross-dated well between themselves, and also dated well against the local historical dating master (see **Table 1**, column 6), three (EMLUNY03, 04, 08) had field assessed bark edge remaining after sampling, and three (EMLUNY02, 06, 07) had wane at the start of coring which was lost during sampling due to degradation of the wood. One sample (EMLUNY05) had identified sapwood but without wane edge present, while EMLUNY09 (companion to EMLUNY08) was found under microscopic examination to have retained the wane edge thought lost during sampling.

With a single exception, the evidence in aggregate indicates a cutting date in the dormant period between 1805/06, that is, cutting of the sampled timbers occurred during winter growth dormancy from approximately November 1805 until February 1806 Initial usage of these wood materials took place not long after harvesting, for *in situ* inspection of the timbers indicated that most if not all were worked very soon after cutting, in keeping with historical woodworking practices and carpentry techniques. Therefore, a strong, reasoned supposition is that construction of the present structural configuration took place during 1806, possibly continuing into 1807.

A single sample proved anomalous to an otherwise chronologically congruent whole: EMLUNY03, a notably larger timber positioned as a central joist ("summer beam"?) in the cellar space. This timber dated to the dormant period between 1768/69, that is, cutting of this timber occurred during winter growth dormancy from approximately November 1768 until February 1769. A plausible supposition is that this "summer beam" represents the re-use of an older timber in a newer structure. It is not impossible that this new construction replaced a structure previously standing on the same site, or alternately, that this timber was found elsewhere and then brought specifically from that location to satisfy a perceived need in the construction.

Although not suggested by any of the timbers analyzed in this project, other construction phases prior or subsequent to the dates identified by this investigation cannot be supported or discounted. Re-use of the timbers in other construction phases, although not evidenced directly in the materials, cannot be excluded and must be considered when purporting the site's construction history. However, given the uniformity of the dating of the tested timbers, selected as structurally representative after deliberate inspection, it is very likely that the dates given are demonstrative of the history of the existing building unit.

Table 1. Dendrochronological dating results for oak samples from the Elting Library at New Paltz, Ulster County, New York. All correlations are Spearman rank correlations of each series against the mean of all of the others of the same species. For WANEY, +BE means the bark edge ring 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 strong likelihood that sapwood rings are present; if so, the outermost date will be close to the cutting date. 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. "Inc" means that the outermost ring was not fully formed, meaning that the tree was felled during the spring/summer growing season of the indicated calendar year.

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
EMLUNY01	Oak	Cellar, E end, joist, 1st from E wall/fireplace	-BE, -SP	178	1580 1757	0.491
EMLUNY02	Oak	Cellar, E end, joist, 2nd from E wall	-BE+SP (BEpres @start)	213	1584 1796	0.352
EMLUNY03	Oak	Cellar, E end, joist ("summer beam"), 3rd from E wall/fireplace	+BE(?), +SP comp.	173	1596 1768	0.404
EMLUNY04	Oak	Cellar, E end, joist, 4th from E wall/fireplace	+BE comp.	214	1592 1805	0.542
EMLUNY05	Oak	Cellar, W end, joist, 5th from E wall/fireplace	+BE(?), +SP	110	1694 1803	0.512
EMLUNY06	Oak	Cellar, W end, joist, 6th from E wall/fireplace	-BE+SP (BEpres @start)	81	1712 1792	0.556
EMLUNY07	Oak	Cellar, W end, joist, 7th from E wall/fireplace	-BE+SP (BEpres @start)	133	1661 1793	0.629
EMLUNY08	Oak	Cellar, W end, joist, 8th from E wall/fireplace	+BE comp.	144	1662 1805	0.560
EMLUNY09	Oak	Cellar, W end, joist, 8th from E wall/fireplace (same at #08)	+BE	117	1689 1805	0.510

Table 1. Dendrochronological dating results for oak samples taken from the Elting Memorial Library' located in New Paltz, Ulster County, New York. For interpreted felling dates of the trees used for construction, +BE means that the bark edge was present and believed 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

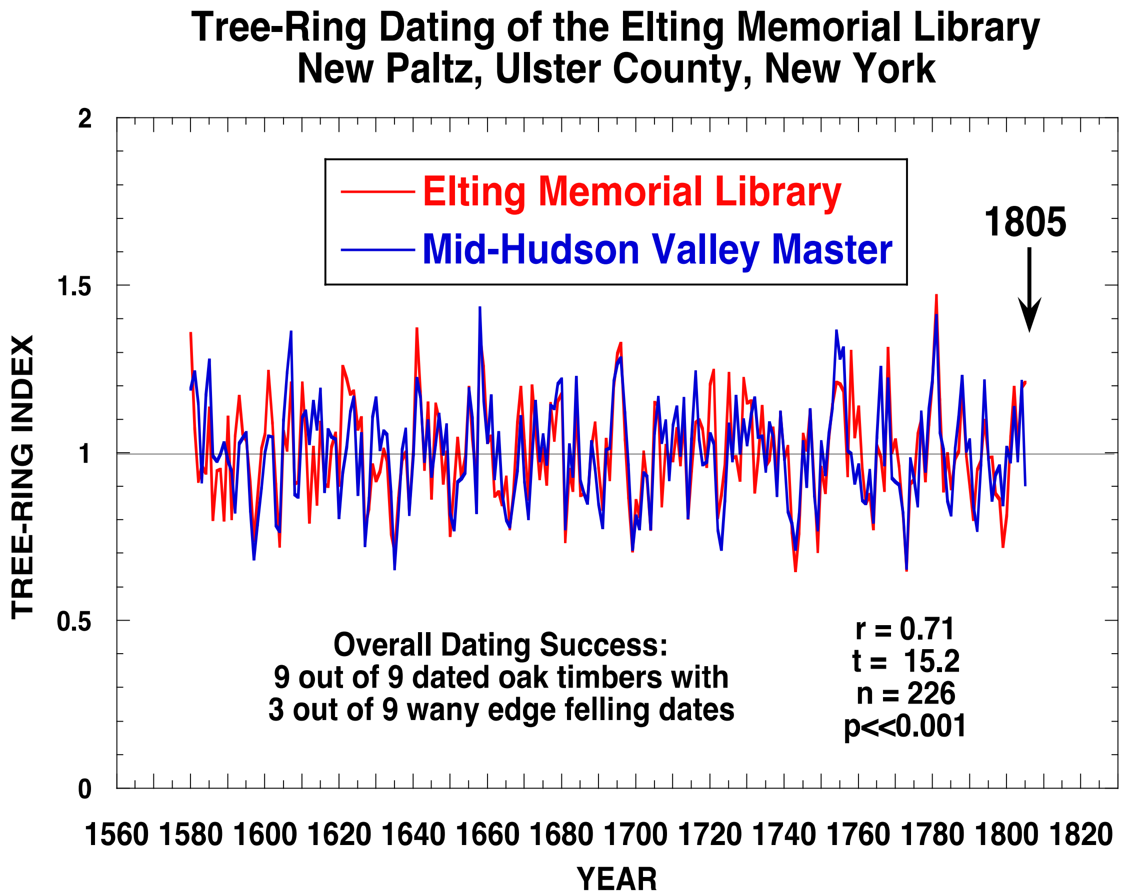
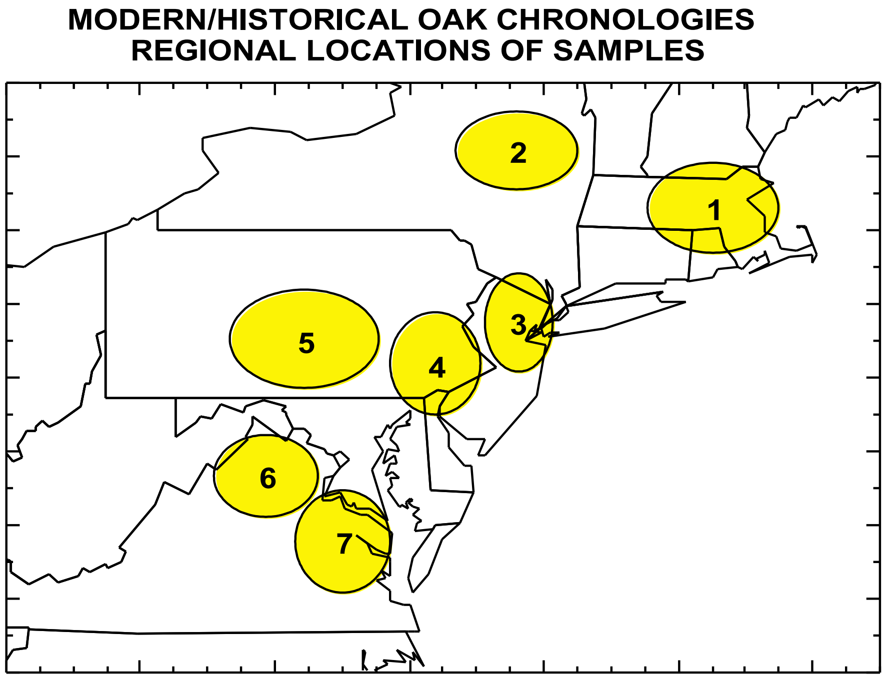
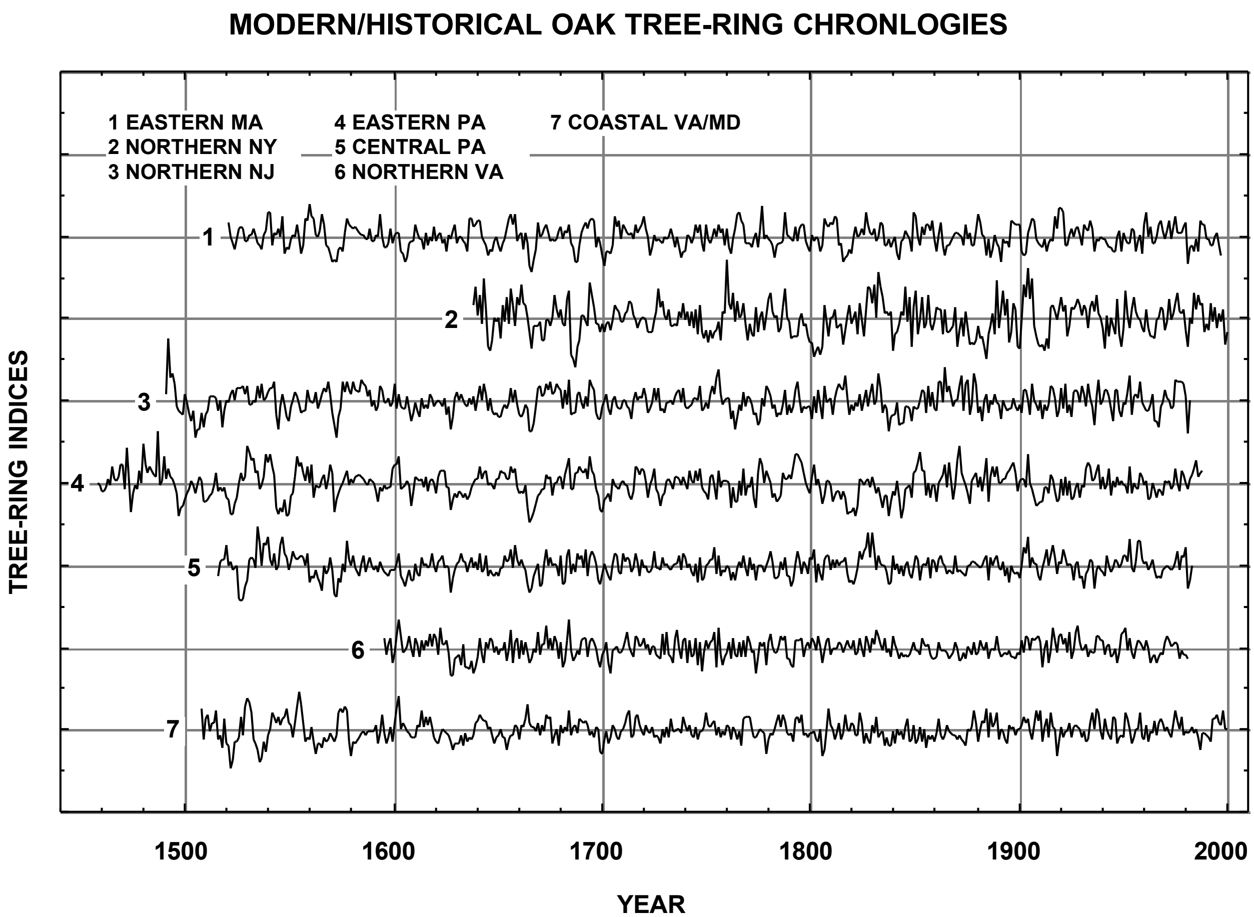


Figure 1. Comparison of the cross-dated, compiled site oak chronologies for the Elting Library (red plot) against a regional historical oak dating master from Hudson Valley, New York (blue plot). Three of the nine sampled timbers from the unit provided felling dates, two of 1805 with the outermost annual rings complete, indicating that the trees were felled in the growth dormancy period of 1805/06 (fall/winter months between the calendar years). One of the felling date timbers provided a felling date of 1768 with the outermost annual ring complete, indicating that the tree was felled in the growth dormancy period of 1768/69 (fall/winter months between the calendar years). This timber's dating represents a singular anomaly within the otherwise chronologically congruent materials.

The Spearman rank correlation between the series (t=15.2) associated with the correlation between the Elting Library compiled oak series and the regional oak master chronology (r=0.71) is statistically very significant ($p<<0.001$) for a 226-year overlap. For that reason, there can be no doubt that the dates presented here for the sampled oak elements of the structure are robustly valid, and that the statistical chance of the cross-dates being incorrect is exponentially far less than 1 in 1000.

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 exponentially increasing, stronger statistical certitude.


MODERN/HISTORICAL OAK CHRONOLOGIES
REGIONAL LOCATIONS OF SAMPLES
1
2
3
4
5
6
7


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
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 research 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 Isle, Lancaster County, VA
Bowne House, Queens, NY
Carpenter's Hall, Philadelphia, PA
Charpentier House, Philadelphia PA
Christ's Church, Philadelphia, PA
Clifton, Northumberland County, VA
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
Ferris House, Old Greenwich, Fairfield County, CT
Fawcett House, Alexandria, VA
Gadsby's Tavern, Alexandria, VA
Garrett House, Sugartown PA
Gilmore Cabin, Montpelier, Montpelier Station, VA
Gracie Mansion (Mayor's Residence), New York, NY
Grove Mount, Richmond County, VA
Hanover Tavern, Hanover Courthouse, VA
Harriton House, Bryn Mawr, PA
Hills Farm, Accomack County, VA
Hollingsworth House, Elk Landing, MD
Indian Banks, Richmond County, VA
Indian King Tavern, Haddonfield NJ
Independence Hall, Philadelphia, PA
John Bowne House, Forest Hills, NY
Kirnan, Westmoreland County, VA
Linden Farm, Richmond County, VA
Log Cabin, Fort Loudon, PA
Lower Swedish Log Cabin, Delaware County, PA
Lummis House, Ipswich MA
Marmion, King George County, VA
Martin Cabin, New Holland PA
Menokin, Richmond County, VA
Merchant's Hope Church, Prince George County, VA
Millbach House, Lebanon County, PA
Monaskon, Lancaster County, VA
Morris Jumel House, Jamaica, NY
Frederick Muhlenberg House, Trappe, PA
Nottingham DeWitt House, NY
Old Barn, Madison VA
Old Caln Meeting House, Thorndale, PA
Old Parsonage, Kinderhook NY
Old Swede's Church, Philadelphia, PA
OTB House, West Nyack, NY
Panel Paintings, National Gallery, Washington, DC
Pennock House & Barn, London Grove, PA
Penny Watson House, Greenwich, NJ
Podrum Farm, Limekiln, PA
Powell House, Philadelphia, PA
Pyne House, Cape May, NJ
Radcliff van Ostrade, Albany, NY
Reese's Corner House, Rock Hall, MD
Rippon Lodge, Prince William County, VA
Rochester House, Westmoreland County, VA
Rockett¨s, Doswell VA
Rural Plains, Hanover County, VA
Sabine Hall, Richmond County, VA
Shirley, Charles City County, VA
Sisk Cabin, Culpeper VA
Stiles Cabin, Sewickely PA
Spangler Hall, Bentonville, VA
Springwater Farm, Stockton, NJ
St. Peter's Church, Philadelphia, PA
Strawbridge Shrine, Westminster, MD
Sweeney-Miller House, Kingston, NY
Thomas & John Marshall House, Markham, VA
Thomas Grist Mill, Exton, PA
Thomas Thomas House, Newtown Square, PA
Ticonderoga Pavilion, Ticonderoga, NY
Tuckahoe, Goochland County, VA
Tullar House, Egremont MA
Updike Barn, Princeton, NJ
Varnum's HQ, Valley Forge, PA
Verville, Lancaster County, VA
West Camp House, Saugerties, NY
Westover, Charles City County, VA
White Plains House, King George, VA
Wilton, Westmoreland County, VA
Yew Hill, Fauquier County, VA