Dendrochronological Analysis of Springwater Farm, Stockton, Hunterdon County, New Jersey

Dr. Edward R. Cook
William J. Callahan, Jr.

October 2009

Introduction

This is the final report on the dendrochronological analysis of the structure known as the *Springwater Farm House*, located at 351 Rosemont Ringoes Road, Stockton, Hunterdon County, NJ 08559 (Latitude: N40º 26'/Longitude: W74º 55').

In an effort to describe and certify the construction history of the section of this building purportedly earliest (so called 1st period), the owner Brian Skeuse (26 Old Hill Rd.Flemington, NJ 08822, tele: 908 782-6449.) requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of its structural timbers.

Together with Mr Skeuse, Callahan visited the house on 30 September, 2009, and collected assorted core and cross-section samples for the dendrochronological analysis of the timbers. Of the 15 samples acquired, 12 were of sufficient quality for submission for laboratory analysis, all 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.

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 Springwater Farm 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 all were 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 greatly 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 Springwater Farm study, species specific, regional composite master chronologies from living trees and historical structures from the Philadelphia and New Jersey regions were referenced primarily. All dating results were verified finally by comparison with independent dating masters from surrounding areas in New York state, New Jersey, Maryland, and central and eastern Pennsylvania. In each case, the datings as reported here were verified as correct.

Results and Conclusions

The results of the dendrochronological dating of the Springwater Farm timbers are summarized in **Table 1** and **Figures 1**. A total of 12 oak samples were analyzed in the laboratory, with 11 samples providing firm dendrochronological dates. The single exception to successful dating had too few rings for statistical viability.

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 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.

Of the 11 oak samples that cross-dated well between themselves, and also dated well against the local oak historical dating masters (see **Table 1**, column 6), 6 had verifiable bark-edge at the time of laboratory analysis, and 1 other had evidence of being at or very near the bark-edge of the timber. Microscopically in the laboratory, all 6 of the bark-edged oak samples (SPFSNJ01, 02, 05, 08, 10, 12) were determined to have a complete growth ring in their cutting year (indicating felling during winter dormancy, that is, the tree was cut during dormancy after the end of the growth season, late in the autumn or immediately before the beginning of the growth season of the spring, i.e., approximately November through February).

From the datings that were achieved for the samples, there emerged evidence of an intrinsic construction period for this portion of the Springwater Farm House. The absolutely dated, bark-edged samples SPFSNJ01, 02, 05, 08, 10, 12, redundantly supported by the remaining datings, indicate a construction phase for this section of the house some time during the late autumn months of the year 1805, or (most likely) during 1806. The high degree of statistical correlation noted between the structural timbers and the regional chronology demonstrates that the timber source was local.

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 phases cannot be excluded absolutely. However, the chronological and structural homogeneity of the dated samples makes eventual re-use of timbers of no germane consequence to the present dendrochronological dating analysis.

Table 1. Dendrochronological dating results for the oak samples taken from the Springwater Farm, Hunterdon County, New Jersey. 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 of the sample 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
SPFSNJ 01	Oak	Half stud under window, 1st period, north sides 1st floor, southeast end	+BE comp	58	1748 1805	0.35
SPFSNJ 02	Oak	Beam between 1st/2nd floor, south side 1st period, southwest end south wall	+BE comp	46	1760 1805	0.58
SPFSNJ 03	Oak	Joist between 1st/2nd floor, south side 1st period, 3rd from south wall	-BE, SP?	100	1686 1785	0.56
SPFSNJ 04	Oak	Joist between 1st/2nd floor, 4th from south wall, south side 1st period, southwest end	-BE(?), +SP??	110	1671 1780	0.40
SPFSNJ 05	Oak	Joist between 1st/2nd floor, 7th from south wall, south side 1st period, southwest end	+BE comp	100	1706 1805	0.62
SPFSNJ 06	Oak	N/S summer, cellar, 1st period	-BE (+BE at start)	59	1737 1795 (1805 likely)	0.47
SPFSNJ 07	Oak	Joist, cellar, west side, 8th from north wall	+BE comp	30+	Too few rings	-.--
SPFSNJ 08	Oak	Joist, 4th from north wall, 2nd floor 1st period	+BE comp	70	1736 1805	0.30
SPFSNJ 09	Oak	Cross beam, above window, north side send, between 1st/2nd floor	-BE(?), +SP	52	1752 1803	0.49
SPFSNJ10	Oak	Middle post at door frame, north side	+BE comp	69	1737 1805	0.56
SPFSNJ11	Oak	Attic, 1st period, joist, 1st from north end, south section	-BE, +SP	67	1738 1804	0.42
SPFSNJ12	Oak	Attic, 1st period, joist, 3rd from north end, south section	+BE comp	54	1752 1805	0.55

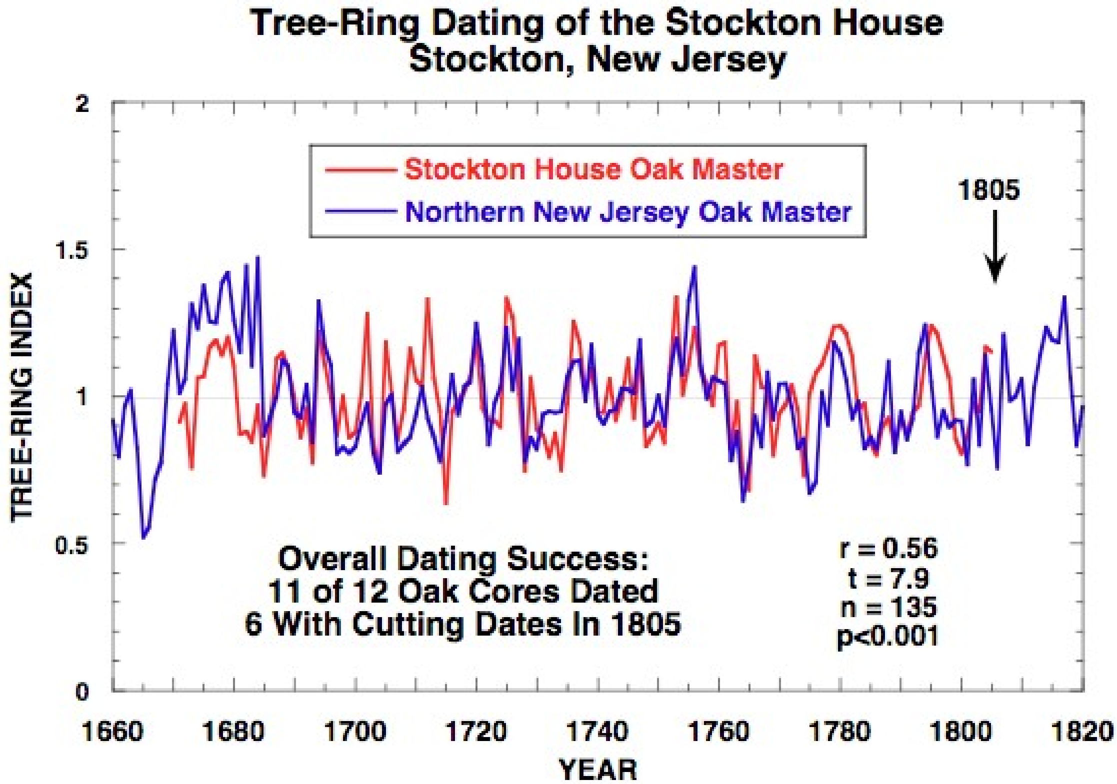
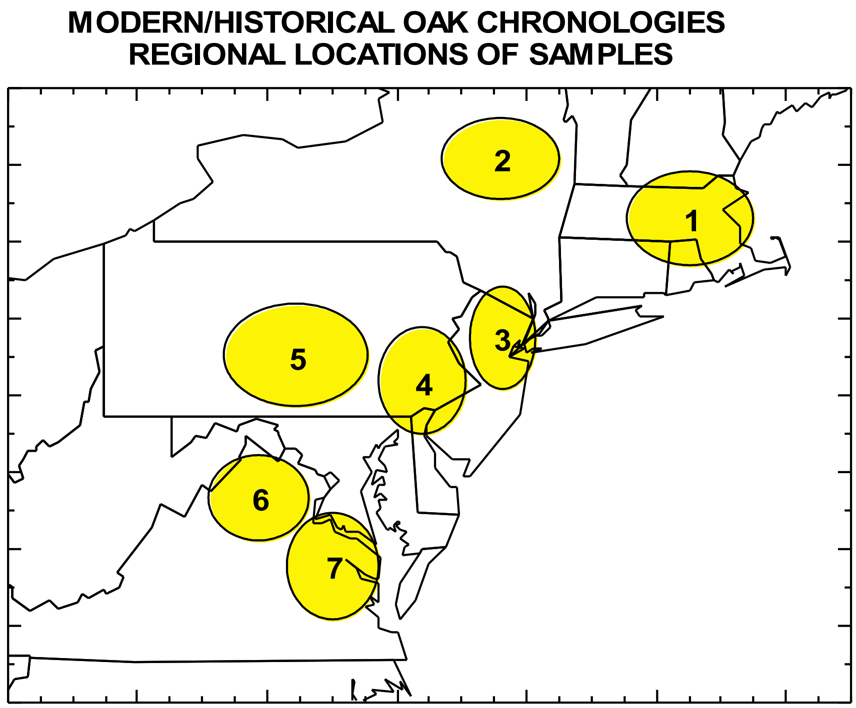
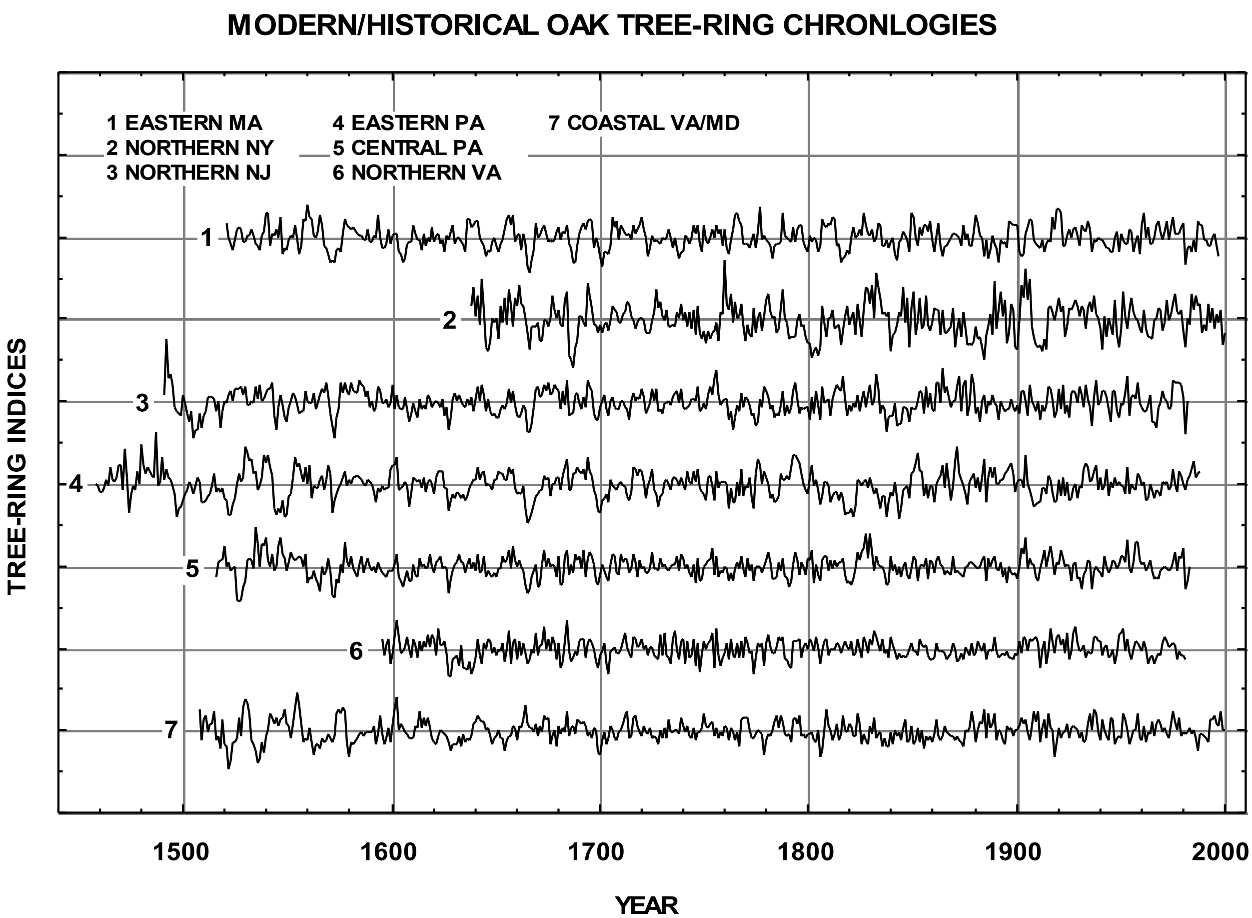


Figure 1. Comparison of the cross-dated oak master chronology for the Springwater Farm against an historical oak dating master for the northern and central regions of New Jersey. The Spearman rank correlation between the series (r=0.56) is highly significant (p<0.001) with an overlap of 135 years and a t-statistic of 7.9. Other independent oak dating masters from New York state, New Jersey, and central and eastern Pennsylvania, also confirmed the same outermost date, but with lower t-statistics.

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=7.9) associated with the correlation between the series (r=0.56) is statistically significant (p<<0.001) for a 135-year overlap. For that reason, there can be no doubt that the dates presented here for the sampled oak sections of the Springwater Farm are valid, and that the statistical chance of the cross-dates being incorrect is less than 1 in 1000.


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
1
2
3
4
5
6
7
1500
1600
1700
1800
1900
2000
YEAR

Some 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 vedanatomisk 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., Callahan, W.J. and Wells, Camille 2007. *Dendrochronological Analysis of Rural Plains, Mechanicsville, Hanover County,Virginia. Limited professional distribution.*

Cook, E.R. and Callahan, W.J. 2008. *Dendrochronological Analysis of Freer-Low House,Huguenot Street, New Paltz, Ulster County,NewYork. 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 Rationisilerung 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 Massachuesetts: Completion Report*. Great Bay Tree-Ring Laboratory, May 2001.

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
Allen House, Shrewsbury, NJ
Belle Ilse, Lancaster County, VA
Bowne House, Queens, NY
Carpenter's Hall, 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
Fawcett House, Alexandria, VA
Gadsby's Tavern, Alexandria, VA
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
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
Marmion, King George County, VA
Menokin, Richmond County, VA
Merchant's Hope Church, Prince George County, VA
Monaskon, Lancaster 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
Penny Watson House, Greenwich, NJ
Podrum Farm, Limekiln, PA
Powell House, Philadelphia, PA
Pyne House, Cape May, NJ
Radcliff van Ostrade, Albany, NY
Rippon Lodge, Prince William County, VA
Rochester House, Westmoreland County, VA
Rural Plains, Hanover County, VA
Sabine Hall, Richmond County, VA
Shirley, Charles City County, VA
Spangler Hall, Bentonville, VA
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
Tuckahoe, Goochland County, VA
Updike Barn, Princeton, NJ
Varnum's HQ, Valley Forge, PA
Verville, Lancaster County, VA
West Camp House, Saugerties, NY
Westover, Charles City County, VA
William Garrett House, Sugartown, PA
Wilton, Westmoreland County, VA
Yew Hill, Fauquier County, VA