A Dendrochronological Analysis of the "Graham/Brush House", Pine Plains, Dutchess County, New York.

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Introduction

This is the final report on the dendrochronological analysis of a timber structure known as the "Graham/Brush house" which stands at 2991 Church Street, Pine Plains, Dutchess County, New York 12567 (41°58'49"N - 73°39'19"W). This historic log building was acquired in 1997-1998 by a local organization, the Little Nine Partners Historical Society. In 1999, the Graham/Brush house was added to the National Register of Historic Places.

In an effort to establish the precise age of the building, Mr. Walter Wheeler of Hartgen Archeological Associates Inc. of Rensselaer NY, representing the Historical Society, requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of selected representative structural timbers. Together with Mr. Wheeler, board member Mr. Robert Hedges and other members of the Historical Society, Callahan visited the site on 28 & 29 August 2016 and collected samples for the dendrochronological analysis of the timbers.

Of the 14 field samples taken initially, 12 were deemed of sufficient quality for submission for laboratory analysis. All collected samples 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 the absolute cutting date, or dates, of the trees used in the construction. After analysis, the core 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 Graham/Brush house 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. 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, internally cross-dated series are compiled and are compared 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.

In the Graham/Brush house study, species specific, regional composite master chronologies from living trees and historical structures from New York, New Jersey, Pennsylvania, and other near-lying regions were referenced primarily. All dating results were verified finally by subsequent comparison with other independent dating masters from the surrounding areas. In each case, the datings as reported here were confirmed as correct.

Results and Conclusions

The results of the dendrochronological dating of the Graham/Brush house timbers are summarized in **Tables 1** and **Figures 1**. A total of 12 samples were analyzed in the laboratory, with 11 of the samples providing firm dendrochronological dates. The single undated sample (GBHDNY07), probably a tree branch, exhibited strongly distorted "compression wood" which precluded proper ring measurement. The 2 additional field samples collected, but not listed, were of insufficient wood-anatomical quality to satisfy rigorous analysis, and after primary assessment in the laboratory were discarded in advance of final dating and statistical processing.

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 outermost ring on a waney, bark-edged sample identifies the absolute cutting year. Absence of the wane on a sample indicates that the outermost extant ring is not the year of cutting, but this condition still allows the identification of a specific year preceding the cutting.

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.

Analysis of the degree of development of the outermost rings indicates that cutting of many or most of the wane-edged timbers occurred during the regional period of dormancy following the end of the growth season, i.e. cutting took place during approximately November to February (see **Table 1**). Some few timbers may have begun early growth, indicating cutting during the very first stages of the spring season, i.e. approximately February or March. Though no samples were extracted at Graham/Brush house from surface locations that were obviously worked to remove the bark and/or surface wood, it must be remembered that despite close field examination some analyzed samples may in fact be missing one or more of their outermost rings due to misinterpretation or to inadvertent loss during extraction. Usage of the materials apparently took place not long after harvesting, for *in situ* inspection of the timbers indicated that most if not all were worked soon after cutting, in keeping with historical woodworking and carpentry techniques.

Of the 11 samples that cross-dated well between themselves, and also dated well against the local historical dating master (see **Table 1**, column 6), several had field identified wane at the time of sampling (see **Table 1,** column 4). The degree of uniformity in the achieved datings of selected timbers from the building indicates that a significant construction phase for the Graham/Brush house took place at the very end of 1771 or, more likely, during 1772. Four of the tested timbers from this construction (labelled "period 2", **Table 1**: GBHDNY03, 04, 05, 06) were evidently cut during dormancy 1771/72, and one (GBHDNY02) seemingly very early in the spring growth phase of 1772. One sample (GBHDNY01) dated to 1767 but was determined to possibly be missing several rings from its outermost dated year, thus plausibly aligning it with the 1771/72 dating. Of course, final construction activities may have continued into as late as 1773 or beyond.

Historical archives and architectural surveys of Graham/Brush house describe the extant building as incorporating a pre-existing structure, a fact easily confirmed by a simple visual examination of the walling. Unfortunately, due to the lack of congruent redundancy in the achieved results ("phase 1", **Table 1**), no single construction date for this earlier building can be established from the tested materials. The limited number of samples and their varying dates do not allow a coherent conclusion to be drawn about when this unit was built. One timber (GBHDNY08) seems to be an inclusion from during the 1771/2 construction phase, perhaps a replacement for a degraded older wall log. Two other timbers with somewhat congruent dates (GBHDNY09 & 11) arguably may be presumed to be remains of a construction phase that occurred during the middle 1750's, conceivably the original construction, but without additional evidence no certainty exists. Conducting a follow-up sampling to target previously untested timbers from the "phase 1" section can rectify this deficiency and should provide the evidence necessary to clarify the chronological narrative.

Other specific construction phases for the building prior to or subsequent to the dates identified by this investigation cannot be empirically supported or discounted. Moreover, re-use of individual older timbers in any construction phase always must be considered whenever purporting a site's construction history.

Table 1. Dendrochronological dating results for samples from the "Graham/Brush House", Pine Plains, Dutchess County, New York. For WANEY, +BE means the bark edge ring was interpreted as 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 outermost date will 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. "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
		"Period 2"				
GBHDNY01	Pine	Wall plank, 5th from top, E end wall	+BE??, missing outer rings?	73	1695 1767	0.40
GBHDNY02	Pine	Ceiling joist, 1st from E end wall	+BE? Inc.	67	1706 1772	0.60
GBHDNY03	Pine	Wall plank, 6th from top, N wall, E end	+BE, comp	70	1702 1771	0.65
GBHDNY04	Pine	Wall plank, 4th from top, W interior wall (passageway) of E room	+BE comp	95	1677 1771	0.62
GBHDNY05	Pine	2nd floor, W wall, 12th log from bottom	-BE? comp	51	1721 1771	0.45
GBHDNY06	Pine	ST 05 (supplement to bridge break in 05)	+BE, comp	33	1739 1771	0.55
GBHDNY07	Pine	Old rafter, attic, 2nd from E end wall	+BE	101	No Date; suppression wood	-.--
		"Period 1"				
GBHDNY08	Pine	Wall plank, 4th from bottom, N wall W end	+BE, inc	89	1682 1770	0.56
GBHDNY09	Pine	Wall plank, 4th from bottom, E interior wall (passageway)of W room	+BE, inc	82	1674 1755	0.55
GBHDNY10	Pine	Wall plank, 3rd from bottom, W exterior wall, N side of fireplace	+BE, comp?	54	1682 1735	0.46
GBHDNY11	Pine	Ceiling joist, 2nd from W wall fireplace	+BE, comp	62	1696 1756	0.54
GBHDNY12	Pine	Ceiling joist, 4th from W wall fireplace	+BE, comp?	83	1685 1767	0.47

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.

The t-statistics (t=6.2) associated with the correlation between the Graham/Brush house pine series and the regional pine master chronology (r=0.53) is statistically very significant (p<<0.001) for a 99-year overlap. For that reason, there can be no doubt that the dates presented here for the sampled oak elements of the barn are robustly valid, and that the statistical chance of the cross-dates being incorrect is exponentially far less than 1 in 1000.

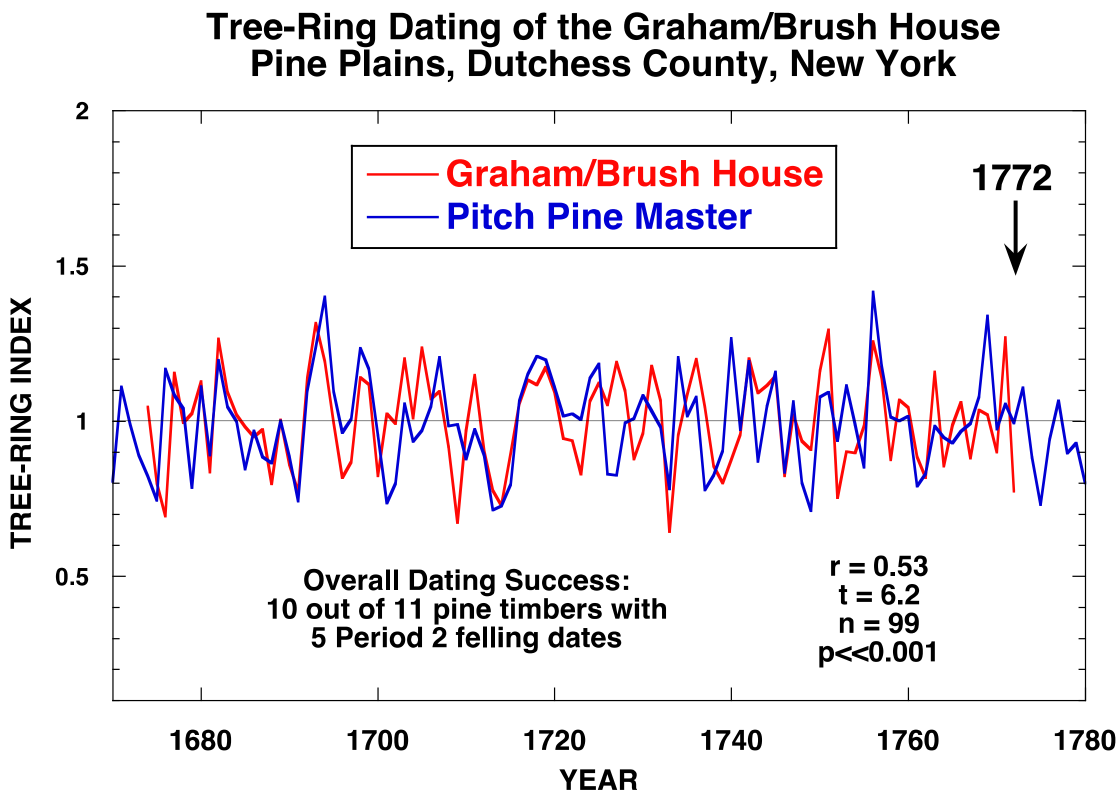
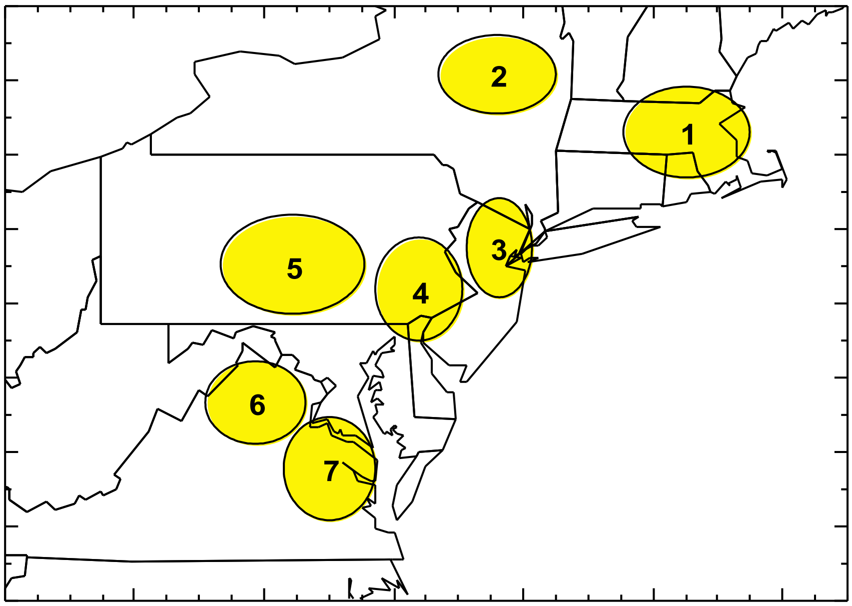
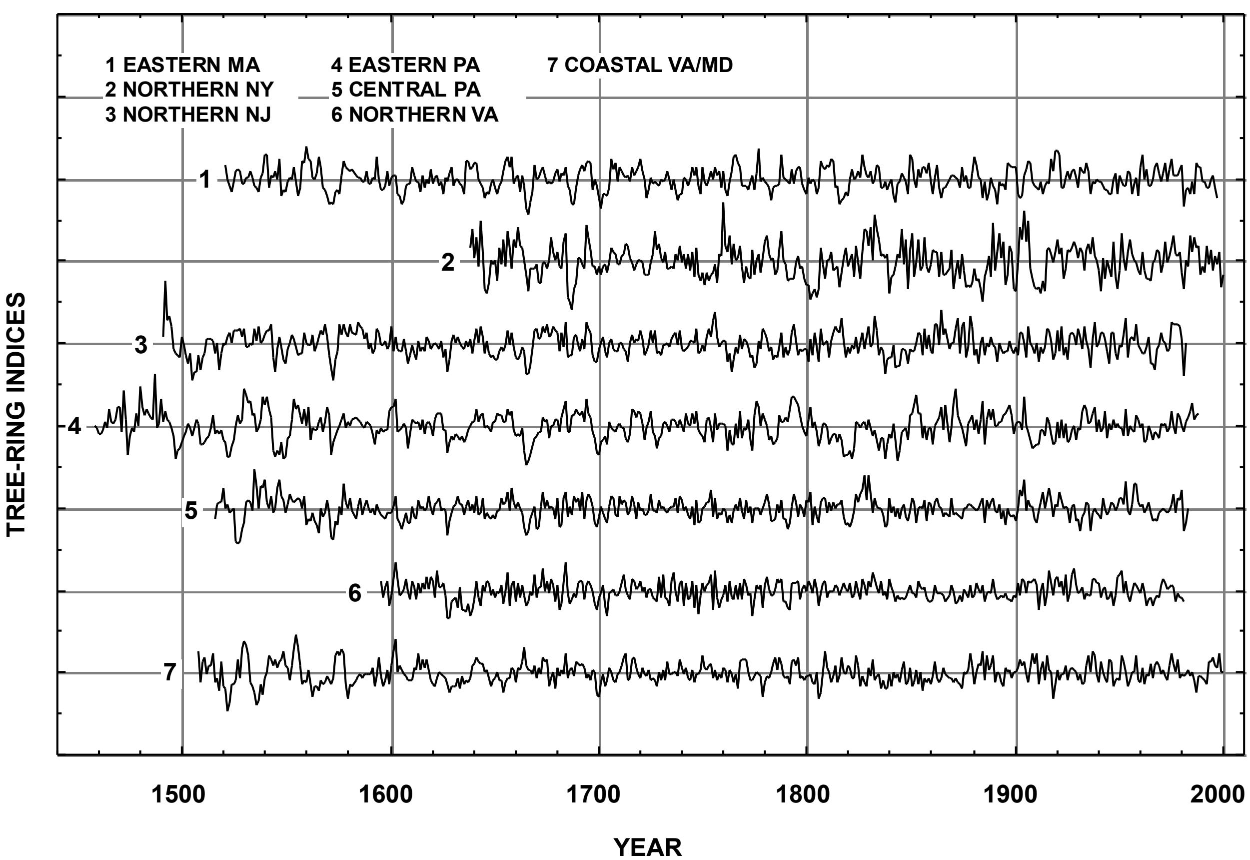


Figure 1. Comparison of the dated master series from the Graham/Brush House (red plot) versus an independent pitch pine dating master (blue plot). Eleven of twelve sampled pine timbers dated, with all having confirmed felling dates. The Graham/Brush House master has a highly significant ($p<<0.001$) Spearman rank correlation with the dating master. See Table 1 for more details on the dating.

MODERN/HISTORICAL OAK CHRONOLOGIES
REGIONAL LOCATIONS OF SAMPLES



MODERN/HISTORICAL OAK TREE-RING CHRONLOGIES



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 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 Ilse, 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, Fieldfield 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
Graham/Brush House, Pine Plains 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 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
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
Skiles 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
Voorhees Family Barn, Branchburg, NJ
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