Dendrochronological Analysis of The Nottingham/Dewitt House, Stone Ridge, Kingston, Ulster County, New York

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Introduction

This is the final report on the dendrochronological analysis of the structure known as the *Nottingham/Dewitt House*, 550 N. Marbletown Road, Stone Ridge (aka Marbletown; post address Kingston), NY 12401 (41º53'01"N, 74º06'50"W). In an effort to describe the construction history of this building, the owner, Mr. Ken Krabbenhoft, requested that dendrochronologists William Callahan and Dr. Edward Cook perform a tree-ring analysis of its structural timbers.

Together with renovation project leader Mr James Decker of J. Decker Restorations, Box 655 Hurley NY 12443 (845-338-8558), Callahan visited the site on 18 February 2011, and collected core samples for the dendrochronological analysis of the timbers. Of the 17 field samples taken, 13 were of sufficient quality for submission for laboratory analysis, 5 of oak (Quercus sp.) and 8 of white 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.

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 Nottingham/Dewitt 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 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 Nottingham/Dewitt House study, species specific, regional composite master chronologies from living trees and historical structures from the Hudson Valley and near-lying 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, Massachusetts, 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 Nottingham/Dewitt House timbers are summarized in **Tables 1 & 2** and **Figures 1 & 2**. A total of 5 oak samples and 8 pine samples were analyzed in the laboratory, with 3 oak and 7 pine samples providing firm dendrochronological dates. The 4 additional samples collected but not submitted to the laboratory for dating had varying degrees of degradation or 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 **Tables 1 & 2**). 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 **Tables 1 & 2**. 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 3 oak samples and 7 pine samples that cross-dated well between themselves, and also dated well against the local historical dating masters (see **Tables 1 & 2**, column 6), none had field verified bark edge at the time of laboratory analysis. The undated pine sample had too few rings to permit statistically viable dating. The two oak samples that remained undated (NDUCNY02 & 5) were a curious methodological anomaly; in general samples of this species and of these lengths (163 and 199 rings, respectively) provide dating routinely. In these oak samples, however, the core series were substantially and repeatedly disrupted with patches of reaction wood, interpreted in the laboratory as the aftereffects of forest fires that severely stressed the growth without being fatal to the trees. Unfortunately, this repetitive disruption of growth made reliable dating of the series unattainable.

Assessment of the general results of the study at Nottingham/Dewitt House presented several challenges. The absence of dated wane edged samples precluded the assignment of an absolute cutting date for the materials, and the absence of obvious homogenous structural integrity made the exclusion of material reuse in later construction impossible.

However, the degree of congruency in the achieved datings (with a single exception: NDUCNY03, possibly a re-used timber), both within and between the two represented species, does strongly indicate a likely construction phase in the mid-to-latter part of the 1770's or perhaps a few years into the 1780's. Two dated oak samples (**Table 1**), although lacking wane edge, included sapwood in their lengths, wood anatomical evidence that the missing wane was originally close to the outermost extant rings. The dated pine samples (**Table 2**), broad floorboards milled to fit their function and thus also lacking wane, all contained large numbers of rings and were of a length indicating substantial trees of a size close to their maximum natural diameter. It is very likely, therefore, that the outermost extant rings of these pine samples, similarly to the oak samples, are close to their original wane edge.

Taken together, these factors strongly support a reasonable, though not conclusive, supposition that general construction of the house occurred during the aforementioned time period. Speculatively, the construction could indicate a resumption of local stability after the economic impairment of the American Revolution. Close *in situ* inspection of the oak timbers indicated that these 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, although not specifically evidenced, cannot be excluded absolutely.

Table 1. Dendrochronological dating results for oak samples taken from the Nottingham/DeWitt House, Marbletown, 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. 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 White pine 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.

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
NDUCNY01	Oak	1st floor, joist, 5th from S wall, N section basement (block, not in situ)	-BE +SP	164	1607 1770	0.41
NDUCNY02	Oak	1st floor, joist, 1st from S wall, S section basement	+BE? +SP	163	No date	-.--
NDUCNY03	Oak	1st floor, joist, 2nd from S wall, S section basement	-BE? +SP	100	1607 1706	0.44
NDUCNY04	Oak	1st floor, joist, 6th from S wall, N section basement	-BE +SP?	86	1681 1766	0.36
NDUCNY05	Oak	1st floor, joist, 3rd from S wall, S section basement	+BE	199	No date	-.--

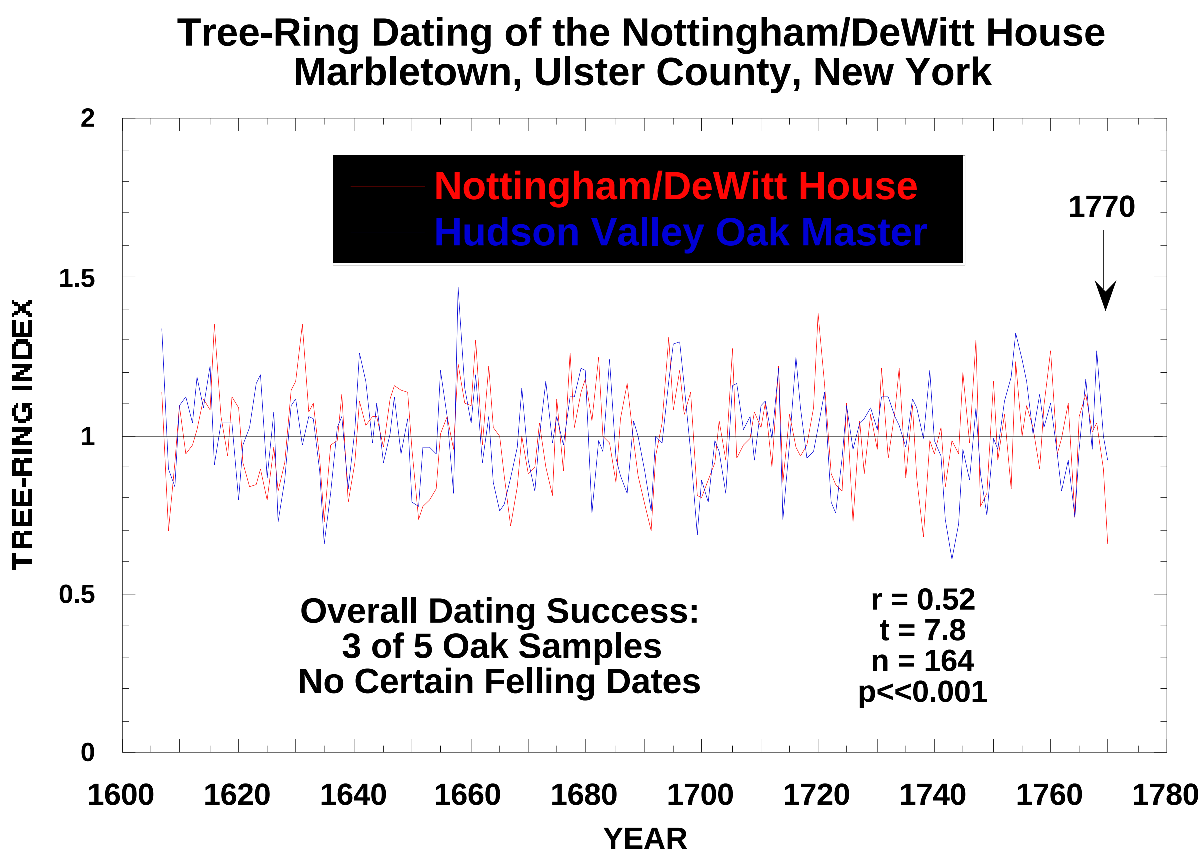
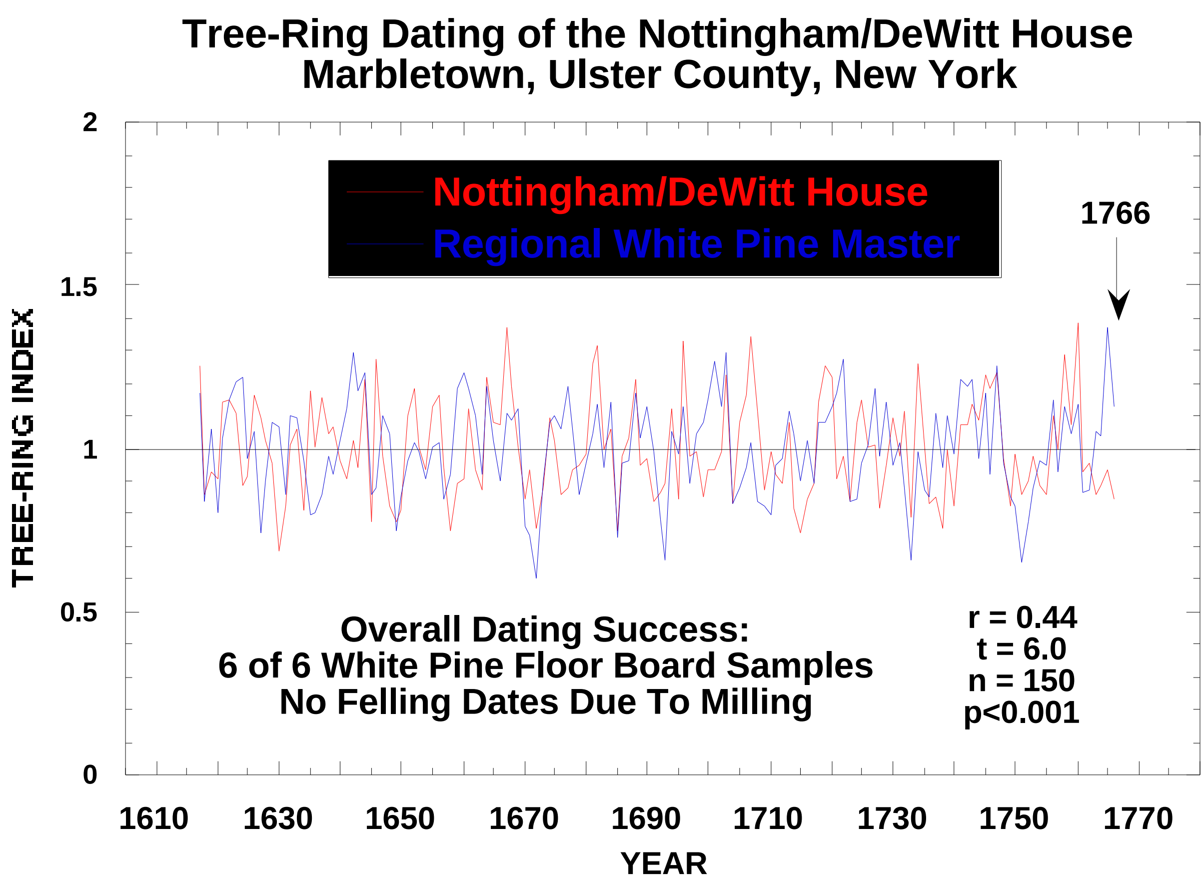


Figure 1 shows a comparison of the cross-dated internal oak chronology for the Nottingham/Dewitt House against an historical oak dating master derived from living trees and historical structures in central Pennsylvania. The Spearman rank correlation between the series (r=0.45) is highly significant (p<0.001) with an overlap of 112 years and a t-statistic of 5.3. The 1785 felling date based on sampled oak timbers is indicated. See Table 1 for details of individual samples.

Table 2. Dendrochronological dating results for white pine samples taken from the Nottingham/DeWitt House, Marbletown, 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. 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 White pine 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.

ID	SPECIES	DESCRIPTION	WANEY	RINGS	DATING	CORREL
NDUCNY06	White pine	Kitchen girt, not in situ	+BE	52	No date	-.--
NDUCNY07	White pine	Floor board, not in situ	-BE	114	1630 1743	0.37
NDUCNY08	White pine	Floor board, not in situ	-BE	118	1617 1734	0.63
NDUCNY09	White pine	Floor board, not in situ	-BE	76	1677 1752	0.47
NDUCNY10	White pine	Floor board, not in situ	-BE	81	1673 1753	0.60
NDUCNY11	White pine	Floor board, not in situ	-BE	76	1691 1766	0.47
NDUCNY12	White pine	Floor board, not in situ	-BE	126	1617 1742	0.45
NDUCNY13	White pine	Floor board, not in situ	-BE	113	1646 1758	0.58

Figure 2. Comparison of the cross-dated white pine master chronology for the Nottingham/DeWitt House against a regional white pine dating master based on pine tree-ring data from living trees and archaeological timbers. The Spearman rank correlation between the series (r=0.44) is highly significant (p<0.001) with an overlap of 150 years and a t-statistic of 6.0.

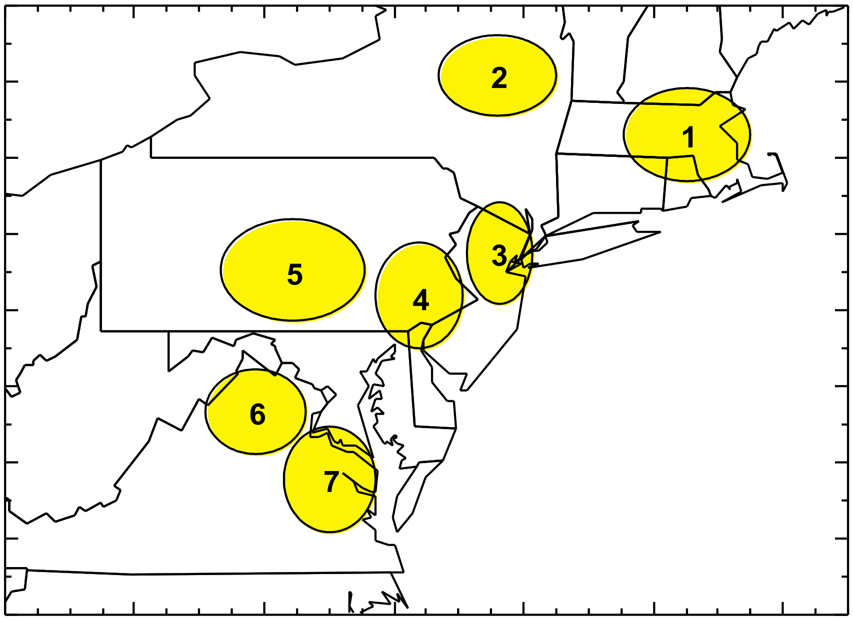


The "r-factor" is the Spearman rank correlation coefficient, a measure of relative statistical agreement between two groups of measurements or data. It can range from +1 (perfect direct agreement) to -1 (perfect opposite agreement). The "t-value" is Student's distribution test for determining the unique 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.

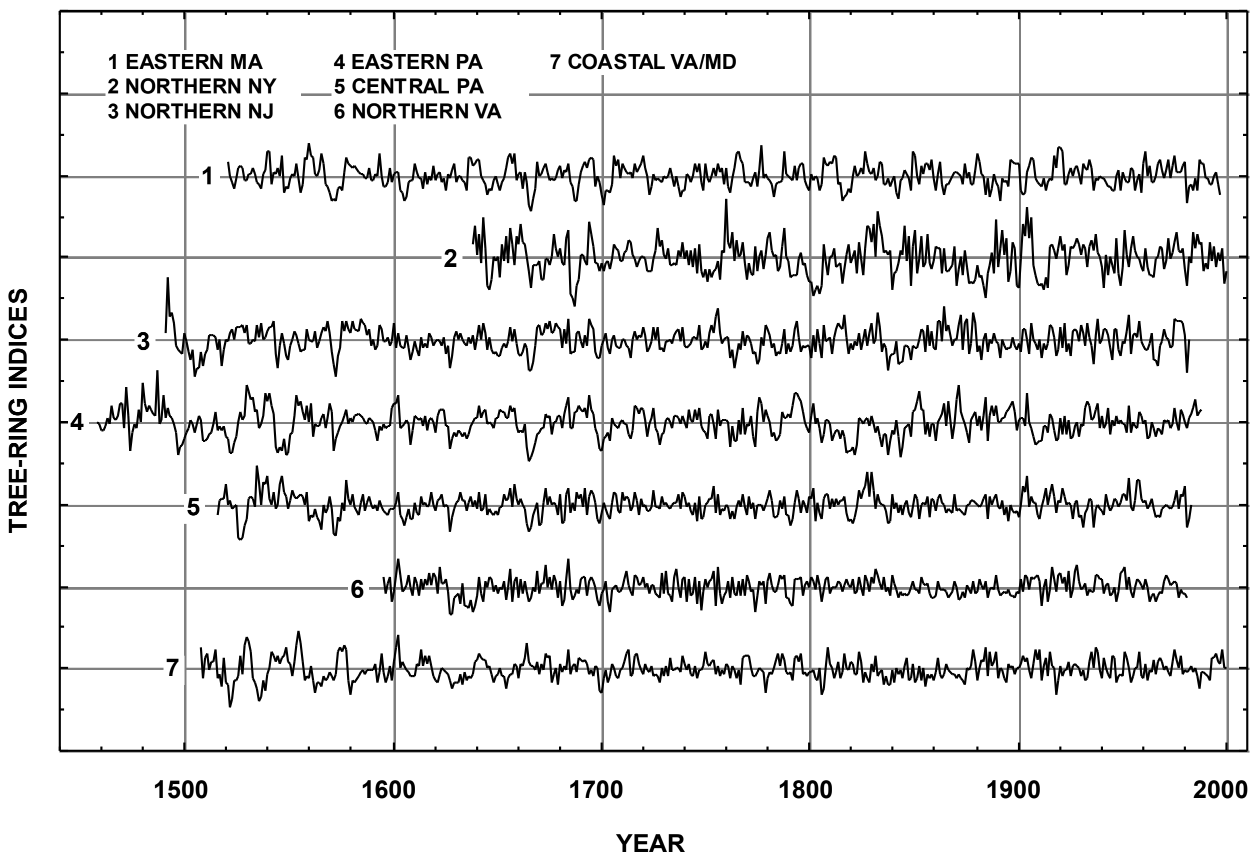
The t-statistics (t=7.8) associated with the correlation between the internal oak series and the regional oak master chronology (r=0.52) is statistically significant (p<<0.001) for a 164-year overlap. For that reason, there can be no doubt that the dates presented here for the sampled oak elements of the Nottingham/Dewitt House are valid, and that the statistical chance of the cross-dates being incorrect is far less than 1 in 1000.

The t-statistics (t=6.0) associated with the correlation between the internal pine series and the regional pine master chronology (r=0.44) is statistically significant (p<<0.001) for a 150-year overlap. For that reason, there can be no doubt that the dates presented here for the sampled pine elements of the Nottingham/Dewitt House are valid, and that the statistical chance of the cross-dates being incorrect is far less than 1 in 1000.

MODERN/HISTORICAL OAK CHRONOLOGIES
REGIONAL LOCATIONS OF SAMPLES



MODERN/HISTORICAL OAK TREE-RING CHRONLOGIES



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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
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
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
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