National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Vegetation Classification and Mapping at Thomas Stone National Historic Site, Maryland

Natural Resource Technical Report NPS/NER/NRTR—2012/550

ON THE COVER
Dry Mesic Forest at Thomas Stone National Historic Site.
Photograph by: Chris Lea.

Vegetation Classification and Mapping at Thomas Stone National Historic Site, Maryland

Natural Resource Technical Report NPS/NER/NRTR—2012/550

Chris Lea[1], Lesley A. Sneddon[2], and Elizabeth Eastman[3]

[1] National Park Service
Natural Resource Information Division
Vegetation Mapping Program
P.O. Box 25287
Denver, CO 80228-0287

[2] NatureServe
c/o University of Massachusetts at Boston
Biology Department
100 Morrissey Blvd.
Boston, MA 02125-3393

[3] North Carolina State University
Center for Earth Observation
Campus Box 7106
Raleigh, NC 27695-7106

February 2012

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

Lea, C., L.A. Sneddon, and E. Eastman. 2012. Vegetation classification and mapping at Thomas Stone National Historic Site, Maryland. Natural Resource Technical Report NPS/NER/NRTR—2012/550. National Park Service, Fort Collins, Colorado.

NPS 477/112894, February 2012

Contents

Page

Figures v

Tables ix

Appendixes xi

Acknowledgments xiii

Executive Summary xv

Introduction 1

General Background 1

Park-specific Information 2

Project Area 5

Location and Regional Setting 5

Park Environmental Attributes and Site History 5

Floristic setting 7

Materials and Methods 9

Planning and Scoping 9

Preliminary Data Collection and Review of Existing Information 10

Aerial Photography Acquisition and Processing 10

Orthophoto Mosaic Metadata 10

Photointerpretation and Development of the Formation-level Map 13

Field Data Collection and Classification 14

Vegetation Map Preparation 21

Accuracy Assessment 21

Results 31
Vegetation Classification - Observation Points 31
Vegetation Classification - Plots 32
Association Descriptions 34
Vegetation Map Production 97
Accuracy Assessment 102
Project Deliverables 102
Discussion 105
Vegetation Classification and Characterization 105
Vegetation Map Production 107
Accuracy Assessment 107
Recommendations for Future Projects 108
Literature Cited 109

Figures

Page

Figure 1. Location of Thomas Stone National Historic Site, Charles County, Maryland. 3

Figure 2. Soil series of Thomas Stone National Historic Site (adapted from Hall and Mathews 1974). 6

Figure 3. Photo centers of the Thomas Stone National Historic Site leaf-on (fall) 2002 orthophoto mosaic, with association map for reference. 11

Figure 4. Photo centers of the Thomas Stone National Historic Site leaf-off (spring) 2002 orthophoto mosaic, with association map for reference. 12

Figure 5. Vegetation observation (rapid assessment) points at Thomas Stone National Historic Site, May 2001. 16

Figure 6. Vegetation plots sampled at Thomas Stone National Historic Site. 18

Figure 7. Ground control points (n=23) used to calculate horizontal positional accuracy of the Thomas Stone National Historic Site leaf-off (spring) orthophoto mosaic. 23

Figure 8. Ground control points (n=22) used to calculate horizontal positional accuracy of the Thomas Stone National Historic Site leaf-on (fall) orthophoto mosaic. 24

Figure 9. Locations of sampling points in the northern section of Thomas Stone National Historic Site for the 2004 thematic accuracy assessment. 27

Figure 10. Locations of sampling points in the southern section of Thomas Stone National Historic Site for the 2004 thematic accuracy assessment. 28

Figure 11. Pine - Oak Forest in Thomas Stone National Historic Park (plot THST.211). July 2006. 41

Figure 12. Pine - Oak Forest in Thomas Stone National Historic Park (plot THST.201). July 2006. 42

Figure 13. Dry Mesic Forest in Thomas Stone National Historic Park (plot THST.311). July 2006. 48

Figure 14. Dry Mesic Forest in Thomas Stone National Historic Park (plot THST.301). July 2006. 48

Figure 15. Early Successional Mesic Forest in Thomas Stone National Historic Park (plot THST.202). 57

Figure 16. Early Successional Mesic Forest in Thomas Stone National Historic Park (plot THST.212). July 2006. 57

Figure 17. Oak - Heath Forest in Thomas Stone National Historic Park (plot THST.501). July 2006. 63

Figure 18. Oak - Heath Forest in Thomas Stone National Historic Park (plot THST.431). July 2006. 64

Figure 19. Floodplain Forest in Thomas Stone National Historic Park (plot THST.421). July 2006. 72

Figure 20. Floodplain Forest in Thomas Stone National Historic Park (plot THST.502). July 2006. 73

Figure 21. Upland Depression Swamp in Thomas Stone National Historic Park (plot THST.603). July 2006. 79

Figure 22. Upland Depression Swamp in Thomas Stone National Historic Park (plot THST.603). July 2006. 79

Figure 23. Seepage Swamp in Thomas Stone National Historic Park (plot THST.221). July 2006. 85

Figure 24. Seepage Swamp in Thomas Stone National Historic Park (plot THST.321). July 2006. 85

Figure 25. Formation map of Thomas Stone National Historic Site. 98

Figure 26. Vegetation association map of Thomas Stone National Historic Site. 100

Figure 27. Comparison of Oak - Heath Forest (on left) with Dry Mesic Forest (on right). 119

Figure 28. Two examples of Sweetgum Forest (upper polyon in photo on right). 120

Figure 29. Two examples of Early Successional Mesic Forest. 120

Figure 30. Two examples of Oak - Heath Forest. 121

Figure 31. Floodplain Forest, (compared to Early Successional Mesic Forest (right-most polygon): October imagery at left, February imagery at right. 122

Figure 32. Floodplain Forest (middle polygon depicts shorter hydroperiod) compared to Early Successional Mesic Forest (left-most polygon); October imagery at left, February imagery at right. 122

Figure 33. Pine - Oak Forest (three polygons in upper central and lower corners of photo) compared to Oak - Heath Forest (large contiguous polygon), October imagery; Pine - Oak Forest, February imagery (on right). 123

Figure 34. Pine - Oak Forest, second example, depicted by dark red signature, October imagery, and February imagery on right..... 123

Tables

Page

Table 1. Location and classification of vegetation observation points at Thomas Stone National Historic Site, May 2001. 15

Table 2. Allocation of points by map class on the association-level map for the 2004 thematic accuracy assessment. 26

Table 3. TWINSPAN output tables (Hill 1979; McCune and Mefford 1997) for analysis of 59 forest vegetation observation points at Thomas Stone National Historic Site, showing plot abundance scores for the 27 most frequent woody species and final point assignment. 31

Table 4. Bray-Curtis percent similarity (Bray and Curtis 1957) between sample unit (plot) pair combinations (species abundances used to calculate similarities follow scale of Fleming et al. 2001). 33

Table 5. Location (center of plot), survey date, and common name of USNVC association for vegetation plots at Thomas Stone National Historic Site (easting and northing units are UTM meters, NAD-83). 35

Table 6. U.S. National Vegetation Classification formation-level vegetation and Anderson Level II land use/land cover categories mapped in and around Thomas Stone National Historic Site. 97

Table 7. U.S. National Vegetation Classification (USNVC) numbers and names, and plot numbers of associations identified at Thomas Stone National Historic Park (THST). 99

Table 8. Mapped extent within the park and project area for vegetation associations and Anderson Level II land cover categories at Thomas Stone National Historic Site. 101

Table 9. Contingency table for thematic accuracy assessment for Thomas Stone National Historic Site vegetation map, showing producer's and user's accuracies and 90% confidence intervals by map class. 103

Table 10. Overall map classification accuracies, 90% confidence intervals, and Kappa statitsics for (1) all map classes, (2) natural vegetation classes, and (3) managed vegetation and storm residue classes for Thomas Stone National Historic Site vegetation map. 104

Table 11. Summary of products resulting from the Thomas Stone National Historic Site vegetation classification and mapping project. 104

Table 12. Frequency of plots and observation points at Thomas Stone National Historic Site by soil series (see Figure 2) and topographic position. 106

Appendixes

Page

Appendix A. Summary of key information for Thomas Stone National Historic Site leaf-off (spring) orthophoto mosaic. 113

Appendix B. Summary of key information for Thomas Stone National Historic Site leaf-on (fall) orthophoto mosaic. 115

Appendix C. Summary of key information for Thomas Stone National Historic Site formation-level vegetation dataset. 117

Appendix D. Aerial photograph interpretation keys to selected formation- and association-level vegetation types at Thomas Stone National Historic Site. 119

Appendix E. Plot data collection form. 125

Appendix F. Plots 2.0 database metadata. 127

Appendix G. Dichotomous field key to the vegetation associations of Thomas Stone National Historic Site. 133

Appendix H. Accuracy assessment data form. 139

Appendix I. TWINSPAN (Hill 1979; McCune and Mefford 1997) output tables for analysis of 23 vegetation plots at Thomas Stone National Historic Site, showing abundance scores for 100 most frequent species and final plot assignment. 141

Appendix J. Index of representative photographs of vegetation classification sampling plots in Thomas Stone National Historic Site. 147

Appendix K. Plants observed in Thomas Stone National Historic Site during vegetation plot and thematic accuracy assessment sampling. 149

Appendix L. Field definitions for local and global vegetation descriptions. 155

Appendix M. Bibliography for global vegetation descriptions from the U. S. National Vegetation Classification. 167

Acknowledgments

Wendy Cass (Shenandoah National Park), Kristen Gounaris Allen (Richmond National Battlefield Park), Helen Hamilton (Assateague Island National Seashore), Becky Loncosky (Catoctin Mountain Park), Rijk Morawe (George Washington Birthplace National Monument), and Brent Steury (National Capital Parks East) conducted vegetation plot sampling for this project. They are to be commended for an outstanding effort and producing a data set of high quality and accuracy in an area unfamiliar to them. The staffs of their respective parks are acknowledged for facilitating this detail.

Brian Biegler, formerly of Thomas Stone National Historic Site, provided background information on the site and assisted field efforts.

William Millinor of North Carolina State University, Eric Stiles of Worcester County, Maryland government, Mark Duffy of Assateague Island National Seashore, and staff of the Natural Resource Conservation Service (Charles County office) provided spatial data helpful to environmental analysis and description.

Gary Fleming and Karen Patterson of the Virginia Division of Natural Heritage, Jason Harrison of the Maryland Natural Heritage Program, Jim Vanderhorst of the West Virginia Natural Heritage Program, Sue Gawler of NatureServe, and Brent Steury reviewed regional vegetation information that provided provisional names to associations. Jason Harrision also provided data useful in expanding the geographic scope of the data analysis and Gary Fleming shared unpublished data and analyses that assisted classification, as well as reviewing early drafts of this document. Ery Largay and Mark Hall of NatureServe organized the information into a standard National Park Service report.

Jeffrey Shreiner of Delaware Water Gap National Recreation Area and Brent Steury spent several days in the park validating the classification units on the ground.

The National Park Service Northeast Region Inventory and Monitoring Program funded this project. Elizabeth Johnson, Northeast Region Inventory and Monitoring Program Coordinator, is acknowledged for her support and facilitation of this study.

Executive Summary

Vegetation classification and mapping of Thomas Stone National Historic Site follows the guidelines developed for the U.S. National Vegetation Classification (USNVC). An initial site visit was conducted to observe and record the range of compositional and environmental variation within the park. These data were then used to identify representative stands where twenty-three vegetation plots were sampled. Vegetation plots included quantitative and qualitative data on vegetation composition and structure as well as environmental characteristics. Plot data collected at Thomas Stone National Historic Site were added to a larger data set collected at nearby National Park System units of the National Capital Region and analyzed using an array of multivariate techniques to produce the vegetation classification.

Twelve USNVC associations and three land use categories are described for the lands within and adjacent to Thomas Stone National Historic Site. The upland areas are characterized by Dry Mesic Forest, Oak – Heath Forest, and three successional hardwood forest types, including Sweetgum Forest, Early Successional Mesic Forest, and a Pine - Oak successional type dominated by Virginia pine (*Pinus virginiana)*. Wetland forests are characterized by a locally-defined Depositional Bar association dominated by river birch (*Betula nigra*) occurring on rocky bars in and along streams, a Floodplain Forest dominated by tuliptree (*Liriodendron tulipifera*) and sweetgum (*Liquidambar styraciflua*) at stream edges, and two red maple (*Acer rubrum*) types, one type in basin depressions (Upland Depression Swamp) and the other in seasonally flooded areas (Seepage Swamp). Non-forested types include a seasonally flooded herbaceous marsh (Woolgrass Marsh), as well as two cultural/human altered herbaceous types: Dry Meadow, dominated by fescue, and Wet Meadow, a locally defined deer-tongue grass type which was observed along powerline rights-of-way and road sides just outside the park boundary. Ten and nine of the USNVC types were mapped as individual polygons within the project area and the park, respectively. Two of the types were present in too small of an area to be mapped.. Areas that could not be readily mapped to USNVC associations were assigned to mosaic or unvegetated cover classes as appropriate.

Detailed descriptions of the local and global expressions of each vegetation type, a field key to vegetation types, a plant species list derived from the plot samples, and an index to photographic documentation are included as appendixes.

Keywords: accuracy assessment, association, vegetation classification, vegetation mapping, Thomas Stone National Historic Site.

Introduction

General Background

The purpose of this study is to classify and describe vegetation at Thomas Stone National Historic Site within the framework of the U.S. National Vegetation Classification (USNVC) (Federal Geographic Data Committee Vegetation Subcommittee 1997, Jennings et al. 2004) and in accordance with standards developed for units of the National Park Service (TNC and ESRI 1994b). In 1992, the National Park Service implemented a national program to classify, describe, and map detailed vegetation communities (http://biology.usgs.gov/npsveg). The vegetation map is one of the minimal data sets of an essential resource inventory for managing more than 270 units in a national park system with significant natural resources (http://www.nature.nps.gov/im). Vegetation units are classified, described, and named to the association level of the USNVC (http://www.natureserve.org). The U.S. Geological Survey (USGS)/National Park Service (NPS) Vegetation Mapping Program has identified the association level to be the desired fundamental map unit whenever possible (TNC and ESRI 1994b). Vegetation types described to the level of the USNVC association are the basis for vegetation mapping of Thomas Stone National Historic Site.

The USNVC is a hierarchical system with physiognomic criteria at the highest levels of the hierarchy and floristic criteria at the lower levels. The physiognomic units have a broad geographic perspective and the floristic units have a local and site-specific perspective (Grossman et al. 1998).

The USNVC includes most existing vegetation, whether natural or cultural, but relatively more attention has been focused on natural and semi-natural vegetation types. Natural vegetation, as defined by The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI 1994b), includes types that "occur spontaneously without regular management, maintenance, or planting, and have a strong component of native species." Cultural vegetation includes planted/cultivated or heavily managed vegetation types such as orchards, pastures, and vineyards. Semi-natural vegetation lies between the two concepts, in that it is of spontaneous origin, but is characterized by a higher component of nonnative species.

The physiognomic-floristic classification includes all upland terrestrial vegetation and all wetland vegetation with rooted vascular plants. The hierarchy has five physiognomic levels and two floristic levels. The physiognomic portion of the classification is based upon the United Nations Educational, Scientific, and Cultural Organization (UNESCO) world physiognomic classification of vegetation, which was modified to provide greater consistency at all hierarchical levels and to include additional types (Grossman et al. 1998). At the uppermost level, the USNVC is divided into seven broad physiognomic classes: Forest, Woodland, Shrubland, Dwarf-shrubland, Herbaceous, Sparse (vascular), and Non-vascular. The lowest level of the physiognomic portion of the classification is the Formation, defined by dominance of a given growth form in the uppermost stratum and characteristics of the environment (e.g., Temporarily Flooded Cold-deciduous Forest).

The two floristic levels are alliances and associations. The alliance is a physiognomically uniform group of plant associations that share dominant or diagnostic species, usually in the uppermost stratum of the vegetation. For forested types, the alliance is roughly equivalent in

scale to the “cover type” of the Society of American Foresters (Eyre 1980). Alliances also include non-forested types.

The basic unit of the classification system, the association, is roughly equivalent in scale to the plant association of European phytosociologists (Becking 1957). The association is a unit of vegetation that is more or less homogeneous in composition and structure and occurs on uniform habitat. Alliances are generally more wide-ranging geographically than are associations, although many monotypic alliances have been classified.

Although associations are defined by the plants that comprise them, they are, in fact, communities of all the component organisms of that association, including animals, protozoans, bacteria, and fungi. Associations are classified from a range-wide perspective (termed "global," although in fact any association only ranges over part of a continent), and are assigned global rarity ranks as well as ranking specifications to be applied to individual occurrences of associations across their range. A map of associations occurring at a site can provide information about the abundance and distribution of each type and the significance of the individual occurrences, as well as surrogate information about the location and abundance of individual species characteristic of the association.

Park-specific Information

Thomas Stone National Historic Site was established in 1978 and has been managed by the National Park Service since 1981. It is located 5 km (3.1 mi) west of La Plata, in Charles County, Maryland (Figure 1). The area of the park is approximately 133 ha (328 ac), of which about 130.5 ha (322.5 ac) are federally owned land and about 2.5 ha (5.5 ac) are a privately owned inholding (NPS 1990b). Approximately 66% of the site, or 90 ha (222.4 ac), is covered by relatively natural vegetation (forest, including some non-tidal wetlands), with the remaining 43 ha (106.3 ac) comprised of fields and other forms of land cover that are cleared of trees for maintaining historic scenes or utility rights-of-way (Gailey and Shrout 1993).

The primary significance of Thomas Stone National Historic Site is its historic role as the home of Thomas Stone, a Maryland delegate to the Continental Congress and a signer of the Declaration of Independence. The site was occupied by the Stone family, beginning with Thomas Stone from 1770–1787, and later by Michael Stone from 1913–1936.

Management objectives for the site are (1) to preserve and protect the resources essential for commemorating Thomas Stone, (2) to manage and protect the natural resources of the site consistent with the need to interpret agrarian lifestyles and re-establish historic landscapes, and (3) to rehabilitate structural and landscape elements essential for interpreting Thomas Stone’s home, 19th century farming practices, and buildings contributing to the site’s history (NPS 1990a).

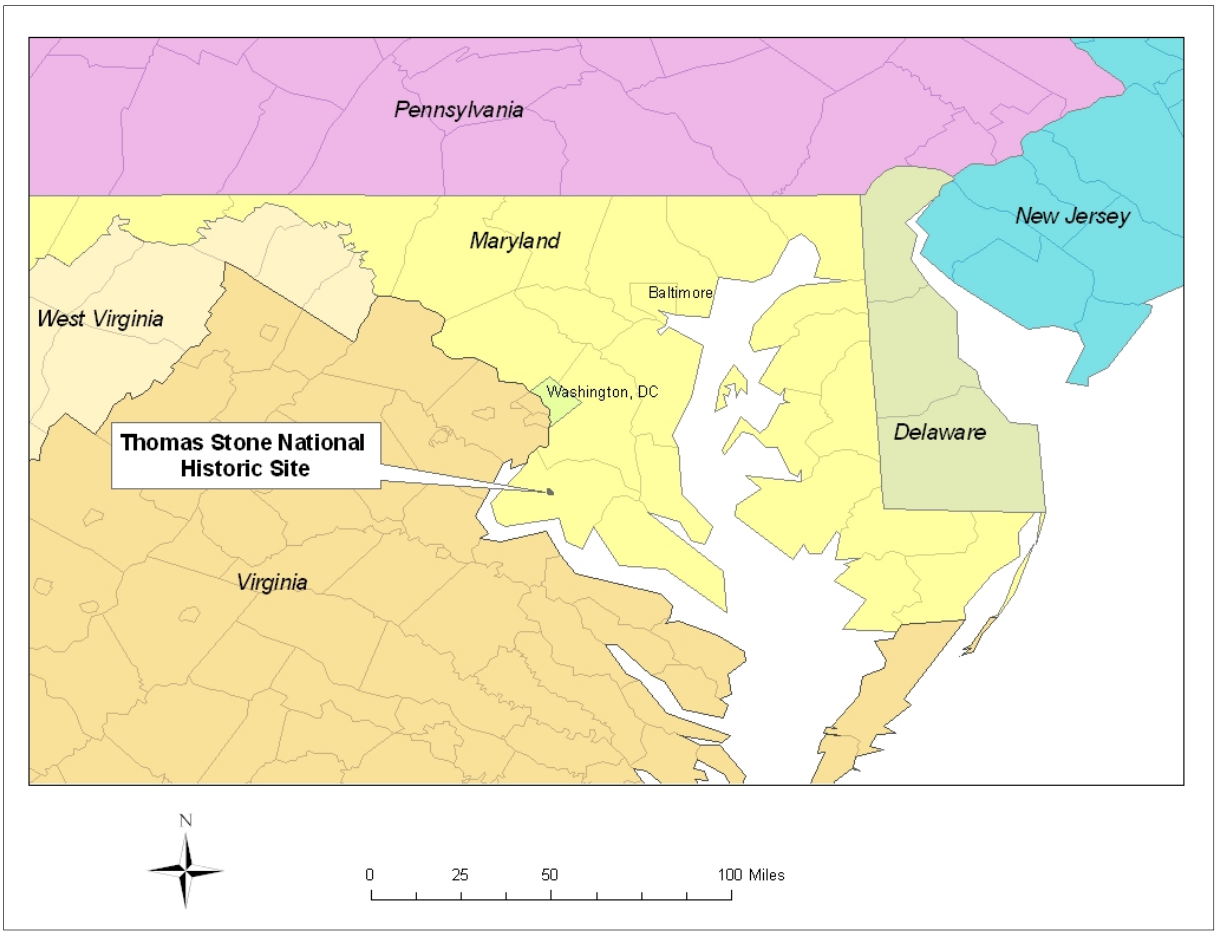


Figure 1. Location of Thomas Stone National Historic Site, Charles County, Maryland.

Project Area

Location and Regional Setting

Thomas Stone National Historic Site lies within the Western Shore [of the Chesapeake Bay] section of the Coastal Plain of Maryland (Shreve et al. 1910, Schmidt 1993). This region is also often called the Inner Coastal Plain. The Coastal Plain in Maryland is of low relief and underlain by unconsolidated sediments of primarily fluvial or estuarine origin, with the Western Shore consisting of generally older surficial material and having greater and more diverse topographic relief than does the Eastern Shore (Schmidt 1993). The project area includes the park proper, as well as a buffer of variable width extending outside of the park to provide additional context.

Park Environmental Attributes and Site History

Elevations within the park range from about 12 m (40 ft) to slightly more than 52 m (170 ft) above sea level. The entire park unit lies within the watershed of Hoghole Run, a tributary of the Port Tobacco River. Mean annual precipitation for Charles County is 119 cm (47 in) (Hall and Mathews 1974).

Most of the uplands in the area of Thomas Stone National Historic Site are underlain by unconsolidated deposits of Quaternary age gravels and sands, with minor silts and clays (Cleaves et al. 1968). Larger streams, including at least the lower reaches of Hoghole Run, have exposed sediments of older (Tertiary) age. In the vicinity of Thomas Stone National Historic Site, the exposed older sediments are most likely Miocene age Calvert Formation and/or the Eocene age Nanjemoy Formation (Cleaves et al. 1968). Both are comprised of silts, clays, and argillaceous sands, with some marine fossils (Cleaves et al. 1968, Schmidt 1993). The prevalent soil series at Thomas Stone National Historic Site is Beltsville silt loam. Seven different soil series (Hall and Mathews 1974) occur within the site boundaries (Figure 2).

The topographically higher (generally above 46 m [150 ft] above sea level), low slope areas are underlain by unconsolidated deposits of Pliocene age, here comprised mostly of the Beltsville silt loam (a typic fragiudult), with Exum silt loam (an aquic hapludult) and Sassafras sandy loam (a typic hapludult) occupying relatively minor areas. These are moderately well-drained to well-drained soils with a fragipan in the subsoil that inhibits downward water movement. Inspection indicated that areas mapped as the Beltsville silt loam consistently had a fragipan of high clay content, the top of which was generally from 5 to 25 cm (5–10 in) below the soil surface and which was barely to not at all penetrable by a soil sampling probe.

Where streams such as Hoghole Run and its tributaries have dissected the landscape much below the elevation of these upper deposits (generally between 30 and 46 m [100–150 ft] above sea level in the northern part of the site and between 15 and 46 m [50–150 ft] in the southern part), the surface is predominantly gravelly deposits. The soils represented most prominently in these dissected settings at Thomas Stone National Historic Site are the Aura gravelly sandy loam and, to a lesser extent, the Croom gravelly loam (both typic hapludults). Field inspection confirmed that areas mapped as either of these series had soils that were consistent with descriptions of the series in Hall and Mathews (1974). They can be consistently identified at the site by rounded gravel particles up to 5 cm (2 in) in diameter.

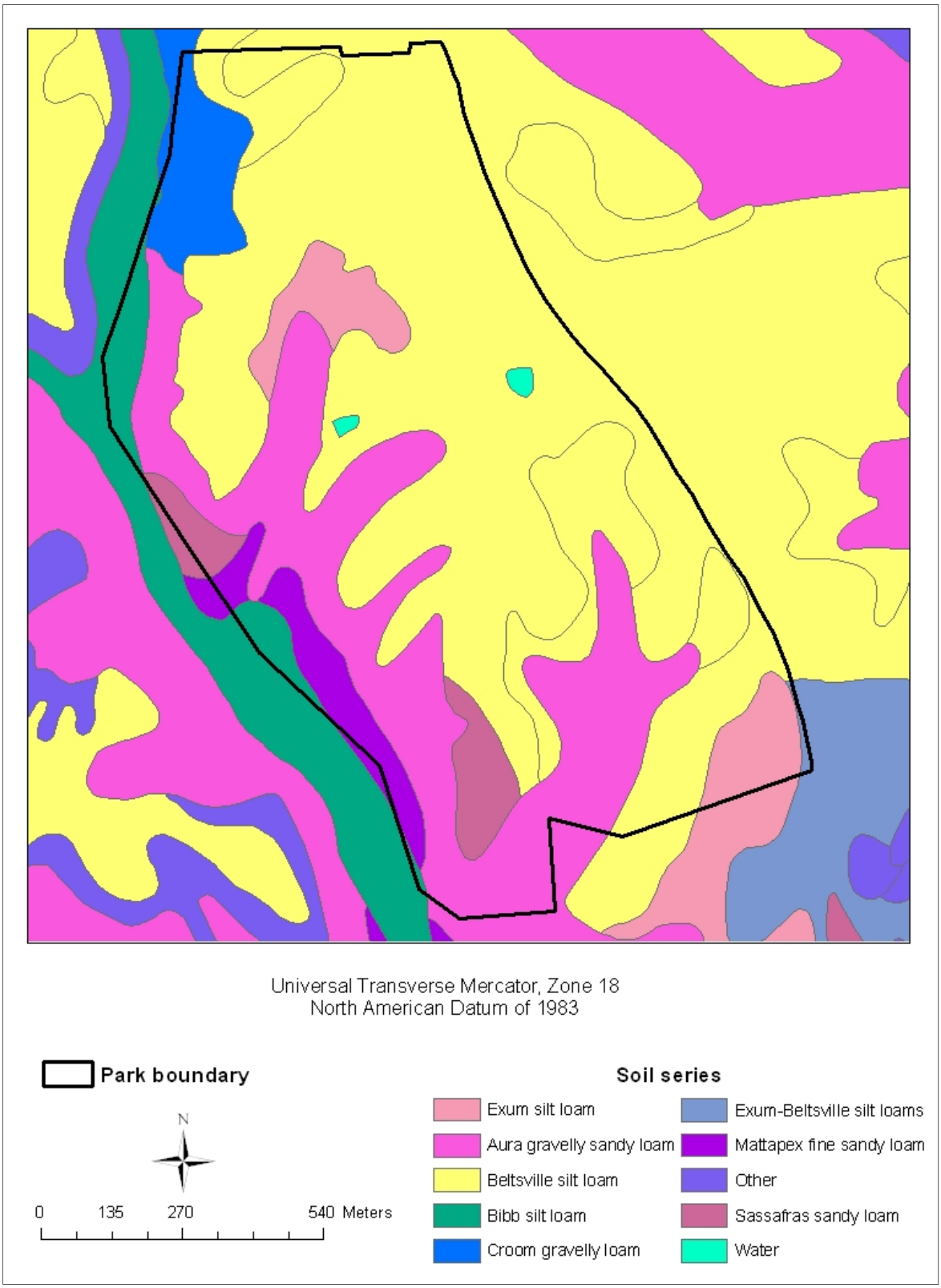


Figure 2. Soil series of Thomas Stone National Historic Site (adapted from Hall and Mathews 1974).

In the lowest elevations along Hoghole Run are recent soils of alluvial origin (Hall and Mathews 1974). These are dominated by the Bibb silt loam (a typic haplaquent), which predominates near the channel, with Mattapex fine sandy loam (an aquic hapludult) often present in slightly higher areas.

The estate known as Haberdeventure, within which present-day Thomas Stone National Historic Site is located, was patented in 1682 (DeNadai et al. 1994). Although knowledge of early history of the site is incomplete, it is likely that most or all forests at the site have been cleared for agriculture and/or cut for wood periodically or continuously since at least that time. Gailey and Shrout (1993) identified four forest stands within the park based on tree age. In the oldest stand, remaining in continuous forest cover for up to 250 years, some trees were estimated to be up to 120 years old. Another stand estimated at 150–200 years old, described as transitional climax, supports trees ranging from 60 to 120 years in age. Trees were harvested in the 1970s, and included apparent commercial logging of some stands immediately before the National Park Service acquired the property in 1978. Aerial photographs taken in 1937, 1957, and 1989 indicate that most areas forested today have been continuously forested since at least 1937 (DeNadai et al. 1994).

Thomas Stone National Historic Site was impacted by a severe tornado that affected Calvert, Charles, and Dorchester counties in April 2002. The tornado cut a swath nearly 250 m wide at its broadest point, in an east-west orientation through the center of the park. This disturbed vegetation is identified as “Storm Residue” on the vegetation maps in this report.

Floristic setting

At the start of this study, little information on flora or vegetation specific to Thomas Stone National Historic Site was known to exist. A forest stewardship plan developed for the site (Gailey and Shrout 1993) examined stands of forest and presented brief descriptions of tree and shrub species composition, stand age, and past forest use. While the plan provides some information on past land history that is useful for understanding some vegetation patterns, it does not contain sufficient detail about stand floristic composition to be of great use for vegetation classification.

In an early description of the vegetation of Maryland, Shreve et al. (1910) provided some general information about vegetation of the region which is useful and somewhat applicable today. The authors described three upland forest and four lowland forest associations (defined more broadly than the concept of the association of the USNVC) for the Western Shore District of the Coastal Zone, their designation for the phytogeographic area of which Charles County is part. They also described distribution and frequency of common tree species in these forests, as well as forest successional patterns. From descriptions of composition of several upland stands by Shreve et al. (1910), it is evident that American chestnut (*Castanea dentata*) was an important component of mature dry forests on much of the Western Shore before the onset of chestnut blight in Maryland. American chestnut may have been a former component of forests at Thomas Stone National Historic Site, since it is within the Oak - Chestnut Forest Region (in the sense of Braun 1950), with some elements characteristic of the Oak - Pine Region present.

As part of an effort to develop a statewide classification of vegetation in conformance with the USNVC, the Maryland Department of Natural Resources conducted two studies of riparian vegetation that included areas in Charles County. The first (Meininger and McCarthy 1998) was specific to the non-tidal wetlands of Zekiah Swamp, a riparian system within Charles County that constitutes the next large first-order tributary of the Potomac River to the east of the Port Tobacco River. Meininger and McCarthy (1998) described four bottomland forest associations for that system. Thomson et al. (1999) conducted a survey of floodplain forest vegetation for the Potomac River and its tributaries within Maryland; the authors described fourteen associations, with several occurring in Charles County.

State and regional classifications that include the area of the Inner Coastal Plain of Maryland and Virginia have synthesized data and descriptions from individual projects employing the USNVC. Fleming et al. (2001) described vegetation of calcareous ravines. Fleming et al. (2007) conducted an intensive classification effort of national parks in the coastal plain. Steury (2002) conducted a brief floristic survey of Thomas Stone National Historic Site pursuant to this vegetation study and documented 178 vascular plant species.

Materials and Methods

Planning and Scoping

Planning for field work and data collection generally follows the methodology developed by the USGS/NPS Vegetation Mapping Program (VMP) (TNC and ESRI 1994a). The following is a summary of these methods as applied to Thomas Stone National Historic Site.

Thomas Stone National Historic Site is considered to be either a “small” or “medium” sized park (i.e., a park in which the sample area is the entire land area of the unit) (TNC and ESRI 1994a). Decisions regarding number of plots and plot placement by environmental stratification were based on the whole park, in contrast to sampling in large parks where plot placement and stratification is focused on only a section of the park, and results extrapolated to the whole park.

Because the natural vegetation of the park comprises an area small enough (about 80 ha) to feasibly visit nearly all mapped polygons, and because aerial photographs useful for delineating vegetation were not initially available, initial planning focused on visiting the park and attempting to observe the entire range of vegetation and pertinent environmental conditions on the ground. It is assumed that ground reconnaissance alone was successful in identifying representative stands of all individual vegetation assemblages that could represent potential USNVC associations.

About one-third of the site has vegetation that would be classified to the Cultural subgroup within the USNVC framework (Grossman et al. 1998). This subgroup includes types that are actively managed to prevent natural vegetation succession. At Thomas Stone National Historic Site, cultural vegetation types include pastures and lawns maintained as part of the cultural landscape and utility line corridors passing through the park. While cultural vegetation can be described within the framework of the USNVC, precise assignment within the USNVC hierarchy based on floristic composition is problematic for several reasons. First, vegetation composition is less linked to observable environmental conditions than it is in natural and semi-natural types; therefore, it is less predictable on a phytogeographic basis. Second, the USNVC has been developed primarily as a tool for evaluating biological diversity, and Cultural subgroup types have not been evaluated extensively or consistently. Finally, precise floristic classification and description are seldom used for management of cultural vegetation. Nevertheless, Cultural subgroup types represent a significant amount of land area that must be accounted for in a vegetation mapping project. Cultural types at Thomas Stone National Historic Site were evaluated and described from qualitative observation only. Floristic descriptions for these are limited to the minimal amount necessary to recognize them in the field. Unvegetated land cover (e.g., roads, buildings) and natural aquatic communities (e.g., ponds, permanently flooded parts of stream channels) that are typically identified in mapping projects as non-vegetated land cover are not included in the USNVC, and instead mapped at Level II of the Anderson et al. (1976) land use and land cover classification.

Preliminary Data Collection and Review of Existing Information

The principal investigator made an initial one-day reconnaissance visit to the park with the park's Integrated Resources Program Manager in December of 2000. The objectives of this visit were to examine the general composition of the vegetation, to observe environmental factors affecting composition, and for the principal investigator to become familiar with access points and other logistics needed for planning vegetation and environmental data sampling.

Aerial Photography Acquisition and Processing

Two digital orthophoto mosaics, leaf-off (spring) and leaf-on (fall), were created for Thomas Stone National Historic Site. Kucera International acquired color infrared, stereo pair 1:6,000 scale aerial photography for the leaf-off mosaic on February 18, 2002, and for the leaf-on mosaic on November 8, 2002. The photography was delivered to the National Park Service (NPS), quality checked, accepted as provided, and sent to North Carolina State University (NCSU). Upon receipt at NCSU, the air photos were counted to ensure that none were missing, scanned, and saved in Tagged Image File (.tif) format. Photos and ancillary data are now archived at and made available to the public by the USGS Earth Resources Observation and Science (EROS) Center. Associated data and information provided by Kucera International that are also stored in the air photo archive include the airborne global positioning system (GPS) and inertial mapping unit (IMU) data files, the camera calibration certificates for the cameras, and hardcopy flight reports for the photography that reference the airborne GPS and IMU data to the photo frame numbers.

The leaf-off and leaf-on mosaics were each produced from ten color infrared air photos scanned at 600 dpi with 24-bit color depth. Figures 3 and 4 show the photo centers of the leaf-off and leaf-on mosaics. For each mosaic, scanned .tif images of the relevant air photos were imported into ERDAS Imagine Version 8.7 (.img) (Chambers1994) format where a photo block was created using the airborne GPS and IMU data that Kucera International supplied with the aerial photography. Each photo block was manipulated until it could be triangulated with a root mean square error of less than one. At this point, single frame orthophotos (one for each air photo) were generated within ERDAS Imagine (.img) and exported to Imagine .lan format. The .lan files were then imported into ER Mapper Version 6.4 native (.ers) format, and an ER Mapper algorithm was created. The algorithm contains the color balancing information and the cutlines created for each of the final mosaics. Band interleaved by line (.bil) image and header files for each mosaic were generated in ER Mapper, the .bil images were imported into Imagine .img format, and, finally, the .img images were compressed using MrSID MG 4 software (Skiffington 2010) with a 20:1 compression ratio. The final mosaics, in both .img and MrSID formats, are stored in the USGS EROS data archive.

Orthophoto Mosaic Metadata

Metadata records for both orthophoto mosaics were prepared in accordance with the current Federal Geographic Data Committee standards (FGDC 1998a). Metadata were produced in notepad and parsed using the USGS metadata compiler (USGS 2004). After all errors and omissions identified by the parser were corrected, the metadata compiler was used to generate final TXT, HTML, and XML versions of each metadata record stored in the air photo archive. Key information for the leaf-off (spring) and leaf-on (fall) mosaics is summarized in Appendixes A and B, respectively.

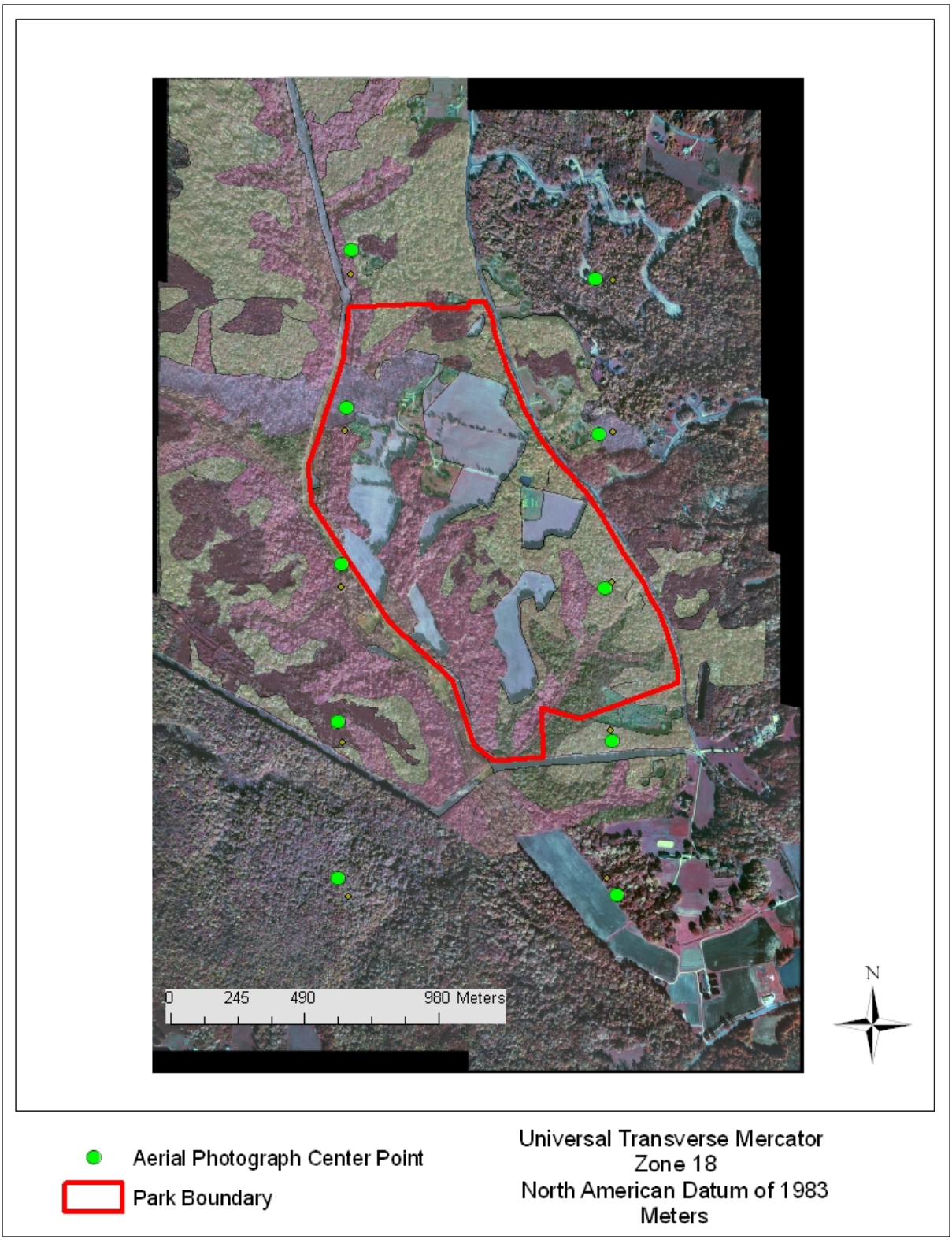


Figure 3. Photo centers of the Thomas Stone National Historic Site leaf-on (fall) 2002 orthophoto mosaic, with association map for reference.

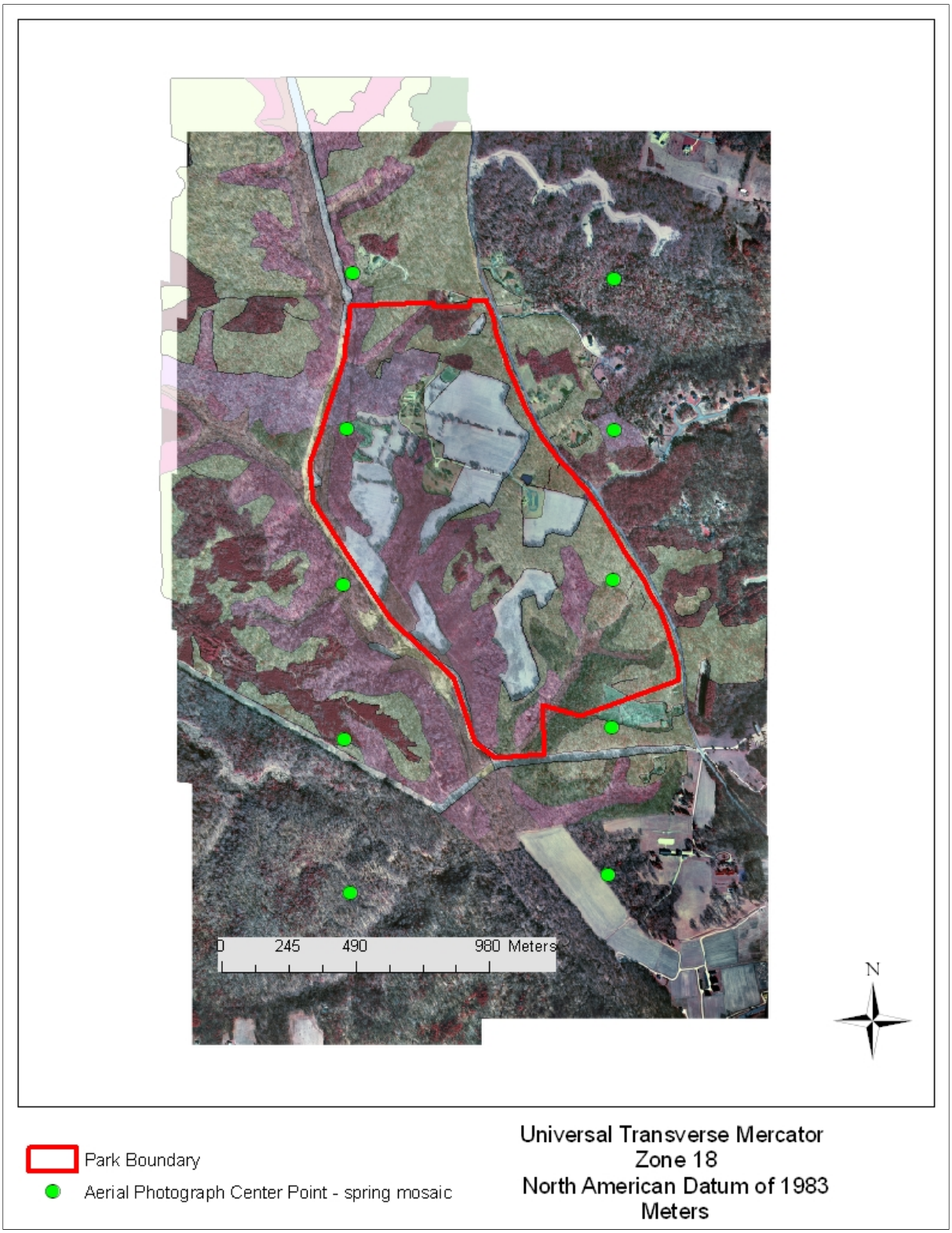


Figure 4. Photo centers of the Thomas Stone National Historic Site leaf-off (spring) 2002 orthophoto mosaic, with association map for reference.

Photointerpretation and Development of the Formation-level Map

A preliminary vegetation dataset for Thomas Stone National Historic Site was created by interpreting the digital orthophoto mosaics to delineate polygons at a more general level than that of the association, related in part to the formation level defined in the U.S. National Vegetation Classification (FGDC 1997, Grossman et al. 1998). The formation is defined as a group of vegetation types sharing similar physiognomy and broadly defined environmental factor, relative landscape position, and hydrologic regime (Grossman et al. 1998). An example of a formation is Rounded-crowned temperate or subpolar needle-leafed evergreen forest. Formations are indicated by codes of the form I.A.8.N.b., each letter or number indicating a different level in the USNVC hierarchy: I is Forest, I.A. is temperate or subpolar forest, and so on. In general, formations can be identified from aerial photography alone because vegetation structure can be discerned remotely, and hydrologic regime and land contours are usually evident on leaf-off photography.

Not all polygons of the dataset are natural vegetation (e.g., lawns), and some are not vegetation at all, (e.g., roads and buildings). In accordance with USGS/NPS VMP protocols (USGS 1994), the Level II land use and land cover classification system developed by Anderson et al. (1976) was used to attribute these polygons. This classification is hierarchical, with broadly defined land use classes at Level I (urban or built-up land, for example), and more finely classified units at lower levels. We classified the limited number of polygons not attributed to a formation to Level II. Examples of this level include residential and transportation. Although the resulting map is referred to as “formation-level,” it is in fact a hybrid map representing the USNVC and Anderson et al (1976) classifications.

To create the formation-level vegetation data set, a photointerpreter, viewing the leaf-off and leaf-on orthophoto mosaics in two dimensions, delineated visible areas of homogeneous vegetation, land cover, and land use using onscreen digitizing tools of ArcView version 9.1 (ESRI 2001–2005). The minimum mapping unit was 0.5 ha (1.25 ac); however, the photointerpreter was able to delineate polygons as small as 0.2 ha (0.5 ac). After polygons were delineated for the entire park area, the photointerpreter created and populated three fields in the attribute table, entering a unique polygon identification number, the formation-level vegetation class or other land use/land cover code, and notes if the interpreter was unsure of the appropriate code or could not assign a code. Next, the photointerpreter examined each formation-level vegetation polygon in three dimensions using ERDAS Stereo Analyst software version 8.6 (Chambers 2004), checked the vegetation class code entered in the attribute table, and entered a corrected formation or land use code if appropriate. The final formation-level vegetation dataset is archived in ESRI personal geodatabase and shapefile formats in the NCSU data archive. Metadata records of the formation-level vegetation dataset were prepared in accordance with the current FGDC standards (FGDC 1998a). Information for the formation-level vegetation dataset is summarized in Appendix C. A key to aerial photointerpretation is included in Appendix D.

It is important to note that the vegetation formations listed in the attribute table of the final association shapefile were determined by the hierarchical nature of the USNVC. Based on the USNVC, each polygon was attributed with the appropriate formation for the polygon’s USNVC association. The original formation-level map created during this study is not strictly a map of formations, but rather a map of more broadly classified units of a scale closely comparable to that of the formation level. The initial map was then used to guide sampling efforts.

Field Data Collection and Classification

Field Surveys

In late May 2001, the principal investigator made a two-day site visit to conduct a "rapid assessment" of the park vegetation. The purposes of this initial systematic assessment were to: (1) observe a large number of vegetation stands representing the full range of vegetation diversity; (2) collect limited quantitative (tree species composition) and qualitative (dominant or characteristic species) information to allow preliminary grouping of vegetation types into broad classes to maximize the efficiency of more intensive plot sampling; and (3) increase the number of spatially referenced training points for interpretation of remote sensing images. Observation points (Table 1 and Figure 5) were chosen subjectively to cover the full range and combination of environmental factors expected to exert the greatest influence on vegetation composition, including topographic position, hydrology, soil type (series), slope, aspect, and degree of recovery from prior anthropogenic disturbance. The large number of observation points (76) and the small size of the park ensured against missing any major vegetation types.

At each observation point, the investigator rotated in a full circle and counted the number of trees of each species filling the basal area factor 5 opening of a Jim-Gem® Cruz-All timber cruising tool. Such a count yields an estimate of the basal area of each species in square feet per 0.2 ac. Each count was multiplied by 5 to yield an estimated basal area in sq ft / ac (=0.2296 m^2 / ha) for each species at each observation point. Notes were made on dominant and/or characteristic understory species. The position of each observation point was recorded using a Trimble Pro XR Global Positioning System (GPS), with most positions differentially corrected in real-time via radio link with a nearby Continuously Operating Reference Station (CORS). For several points recorded during a loss of radio link, differential correction was conducted in Trimble Pathfinder Office 2.90 (Trimble Publications Group 2002) using data collected simultaneously at a Charlottesville, Virginia CORS station. The recorded positions of all observation points are considered to be accurate to within 2 m of the actual positions.

The observation point data collected during the rapid assessment were entered into a Microsoft Excel spreadsheet and converted to a format suitable for analysis using PC-ORD v. 3.04 (McCune and Mefford 1997). The Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979) program module was used to identify major groups of vegetation using the observation point (tree basal area) data. TWINSPAN successively divides plots into groups that are similar in species composition within percent cover classes. Cut levels (divisions of cover classes) were set at 1, 2, 3, 4, 5, 6, 8, 10, and 12 trees / observation point.

Table 1. Location and classification of vegetation observation points at Thomas Stone National Historic Site, May 2001. Data projected in Universal Transverse Mercator (UTM) Zone 18 North, North American Datum 1983 (NAD83), meters.

ID	Easting	Northing	Anderson et al. (1976) / USNVC Classification[1]	ID	Easting	Northing	Anderson et al. (1976)/ USNVC Classification
01	322251	4266663	Residential	39	322687	4266365	Oak - Heath Forest
02	322282	4266655	Residential	40	322704	4266317	Dry Mesic Forest
03	322298	4266752	Dry Meadow	41	322805	4265946	Dry Mesic Forest
04	322343	4266738	Dry Meadow	42	322840	4265908	Sweetgum Forest
05	322421	4266740	Dry Meadow	43	322778	4265921	Dry Mesic Forest
06	322478	4266710	Dry Meadow	44	322734	4265926	Dry Mesic Forest
07	322492	4266644	Seepage Swamp	45	322748	4265966	Dry Mesic Forest
08	322495	4266583	Oak - Heath Forest	46	322685	4265872	Dry Mesic Forest
09	322483	4266539	Oak - Heath Forest	47	322603	4265763	Dry Mesic Forest
10	322447	4266560	Oak - Heath Forest	48	322477	4265681	Floodplain Forest
11	322451	4266526	Oak - Heath Forest	49	322469	4265718	Floodplain Forest
12	322408	4266511	Pine - Oak Forest	50	322510	4265771	Successional Forest
13	322372	4266526	Oak - Heath Forest	51	322584	4265796	Successional Forest
14	322323	4266538	Oak - Heath Forest	52	322572	4265855	Successional Forest
15	322324	4266490	Oak - Heath Forest	53	322634	4265869	Floodplain Forest
16	322347	4266480	Oak - Heath Forest	54	322616	4265916	Floodplain Forest
17	322349	4266432	Pine - Oak Forest	55	322706	4265992	Floodplain Forest
18	322379	4266415	Pine - Oak Forest	56	322656	4266014	Floodplain Forest
19	322408	4266391	Pine - Oak Forest	57	322669	4266136	Oak - Heath Forest
20	322453	4266412	Oak - Heath Forest	58	322653	4266111	Oak - Heath Forest
21	322437	4266354	Oak - Heath Forest	59	322746	4266089	Floodplain Forest
22	322436	4266352	Pine - Oak Forest	60	322554	4266249	Floodplain Forest
23	322447	4266211	Dry Meadow	61	322409	4266062	Successional Forest
24	322456	4266123	Dry Meadow	62	322048	4267028	Successional Forest
25	322384	4265997	Successional Forest[2]	63	321978	4267039	Floodplain Forest
26	322350	4266006	Successional Forest	64	321932	4267047	Floodplain Forest
27	322349	4266024	Successional Forest	65	321872	4267068	Floodplain Forest
28	322316	4266052	Successional Forest	66	321857	4266987	Dry Mesic Forest
29	322309	4266094	Successional Forest	67	321822	4266896	Floodplain Forest
30	322309	4266152	Successional Forest	68	321806	4266848	Floodplain Forest
31	322347	4266140	Successional Forest	69	322127	4267208	Oak - Heath Forest
32	322200	4266071	Floodplain Forest	70	322166	4267158	Successional Forest
33	322197	4266034	Wet Meadow	71	322428	4265695	Dry Mesic Forest
34	322109	4266175	Floodplain Forest	72	322357	4265780	Successional Forest
35	322062	4266218	Floodplain Forest	73	322347	4265882	Dry Mesic Forest
36	322061	4266366	Successional Forest	74	322455	4266600	Seepage Swamp
37	322675	4266679	Oak - Heath Forest	75	322321	4266541	Floodplain Forest
38	322708	4266430	Oak - Heath Forest	76	322244	4267101	Sweetgum Forest

[1]USNVC and Anderson (1976) names were assigned following data analysis but are noted here for clarity.

[2]Full name: Early Successional Mesic Forest.

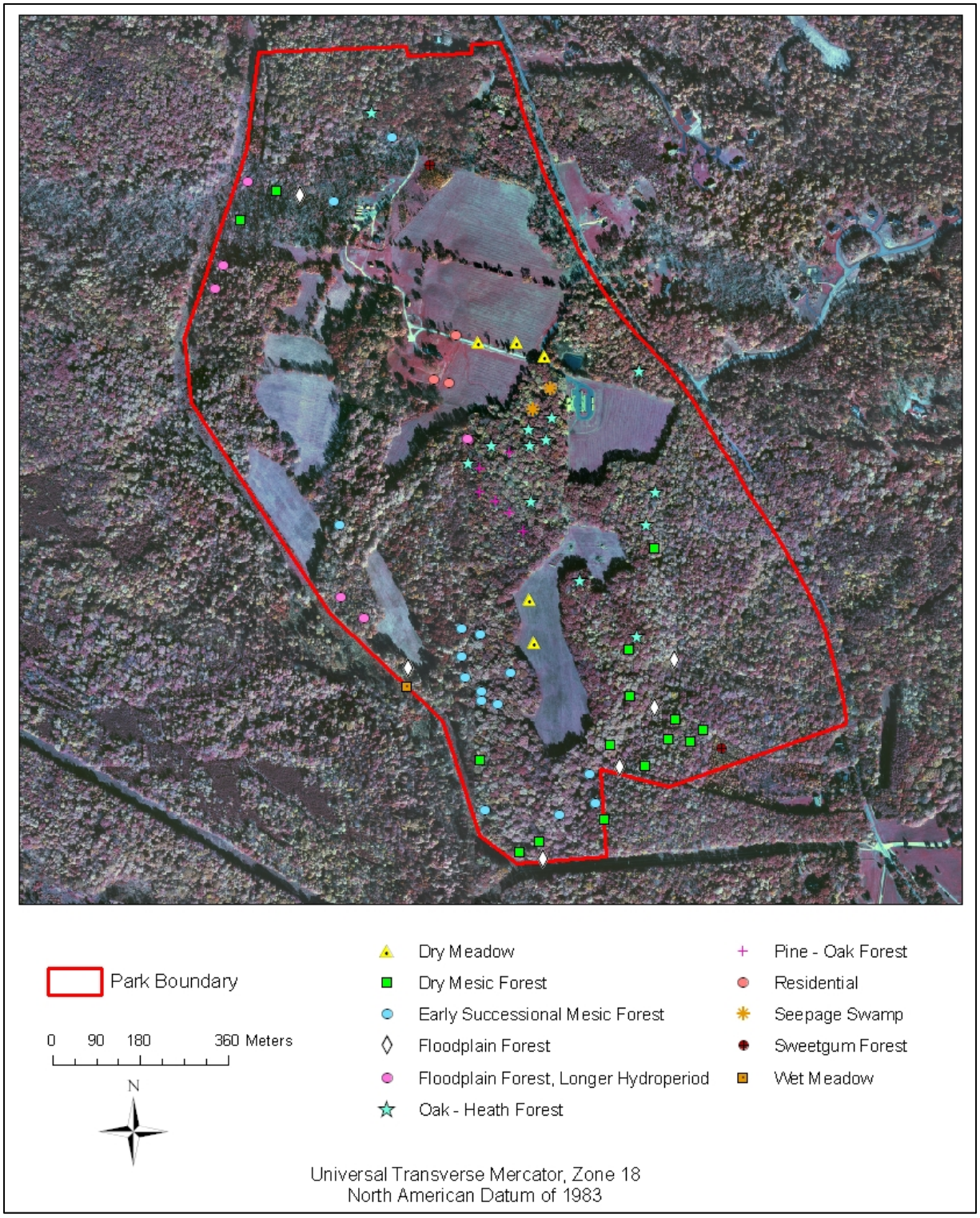


Figure 5. Vegetation observation (rapid assessment) points at Thomas Stone National Historic Site, May 2001. USNVC common names assigned following data analysis.

The initial units[1] derived from analysis of the observation point data were assigned to the observation point data (Figure 5). Table 1 summarizes the location and classification of each of the points. The initial units were then used in three ways: a) to identify all USNVC associations likely to occur at a potential sampling site; b) to identify vegetation stands that would maximize efficiency of plot data collection; and c) for supplemental information to more fully describe the respective associations. Twenty-three vegetation plots were placed within stands assigned to one of these preliminary units. Three stands representing two small-patch types not included or not well represented in the initial observation point data were targeted for sampling. All plot data were collected for each of these stands, for a total of 26 plots.

During July 16–20, 2001, seven National Park Service staff collected vegetation and other environmental data at 26 plots both in representative stands based on TWINSPAN analysis of observation point data and in small-patch vegetation types identified in the field as likely representing distinct types. Plots were subjectively placed to be most representative of the stand. Most plots were 400 m^2 in area, with the default dimensions set at 16×25 m for plots [2].
This plot size follows USGS/NPS VMP standards for forest stands (TNC and ESRI 1994a). One 12.5×32 m plot was employed to keep sampling within a long, narrow stand, and two 100 m^2 plots were used for small patch types. On August 1, 2001, data were collected from three additional plots, making a total of 26 plots (Figure 6).

Field crews visually assigned the vegetation in each plot to strata (tree canopy, tree subcanopy, tall shrub, short shrub, and herbaceous) and recorded all the vascular plant species of each stratum. The abundance of each species in each stratum in each plot was recorded as belonging to one of nine cover classes (Fleming et al. 2001), with zero scored if a species was absent in a stratum. Total abundance for each species in the plot was not estimated separately, but was calculated by summing the individual midpoints for each cover range represented by the corresponding cover class value for the species in each stratum and converting this sum to the appropriate cover class. Additional species within the stand (area of apparently similar vegetation) that occurred outside of sampled plots (typically within 20 m of the plot boundaries) were listed separately. The cover of plants that could not be identified with confidence was recorded for plots in which they were found, but these data were not included in subsequent analyses. Nomenclature follows the PLANTS 3.5 Database developed by the Natural Resource Conservation Service in cooperation with the Biota of North America Program (USDA, NRCS 2004).

[1] Because preliminary data analysis results often do not conform neatly to any particular unit in the USNVC, we use the generic term “units” rather than “association”, “formation” or other USNVC terms for units identified in preliminary results.

[2] rectangular plots were preferred to square plots by the researcher, who found them to be more efficient for assessing vegetation composition

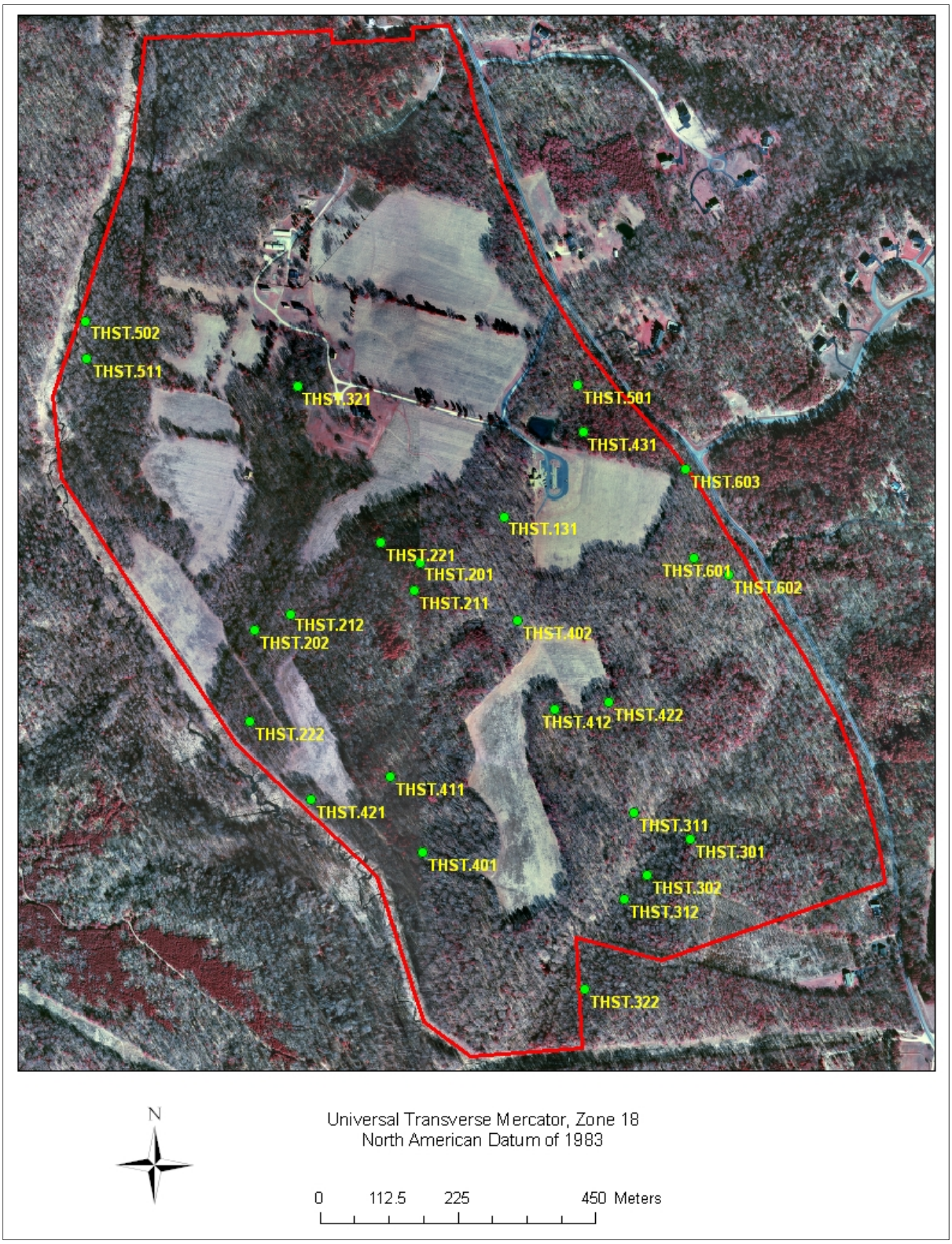


Figure 6. Vegetation plots sampled at Thomas Stone National Historic Site.

In addition to floristic data, the following environmental information was recorded on field forms: soil profile description, flooding regime, soil moisture regime, soil texture, slope, aspect, and evidence of disturbance. Flooding regime is evaluated based on the presence of soil mottles, presence of peat, evidence of flooding debris, and the like. While soil drainage is based on soil morphology only, moisture regime is based on the amount of water available to plants. It is evaluated on the basis of soil drainage, soil structure, and texture. A topographic cross-section profile was sketched by hand to represent the location and setting of the plot. Three soil samples were taken from subjectively chosen representative locations within the plot by inserting a 1.905 cm (3/4 in) diameter soil probe at least 25 cm (9.8 in), when possible, beneath the soil surface to extract the sample. A soil profile depicting changes in soil color and composition with depth was sketched for each 25 cm deep soil sample. Soil texture was subjectively assessed by a consensus of three feel tests (one from each soil sample) of material from the B horizon whenever stratification was evident and whenever possible (TNC and ESRI 1994a). For cases where soil stoniness or a fragipan prevented collection from the B horizon, the sample was taken from as deep within the A horizon as possible. Soil pH was assessed by placing a sample of 10 to 15 cm^3 of B (or deep A) horizon soil from each soil sample into a vial and mixing it with deionized water to form a slurry with a total volume of 30 cm^3. The slurry was allowed to stand for at least five minutes and the pH measured with a soil pH test meter (Oakton model WD-35624-66).

The mean of the three sample pH readings was recorded as the measure of soil pH for the plot. The meter was thoroughly rinsed with deionized water between sample tests and calibration was checked against a pH 7.0 buffer solution before and after each day of use. For two plots in seepage swamps with emerging groundwater present, the pH of the surface water, rather than that of the soil, was measured. Additional environmental data, as specified on a plot data collection form (Sneddon 1993), were recorded in the field (Appendix E).

The position of the center of each plot was visually estimated and recorded by a GPS in Universal Transverse Mercator (UTM) Zone 18 North, North American Datum 1983 (NAD83), meters, and the GPS data were processed as described for the rapid assessment points. Slope and aspect for each plot were estimated by overlaying the plot position in ArcView version 9.1 software (ESRI 2001–2005) onto slope and aspect model maps. The slope and aspect maps were generated from digital elevation models derived from USGS 7.5 minute quadrangle hypsography (digital line graph) data. Plotting vegetation plot positions onto a digital version of the Charles County soil map (Hall and Mathews 1974) derived the soil series recorded for each plot.

For stands that were classified as Cultural or very early successional Natural/Semi-natural vegetation, quantitative data were not collected, but dominant or characteristic species were recorded.

Vegetation Classification and Characterization

Plot data were entered into the USGS/NPS VMP PLOTS 2.0 database (http://biology.usgs.gov/npsveg/links.html) and ultimately will be archived by the USGS/NPS VMP. Metadata for the PLOTS data fields are listed in Appendix F.

Three plots representing small-patch types were immediately recognized as structurally and floristically distinct from the remaining 23 plots and were not included in TWINSPAN data analysis. The three plots (603, 221, and 321) were compared to existing USNVC associations

and readily classified by subjective assignment, so no further analysis was necessary. The remaining 23 plots were analyzed using TWINSPAN with the same nine cover value cut levels as were used for the observation point data.

The output tables from these analyses were used in combination with other studies and regional descriptions (Fleming et al. 2001, NatureServe Explorer 2001, Lea et al. 2003) to assign vegetation into units within the existing framework of the USNVC. The relationships among and between the resulting preliminary units were checked by calculating Bray-Curtis percent similarities (Ludwig and Reynolds 1988) between all possible combinations of plot pairs. This measure can reveal the degree of similarity of two plots that might be classified as different associations using the initial TWINSPAN output. This information was used where the decision to divide plots into different associations was ambiguous.

In order to take advantage of a region-wide analysis, a second analysis was conducted in 2007 in which the vegetation plot data from Thomas Stone National Historic Park were added to a larger data set analyzed for a vegetation classification project for the National Park Service's National Capital Region. This analysis, conducted by Virginia Natural Heritage Program, included plots from all eleven National Capital Region parks, as well as other plot data previously collected in the vicinity by the natural heritage programs in Virginia, West Virginia, and Maryland. The data set of 2,250 plots was first divided into five broad ad-hoc groups based on ecological knowledge, previous assignment to a provisional National Capital Region class, or previous assignment to the Virginia Natural Heritage Program's Ecological Groups classification. The groups (basic upland forest, acidic upland forest, rock outcrop / woodland, alluvial wetland, non-alluvial wetland) were analyzed individually using the software program PC-ORD (version 5.04; McCune and Mefford 1999) for multivariate numerical analyses. Cluster analysis using the Lance-Williams Flexible-Beta linkage method (Lance and Williams 1966, 1967) and the Bray-Curtis dissimilarity measure (Bray and Curtis 1957) were used to identify compositionally similar groups that were again analyzed individually. See Fleming et al. (2007) for a detailed description of classification methods.

Once the classification was finalized, the resulting units were subjectively compared to existing USNVC associations. All of the units were assigned to an existing association. Global descriptions were edited as appropriate to account for new data.

The associations identified at Thomas Stone National Historic Site were then further described in more detail, called "local information," to account for any variation between the globally described type and its manifestation at the park.[3]

[3] In general, associations occur over a wide geographic area, and as a concept, encompass a larger number of species than are present at any individual location. The local information is restricted to the species present at the park.

Detailed local descriptions for twelve semi-natural associations were written based on the plot and observation point data, photographs of each plot, and the ecologists' field experiences at Thomas Stone National Historic Site and other nearby national parks. In addition, existing global descriptions of associations were edited as appropriate with new information from plots and observation point data. A dichotomous key was also developed for the twelve associations, as well as one anthropogenic category, at Thomas Stone National Historic Site (Appendix G). The dichotomous key should be used in conjunction with the detailed association descriptions to confirm that the association selected with the key is appropriate. This key and the detailed association descriptions were used in the thematic accuracy assessment and may be used by park resource managers and others to identify or confirm the identity of associations in the park.

Vegetation Map Preparation

Following the vegetation data analysis, the formation-level vegetation map was further edited and refined to develop an association-level vegetation map. All classified plot and observation point locations for Thomas Stone National Historic Site were transferred to a project base map, where they facilitated interpretation of orthophoto mosaic images and/or aerial photographs during the mapping phase of this project. Observation points were retrospectively assigned by subjective assignment to the USNVC associations identified during data analysis, or to the additional two small-patch USNVC associations newly classified in this study. For the most part, polygon boundaries were unchanged, but where distinctions noted in the field were not evident on either set of aerial photography, revisions to existing polygons were made based on GPS readings of the observation points. Each polygon containing a plot or observation point was attributed with the name of an association based on classification results. The remaining polygons were assigned to associations based on the previously assigned formation (land use polygons were not altered), as well as the soil map, topographic map, and finer signature distinctions detected on the aerial photography, such as crown shape. For example, polygons attributed to Lowland or submontane cold-deciduous forest were further classified as Oak - Heath Forest, Dry Mesic Forest, etc. based on these features. One additional ad hoc map unit, "Storm Residue," was delineated to account for the disturbed vegetation resulting from an April 2002 tornado that cut a swath nearly 250 m wide at its broadest point, in an east-west orientation, through the center of the park. After the vegetation association map was completed, the thematic accuracy of this map was assessed.

Accuracy Assessment

Two sources of potential error in the vegetation map include: 1) horizontal positional accuracy, in which a location on the orthophoto mosaic does not accurately align with the same location on the ground due to errors in orthorectification or triangulation; and 2) thematic accuracy, in which the vegetation type assigned to a particular location on the map does not correctly represent the vegetation at the same location in the park due to mapping error (ESRI et al. 1994).

Positional Accuracy Assessment

The horizontal positional accuracy of the leaf-on and leaf-off orthophoto mosaics was assessed using guidelines of the USGS/NPS VMP (ESRI et al. 1994). Well-defined positional accuracy ground control points were placed throughout all quadrants of each orthophoto mosaic in ArcMap. Ground control points and zoomed-in screenshots of each point were plotted on hard copy maps with the aerial orthophoto mosaic as a background. These maps and plots were used to locate the ground control points by recording the ground control point coordinates with a

Trimble Pro XR/XRS or GeoXT GPS unit. Mapped ground control points that were physically inaccessible were noted as such. The field crew collected accuracy assessment data at 23 ground control points for the leaf-off orthophoto mosaic and at 22 ground control points for the leaf-on orthophoto mosaic. The coordinate data were collected using GPS and were differentially corrected from a base station in Virginia using Pathfinder Office software. The field-collected GPS coordinates for both orthophoto mosaics were compared to the coordinates obtained from each orthophoto mosaic viewed in ArcMap. Both pairs of coordinates for each point were entered into a spreadsheet in order to calculate horizontal accuracy (in meters). The accuracy calculation formula is based on root mean square error (FGDC 1998b, Minnesota Governor's Council on Geographic Information and Minnesota Land Management Information Center 1999). Ground control points for calculating horizontal positional accuracy are shown in Figures 7 and 8.

Thematic Accuracy Assessment - USNVC Association-level Vegetation Map

The accuracy assessment estimates thematic errors in the data, providing users the information needed to assess data suitability for a particular application. At the same time, data producers are able to learn more about the nature of errors in the data. Thus, there are actually two views to an accuracy assessment: "users' accuracy and producers' accuracy." Users' accuracy is the probability that an accuracy assessment point has been mapped correctly. User's accuracy is calculated by dividing the number of correctly classified samples of a map class[4] by the total number of field samples that were classified in that map class. Errors in users' accuracy are also referred to as errors of commission, indicating that more polygons of a particular type were mapped than actually occurred on the ground. "Producers' accuracy" checks to see if the map actually represents what was found on the ground. It is calculated by dividing the number of correctly classified samples of a map class by the total number of field samples of that map class. Errors in producers' accuracy (also referred to as errors of omission) indicate that more polygons of a particular type actually occur on the ground than were mapped. Both users' and producers' accuracy can be obtained from the same set of data using different analyses. A major assumption of accuracy assessment is that the process of mapping and the process of the assessment (i.e., the application of the classification system) are identical, so that a false error is not detected because of procedural differences.

Results of the accuracy assessment are presented in an error or misclassification matrix (also referred to as a contingency or confusion matrix). The accuracy numbers are interpreted as the probability of encountering a particular map class when visiting a particular spot, or point, rather than a particular polygon. Requirements for the project specify 80% overall accuracy (the proportion of correctly assessed sites) for each vegetation map class.

[4] Map class is a generic term for the entity depicted on a map legend. In this project, the map class is either an NVC association or an Anderson Level II land use/land cover category.

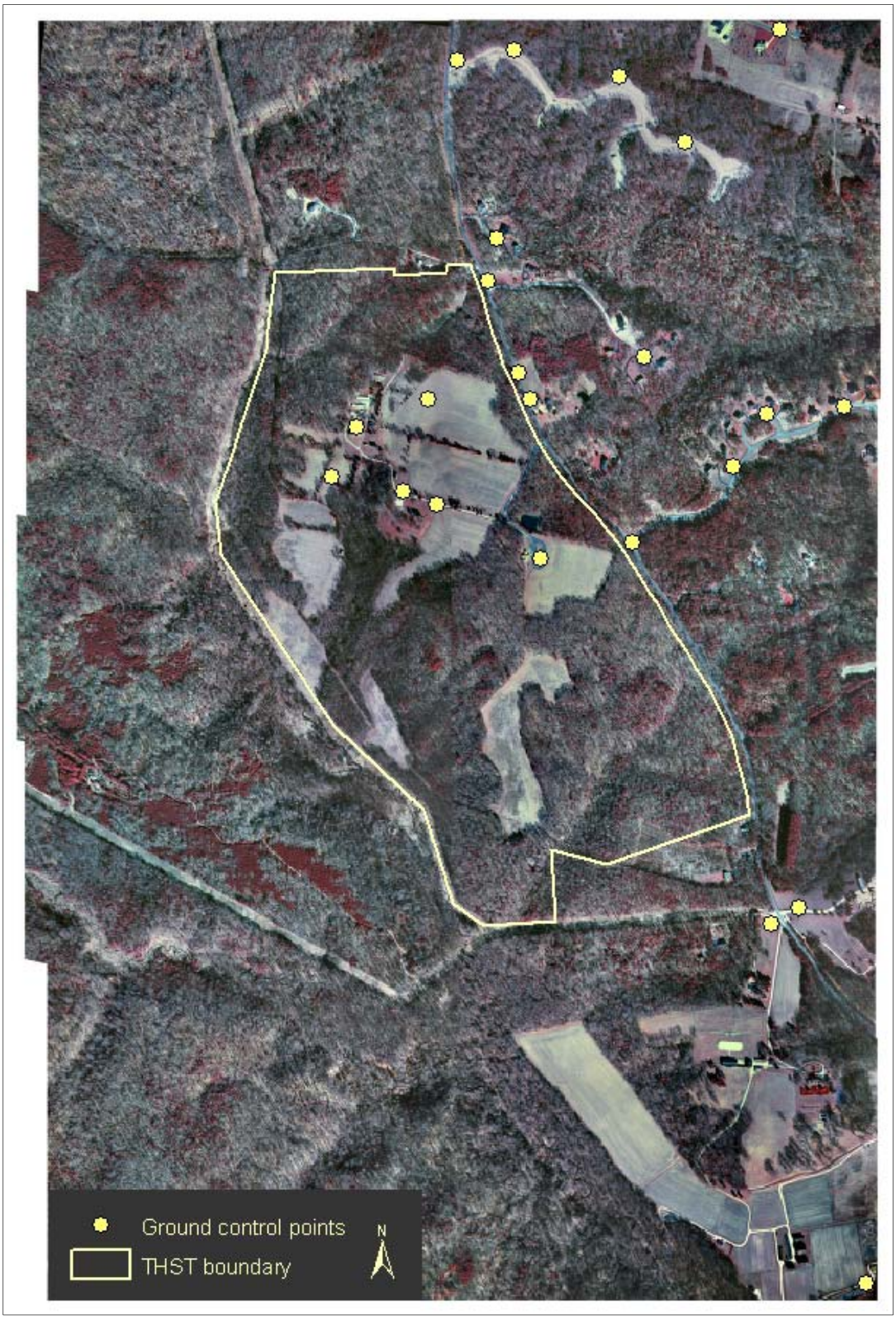


Figure 7. Ground control points (n=23) used to calculate horizontal positional accuracy of the Thomas Stone National Historic Site leaf-off (spring) orthophoto mosaic.

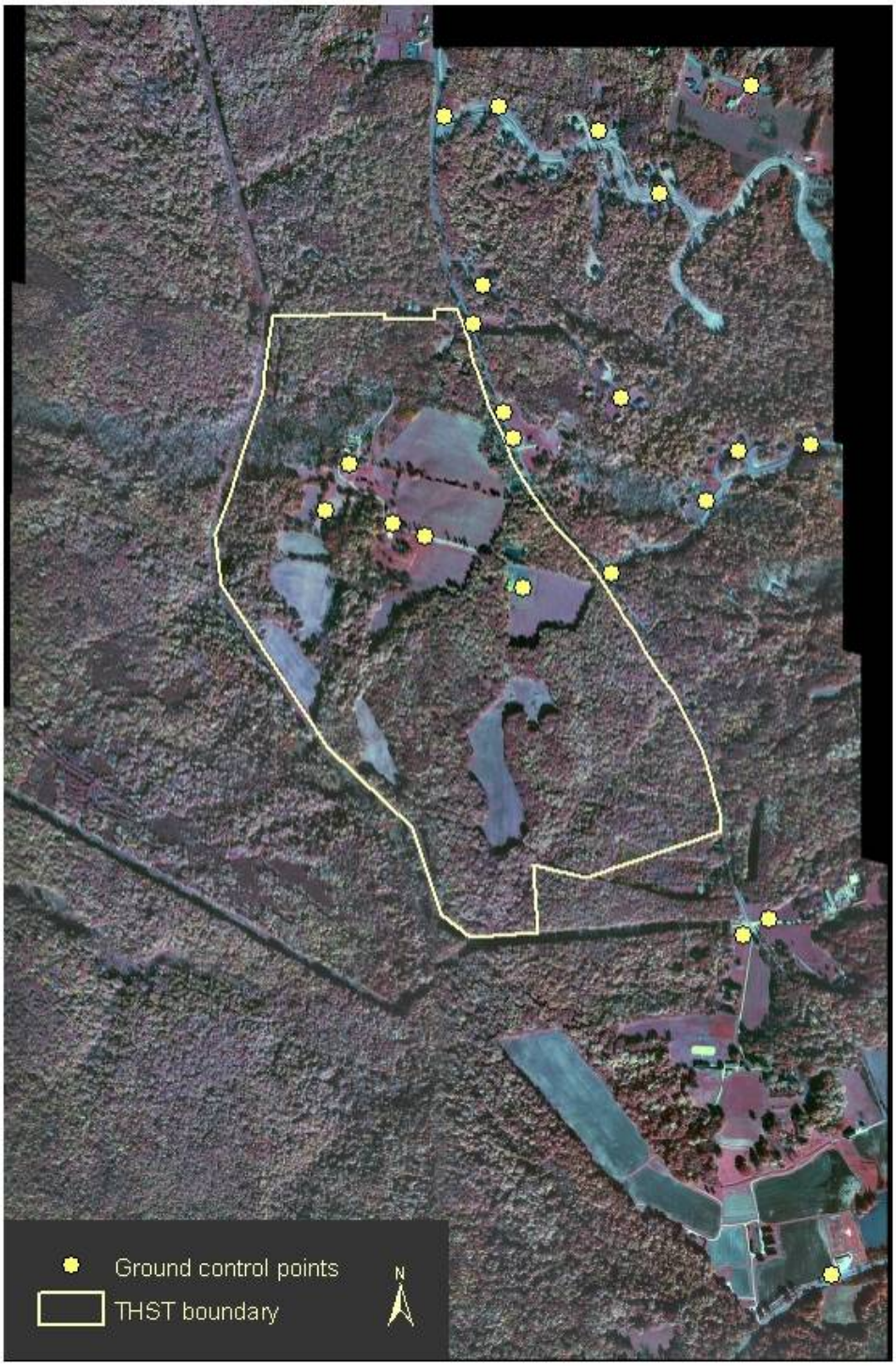


Figure 8. Ground control points (n=22) used to calculate horizontal positional accuracy of the Thomas Stone National Historic Site leaf-on (fall) orthophoto mosaic.

Thematic accuracy assessment was conducted on the USNVC association-level map of Thomas Stone National Historic Site. No accuracy assessment was performed on the formation-level map. It was assumed that the broader classification units of the formation-level map were reliable, and because this map was produced largely to inform the placement of classification plots and not intended to be used for other purposes.

A dichotomous key to the associations was developed and provided to researchers conducting the accuracy assessment, along with the local descriptions of associations. Accuracy assessment was conducted during the week of October 6–10, 2003, when most of the points were visited. On November 7, 2003, the remaining natural accuracy assessment points were sampled in addition to points in cultural (managed) vegetation types and the map class representing storm residue (blowdowns from the 2002 tornado). Following analysis of the results, it was determined that several situations contributed to high error rates between some similar classes.

The observers had not had adequate practice with the key or the concepts in the descriptions, nor had the key itself been tested on observers in representative vegetation in order to correct key errors. As a result, it was decided to treat the initial accuracy assessment effort as a map validation to improve the classification, the map, and the key. Modifications were made to the classification scheme, the descriptions, and key for most of the map classes/associations representing natural vegetation. Because these modifications were made from information gained by the validation, a subsequent, independent accuracy assessment was conducted in June 2004 for each map class/association that was modified. Accuracy assessment data collected in 2003 for classes/associations not modified were retained.

Accuracy assessment largely followed the protocols of the USGS/NPS VMP (ESRI and TNC 1994). Deviations of this protocol are as follows: Because of the small size of Thomas Stone National Historic Site, the total number of polygons in the map is small, with no map class having more than seven polygons inside the park boundary, and the maximum area included in any single map class about 35 ha. The USGS/NPS VMP protocols would recognize two map classes at Thomas Stone National Historic Site as rare, and all others as very rare, and would recommend 43 accuracy assessment points for the entire park and a maximum of five accuracy assessment points for any map class. While 43 points would produce narrow enough confidence intervals to give a reasonable assessment of the overall accuracy for the project, stratifying by map class according to the protocols would not have been fruitful, since no map classes would have sample confidence intervals narrow enough to be meaningful. Therefore, we chose to exceed the number of accuracy assessment points recommended by USGS/NPS VMP protocols, since the points can still be considered independent observations. As a result, we weighted accuracy assessment points proportionally by area of map class occupied. The maximum number of accuracy assessment points (up to 30) that could be accommodated by the configuration of vegetation polygons within a map class without spatial overlap was selected for each class. This alternative design may be useful for assessing thematic accuracy at other small parks.

Allocation of numbers of accuracy assessment points by map class in the 2004 accuracy assessment are listed in Table 2. Locations of the accuracy assessment points are shown in Figures 9 and 10. Two associations (Depositional Bar and Woolgrass Marsh), together representing about 2.2% of the total map area, were not present within the park boundaries in sufficient area to allow for a single accuracy assessment point and were not assessed. Wet Meadow, occurring just outside the park boundary, was not assessed for accuracy. For other map classes, the error rate inside the park boundaries is assumed to be representative of that for the entire map area.

Photointerpretation was conducted at a relatively high spatial resolution at Thomas Stone National Historic Site. For this reason, the accuracy assessment was conducted at the scale of a 0.25 ha minimal mapping unit, rather than the 0.5 ha minimal mapping unit assumed by the USGS/NPS VMP protocols. This mapping unit size is evaluated on the ground by a circular observation plot with a radius of 28.2 m around an accuracy assessment sample point. Using ESRI ®ArcMap™ 8.3 (ESRI 2003), a 60-m grid, with an origin established by a randomly selected x (easting) and y (northing) coordinate, was placed over the mapped polygons within the park boundary. Each point on the grid represented a potential accuracy assessment point to serve as the center of a circular observation plot (sample unit). Points that were within 20 m of a polygon boundary were excluded from the population of sample points in order to eliminate possible confounding of causes of error (i.e., ground positioning error using a global positioning system [GPS]). For each map class/association for which 30 or fewer points were available within polygons in that class, all points falling within polygons representing that map class were selected as accuracy assessment points. For map classes/associations that could accommodate more than 30 points, individual points were selected randomly and sequentially until a sample of 30 points was achieved.

Table 2. Allocation of points by map class on the association-level map for the 2004 thematic accuracy assessment.

Map Class	Number of points allocated
Dry Meadow	29
Residential	5
Storm Residue	11
Pine - Oak Forest	5
Oak - Heath Forest	30
Dry Mesic Forest	10
Early Successional Mesic Forest	31
Floodplain Forest	6
Sweetgum Forest	3
Seepage Swamp	2
Upland Depression Swamp	1
Total	133

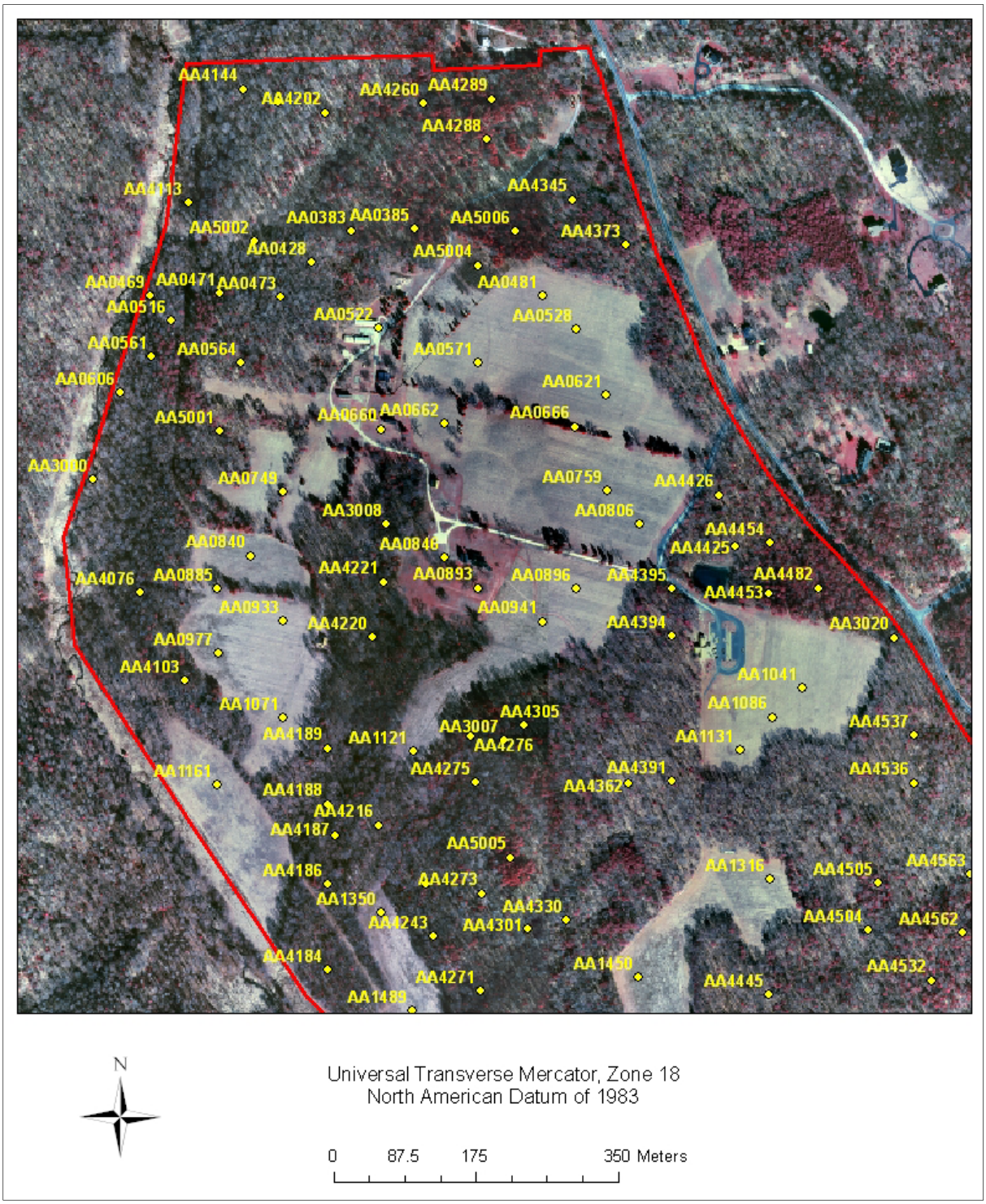


Figure 9. Locations of sampling points in the northern section of Thomas Stone National Historic Site for the 2004 thematic accuracy assessment.

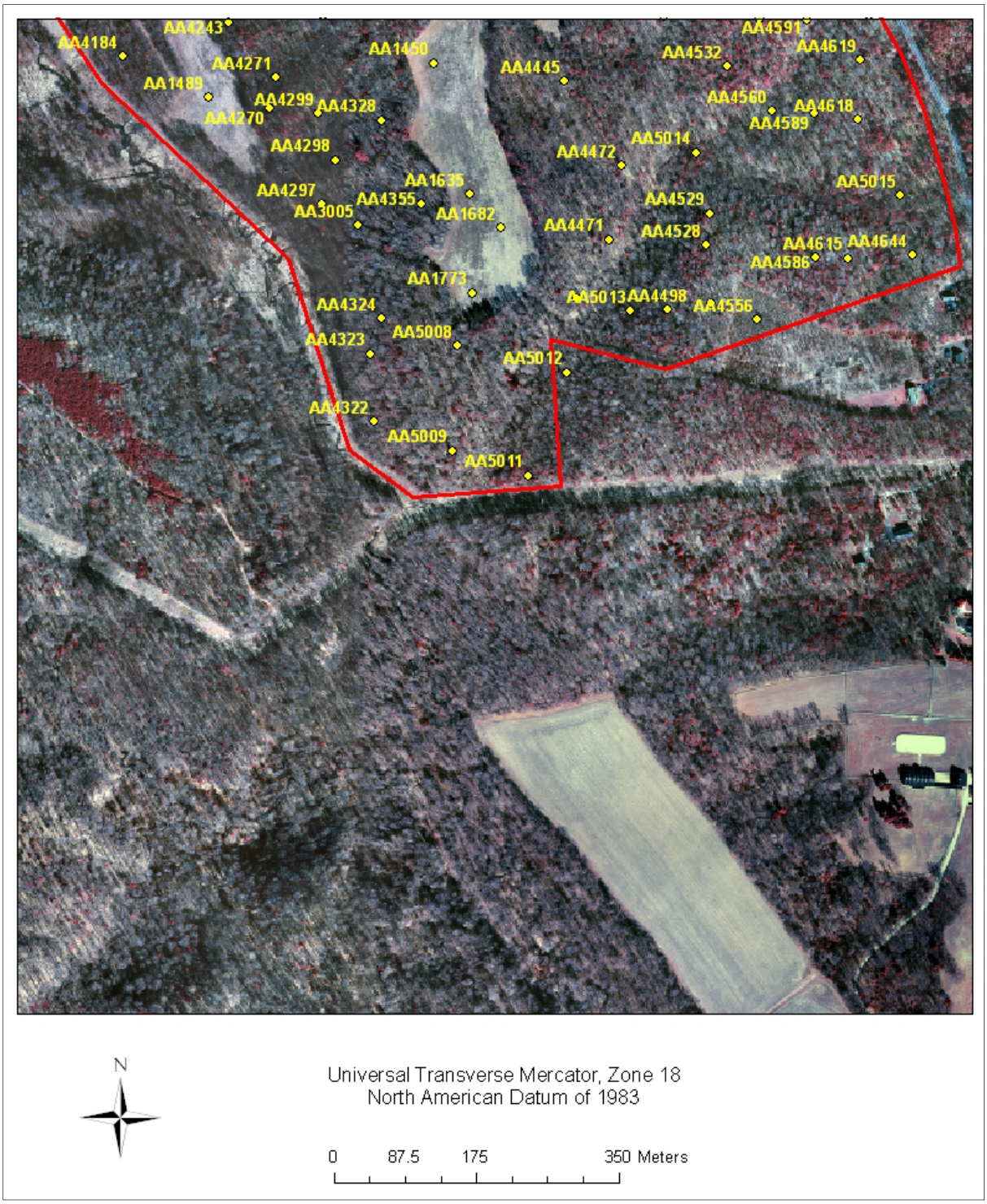


Figure 10. Locations of sampling points in the southern section of Thomas Stone National Historic Site for the 2004 thematic accuracy assessment.

In three forested polygons, the delineated map unit was smaller than the minimum mapping unit. Each stand was visited during plot data collection and was mapped in the field using a GPS. In these cases, a single accuracy assessment point was located in each polygon at the polygon centroid. Since each of these polygons had been thoroughly mapped and assessed on the ground, any errors in these classes could be assumed to be from interpretation of the vegetation key and descriptions, rather than from photointerpretion error. A total of 133 accuracy assessment sampling points were selected and sampled at Thomas Stone National Historic Site.

The coordinates of the points were loaded into a GPS (Garmin 76S or Garmin II+ Differential unit). Typical accuracy of these units is 15 m without Wide Area Augmentation System (WAAS) enabled and 3 m with WAAS enabled (Garmin 2006). WAAS was enabled in July 2003, prior to the accuracy assessment field season. The accuracy assessment observers used the GPS to navigate to each accuracy assessment point. Upon arriving at the point, the observer used the field key and descriptions to assess what association (or Anderson Level II land cover category) occupied the observation area 28.2 m around the point. The appropriate association was recorded on a field form (Appendix H). If other associations were found in the observation area, or if the vegetation could reasonably be interpreted to be more than one map class/association, the alternative types were noted as well. This information was used to assist in assessing cause for errors. The position of the point as measured by the GPS and the GPS error were recorded in the field to assess whether positional error may be confounding in assessing error causes for individual points.

Overall map accuracy and producer’s and user’s accuracies were computed for each map class/association (ESRI and TNC 1994). Ninety percent confidence intervals for overall map accuracy and for individual class accuracy were computed as specified by the USGS/NPS VMP protocols, using the normal approximation to the binomial distribution, with correction for continuity (Snedecor and Cochran 1976). A kappa statistic for overall map accuracy, to correct for the probability of achieving correct answers by chance, was calculated as recommended by the USGS/NPS VMP (Foody 1992).

Results

Vegetation Classification - Observation Points

The TWINSPAN data analysis of 59 of 67 forested observation points (Table 3) indicated five ad-hoc units that were interpreted based on species composition: 1) a floodplain forest unit indicated by American sycamore (*Platanus occidentalis)* or river birch (*Betula nigra*); 2) a mesic slope forest unit; 3) a dry-mesic slope forest unit; 4) a dry oak and oak-beech - dominated unit; and 5) a dry pine-oak unit. Subsequent divisions, indicated on the lower rows of zeroes and ones on the table, suggested additional units at a finer scale, but these units were deemed not to be ecologically significant at the scale of the association. Several observation points were reclassified after examining species composition and environmental information on field forms.

Table 3. TWINSPAN output tables (Hill 1979; McCune and Mefford 1997) for analysis of 59 forest vegetation observation points at Thomas Stone National Historic Site, showing plot abundance scores for the 27 most frequent woody species and final point assignment.

```
Observation point       135634636635367223255225644455456644445 33511623  111611112
Number (read down)      445858213723650890502671107946384616459789735007890129896 72

Species
Betula nigra            -------------4-----------------------------------------  00000
Platanus occidentalis   ---1-2111-311-------------------------------------------  00000
Ulmus americana         --2------1----------------------------------------------  00000
Carya cordiformis       --------21--------1--2835-------------------------------  00001
Quercus palustris       ------11-2-----342---1----------------------------------  00001
Robinia pseudoacacia    -------1-------2----------------------------------------  00001
Carpinus caroliniana    -212-1--11---1-------------1------1-----------------1-----  0001
Liquidambar styraciflua 496696836643-1154453-11-4163-6445166323 1---14---------11---  0001
Liriodendron tulipifera -221554999689896879796658643761427112 13---1---1-2-1125-----  0001
Cornus florida          -----------------1--11------11-1---------1-----------------  001
Ilex opaca              --1---------------14-------1---------111-11----------------  001
Juglans nigra           -------1-------------------1-----------------------------  001
Quercus rubra           -----1---------1-1---1121-3121--2--1461---1----------------  001
Carya alba              -----1------------22--1--2244244--11-1-1432----------------  010
Fagus grandifolia       --1--12----2---1---11---14333246664262--152-12-1-2112214--1  010
Fraxinus americana      ---------1-------------1------1---1-1--------1-------------  010
Nyssa sylvatica         ----1-----------------1-----------1314-5111----2-----------  010
Acer rubrum             44356312-3646631-----2-2--1-126-115256821-2-34--24132421---  011
Prunus serotina         ------------1----1-------------------------1--------------  011
Quercus velutina        ---------------1----1--1-2----22--32----331323---1211--1--1  10
Carya glabra            ---------------------------------------1-1------11-------  110
Juniperus virginiana    ---------------1---------------------------1-------1-----  110
Quercus alba            -------------1----------23-1-11--1-111-6662-396885544----1  110
Quercus stellata        ---------------------------------------------------2------  110
Pinus virginiana        ---------------------1----------45---------32132---46-46999  111
Quercus coccinea        --------------2-------------------------1--12-232221243131  111
Quercus falcata         ----------------1-------1----21--------1-4617--------52121  111

Successive unit         00000000000000000000000000000000000000011111111111111111111
divisions               00000000000000000000000001111111111111110000000000000011111
                        00000000000000011111111110000000001111110000001111111100111
                        000000011111111000000111100000001100000100011100000001
                        000011100011111000111    0000011  00111       0000001
                                  00111          01111                001111

Floodplain Forest  Early Successional Mesic Forest Dry Mesic Forest Seepage Swamp Forest
Oak-Heath Forest Pine-Oak Forest
```

Both species and observation point data are divided successively into smaller units, indicated by the zeroes and ones on right side (species) and bottom (observation points).

For example, point number 59 was initially grouped with the dry-mesic slope forest unit in the larger analysis conducted by the Virginia Natural Heritage Program, indicated by the second row of zeroes and ones on the table. However, further scrutiny of this point revealed more affinity with points classified as a floodplain forest.

Vegetation Classification - Plots

Initial results of the TWINSPAN analysis of plot data indicated five units similar to those identified in the TWINSPAN analysis of the observation point data. Results of Bray-Curtis analysis of the percent similarities (Bray and Curtis 1957) among and between classified associations (Table 4) aided in identifying plots that were of ambiguous classification. Appendix I illustrates the initial divisions on the bottom of the page, in comparison to the final results in which seven plots were reclassified. For example, plot 411, initially classified as Dry Mesic Forest, showed percent similarities of 64.5, 63.0, and 63.8, with three plots classified as Early Successional Mesic Forest, as opposed to percent similarities of 50.0, 57.6, and 53.8, with three plots classified as Dry Mesic Forest.

The percent similarity analysis (Table 4) was used to guide the final classification of plots. Although percent similarities of plot pairs suggested the reclassification of some plots, in other cases, the percent similarities were roughly equivalent between units of the same classification and one other unit (plots 422, 402, and 222). In one case, the plot (312) was reclassified despite indicating higher percent similarity with other plots of the same classification than with Floodplain Forest, to which it was changed. Ultimately classification decisions were made after examining a number of sources, including data not included in the numerical analysis: environmental information such as soils data, topographic position, and structural information such as tree diameters or presence of species indicating land use history. After comparison with existing descriptions and preliminary information (e.g., Fleming et al. 2001, NatureServe Explorer 2001, Lea et al. 2003), and ecological judgement by the principal investigator and reviewers, five USNVC associations were identified in the 2001 data analysis:

- Pine - Oak Forest (*Pinus virginiana* Successional Forest)
- Dry Mesic Forest (*Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest)
- Early Successional Mesic Forest (*Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest)
- Oak - Heath Forest (*Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest)
- Floodplain Forest (*Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema tryphyllum* ssp. *triphyllum* Forest)

In the much more comprehensive 2007 analysis conducted for the National Capital Region that included all plot data from Thomas Stone National Historic Site, attribution of the plot data from Thomas Stone National Historic Site to the same five associations was confirmed. The plots were attributed to the associations in the same manner as were the reclassified plots, with the following exceptions: plots 401 and 411 were assigned to Dry Mesic Forest by Fleming et al. (2007), whereas these two plots were assigned to Early Successional Mesic Forest in the 2001 analysis. These two plots were not reattributed to Dry Mesic Forest due to their relatively greater similarity to Early Successional Mesic Forest.

Table 4. Bray-Curtis percent similarity (Bray and Curtis 1957) between sample unit (plot) pair combinations (species abundances used to calculate similarities follow scale of Fleming et al. 2001). Species compositional similarities between pairs that are between 45% and 50% are marked in yellow; similarities between pairs that are between 50% and 55% are marked in green; similarities between pairs that are greater than 55% are marked in blue.

	Plot:	UD 603	SS 221	SS 321	FP 222	FP 502	FP 511	FP 421	FP 302	FP 312	ME 202	ME 212	ME 401	ME 411	DM 301	DM 311	DM 322	OH 412	OH 131	OH 402	OH 422	OH 431	OH 501	OH 602	PO 201	PO 211	PO 601
UD	603	100.0	27.5	16.0	35.0	29.2	25.1	26.1	21.8	23.7	24.6	23.2	20.9	28.1	32.6	35.6	31.9	38.6	36.9	35.3	34.7	28.6	32.8	37.1	34.2	27.3	36.9
SS	221		100.0	44.0	37.3	38.2	28.9	29.0	36.1	33.6	24.9	27.9	22.7	29.4	32.2	31.0	31.6	26.7	27.3	27.5	28.6	20.4	25.6	24.7	24.5	23.0	30.5
SS	321			100.0	26.6	35.6	33.3	24.9	29.1	26.3	20.7	19.6	22.8	18.3	10.4	16.4	13.4	11.1	5.1	8.6	9.0	4.8	3.7	2.6	7.6	6.6	4.3
FP	222				100.0	45.9	41.2	40.0	50.3	39.8	36.2	38.1	33.2	42.7	44.1	43.2	53.2	39.0	34.0	32.0	43.6	22.9	23.5	26.8	38.6	34.8	36.1
FP	502					100.0	61.1	52.5	56.1	47.1	46.3	45.8	45.4	41.8	28.5	34.1	34.6	26.1	17.3	16.8	20.0	6.1	9.8	9.3	21.0	18.0	16.2
FP	511						100.0	57.2	55.9	47.7	44.8	48.5	49.3	42.5	29.4	38.5	33.9	24.1	15.1	18.2	21.2	12.8	12.2	12.8	20.6	15.3	15.1
FP	421							100.0	49.0	58.6	59.5	52.1	57.6	56.6	35.3	41.6	39.1	32.5	23.2	21.7	24.6	9.4	11.4	11.0	24.6	22.6	19.1
FP	302								100.0	57.8	46.6	52.5	51.2	49.3	38.8	46.2	45.1	30.6	22.4	21.8	26.5	14.3	15.6	16.3	26.4	22.7	22.4
FP	312									100.0	56.3	61.3	55.0	56.2	42.7	54.8	50.0	35.3	32.2	31.2	34.0	18.9	20.7	23.0	26.9	28.4	30.9
ME	202										100.0	67.7	56.9	64.5	42.0	51.9	44.0	39.1	29.6	26.7	32.5	17.1	20.7	14.2	35.9	32.9	27.8
ME	212											100.0	63.1	63.0	43.1	51.2	47.5	32.6	25.0	27.3	33.0	17.8	18.4	16.1	34.5	33.3	28.3
ME	401												100.0	63.8	36.1	51.4	39.7	28.8	17.4	19.9	24.2	10.7	11.1	8.5	26.9	21.0	18.0
ME	411													100.0	50.0	57.6	53.8	41.4	33.3	35.4	36.9	22.4	22.1	25.6	42.1	36.2	31.9
DM	301														100.0	64.0	60.0	57.5	51.7	48.9	54.5	35.1	38.5	37.2	54.4	51.5	52.7
DM	311															100.0	64.6	54.9	43.7	43.3	47.4	30.4	29.2	33.3	44.6	38.4	45.8
DM	322																100.0	51.6	44.3	49.5	58.2	32.3	30.0	35.3	48.0	43.0	44.3
OH	412																	100.0	53.3	57.3	59.5	40.0	40.2	42.8	52.8	49.7	56.3
OH	131																		100.0	66.2	65.3	56.7	57.8	66.1	59.2	54.1	59.6
OH	402																			100.0	66.7	45.7	47.8	53.2	54.4	50.6	56.1
OH	422																				100.0	53.2	55.4	53.6	66.3	64.3	69.0
OH	431																					100.0	71.0	70.3	58.0	53.2	52.1
OH	501																						100.0	62.3	51.3	48.7	52.9
OH	602																							100.0	54.7	47.9	57.9
PO	201																								100.0	79.5	61.5
PO	211																									100.0	60.6
PO	601																										100.0

Plot Classification Abbreviations for USNVC association common names:

UD: Upland Depression Swamp
SS: Seepage Swamp
OH: Oak - Heath Forest
PO: Pine - Oak Forest
DM: Dry Mesic Forest
ME: Early Successional Mesic Forest
FP: Floodplain Forest

The 2007 data analysis included the three Thomas Stone National Historic Site plots that had been attributed by subjective inspection, and also confirmed the classification as originally determined in 2001:

- Upland Depression Swamp (*Liquidambar styraciflua – Acer rubrum – Quercus phellos / Leucothoe racemosa* Forest) (plot 603)
- Seepage Swamp (*Acer rubrum – Nyssa sylvatica – Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea – Woodwardia aereolata* Forest) (plots 221 and 321)

A summary of plot location, date of sampling, and USNVC name are provided in Table 5.

Finally, five associations found within or near Thomas Stone National Historical Site were classified and described from observation point data alone:

- Sweetgum Forest (*Liquidambar styraciflua* Forest)
- Depositional Bar (*Betula nigra* – (*Platanus occidentalis*) Forest)
- Wet Meadow (*Spiraea tomentosa – Rubus* spp. / *Phalaris arundinacea* Shrubland)
- Dry Meadow (*Lolium* (*arundinaceum, pratense*) Herbaceous Vegetation)
- Woolgrass Marsh (*Scirpus cyperinus*) Seasonally Flooded Herbaceous Vegetation)

Association Descriptions

Detailed local and global descriptions of the vegetation associations are presented, followed by representative photographs of each vegetation type from plots.

Additional information is included in appendixes as follows:

- Appendix J: Index of ground photos of plots. Fourteen photos in total, include two photos for seven of the USNVC associations. (No photos were available for Sweetgum Forest, Dry Meadow, Depositional Bar, Wet Meadow, or Woolgrass Marsh).
- Appendix K: List of the plants recorded during vegetation plot sampling and thematic accuracy assessment sampling. The list totals 96 taxa (species, varieties, and subspecies) representing 68 families. Thirty-two taxa were represented by one family; 15 taxa represented two families. Cyperaceae was the largest family, representing 25 taxa, followed by Poaceae, represented by 15 taxa.
- Appendix L: Definition of data fields used by NatureServe's Biotics database for local and global vegetation descriptions.
- Appendix M: A bibliography for the sources cited in the global vegetation descriptions from the USNVC

The following pages provide detailed local and global descriptions for the vegetation associations of Thomas Stone National Historic Site.

Local vegetation descriptions contain two main sources for naming. Scientific and English names within association titles, as well as scientific names within the vegetation descriptions, utilize Biotics/NatureServe (= Kartesz 1999 with few exceptions), but common names within the vegetation descriptions by and large follow PLANTS 3.5.

Table 5. Location (center of plot), survey date, and common name of USNVC association for vegetation plots at Thomas Stone National Historic Site (easting and northing units are UTM meters, NAD-83). Plots are rectangular, with dimensions of 16×25 m, unless otherwise noted.

Plot #	Easting	Northing	Survey Date	USNVC Association Common Name
131	322479	4266551	7/16/2001	Oak - Heath Forest
201	322341	4266477	7/17/2001	Pine - Oak Forest
202	322072	4266366	7/17/2001	Early Successional Mesic Forest
211	322332	4266430	7/17/2001	Pine - Oak Forest
212	322130	4266392	7/17/2001	Early Successional Mesic Forest
221*	322278	4266509	7/17/2001	Seepage Swamp
222	322064	4266217	7/17/2001	Floodplain Forest
301	322782	4266025	7/18/2001	Dry Mesic Forest
302	322712	4265967	7/18/2001	Floodplain Forest
311	322689	4266069	7/18/2001	Dry Mesic Forest
312	322674	4265927	7/18/2001	Floodplain Forest
321*	322142	4266763	7/18/2001	Seepage Swamp
322	322611	4265782	7/18/2001	Dry Mesic Forest
401	322346	4266004	7/19/2001	Early Successional Mesic Forest
402	322501	4266383	7/19/2001	Oak - Heath Forest
411	322292	4266128	7/19/2001	Early Successional Mesic Forest
412	322562	4266237	7/19/2001	Oak - Heath Forest
421	322164	4266090	7/19/2001	Floodplain Forest
422	322649	4266249	7/19/2001	Oak - Heath Forest
431	322607	4266690	7/19/2001	Oak - Heath Forest
501	322598	4266765	7/20/2001	Oak - Heath Forest
502**	321796	4266870	7/20/2001	Floodplain Forest
511	321799	4266808	7/20/2001	Floodplain Forest
601	322788	4266484	8/01/2001	Pine - Oak Forest
602	322845	4266457	8/01/2001	Oak - Heath Forest
603	322775	4266629	8/01/2001	Upland Depression Swamp

* 100 m^2 plots (irregular dimensions) used for small patch types.
** 12×32 m plot used for a linear stand.

Vascular plant species nomenclature within the local and global descriptions follows the nationally standardized list of Kartesz (1999), with very few exceptions. Where Kartesz 1999 differs from PLANTS 3.5, synonymy is indicated parenthetically.

COMMON NAME (PARK-SPECIFIC): PINE - OAK FOREST

SYNONYMS
USNVC English Name: **Virginia Pine Successional Forest**
USNVC Scientific Name: ***Pinus virginiana* Successional Forest**
USNVC Identifier: **CEGL002591**

LOCAL INFORMATION

Environmental Description: At Thomas Stone National Historic Site, this forest association occurs on upland areas of low slope (generally less than 3%), generally above 46 m (150 feet) in elevation, on slopes that are flat to slightly concave, and which have been extensively cleared in recent decades (evidently less than 60 years ago). Stands at lower elevations were not observed but may exist on convex ravine slopes with south- to west-facing exposures. The soil surface is nearly 100% covered with leaf litter, with a 0.5- to 2-cm thick brown humus. A fragipan is consistently present, with its top usually from about 5 to 20 cm below the soil surface. Soils are silt loams, evidently Ultisols, but with poor horizon development evident above the fragipan (possibly due to past plowing). Soil pH range was measured at 4.1 to 4.9. Areas in which stands of this type occur are mapped mostly as Beltsville silt loam, with smaller areas mapped as Exum silt loam (Hall and Mathews 1974).

Vegetation Description: The tree layer may have Virginia pine (*Pinus virginiana*) dominating the canopy above a subcanopy of hardwoods or may be poorly stratified. The hardwood component of the tree layer is diverse and includes white oak (*Quercus alba*), black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), southern red oak (*Quercus falcata*), pignut hickory (*Carya glabra*), mockernut hickory (*Carya alba*), and other species of the more mature dry forests, such as red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*). Shade-intolerant species that are rare to absent in the mature dry forests, including sweetgum (*Liquidambar styraciflua*), bigtooth aspen (*Populus grandidentata*), and tuliptree (*Liriodendron tulipifera*), are present in the tree layer at low cover. The tall-shrub layer is somewhat confluent with the tree layer and is often strongly dominated by American beech (*Fagus grandifolia*), with American holly (*Ilex opaca*) frequent. The short-shrub layer is poorly developed and comprised of ericaceous shrubs, including black huckleberry (*Gaylussacia baccata*), low blueberry (*Vaccinium pallidum*), and deerberry (*Vaccinium stamineum*).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus virginiana*
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Carya glabra
		Nyssa sylvatica
		Quercus alba
		Quercus coccinea
		Quercus velutina
Tall shrub/sapling	Broad-leaved deciduous tree	*Fagus grandifolia*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Ilex opaca*
Short shrub/sapling	Broad-leaved deciduous shrub	*Gaylussacia baccata*
		Vaccinium stamineum
Herb (field)	Forb	*Mitchella repens*
		Uvularia sessilifolia
Herb (field)	Graminoid	*Carex swanii*

Characteristic Species: *Carex willdenowii, Chimaphila maculata, Danthonia spicata, Juniperus virginiana, Pinus virginiana, Populus grandidentata, Prunus serotina, Quercus stellata, Smilax glauca, Smilax rotundifolia.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNA	.	[not crosswalked]	.

Local Range: This association is scattered throughout, but largest patches are in the southwestern and southeastern areas of the park.
Classification Comments: Vegetation that is approximately equivalent to this type is also found in Rock Creek Park in the Piedmont (TNC 1998), with sweetgum (*Liquidambar styraciflua*) evidently absent at Rock Creek Park. *Liquidambar styraciflua* was included as a nominal for the association as expressed at Thomas Stone National Historic Site and perhaps elsewhere on the Coastal Plain, but this distinction may not warrant segregation of this vegetation into two associations.

Stands of vegetation corresponding to *Pinus virginiana* Successional Forest (CEGL002591) (i.e., forests strongly dominated by *Pinus virginiana* and without a significant hardwood component) also occur at Thomas Stone National Historic Site and are more extensive just outside the park. Because they are extremely small within Thomas Stone National Historic Site, such stands within the park have been included in the concept of the mixed hardwood-pine type as described here.

This type is evidently included in the concept of the Pine - Oak Association of the Western Shore District of Shreve et al. (1910). This type is similar or equivalent to the Virginia pine successional forest of southern New Jersey of Collins and Anderson (1994).
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: 201, 211.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)
Alliance	*Pinus virginiana* Forest Alliance (A.131)
Alliance (English name)	Virginia Pine Forest Alliance
Association	*Pinus virginiana* Successional Forest
Association (English name)	Virginia Pine Successional Forest
Ecological System(s):	Central Appalachian Dry Oak - Pine Forest (CES202.591). Northeastern Interior Dry - Mesic Oak Forest (CES202.592). Southern Appalachian Low-Elevation Pine Forest (CES202.332).

GLOBAL DESCRIPTION

Concept Summary: This community occurs in areas where canopy removal has created dry, open conditions and bare mineral soil, allowing for the establishment of *Pinus virginiana*. These

habitats include old fields, old pastures, clearcuts, and burned or eroded areas. This forest typically has a very dense canopy of *Pinus virginiana* and little understory vegetation. The dense canopy may also include admixtures of other *Pinus* species (e.g., *Pinus taeda, Pinus echinata*) or other early-successional deciduous trees (e.g., *Acer rubrum, Liquidambar styraciflua, Prunus serotina, Liriodendron tulipifera*). Associated woody and herbaceous species vary with geography but are typically ruderal or exotic species. Shrub and herb layers are frequently very sparse. Stands are short-lived, generally less than 75 years.

Environmental Description: This community occurs in areas where canopy removal has created open conditions and bare mineral soil, allowing for the establishment of *Pinus virginiana*. These conditions can include old fields, old pastures, clearcuts, and burned or eroded areas. In the Central Appalachians, this vegetation occurs where soft shales have been farmed (primarily in valleys), resulting in stands with nothing but successional species in the understory. Soils are well-drained and range in pH from moderately acidic to very strongly acidic.

Vegetation Description: This forest typically has a very dense canopy of *Pinus virginiana* and little understory vegetation. *Pinus taeda* or *Pinus echinata* may co-occur with *Pinus virginiana* in the canopy. The canopy can also have significant admixtures of early successional deciduous trees (e.g., *Acer rubrum, Liquidambar styraciflua, Liriodendron tulipifera*). Associated woody and herbaceous species vary with geography but are typically ruderal or exotic species. Shrub and herb strata are absent to sparse in coverage. In eastern Tennessee the subcanopy may contain *Acer saccharum* and *Cornus florida*; other associated species may include *Cercis canadensis, Parthenocissus quinquefolia, Lonicera japonica*, and *Microstegium vimineum* (Andreu and Tukman 1995). In the Central Appalachians, associates include *Pinus taeda, Pinus echinata*, and *Pinus rigida*. The dense ericaceous shrub stratum contains *Vaccinium* spp., *Gaylussacia* spp., *Kalmia latifolia*, and *Rhododendron* spp.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus virginiana*
Tree subcanopy	Needle-leaved tree	*Juniperus virginiana*
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Cornus florida
		Nyssa sylvatica
		Oxydendrum arboreum
Tall shrub/sapling	Broad-leaved deciduous tree	*Cornus florida*
		Nyssa sylvatica
		Oxydendrum arboreum
Tall shrub/sapling	Broad-leaved evergreen tree	*Vaccinium arboreum*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Vaccinium stamineum*
Short shrub/sapling	Broad-leaved deciduous tree	*Cercis canadensis*
		Cornus florida
		Oxydendrum arboreum
		Quercus alba
		Sassafras albidum
Herb (field)	Vine/Liana	*Lonicera japonica*
		Smilax glauca
		Toxicodendron radicans

Characteristic Species: *Pinus virginiana*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This successional community is possible in the Piedmont from Pennsylvania south to Alabama and ranges west into the Appalachians, Ridge and Valley, the Cumberland Plateau, and in scattered locales of the Interior Low Plateau.

States/Provinces: AL, GA, IN, KY, MD, NC, NJ, PA, SC, TN, VA, WV.

Federal Lands: NPS (Big South Fork, Blue Ridge Parkway?, Cumberland Gap, Gettysburg, Great Smoky Mountains, Kings Mountain, Lincoln Birthplace, Little River Canyon?, Mammoth Cave, Natchez Trace, New River Gorge, Obed, Shenandoah, Shiloh, Thomas Stone); TVA (Tellico); USFS (Bankhead, Chattahoochee, Chattahoochee (Piedmont), Chattahoochee (Southern Blue Ridge), Cherokee, Daniel Boone, George Washington, Jefferson, Sumter, Sumter (Andrew Pickens RD), Sumter (Enoree/Long Cane RD), Uwharrie?).

CONSERVATION STATUS

Rank: GNA (ruderal) (13-Jun-2000).

Reasons: This forest represents early-successional vegetation and is thus not of conservation concern.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Information not available.

Similar Associations:

- *Pinus echinata* Early-Successional Forest (CEGL006327)--occurs in similar environments but is dominated (>50% of canopy) by *Pinus echinata* instead of *Pinus virginiana*.
- *Pinus taeda - Liquidambar styraciflua* Semi-natural Forest (CEGL008462)--is commonly found in the same area as CEGL002591 in the Piedmont. CEGL008462 contains at least 50% *Pinus taeda* in the canopy, whereas CEGL002591 is mostly *Pinus virginiana*.
- *Pinus taeda / Liquidambar styraciflua - Acer rubrum* var. *rubrum / Vaccinium stamineum* Forest (CEGL006011)--occurs in similar environments with similar disturbance histories but is dominated by (>50% of canopy) *Pinus taeda* instead of *Pinus virginiana*.
- *Pinus virginiana - Juniperus virginiana* var. *virginiana - Ulmus alata* Forest (CEGL007121)--on more calcareous or circumneutral substrates.
- *Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum* Forest (CEGL007119)--can have a very similar canopy in the Piedmont and Blue Ridge ecoregions, but CEGL007119 is generally created and maintained by fire and/or logging but not heavy plowing and/or erosion. CEGL002591 generally has signs of heavy agricultural use such as sparse herbaceous or shrub layers, large percentage of invasive exotics such as *Lonicera japonica* in the herbaceous layer, old plowlines, human debris, and extremely even-aged canopy, whereas CEGL007119 generally has a more intact herbaceous/shrub layer (especially *Vaccinium pallidum*) and less signs of severe human disturbance.

Related Concepts:

- IA7c. Xeric Virginia Pine Ridge Forest (Allard 1990) B
- Pine - Oak Association of the Western Shore District (Shreve et al. 1910) B
- Unclassified Old-Field Successional Forest (Fleming and Moorhead 2000) ?
- Virginia Pine - Oak: 78 (Eyre 1980) B
- Virginia Pine Type (Schmalzer and DeSelm 1982) B
- Virginia Pine, RV (Pyne 1994) B
- Virginia Pine: 79 (Eyre 1980) B
- Virginia pine successional forest (Collins and Anderson 1994) =
- Xeric Pine Forest (Ambrose 1990a) B

SOURCES

Description Authors: M. Andreu and M. Tukman, mod. K. D. Patterson.

References: Allard 1990, Ambrose 1990a, Andreu and Tukman 1995, Collins and Anderson 1994, Eyre 1980, Fike 1999, Fleming and Coulling 2001, Fleming and Moorhead 2000, Hall and Mathews 1974, Nelson 1986, Patterson et al. 1999, Pyne 1994, Schmalzer and DeSelm 1982, Schotz pers. comm., Shreve et al. 1910, Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC 1998.

Figure 11. Pine - Oak Forest in Thomas Stone National Historic Park (plot THST.211). July 2006.

Figure 12. Pine - Oak Forest in Thomas Stone National Historic Park (plot THST.201). July 2006.

COMMON NAME (PARK-SPECIFIC): DRY MESIC FOREST

SYNONYMS

USNVC English Name:	**American Beech - (White Oak, Northern Red Oak) - Tuliptree / (American Holly) Christmas Fern Forest**
USNVC Scientific Name:	***Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca var. opaca) / Polystichum acrostichoides* Forest**
USNVC Identifier:	**CEGL006075**

LOCAL INFORMATION

Environmental Description: At Thomas Stone National Historic Site, this forest association occurs on convex to flat, moderately steep (5–15%) slopes of ravines, generally below 46 m (150 feet) in elevation. Stands are apparently relatively old and usually show no signs of recent (i.e., within the previous 60 years) extensive clearing. In some stands, more recent selective cutting may be evident. The soil surface is approximately 95% covered with leaf litter, with bare soil patches frequent. The humus layer is typically very thin (0 -1 cm) and brown. Soils are gravelly loams or gravelly sandy loams, probably Ultisols, and are very stony, with frequent rounded gravel particles up to 2 cm in diameter. Soil pH was measured to be from 4.3 to 4.9. Areas in which stands of this type occur are mapped almost exclusively as Aura gravelly sandy loam.
Vegetation Description: At Thomas Stone National Historic Site, this forest is characterized by a relatively even mix of tree species in the canopy and subcanopy, including white oak (*Quercus alba*), American beech (*Fagus grandifolia*), tuliptree (*Lir iodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), mockernut hickory (*Carya alba*), northern red oak (*Quercus rubra*), and, to a lesser extent, black oak (*Quercus velutina*) and white ash (*Fraxinus americana*). Frequent subcanopy species are red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*), with American hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), and American holly (*Ilex opaca*) present as small trees or tall shrubs. A greater abundance of tuliptree and/or sweetgum in the canopy is probably indicative of stands that have been disturbed more recently. Pawpaw (*Asimina triloba*) is often frequent as a short to tall shrub; its presence and/or abundance in this type may reflect recent invasion by this species in response to selective browsing by white-tailed deer. The herbaceous layer is of relatively low cover but is moderately diverse, with several sedges [slender woodland sedge (*Carex digitalis),* Swan's sedge (*Carex swanii),* whitetinge sedge (*Carex albicans* var. *albicans*)], Christmas fern (*Polystichum acrostichoides*), downy rattlesnake plantain (*Goodyera pubescens*), Indian pipe (*Monotropa uniflora*), Jack-in-the-pulpit (*Arisaema triphyllum*), partridgeberry (*Mitchella repens*), sessileleaf bellwort (*Uvularia sessilifolia*), false Solomon's-seal (*Maianthemum racemosum*), and prickly woodrush (*Luzula echinata*) frequent. Seedlings of Virginia creeper (*Parthenocissus quinquefolia*), greenbriers (*Smilax glauca, Smilax rotundifolia*), poison-ivy (*Toxicodendron radicans*), and strawberrybush [(*Euonymus americana = Euonyms americanus*)] are also characteristic.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Carya alba*
		Fagus grandifolia
		Liquidambar styraciflua
		Liriodendron tulipifera
		Quercus alba
		Quercus rubra
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Asimina triloba
		Cornus florida
		Nyssa sylvatica
Tall shrub/sapling	Broad-leaved deciduous shrub	*Carpinus caroliniana*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Ilex opaca*
Short shrub/sapling	Broad-leaved deciduous shrub	*Vaccinium pallidum*
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia*
		Smilax glauca
		Smilax rotundifolia
Herb (field)	Forb	*Goodyera pubescens*
Herb (field)	Graminoid	*Carex albicans* var. *albicans*
		Carex digitalis
		Carex swanii
Herb (field)	Fern or fern ally	*Polystichum acrostichoides*

Characteristic Species: *Carex albicans* var. *albicans*, *Carex laxiculmis*, *Carpinus caroliniana*, *Carya alba*, *Euonymus americanus*, *Galium circaezans*, *Goodyera pubescens*, *Luzula echinata*, *Mitchella repens*, *Quercus rubra*, *Quercus velutina*, *Symphyotrichum divaricatum*, *Uvularia sessilifolia*.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	1	*Fagus grandifolia* - *Quercus alba* - *Liriodendron tulipifera* - *Carya* spp. Forest	Harrison 2004

Local Range: This association is largely confined to the southeastern portion of the park.

Classification Comments: At Thomas Stone National Historic Site, *Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / Ilex opaca* var. *opaca / Polystichum acrostichoides* Forest (CEGL006075) is distinguished from *Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest (CEGL007220) (drier versions of which may represent stands succeeding to the former type) by (1) the position of tuliptree (*Liriodendron tulipifera*) as a frequent or, at most, a codominant species in the canopy, rather than as a strongly leading dominant, (2) by the absence of northern spicebush (*Lindera benzoin*) as a significant component of the shrub layer, and (3) by the rarity or absence of calciphilic species. It is distinguished from *Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest (CEGL008521) by (1) a higher richness of herbaceous species, (2) a relatively low frequency to absence of ericaceous species in the shrub layer, (3) the absence of species restricted to acidic forests [particularly scarlet oak (*Quercus coccinea*) and black huckleberry (*Gaylussacia baccata*)], (4) the presence of more mesic species, including northern red oak (*Quercus rubra*), tuliptree (*Liriodendron tulipifera*), American hornbeam (*Carpinus caroliniana*), and Christmas fern (*Polystichum acrostichoides*), and (5) its position on ravine slopes, rather than on higher, relatively level land.

Other Comments: A specimen of slender woodland sedge (*Carex digitalis*) collected from this vegetation at Thomas Stone National Historic Site was determined by R. Naczi to be *Carex*

digitalis var. *floridana*. This is currently the only known Maryland site and possibly the most northern known station for this taxon.
Local Description Authors: C. Lea.
Plots: 301, 311, 322.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	*Fagus grandifolia - Quercus rubra - Quercus alba* Forest Alliance (A.229)
Alliance (English name)	American Beech - Northern Red Oak - White Oak Forest Alliance
Association	*Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest
Association (English name)	American Beech - (White Oak, Northern Red Oak) - Tuliptree / (American Holly / Christmas Fern Forest
Ecological System(s):	Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242). Northern Atlantic Coastal Plain Dry Hardwood Forest (CES203.475).

GLOBAL DESCRIPTION

Concept Summary: This forest of mesic to submesic, well-drained soils occurs in the Piedmont and Coastal Plain of Virginia and Maryland, extending north to southern New England on the Coastal Plain. It also occurs occasionally at low elevations of the Blue Ridge and adjacent Ridge and Valley in Virginia and Maryland. It is characteristically a mixed forest dominated by *Fagus grandifolia, Quercus alba, Quercus rubra*, and *Liriodendron tulipifera* in various proportions. Overstory associates over the range include *Quercus velutina, Quercus falcata, Quercus coccinea, Liquidambar styraciflua, Acer rubrum, Nyssa sylvatica, Carya alba, Carya glabra*, and *Fraxinus americana*. The subcanopy is characterized by young *Fagus grandifolia, Acer rubrum, Carpinus caroliniana, Cornus florida*, and *Sassafras albidum*. *Ilex opaca* is particularly characteristic and abundant on the Coastal Plain. The shrub layer varies from very sparse to well-developed and can include *Asimina triloba, Viburnum acerifolium, Viburnum dentatum*, and *Euonymus americanus*. Heath shrubs, such as *Vaccinium corymbosum* and *Vaccinium pallidum*, may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia, Smilax glauca*, and *Toxicodendron radicans*. In the southern part of the range, *Oxydendrum arboreum* and *Vitis rotundifolia* may be conspicuous members of the understory. The herb layer is comprised of *Polystichum acrostichoides, Thelypteris noveboracensis, Uvularia perfoliata, Cypripedium acaule, Mitchella repens, Tipularia discolor, Goodyera pubescens, Eurybia divaricata (= Aster divaricatus), Chimaphila maculata, Carex swanii, Medeola virginiana, Athyrium filix-femina, Carex digitalis, Carex willdenowii, Epifagus virginiana, Maianthemum canadense, Desmodium nudiflorum, Polygonatum biflorum, Podophyllum peltatum, Arisaema triphyllum*, and *Maianthemum racemosum (= Smilacina racemosa)*.
Environmental Description: This forest association occurs on mesic to submesic slopes or gentle gradients. Ravines in dissected topography are particularly typical sites in the Piedmont and parts of the Inner Coastal Plain. The type also occupies rolling uplands with deep soils. Soils are typically well-drained, acidic sandy and silt loams derived from parent material of low to

moderate fertility. This association is found throughout the Piedmont from south-central Virginia to New Jersey and Pennsylvania and on the Mid-Atlantic Coastal Plain from northern Virginia northward.

Vegetation Description: Rangewide, this vegetation type is characteristically a mixed mesophytic forest dominated by *Fagus grandifolia, Quercus alba, Quercus rubra*, and *Liriodendron tulipifera* in various proportions. Overstory associates over the range include *Carya alba, Carya glabra, Quercus velutina, Quercus falcata, Quercus coccinea, Liquidambar styraciflua, Acer rubrum, Nyssa sylvatica*, and *Fraxinus americana*. The subcanopy is characterized by young *Fagus grandifolia, Acer rubrum, Carpinus caroliniana, Cornus florida, Ilex opaca*, and *Sassafras albidum*. The shrub layer varies from very sparse to well-developed and can include *Asimina triloba, Viburnum acerifolium, Viburnum dentatum*, and *Euonymus americanus*. Heath shrubs, such as *Vaccinium corymbosum* and *Vaccinium pallidum*, may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia, Smilax glauca*, and *Toxicodendron radicans*. The herb layer is comprised of *Polystichum acrostichoides, Uvularia perfoliata, Cypripedium acaule, Mitchella repens, Tipularia discolor, Goodyera pubescens, Eurybia divaricata (= Aster divaricatus), Chimaphila maculata, Carex swanii, Medeola virginiana, Athyrium filix-femina, Carex digitalis, Carex willdenowii, Epifagus virginiana, Maianthemum canadense, Desmodium nudiflorum, Polygonatum biflorum. Podophyllum peltatum, Arisaema triphyllum*, and *Maianthemum racemosum (= Smilacina racemosa).*

Several intergrading compositional variants have been noted in regional and local landscape analyses. On more submesic, convex slopes, *Fagus grandifolia, Quercus alba, Cornus florida*, and *Vaccinium pallidum* tend to be prominent, while pronounced mesophytes such as *Carpinus caroliniana* and herbaceous species in general are usually sparse. Coastal Plain stands tend to have understories heavily dominated by *Ilex opaca*, while Piedmont stands generally have only scattered *Ilex opaca* as well as slightly higher herbaceous richness.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Fagus grandifolia*
		Liriodendron tulipifera
		Quercus alba
Tree subcanopy	Broad-leaved deciduous tree	*Cornus florida*
Tree subcanopy	Broad-leaved evergreen tree	*Ilex opaca*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Viburnum acerifolium*
Shrub/sapling (tall & short)	Vine/Liana	*Parthenocissus quinquefolia*
Herb (field)	Forb	*Podophyllum peltatum*
		Polygonatum biflorum
Herb (field)	Fern or fern ally	*Polystichum acrostichoides*

Characteristic Species: *Fagus grandifolia, Ilex opaca, Quercus alba, Viburnum acerifolium*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is currently described from Virginia northward to Long Island, New York. The type is characteristic of the Coastal Plain throughout its range and of the Piedmont from south-central Virginia through much of Maryland. Small outliers of this vegetation occur at low elevations on both flanks of the Blue Ridge in Virginia and Maryland.

States/Provinces: CT, DC, DE:S5, MD, NJ:S3, NY, PA:S1, VA:S5.

Federal Lands: NPS (C&O Canal, George Washington Parkway, National Capital-East, Prince William, Rock Creek, Shenandoah, Thomas Stone).

CONSERVATION STATUS
Rank: G5 (24-Jan-2005).
Reasons: This association is common and widespread on the eastern Coastal Plain.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: Information not available.
Similar Associations:

- *Fagus grandifolia - Betula lenta - Quercus (alba, rubra) / Carpinus caroliniana* Forest (CEGL006921).
- *Fagus grandifolia - Quercus alba - (Acer barbatum)* / Mixed Herbs Forest (CEGL007206).
- *Fagus grandifolia - Quercus alba - Quercus rubra* Forest (CEGL006377).
- *Fagus grandifolia - Quercus rubra / Cornus florida / Polystichum acrostichoi.des - Hexastylis virginica* Forest (CEGL008465).
- *Quercus alba - Carya glabra* / Mixed Herbs Coastal Plain Forest (CEGL007226).

Related Concepts:

- *Fagus grandifolia - Liriodendron tulipifera - Quercus (alba, rubra) / Polystichum acrostichoides - Aster divaricatus* Forest (Fleming 2001) ?
- *Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / Ilex opaca* var. *opaca - (Asimina triloba)* Forest (Patterson pers. comm.) ?
- *Quercus* spp. - *Carya* spp. / *Cornus florida - Ilex opaca* Mesic Forest (Clancy 1993) ?
- CNE Mesic hardwood Forest on acidic bedrock / till (Rawinski 1984) ?
- Coastal Plain Forest (Smith 1983) B
- Maritime forest (Rawinski 1984) ?
- Mesic Coastal Plain mixed oak forest, mixed oak - beech forest subtype (Breden 1989) ?
- Mixed oak forest of the south Jersey mesic uplands (Robichaud and Buell 1973) ?
- Southern New England oak / pine forest on sandy / gravelly soils (Rawinski 1984) ?

SOURCES
Description Authors: S. L. Neid, mod. G. Fleming and L. A. Sneddon.
References: Bartgis 1986, Berdine 1998, Bernard and Bernard 1971, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1993b, Clancy 1996, Davis et al. 1992, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Lea 2003, McCoy and Fleming 2000, Metzler and Barrett 2001, Patterson pers. comm., Rawinski 1984, Robichaud and Buell 1973, Smith 1983.

Figure 13. Dry Mesic Forest in Thomas Stone National Historic Park (plot THST.311). July 2006.

Figure 14. Dry Mesic Forest in Thomas Stone National Historic Park (plot THST.301). July 2006.

COMMON NAME (PARK-SPECIFIC): SWEETGUM FOREST

SYNONYMS
USNVC English Name: **Sweetgum Forest**
USNVC Scientific Name: ***Liquidambar styraciflua* Forest**
USNVC Identifier: **CEGL007216**

LOCAL INFORMATION

Environmental Description: This type occurs in abandoned fields and in utility rights-of-way that have not been mowed in several years or where mowing has ceased and sweetgum (*Liquidambar styraciflua)* is rapidly invading. It is apparently the earliest successional forest type to occur at Thomas Stone National Historic Site on all but the driest soils.
Vegetation Description: This association is described from observations only; plot data were not collected. It is designated as a class for very young forests strongly dominated by saplings or pole-sized trees of sweetgum (*Liquidambar styraciflua*) in the canopy (usually with the largest trees less than 25 cm diameter at breast height). The physiognomic expression at Thomas Stone National Historic Site is perhaps better characterized as a shrubland. There is little or no discernible stratification of the woody layers. The herbaceous layer is often dominated by tall fescue [(*Lolium arundinaceum (= Festuca arundinacea*)] and other formerly planted grasses, with other early-successional (including "old field") species present. This type includes dense stands of sweetgum saplings of shrub size (<2 m tall) that have invaded fields that have not been mowed in several years.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Liquidambar styraciflua*
Herb (field)	Graminoid	*Lolium arundinaceum*

Characteristic Species: *Liquidambar styraciflua*.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNA	.	[not crosswalked]	.

Local Range: This association occurs as small patches at the edges of dry meadows in the vicinity of the tobacco barn, horse barn, and the Stone Mansion. An additional patch occurs in the southeastern corner of the park.
Classification Comments: This association includes all stands occurring on uplands that are strongly dominated by sweetgum (*Liquidambar styraciflua)*. For Thomas Stone National Historic Site, it is differentiated from all other (later seral) associations that may have even-aged *Liquidambar styraciflua* as the leading dominant in the tree layer by the absence of a herbaceous layer that shows the patterns of the later seral types.

At Thomas Stone National Historic Site, most stands attributable to this association appear physiognomically as shrublands but are classified here (CEGL007216) (a forest type) in order to conform with the USNVC. The Land Use / Land Cover fields in the map database designate them as shrub types from a land cover perspective.

This type is similar or equivalent to the sweetgum successional forest of southern New Jersey of Collins and Anderson (1994).
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: None.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	*Liquidambar styraciflua* Forest Alliance (A.234)
Alliance (English name)	Sweetgum Forest Alliance
Association	*Liquidambar styraciflua* Forest
Association (English name)	Sweetgum Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This early-successional upland forest results from succession following human activities, such as logging and clearing. Stands are dominated by *Liquidambar styraciflua*, sometimes to the exclusion of other species. A related, later-successional bottomland association is *Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* var. *triphyllum* Forest (CEGL004418).
Environmental Description: This association is found in uplands that have been heavily impacted by agriculture or other severe disturbances and are recovering.
Vegetation Description: Stands are dominated by *Liquidambar styraciflua*, sometimes to the exclusion of other species.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	*Liquidambar styraciflua*

Characteristic Species: *Liquidambar styraciflua*.
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: Information not available.
States/Provinces: AL, AR?, GA, KY, LA, MD, MS, NC, NJ, OK, SC, TN, VA.
Federal Lands: NPS (Big South Fork, Chickamauga-Chattanooga?, Cowpens, Guilford Courthouse, Kings Mountain, Mammoth Cave, Natchez Trace, Ninety Six, Shiloh, Thomas Stone, Vicksburg); USFS (Oconee?, St. Francis?); USFWS (Great Swamp).

CONSERVATION STATUS

Rank: GNA (modified/managed) (19-Aug-2002).
Reasons: This is an upland successional vegetation type composed of native species. Its conservation value is limited, but it may provide buffer for communities of greater conservation value.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: Information not available.

Similar Associations:

- *Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* ssp. *triphyllum* Forest (CEGL004418)--a later-successional bottomland association.
- *Liquidambar styraciflua - Quercus (alba, falcata)* Forest (CEGL007217)--of interior provinces.
- *Liquidambar styraciflua - Quercus (nigra, phellos) - Pinus taeda / Vaccinium elliottii - Morella cerifera* Forest (CEGL007726)--a more diverse successional forest of the Coastal Plain.

Related Concepts:

- sweetgum successional forest (Collins and Anderson 1994) =

SOURCES

Description Authors: R. White, mod. M. Pyne.

References: Collins and Anderson 1994, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data.

COMMON NAME (PARK-SPECIFIC): EARLY SUCCESSIONAL MESIC FOREST

SYNONYMS
USNVC English Name: **Tuliptree / (Eastern Redbud) / (Northern Spicebush) Forest**
USNVC Scientific Name: ***Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest**
USNVC Identifier: **CEGL007220**

LOCAL INFORMATION

Environmental Description: At Thomas Stone National Historic Site, this forest occurs on flat to concave-shaped, moderately steep (2–12%) slopes of ravines, generally below 46 m (150 feet) in elevation. At least one stand occurs on what is apparently a higher, well-drained stream terrace along Hoghole Run. The soil surface is approximately 80–90% covered with a layer of leaf litter, which is typically thin, with bare soil patches occurring elsewhere. A humus layer is very shallow, when present at all. Soils are gravelly loams or gravelly sandy loams, probably Ultisols, and are very stony, with frequent rounded gravel particles up to 2 cm in diameter. Organic matter is well-mixed with mineral soil to a depth well below the soil surface, so that the A horizon is deep, with the mineral soil color obscured within the upper 25 cm. Soil pH was measured to be from 4.3 to 4.6. Areas in which stands of this type occur are mapped mostly as Aura gravelly sandy loam or Croom gravelly loam. The association is an early-seral stage following clearing of dry-mesic to mesic forests on slopes and, at Thomas Stone National Historic Site, is evidently successional to *Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest (CEGL006075).
Vegetation Description: Tuliptree (*Liriodendron tulipifera*), flowering dogwood *(Cornus florida),* northern spicebush (*Lindera benzoin),* nodding fescue (*Festuca subverticillata*), licorice bedstraw (*Galium circaezans),* broadleaf enchanter's nightshade (*Circaea lutetiana),* rattlesnake fern (*Botrychium virginianum),* eastern narrowleaf sedge (*Carex amphibola),* bitternut hickory (*Carya cordiformis),* Canadian blacksnake root (*Sanicula canadensis),* black walnut (*Juglans nigra*) are considered diagnostic with white ash (*Fraxinus americana*), sweetgum (*Liquidambar styraciflua*), pawpaw (*Asimina triloba*), Japanese honeysuckle (*Lonicera japonica),* ebony spleenwort (*Asplenium platyneuron),* Virginia creeper (*Parthenocissus quinquefolia*), trumpet creeper (*Campsis radicans),*Swan's sedge (*Carex swanii),*stiff marsh bedstraw (*Galium tinctorium*), Christmas fern (*Polystichum acrostichoides*), round leaf greenbrier (*Smilax rotundifolia),* Poison ivy *(Toxicodendron radicans),* riverbank grape (*Vitis vulpina*), lowland bladderfern *(Cystopteris protrusa),*bristly dewberry (*Rubus hispidus*), Virginia wild rye (*Elymus virginicus),* cutleaf grapefern (*Botrychium dissectum),* Clayton's sweetroot (*Osmorhiza claytonia*), Bosc's panicgrass (*Dichanthelium bosciii)* considered characteristic.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liriodendron tulipifera*
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Carpinus caroliniana
		Cornus florida
Tall shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Ilex opaca*
Herb (field)	Forb	*Arisaema triphyllum*
Herb (field)	Graminoid	*Festuca subverticillata*

Characteristic Species: *Botrychium virginianum, Carex amphibola, Carya cordiformis, Circaea lutetiana, Cornus florida, Festuca subverticillata, Galium circaezans, Liriodendron tulipifera, Sanicula canadensis*.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNA	.	[not crosswalked]	.

Local Range: This association occurs in relatively large patches in the southern portion of the park, in association with dry meadows and adjacent to floodplain forest.
Classification Comments: This type is evidently included in the concept of the Oak - Hickory Association of the Western Shore District of Shreve et al. (1910). The somewhat low pH measurements for stands of this type (slightly higher than for the dry oak forests) seem inconsistent with the rich woods flora in them, but is consistent with the assessment of Hall and Mathews (1974) that Aura gravelly sandy loams are strongly acidic. This has yet to be explained, though these forests may be rich in some essential plant nutrients, despite their low pH.
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: 202, 212, 401, 411.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	*Liriodendron tulipifera* Forest Alliance (A.236)
Alliance (English name)	Tuliptree Forest Alliance
Association	*Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest
Association (English name)	Tuliptree / (Eastern Redbud) / (Northern Spicebush) Forest
Ecological System(s):	Appalachian (Hemlock) - Northern Hardwood Forest (CES202.593). Southern Interior Low Plateau Dry - Mesic Oak Forest (CES202.898).

GLOBAL DESCRIPTION

Concept Summary: This semi-natural or successional community dominated by *Liriodendron tulipifera* occurs in the Ridge and Valley of Tennessee and Virginia, the Interior Low Plateau of Kentucky, and the Central Appalachians, Piedmont and inner Coastal Plain regions of Virginia, West Virginia, and Maryland. It may also occur in similar regions of Pennsylvania and Delaware. It is distinguished from other upland communities dominated by *Liriodendron tulipifera* by the presence of species associated with soils with moderately high base saturation levels (rich soils). Species found in stands attributable to this type may be fairly diverse and result in a varied composition. In addition to *Liriodendron tulipifera*, other canopy species may include *Liquidambar styraciflua, Acer saccharum, Robinia pseudoacacia, Juglans nigra, Fraxinus americana, Aesculus flava, Magnolia acuminata, Ulmus rubra, Quercus imbricaria, Quercus muehlenbergii, Prunus serotina*, and *Carya ovata*. Species often found in the subcanopy include *Acer saccharum, Cercis canadensis, Ulmus alata, Fraxinus americana, Morus rubra*, and *Cornus florida*. Shrubs include saplings of the subcanopy and canopy species, as well as

Lindera benzoin, Symphoricarpos orbiculatus, Asimina triloba, Staphylea trifolia, Acer negundo, and *Juniperus virginiana* var. *virginiana*. Exotic shrubs, including *Rosa multiflora, Rubus phoenicolasius*, and *Lonicera japonica*, are present at some sites. Herbaceous species include the exotics *Microstegium vimineum, Alliaria petiolata*, and *Veronica hederifolia*, as well as *Toxicodendron radicans, Parthenocissus quinquefolia, Actaea racemosa, Caulophyllum thalictroides, Laportea canadensis, Impatiens pallida, Hydrophyllum canadense, Adiantum pedatum, Polygonatum pubescens, Verbesina alternifolia, Amphicarpaea bracteata*, and *Polystichum acrostichoides*.

Environmental Description: These forests are found on disturbed mesic areas underlain by rich soils with moderately high base saturation levels. Soils may be underlain by a variety of geologic strata that weather to base-rich soils including limestone, dolomite, calcareous shale, shell deposits, metabasalts and granitic complexes. In Kentucky this association may occur on calcareous substrates in the Dripping Springs Escarpment. At Shenandoah National Park in Virginia, this community is underlain by Catoctin metabasalt or a pyroxene-bearing granitic complex.

Vegetation Description: Stands are dominated by *Liriodendron tulipifera* but also include various other species, including ones indicative of rich or circumneutral environments. Other species include *Liquidambar styraciflua, Acer saccharum, Robinia pseudoacacia, Juglans nigra, Fraxinus americana, Ulmus rubra, Quercus imbricaria, Quercus muehlenbergii*, and *Carya ovata* (NatureServe Ecology unpubl. data, VDNH unpubl. data). Species often found in the subcanopy include *Acer saccharum, Cercis canadensis, Ulmus alata, Morus rubra*, and *Cornus florida*. *Cercis canadensis* is often abundant on soils underlain by carbonate strata. Shrubs include saplings of the subcanopy and canopy species, as well as *Symphoricarpos orbiculatus, Lindera benzoin, Asimina triloba*, and *Juniperus virginiana* var. *virginiana*. *Lindera benzoin* is often abundant in occurrences of this community in the Central Appalachians, Piedmont and inner Coastal Plain regions of Virginia, West Virginia, and Maryland. Exotic shrubs, including *Rosa multiflora, Rubus phoenicolasius*, and *Lonicera japonica*, are present at some sites. Herbaceous species include the exotics *Microstegium vimineum, Alliaria petiolata*, and *Veronica hederifolia*, as well as *Toxicodendron radicans, Parthenocissus quinquefolia, Actaea racemosa, Caulophyllum thalictroides, Laportea canadensis, Impatiens pallida, Hydrophyllum canadense, Adiantum pedatum, Polygonatum pubescens, Verbesina alternifolia, Amphicarpaea bracteata*, and *Polystichum acrostichoides*. (Andreu and Tukman 1995, NatureServe Ecology unpubl. data, WVNHP unpubl. data, VDNH unpubl. data). Examples at Fort Donelson that have been very heavily disturbed may have local dominance by *Celtis laevigata* and *Juglans nigra*.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liriodendron tulipifera*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin*

Characteristic Species: *Liriodendron tulipifera*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This type occurs in the Ridge and Valley and Cumberland Plateau of Tennessee, the Interior Low Plateau of Kentucky, the Upper East Gulf Coastal Plain of Mississippi, and the Central Appalachian, Piedmont and Inner Coastal Plain regions of Virginia, West Virginia, Maryland and possibly Pennsylvania and Delaware. Its full range is unknown.

States/Provinces: DC, DE?, KY, MD, MS, PA?, TN, VA, WV.

Federal Lands: DOD (Camp Dawson); NPS (Antietam, Big South Fork, Blue Ridge Parkway, C&O Canal, Catoctin Mountain, Chickamauga-Chattanooga, Cumberland Gap, Fort Donelson, George Washington Parkway, Harpers Ferry, Lincoln Birthplace, Mammoth Cave, Natchez Trace, National Capital-East, Obed, Rock Creek, Shenandoah, Thomas Stone, Vicksburg); TVA (Tellico); USFS (Cherokee?).

CONSERVATION STATUS

Rank: GNA (ruderal) (28-Oct-2003).
Reasons: This forest represents early-successional vegetation and is thus not of conservation concern. It is composed largely of native species, though exotics may be locally abundant. Its conservation value is limited, but mature examples could provide buffer for communities of greater conservation value.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 3 - Weak.
Comments: Information not available.
Similar Associations:

- *Liriodendron tulipifera - Pinus taeda* Forest (CEGL007521)--supports a significant pine component.
- *Liriodendron tulipifera - Quercus* spp. Forest (CEGL007221)--lacks species affiliated with circumneutral conditions.
- *Liriodendron tulipifera* Forest (CEGL007218)--is less diverse and earlier successional.

Related Concepts:

- *Liriodendron tulipifera / Lindera benzoin* Forest (Lea 2000) F
- Oak - Hickory Association of the Western Shore District (Shreve et al. 1910) B
- Successional forest of low-elevation plateaus (Vanderhorst 2001a) B
- Tulip Poplar Type (Schmalzer and DeSelm 1982) B

SOURCES

Description Authors: R. E. Evans, mod. M. Pyne, J. Teague, C. W. Nordman, R. White, S. C. Gawler.
References: Andreu and Tukman 1995, Hall and Mathews 1974, Lea 2000, Lea 2003, Martin 1989, NatureServe Ecology - Southeastern U.S. unpubl. data, Schmalzer and DeSelm 1982, Shreve et al. 1910, Southeastern Ecology Working Group n.d., TDNH unpubl. data, VDNH unpubl. data, Vanderhorst 2001, WVNHP n.d.b.

Figure 15. Early Successional Mesic Forest in Thomas Stone National Historic Park (plot THST.202).

Figure 16. Early Successional Mesic Forest in Thomas Stone National Historic Park (plot THST.212). July 2006.

COMMON NAME (PARK-SPECIFIC): OAK - HEATH FOREST

SYNONYMS

USNVC English Name:	**White Oak - (Scarlet Oak, Black Oak, Chestnut Oak) / Black Huckleberry Forest**
USNVC Scientific Name:	***Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest**
USNVC Identifier:	**CEGL008521**

LOCAL INFORMATION

Environmental Description: At Thomas Stone National Historic Site, this forest association occurs on interfluve upland areas of gentle slope (generally less than 6%), generally above 46 m (150 feet) in elevation, and which have not been extensively cleared of forest in recent decades (i.e., probably at least 60 years old). The soil surface is nearly 100% covered with leaf litter, with a 1- to 5-cm thick red-brown (evidently mor) humus layer. Soils are silt loams, evidently Ultisols, and are yellow-orange in the B horizon, with a nearly ubiquitous fragipan, the top of which is from about 5 to more than to 25 cm below the soil surface. Soil pH was measured to be from 4.1 to 4.9. Areas in which stands of this type occur are mapped mostly as Beltsville silt loam, with some areas mapped as Exum silt loam (Hall and Mathews 1974).

Vegetation Description: In Thomas Stone National Historic Site, this forest is characterized by a dominance in the canopy of oaks typical of dry acidic forests, with white oak (*Quercus alba*) and scarlet oak (*Quercus coccinea*) the leading dominants, and black oak (*Quercus velutina*) and southern red oak (*Quercus falcata*) usually present. American beech (*Fagus grandifolia*) is frequent in the canopy or subcanopy. Exceptionally mature stands may be dominated by *Quercus alba* and *Fagus grandifolia*. Scattered mature Virginia pines (*Pinus virginiana*) are often in the canopy. Blackgum (*Nyssa sylvatica*) is generally the most abundant subcanopy species, with red maple (*Acer rubrum*) and American holly (*Ilex opaca*) also important. The shrub layer is characterized by a usually high cover of ericaceous shrubs, with either black huckleberry (*Gaylussacia baccata*), mountain laurel (*Kalmia latifolia*), or both strongly dominant, and deerberry (*Vaccinium stamineum*) usually present. Other small trees, shrubs or vines that are typically present at low cover are sassafras (*Sassafras albidum*), common serviceberry (*Amelanchier arborea*), pink azalea (*Rhododendron periclymenoides*), and greenbriers (*Smilax glauca* and *Smilax rotundifolia*). The herbaceous layer is very depauperate and is comprised primarily of striped pipsissewa (*Chimaphila maculata*) and seedlings of several woody species.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus virginiana*
Tree canopy	Broad-leaved deciduous tree	*Quercus alba*
		Quercus coccinea
		Quercus falcata
		Quercus velutina
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Fagus grandifolia
		Nyssa sylvatica
Tall shrub/sapling	Broad-leaved deciduous shrub	*Vaccinium stamineum*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Ilex opaca*
		Kalmia latifolia

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Gaylussacia baccata*
		Vaccinium pallidum
Herb (field)	Vine/Liana	*Smilax glauca*
		Smilax rotundifolia
Herb (field)	Forb	*Chimaphila maculata*
Herb (field)	Graminoid	*Carex albicans* var. *emmonsii*
		Carex willdenowii

Characteristic Species: *Amelanchier arborea*, *Carya alba*, *Cypripedium acaule*, *Danthonia spicata*, *Gaylussacia baccata*, *Kalmia latifolia*, *Monotropa uniflora*, *Prunus serotina*, *Quercus coccinea*, *Rhododendron periclymenoides*, *Vaccinium stamineum*.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	1	*Quercus coccinea - Quercus velutina - Quercus alba / Amelanchier arborea / Gaylussacia baccata* Forest	Harrison 2004

Local Range: This association occurs in the southeastern portion of the park, and north of the Storm Residue patch. It also occurs in small patches west of Hog Hole Run.

Classification Comments: This community is distinguished from Pine – Oak Forest (CEGL002591) by the position of Virginia pine (*Pinus virginiana*) as an occasional canopy tree, rather than a leading or codominant canopy species, and by the prevalence of mature, rather than pole-sized, trees among the largest individual hardwoods in the tree layers. It is further distinguished from *Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest (CEGL006075) by (1) a lower richness of herbaceous species, (2) a greater prevalence of ericaceous species in the shrub layer, (3) the presence of species of acidic forests [particularly scarlet oak (*Quercus coccinea*) and black huckleberry (*Gaylussacia baccata*)], (4) the absence of more mesic species, including northern red oak (*Quercus rubra*), tuliptree (*Liriodendron tulipifera*), American hornbeam (*Carpinus caroliniana*), and Christmas fern (*Polystichum acrostichoides*), and (5) its position on higher, relatively level land, rather than on ravine slopes.

Other Comments: Information not available.

Local Description Authors: C. Lea.

Plots: 131, 412, 402, 422, 431, 501, 601, 602.

Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	*Quercus velutina - Quercus alba - (Quercus coccinea)* Forest Alliance (A.1911)
Alliance (English name)	Black Oak - White Oak - (Scarlet Oak) Forest Alliance
Association	*Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest
Association (English name)	White Oak - (Scarlet Oak, Black Oak, Chestnut Oak) / Black Huckleberry Forest
Ecological System(s):	Northeastern Interior Dry - Mesic Oak Forest (CES202.592).

GLOBAL DESCRIPTION

Concept Summary: This community is a matrix forest of dry, nutrient-poor uplands of the Mid-Atlantic Piedmont Plateau, occurring locally in similar low-elevation landscapes of the northern Blue Ridge and Ridge and Valley, Cumberland Plateau and Mid-Atlantic Coastal Plain provinces. The type is well-documented across Virginia, and to a lesser extent in Tennessee and Maryland, but probably also occurs at similar sites in West Virginia and Pennsylvania. Stands are located between 30 and 700 m (100–2300 feet) elevation on rolling to sublevel sites of Piedmont and inner Coastal Plain uplands, mountain valleys and lower mountain slope benches. In the mountains, many documented occurrences are located on ancient alluvial fan deposits, which are especially extensive along the western foot of the Blue Ridge. The vegetation is a closed to very open oak forest with mixed and variable canopy dominance by *Quercus alba, Quercus velutina, Quercus coccinea*, and *Quercus prinus*. Various *Pinus* spp., including *Pinus virginiana, Pinus echinata, Pinus strobus*, and *Pinus rigida*, are frequent overstory associates, particularly following fire or logging disturbances. *Quercus falcata, Quercus stellata, Carya glabra*, and *Carya alba* are infrequent canopy trees. *Nyssa sylvatica, Amelanchier arborea* and, in the southern part of the range, *Oxydendrum arboreum* attain exceptional abundance and stature in these forests, dominating the subcanopy layers and occasionally reaching the overstory. *Acer rubrum* and *Sassafras albidum* are other common understory trees. In typical stands, the shrub layer is dominated by deciduous ericaceous species, herbaceous species are sparse, and species-richness is moderate to very low.

Environmental Description: Stands are located between 30 and 700 m (100–2300 feet) elevation on rolling to sublevel sites of Piedmont and inner Coastal Plain uplands, mountain valleys and lower mountain slope benches. The type is generally distributed in nutrient-poor soils of the Piedmont uplands. In the mountains, many documented occurrences are located on ancient alluvial fan deposits, which are especially extensive along the western foot of the Blue Ridge from Page County south to Rockbridge County. Similar but smaller fans are common where incising streams drain "piedmont" landforms at the foot of Ridge and Valley strike ridges (Harbor 1996). Slopes of plot-sampled stands range from 1–13 degrees (mean = 6 degrees), with aspects essentially flat to westerly. Soils of these sites are deep, very oligotrophic, gravelly loams with low pH and base status. Exposed rocks of any kind (outcrops, boulders, or stones) are usually sparse to absent. Most sites appear to have a history of fires.

Vegetation Description: The vegetation is a closed to very open oak forest with mixed and variable canopy dominance by *Quercus alba, Quercus coccinea*, and *Quercus prinus*. Various *Pinus* spp., including *Pinus virginiana, Pinus echinata, Pinus strobus*, and *Pinus rigida*, are frequent overstory associates, particularly following fire or logging disturbances. *Quercus falcata, Quercus stellata, Carya glabra*, and *Carya alba* are infrequent canopy trees. *Nyssa sylvatica, Amelanchier arborea* and, in the southern part of the range, *Oxydendrum arboreum* attain exceptional abundance and stature in these forests, dominating the subcanopy layers and occasionally reaching the overstory. *Acer rubrum* and *Sassafras albidum* are other common understory trees. The shrub layer is typically dominated by deciduous ericaceous species, with *Gaylussacia baccata, Vaccinium pallidum*, and/or *Vaccinium stamineum* consistently forming dense colonies. Less abundant or constant shrubs and vines include *Castanea pumila, Quercus ilicifolia, Kalmia latifolia, Rhododendron periclymenoides, Lyonia ligustrina, Vaccinium stamineum, Smilax glauca, Smilax rotundifolia*, and *Cornus florida*. Despite high shrub densities, a number of low-cover herbs and subshrubs occur in the type, including *Chimaphila maculata, Isotria verticillata, Uvularia puberula, Epigaea repens, Pteridium aquilinum* var. *latiusculum*,

Cypripedium acaule, *Gentiana villosa*, *Comandra umbellata*, *Angelica venenosa*, and *Iris verna*. Mean species richness of 40 Virginia plot samples is 25 taxa per 400 square meters.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Quercus alba*
		Quercus coccinea
		Quercus prinus
Tree canopy	Needle-leaved tree	*Pinus virginiana*
Tree subcanopy	Broad-leaved deciduous tree	*Nyssa sylvatica*
		Amelanchier arborea
Tall shrub/sapling	Broad-leaved deciduous shrub	*Gaylussacia baccata*
		Vaccinium pallidum
		Vaccinium stamineum
Short shrub/sapling	Broad-leaved deciduous shrub	*Gaylussacia baccata*
		Vaccinium pallidum
Herb (field)	Vine/Liana	*Smilax glauca*
		Smilax rotundifolia
Herb (field)	Forb	*Chimaphila maculata*

Characteristic Species: *Amelanchier arborea*, *Castanea pumila*, *Gaylussacia baccata*, *Isotria verticillata*, *Nyssa sylvatica*, *Oxydendrum arboreum*, *Quercus alba*, *Quercus coccinea*, *Quercus velutina*, *Rhododendron periclymenoides*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This community is a matrix forest of dry, nutrient-poor uplands of the Mid-Atlantic Piedmont Plateau, occurring locally in similar low-elevation landscapes of the northern Blue Ridge and Ridge and Valley provinces of the Central Appalachians, and the Cumberland Plateau in Tennessee. In Maryland and northern Virginia, the type also occurs on uplands of the dissected Inner Coastal Plain. The type is well-documented through quantitative analysis in Virginia, and qualitatively in Maryland, but probably also occurs at similar sites in West Virginia and Pennsylvania.

States/Provinces: KY?, MD, PA?, TN, VA:S5, WV?

Federal Lands: DOD (Fort Belvoir); NPS (Big South Fork, C&O Canal, Fredericksburg-Spotsylvania, George Washington Parkway, Obed, Prince William, Shenandoah, Thomas Stone); USFS (George Washington, Jefferson).

CONSERVATION STATUS

Rank: G5 (24-Jan-2005).

Reasons: This community is a matrix-forming vegetation type in the Virginia and Maryland Piedmont and is probably more widespread at low elevations of the central Appalachian Mountains than documentation indicates.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Information not available.

Similar Associations:

- *Quercus (prinus, coccinea) / Kalmia latifolia / (Galax urceolata, Gaultheria procumbens)* Forest (CEGL006271)--of southern Appalachians.
- *Quercus alba - Quercus falcata - (Pinus taeda) / Gaylussacia frondosa* Forest (CEGL006269)--of the Mid-Atlantic Coastal Plain.
- *Quercus alba - Quercus falcata / Vaccinium (arboreum, hirsutum, pallidum)* Forest (CEGL008567)--described from southeastern Tennessee, with similar understory and associated species but with prominent *Quercus falcata*.
- *Quercus prinus - (Quercus coccinea, Quercus rubra) / Kalmia latifolia / Vaccinium pallidum* Forest (CEGL006299)--of the Central Appalachians and northern Piedmont.

Related Concepts:

- *Quercus alba - Quercus falcata - Carya tomentosa / Cornus florida* Association (Rawinski et al. 1996) ?
- *Quercus coccinea - Quercus velutina - Quercus alba / Amelanchier arborea / Gaylussacia baccata* Forest (Fleming and Coulling 2001) F
- White Oak - Black Oak - Northern Red Oak: 52 (Eyre 1980) B
- White Oak - Scarlet Oak - Pine Type (Schmalzer and DeSelm 1982) =

SOURCES

Description Authors: G. P. Fleming and P. Coulling, mod. L. A. Sneddon.

References: Eyre 1980, Fleming and Coulling 2001, Fleming et al. 2001, Fleming et al. 2004, Hall and Mathews 1974, Harbor 1996, Harrison 2004, Rawinski et al. 1996, Schmalzer and DeSelm 1982, TDNH unpubl. data.

Figure 17. Oak - Heath Forest in Thomas Stone National Historic Park (plot THST.501). July 2006.

Figure 18. Oak - Heath Forest in Thomas Stone National Historic Park (plot THST.431). July 2006.

COMMON NAME (PARK-SPECIFIC): DEPOSITIONAL BAR

SYNONYMS
USNVC English Name: **River Birch - (Sycamore) Forest**
USNVC Scientific Name: ***Betula nigra - (Platanus occidentalis)* Forest**
USNVC Identifier: **CEGL006976**

LOCAL INFORMATION

Environmental Description: This association occurs on depositional bars in stream channels, where it is likely to remain flooded by high flows for long periods (several days to weeks) during the winter and early spring and occasionally during other seasons. Soil is recently deposited relatively coarse alluvium (likely muddy sands, sands, or gravelly sands), with no discernible horizon development.

Vegetation Description: Because of the small size of the single occurrence at Thomas Stone National Historic Site and the lack of data on communities of depositional bars within the Coastal Plain, the floristic composition of this type is not well-known. Debris-battered and stunted individuals of river birch (*Betula nigra*), which was observed in this occurrence, and American sycamore (*Platanus occidentalis*), which occurred in the vicinity, are probably the most numerous and characteristic tree-layer species. A shrub layer is either sparse or absent. The herbaceous layer is comprised of disturbance-adapted perennial and annual forbs and grasses. The single occurrence seen at Thomas Stone National Historic Site was heavily overrun by the invasive annual Japanese stiltgrass (*Microstegium vimineum*). The perennial deer-tongue witchgrass (*Dichanthelium clandestinum*) is also frequent.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Betula nigra*
Herb (field)	Graminoid	*Microstegium vimineum*

Characteristic Species: Information not available.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	.	[not crosswalked]	.
VA	SNR	.	[not crosswalked]	

Local Range: A single, very small (about 50 square meters) and degraded example was seen within the channel of Hoghole Run, possibly just outside the boundary of Thomas Stone National Historic Site.

Classification Comments: This type is described from observations only. The position and species composition clearly indicate that the occurrence is of depositional bar vegetation that is placed within the *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Forest Alliance (A.280).

Other Comments: Information not available.

Local Description Authors: C. Lea.

Plots: None.

Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Betula nigra - (Platanus occidentalis)* Temporarily Flooded Forest Alliance (A.280)
Alliance (English name)	River Birch - (Sycamore) Temporarily Flooded Forest Alliance
Association	*Betula nigra - (Platanus occidentalis)* Forest
Association (English name)	River Birch - (Sycamore) Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association has been described from Thomas Stone National Historic Park and Fredericksburg-Spotsylvania National Military Park only. Additional data are needed to define this as a standard type in the USNVC.
Environmental Description: See local description.
Vegetation Description: See local description.
Most Abundant Species: See local description.
Characteristic Species: See local description.
Other Noteworthy Species: See local description.
USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: Information not available.
States/Provinces: MD, NJ, VA.
Federal Lands: NPS (Fredericksburg-Spotsylvania, Thomas Stone).

CONSERVATION STATUS

Rank: GNR (8-Nov-2000).
Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Nonstandard.
Confidence: Information not available.
Comments: Information not available.
Similar Associations:
Betula nigra - Quercus palustris / Cornus amomum Forest (CEGL006948).
Related Concepts: Information not available.

SOURCES

Description Authors: Chris Lea.
References: Eastern Ecology Working Group n.d.

COMMON NAME (PARK-SPECIFIC): FLOODPLAIN FOREST

SYNONYMS

USNVC English Name:	**Sweetgum - Tuliptree / Northern Spicebush / Jack-in-the-Pulpit Forest**
USNVC Scientific Name:	***Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* ssp. *triphyllum* Forest**
USNVC Identifier:	**CEGL004418**

LOCAL INFORMATION

Environmental Description: This association occurs on small (first or second order) streams that are tributaries to Hoghole Run and also on the Hoghole Run floodplain or on adjacent lower slopes. Slope is generally gentle in the former situation but can range up to 9% in the latter setting. Floodplain Forests closer to the channel receive longer periods of flooding, or hydroperiods, than do those slightly upslope. The return interval for overbank flow is probably less than one year along the Hoghole Run floodplain and greater than one year for the tributaries. The soil surface is mostly (85–98%) covered with a thin (0.5 to 1 cm) layer of leaf litter. A humus layer is generally absent or, if present, very shallow. An upper mineral (A) horizon, stained dark brown with organic matter, varies from about 1–15 cm deep on the tributaries and is 1–5 cm deep along the Hoghole Run floodplain. Gleying in the mineral horizon is consistently seen within 0–20 cm of the soil surface along the smaller tributaries and is present to the surface along the Hoghole Run floodplain. Mottles are sometimes seen at a soil depth of 10–15 cm but are not consistently evident along the tributaries. However, mottles were consistently seen to the soil surface along the Hoghole Run floodplain. Soils were observed to be somewhat poorly drained to moderately well-drained gravelly sandy loams or sandy clay loams along the tributaries and poorly drained silt loams to silty clay loams with little gravel present along the Hoghole Run floodplain. Soil pH was measured to be about 4.5–5.2. Areas along the tributaries in which stands of this type occur are mapped mostly as Aura gravelly sandy loam, with some areas mapped as Croom gravelly loam or as Mattapex fine sandy loam. Areas along the Hoghole Run floodplain in which this vegetation occurs are mapped exclusively as Bibb silt loam.

Vegetation Description: The canopy of this association is dominated by tuliptree (*Liriodendron tulipifera*) and sweetgum (*Liquidambar styraciflua*). Pin oak (*Quercus palustris*), American sycamore (*Platanus occidentalis*), bitternut hickory (*Carya cordiformis*), and river birch (*Betula nigra*) are present at low cover and are more frequent along the Hoghole Run floodplain than along tributaries. Swamp chestnut oak (*Quercus michauxii*) seedlings are present (and rare) along Hoghole Run only, but mature trees of this species were not seen. Red maple (*Acer rubrum*) is the most abundant species in the subcanopy, with American elm (*Ulmus americana*) and American hornbeam (*Carpinus caroliniana*) also often present. Frequent understory trees or tall shrubs are (*Carpinus carolina)* and American elm. Species which regularly occur in the canopy and/or the subcanopy along the tributaries only include American beech (*Fagus grandifolia*), blackgum (*Nyssa sylvatica*), and northern red oak (*Quercus rubra*). Northern spicebush (*Lindera benzoin*) and pawpaw (*Asimina triloba*) are the most common species of the shrub layer, with American holly (*Ilex opaca*) present along the tributaries. Tree-climbing vines are especially common along the Hoghole Run floodplain and include poison-ivy (*Toxicodendron radicans*), roundleaf greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), Virginia creeper (*Parthenocissus quinquefolia*), and trumpetcreeper

(*Campsis radicans*). Along the tributaries, the herbaceous layer covers 10–50% of the forest floor and is quite diverse. Characteristic species of the herb layer include New York fern (*Thelypteris noveboracensis*), partridgeberry (*Mitchella repens*), Jack-in-the-pulpit (*Arisaema triphyllum*), common ladyfern (*Athyrium filix-femina*), Christmas fern (*Polystichum acrostichoides*), princess-pine (*Lycopodium obscurum*), several sedges (*Carex radiata, Carex swanii*), and seedlings or sprouts of strawberry-bush [*Euonymus americana (=Euonymus americanus*)]. Along Hoghole Run floodplain, and in small patches along the tributaries, more hydric species are dominant, with sparse to relatively dense stands of sweet woodreed (*Cinna arundinacea*), false-nettle (*Boehmeria cylindrica*), and/or fowl mannagrass (*Glyceria striata*) characteristic. In these more hydric stands, several sedges [greater bladder sedge (*Carex intumescens),* white edge sedge (*Carex debilis),* blunt broom sedge, (*Carex tribuloides),* fringed sedge (*Carex crinita),* squarrose sedge (*Carex squarrosa*)], and whitegrass (*Leersia virginica*) are frequent. American elderberry (*Sambucus nigra* var. *canadensis*), wrinkleleaf goldenrod (*Solidago rugosa*), swamp aster (*Symphyotrichum lanceolatum*), Virginia bugleweed (*Lycopus virginicus*), swamp bedstraw (*Galium tinctorium*), and sensitive fern (*Onoclea sensibilis*) are species that are usually present at low cover.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
		Liriodendron tulipifera
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Carpinus caroliniana
		Fagus grandifolia, Ilex opaca
Tall shrub/sapling	Broad-leaved deciduous shrub	*Asimina triloba*
		Lindera benzoin
Herb (field)	Forb	*Arisaema triphyllum*
		Boehmeria cylindrica
Herb (field)	Graminoid	*Carex radiata*
Herb (field)	Fern or fern ally	*Athyrium filix-femina*
		Polystichum acrostichoides
		Thelypteris noveboracensis

Characteristic Species: *Carex albolutescens, Carex laxiculmis, Carex swanii, Carya cordiformis, Festuca subverticillata, Leersia virginica, Liriodendron tulipifera, Lycopodium digitatum, Lycopodium obscurum, Platanus occidentalis, Sanicula canadensis, Thelypteris noveboracensis*.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	.	[not crosswalked]	.

Local Range: This association occurs on the Hog Hole Run flooplain or its tributaries.

Classification Comments: More hydric (seasonally flooded) stands of this vegetation (those along Hoghole Run) appear to be early-seral stages of *Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea* Forest (CEGL006605), and, undoubtedly, this type will become more evident with succession. Because the canopy has been disturbed by recent clearing, the characteristic woody species of this type are present at low cover or as seedlings, and tuliptree (*Liriodendron tulipifera)* and sweetgum (*Liquidambar styraciflua)* are more abundant, making differentiation between these two types at Thomas Stone National Historic Site on the basis of floristics difficult. For purposes of vegetation classification, the tributary stands and the Hoghole Run stands are treated as a single variable association, with the more hydric (seasonally flooded)

stands along Hoghole Run floodplain mapped with the National Wetland Inventory (NWI) (Cowardin et al. 1979) status of Seasonally Flooded and the less hydric (temporarily flooded) stands along the low slopes adjacent to the Hoghole Run floodplain and along the floodplains of the tributaries mapped with the NWI designation of Upland/Temporarily Flooded.

This association is evidently included in the concept of the Maple-Gum Association of the Western Shore District of Shreve et al. (1910). Meininger and McCarthy (1998) reported slippery elm (*Ulmus rubra*) but not American elm *Ulmus americana*) from the similar *Liquidambar styraciflua - Quercus palustris / Carpinus caroliniana / Carex intumescens* Forest of floodplains at Zekiah Swamp. Since *Ulmus americana* is the more common elm in this region and was seen frequently at Thomas Stone [slippery elm (*Ulmus rubra* was not seen at Thomas Stone National Historic Site)] and the two species are frequently confused, it seems possible that reports of *Ulmus rubra* from Zekiah Swamp by Meininger and McCarthy (1998) are actually based on *Ulmus americana*.

Other Comments: Kral's sedge (*Carex kraliana*), which is evidently near the northern limit of its (primarily southeastern United States) range and is presently known from only two Maryland sites, has been found in this vegetation type at Thomas Stone National Historic Site. A specimen collected at Thomas Stone National Historic Site was cited as a paratype in the description of the species (Naczi et al. 2002).

Local Description Authors: C. Lea.

Plots: 222, 302, 312, 421, 502, 511.

Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Liquidambar styraciflua - (Liriodendron tulipifera, Acer rubrum)* Temporarily Flooded Forest Alliance (A.287)
Alliance (English name)	Sweetgum - (Tuliptree, Red Maple) Temporarily Flooded Forest Alliance
Association	*Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* ssp. *triphyllum* Forest
Association (English name)	Sweetgum - Tuliptree / Northern Spicebush / Jack-in-the-Pulpit Forest
Ecological System(s):	Southern Piedmont Small Floodplain and Riparian Forest (CES202.323). Northern Atlantic Coastal Plain Stream and River (CES203.070).

GLOBAL DESCRIPTION

Concept Summary: These low-elevation forests develop along small streams in the Coastal Plain of Maryland and Virginia, extending west across the Virginia and North Carolina Piedmont to the Cumberland Plateau and Ridge and Valley. The topographic features of floodplains can heavily influence the individual makeup of examples of this association. Soils are relatively acidic. The canopy, subcanopy, shrub, and herbaceous layers often are well-developed. Dominant canopy species always include *Liquidambar styraciflua* and *Liriodendron tulipifera*, while *Acer barbatum* and *Acer rubrum* var. *rubrum* may also make up significant amounts of the canopy. This community type exists as a continuum between two subtypes, i.e., the tuliptree

subtype and the sweetgum subtype. In some examples, only one or the other dominates the canopy. However, in many examples, both are equally dominant. Common species in the canopy and understory include *Ilex opaca* var. *opaca, Aesculus sylvatica, Carpinus caroliniana* var. *caroliniana, Cornus florida, Fagus grandifolia, Juglans nigra, Morus rubra* var. *rubra, Ostrya virginiana* var. *virginiana, Oxydendrum arboreum, Pinus echinata, Prunus serotina* var. *serotina, Quercus alba, Quercus rubra* var. *rubra, Ulmus rubra, Ulmus americana, Ulmus alata, Juniperus virginiana* var. *virginiana, Nyssa sylvatica, Fraxinus americana, Halesia tetraptera* var. *tetraptera, Arundinaria gigantea* var. *gigantea, Cornus florida, Platanus occidentalis, Betula nigra*, and *Fraxinus pennsylvanica*. *Euonymus americanus, Lindera benzoin* var. *benzoin*, and *Corylus americana* are common and dominant in the shrub layer. The herbaceous layer is species-rich and often has good sedge development. The exotics *Microstegium vimineum, Ligustrum sinense*, and *Lonicera japonica* are common in this community.

Environmental Description: These forests develop along small streams. Soils are relatively acidic and relatively well-drained. Topographic differences from one floodplain to another, such as gradient and height above the creek, as well as floodplain microtopography (i.e., depositional landforms such as natural levees and sloughs) may influence the variation of vegetation within this association. However, in most floodplains supporting this type, the distinct alluvial landforms are poorly developed or occur at very small scales.

Vegetation Description: The canopy, subcanopy, shrub, and herbaceous layers of stands of this association are often well-developed. Dominant canopy species always include *Liquidambar styraciflua* and *Liriodendron tulipifera*, while *Acer barbatum* (in the southern part of the range) and *Acer rubrum* var. *rubrum* may also make up significant amounts of the canopy. This community type exists as a continuum between two subtypes, i.e., the tuliptree subtype and the sweetgum subtype. In some examples, only one or the other dominates the canopy. However, in many examples, both are equally dominant. Other common species in the canopy and understory include *Ilex opaca* var. *opaca, Aesculus sylvatica, Carpinus caroliniana* var. *caroliniana, Cornus florida, Fagus grandifolia, Juglans nigra, Morus rubra* var. *rubra, Ostrya virginiana* var. *virginiana, Oxydendrum arboreum, Pinus echinata, Prunus serotina* var. *serotina, Quercus alba, Quercus rubra* var. *rubra, Ulmus rubra, Ulmus americana, Ulmus alata, Juniperus virginiana* var. *virginiana, Nyssa sylvatica, Fraxinus americana, Halesia tetraptera* var. *tetraptera, Arundinaria gigantea* var. *gigantea*, and *Fraxinus pennsylvanica*. Scattered individuals of *Platanus occidentalis* and *Betula nigra* may also occur in some stands. *Euonymus americanus, Lindera benzoin* var. *benzoin*, and *Corylus americana* are common and dominant in the shrub layer. Other shrub species that may be present include *Viburnum acerifolium, Viburnum nudum* var. *nudum, Viburnum prunifolium, Viburnum rufidulum, Hamamelis virginiana, Asimina triloba*, and *Ilex decidua*, among others. On the most acidic sites of the Maryland Coastal Plain, *Clethra alnifolia, Vaccinium corymbosum*, and *Magnolia virginiana* may be present. Vines are prominent and include *Vitis rotundifolia, Apios americana, Campsis radicans, Aristolochia macrophylla, Bignonia capreolata, Dioscorea quaternata, Gelsemium sempervirens, Parthenocissus quinquefolia (=* var. *quinquefolia), Campsis radicans, Passiflora lutea, Smilax bona-nox, Smilax glauca, Smilax hugeri, Smilax rotundifolia*, and *Toxicodendron radicans* var. *radicans*. The herbaceous layer is species-rich and often has good sedge development. Common species in this layer include *Thalictrum thalictroides, Trillium cuneatum, Arisaema triphyllum, Asplenium platyneuron* var. *platyneuron, Botrychium virginianum, Carex* spp., *Carex impressinervia, Carex striatula, Galium circaezans, Geum canadense, Medeola virginiana, Polystichum acrostichoides*, and *Scutellaria integrifolia*, among many others. *Thelypteris*

noveboracensis is a common patch-dominant in the northern part of the range and the Uwharrie Mountains of North Carolina. The exotics *Microstegium vimineum, Ligustrum sinense*, and *Lonicera japonica* are common in this community. Other exotics that colonize quickly in disturbed and fragmented versions of this association include *Wisteria sinensis, Rosa multiflora, Clematis terniflora, Hedera helix*, and *Elaeagnus* sp.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
		Liriodendron tulipifera
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Euonymus americanus*
		Lindera benzoin var. *benzoin*
		Corylus americana
Herb (field)	Forb	*Arisaema triphyllum*
Herb (field)	Fern or fern ally	*Thelypteris noveboracensis*

Characteristic Species: *Liquidambar styraciflua, Liriodendron tulipifera*.
Other Noteworthy Species: *Carex impressinervia* (G1G2).
USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found in the Chesapeake Bay Lowlands, the Piedmont, and other low-elevation interior ecoregions (e.g., parts of the Cumberland Plateau and Ridge and Valley). It is defined as being absent from the Mid-Atlantic Coastal Plain of southeastern Virginia, the Carolinas, and Georgia. Its status in the Upper East Gulf Coastal Plain is unknown.
States/Provinces: GA, MD, NC, SC?, TN, VA.
Federal Lands: DOD (Fort Belvoir); NPS (Chickamauga-Chattanooga, Colonial, Cowpens, Fredericksburg-Spotsylvania, Guilford Courthouse, Kings Mountain, National Capital-East, Petersburg, Prince William, Richmond, Thomas Stone); USFS (Uwharrie).

CONSERVATION STATUS

Rank: G4 15-Feb-2007.
Reasons: This community is widespread from the Coastal Plain of Maryland and Virginia through the Piedmont of Virginia and North Carolina to the Cumberland Plateau. Very few streams supporting this type have impoundments or diversions, and most are protected by wetland regulations. However, few, if any, pristine examples remain, and all are highly threatened by invasive exotic species that have colonized most of the remaining examples of this association.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 3 - Weak.
Comments: Information not available.
Similar Associations:

- *Liquidambar styraciflua - (Liriodendron tulipifera)* Temporarily Flooded Forest (CEGL007330)--occurs in the same habitat but is a highly impacted version of this forest that occurs on old farm fields and other second-growth areas.
- *Liquidambar styraciflua* Forest (CEGL007216).
- *Liriodendron tulipifera - Acer rubrum - Liquidambar styraciflua / Medeola virginiana* Forest (CEGL006601).

Related Concepts:

- *Liquidambar styraciflua - Quercus palustris / Carpinus caroliniana / Carex intumescens* Forest (Meininger and McCarthy 1998) ?
- Maple-Gum Association of the Western Shore District (Shreve et al. 1910) B

SOURCES

Description Authors: R. K. Peet, mod. R. White, M. Pyne, G. P. Fleming**.**

References: Fleming et al. 2001, Meininger and McCarthy 1998, Naczi et al. 2002, Peet et al. unpubl. data 2002, Schafale and Weakley 1990, Shreve et al. 1910, Southeastern Ecology Working Group n.d.

Figure 19. Floodplain Forest in Thomas Stone National Historic Park (plot THST.421). July 2006.

Figure 20. Floodplain Forest in Thomas Stone National Historic Park (plot THST.502). July 2006.

COMMON NAME (PARK-SPECIFIC): UPLAND DEPRESSION SWAMP

SYNONYMS

USNVC English Name:	**Sweetgum - Red Maple - Willow Oak / Swamp Doghobble Forest**
USNVC Scientific Name:	***Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest**
USNVC Identifier:	**CEGL006110**

LOCAL INFORMATION

Environmental Description: This association occurs in depressions in uplands over a perched water table that is seasonally maintained by a relatively impermeable fragipan. The single large example seen was in an area mapped as Beltsville silt loam, within a matrix forest. Although they may have a small surface and groundwater recharge area, seasonal pools associated with a perched water table are recharged mainly by significant periods of precipitation and probably have lower amounts of nutrients delivered compared to wetlands with more predictable recharge regimes. Standing water may remain above the surface for long periods (weeks or more) in winter or early spring, as suggested by high water lines near tree bases. Increased rates of evapotranspiration typically cause rapid loss of water during the growing season, during which time the soil can be dry at the surface, but is generally moist a few centimeters below the surface. In the single example at Thomas Stone National Historic Site, the soil surface cover was comprised of about 15% bare soil and 85% poorly decomposed, water-stained leaves. A humus layer of about 2 cm depth was usually present at the soil surface, and the upper 2–3 cm of the soil column was stained brown with organic matter. Below this point, the soil column exhibited gleying with mottles to a depth of at least 25–30 cm and was yellow-orange from below this point to the top of the fragipan, which occurred at 25–60 cm depth, a pattern indicative of a perched water table with frequently fluctuating levels. The average soil pH (n=3) in the single example was 4.5.

Vegetation Description: The tree layer is relatively diverse and dominated by species tolerant of prolonged flooding, with sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and blackgum (*Nyssa sylvatica*) most numerous. Willow oak (*Quercus phellos*) and river birch (*Betula nigra*) are present. A few small individuals of white oak (*Quercus alba*) (which is common in the surrounding forest) occur on slightly elevated areas. The shrub layer is sparse and comprised mostly of sweetgum saplings and highbush blueberry (*Vaccinium corymbosum*). A sometimes dense, low growth of roundleaf greenbrier (*Smilax rotundifolia*) climbs on shrubs or the lower parts of trees or is freestanding. The herbaceous layer is very sparse, depauperate, and mostly limited to the rim of the pool, with green-white sedge (*Carex albolutescens*) characteristic and the most frequent species. Widely scattered individuals of wetland species such as soft rush (*Juncus effusus*), woolgrass (*Scirpus cyperinus*), and marsh seedbox (*Ludwigia palustris*) grow in the pool interior.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
		Quercus phellos
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Nyssa sylvatica
Tall shrub/sapling	Broad-leaved deciduous tree	*Liquidambar styraciflua*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Vaccinium corymbosum*
Herb (field)	Vine/Liana	*Smilax rotundifolia*
Herb (field)	Graminoid	*Carex albolutescens*
		Juncus effusus
		Scirpus cyperinus

Characteristic Species: *Carex swanii, Clethra alnifolia, Juncus tenuis, Ludwigia palustris, Parthenocissus quinquefolia, Quercus phellos, Toxicodendron radicans*.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	1	*Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest	Harrison 2004

Local Range: This association occurs in a single small patch east of the visitor center.

Classification Comments: Information not available.

Other Comments: Information not available.

Local Description Authors: C. Lea.

Plots: 603.

Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Seasonally flooded cold-deciduous forest (I.B.2.N.e.)
Alliance	*Liquidambar styraciflua - (Acer rubrum)* Seasonally Flooded Forest Alliance (A.321)
Alliance (English name)	Sweetgum - (Red Maple) Seasonally Flooded Forest Alliance
Association	*Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest
Association (English name)	Sweetgum - Red Maple - Willow Oak / Swamp Doghobble Forest
Ecological System(s):	Atlantic Coastal Plain Northern Basin Swamp and Wet Hardwood Forest (CES203.520).
	Atlantic Coastal Plain Northern Pondshore (CES203.518).

GLOBAL DESCRIPTION

Concept Summary: This association is a seasonally flooded forest of shallow basins and other depressions of the Coastal Plain of the Chesapeake Bay region. The substrate is characterized by mineral soils, generally acidic, gleyed to mottled, sandy or clay loams. Characteristic tree species include *Acer rubrum, Liquidambar styraciflua*, and *Nyssa sylvatica*, which are nearly constant in the canopy. Associates include *Ilex opaca, Magnolia virginiana, Nyssa biflora, Sassafras albidum, Quercus palustris, Pinus taeda*, and *Quercus phellos*, and occasionally *Quercus falcata, Quercus lyrata*, or *Betula nigra*. The shrub layer is characterized by *Leucothoe racemosa,*

Vaccinium corymbosum, Clethra alnifolia, Lindera benzoin, Ilex verticillata, and *Rhododendron viscosum*. *Smilax rotundifolia* is a particularly characteristic vine. The herbaceous layer is generally sparse but may include *Mitchella repens, Osmunda cinnamomea, Chasmanthium laxum, Woodwardia areolata, Onoclea sensibilis, Osmunda regalis, Carex albolutescens, Carex debilis* var. *debilis, Scirpus cyperinus, Juncus effusus*, and *Polygonum* spp. *Carex joorii* is inconstant but locally abundant in some stands in the southern part of the range.

Environmental Description: This type occurs in seasonally flooded shallow basins or depressions. Substrates are acidic, gleyed to mottled, sandy or clay loams. Sites are commonly flooded by perched groundwater to depths up to about 50 cm during the winter and early part of the growing season, but commonly are drawn down by late summer. Soils collected from 12 Virginia plot samples were extremely acidic (mean pH = 4.1) with very low cation levels and total base saturation.

Vegetation Description: Characteristic tree species include *Acer rubrum, Liquidambar styraciflua*, and *Nyssa sylvatica*, which are nearly constant in the canopy. *Quercus phellos* is an important associate or codominant in many stands. Other associates include *Ilex opaca, Magnolia virginiana, Nyssa biflora, Sassafras albidum, Quercus palustris, Pinus taeda*, and occasionally *Quercus falcata, Quercus lyrata*, or *Betula nigra*. The shrub layer is characterized by *Leucothoe racemosa, Vaccinium corymbosum, Vaccinium fuscatum, Vaccinium formosum, Clethra alnifolia, Lindera benzoin, Ilex verticillata*, and *Rhododendron viscosum*. *Smilax rotundifolia* is a particularly characteristic vine, often forming dense tangles among the shrubs. The herbaceous layer is generally sparse but may include *Mitchella repens, Osmunda cinnamomea, Chasmanthium laxum, Woodwardia areolata, Onoclea sensibilis, Osmunda regalis, Carex albolutescens, Carex debilis* var. *debilis, Scirpus cyperinus, Juncus effusus*, and *Polygonum* spp. *Carex joorii* is inconstant but locally abundant in some stands in the southern part of the range.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua*
		Quercus phellos
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum*
		Nyssa sylvatica
Tall shrub/sapling	Broad-leaved deciduous tree	*Liquidambar styraciflua*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Leucothoe racemosa*
		Vaccinium corymbosum
Herb (field)	Vine/Liana	*Smilax rotundifolia*
Herb (field)	Fern or fern ally	*Osmunda cinnamomea*
		Osmunda regalis
Herb (field)	Graminoid	*Juncus effusus*
		Scirpus cyperinus

Characteristic Species: *Liquidambar styraciflua, Quercus phellos, Leucothoe racemosa*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is a seasonally flooded forest of shallow basins and other depressions of the Coastal Plain of the Chesapeake Bay region.

States/Provinces: DE, MD, NJ:S3, NY:S1S2, PA, VA.

Federal Lands: DOD (Fort Belvoir, Yorktown); NPS (Colonial, Fredericksburg-Spotsylvania, National Capital-East, Thomas Stone); USFWS (Chesapeake Marshlands, Prime Hook).

CONSERVATION STATUS
Rank: G4G5 31-Jan-2007.
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 1 - Strong.
Comments: Delaware examples contain *Quercus* spp. and *Magnolia virginiana*. In Maryland, *Clethra* is more prominent than *Leucothoe, Quercus phellos* less characteristic than *Nyssa sylvatica*. Classification of this type is supported by two regional analyses of Maryland and Virginia plot data conducted by VDNH for the NCR vegetation mapping project. It is represented by 15 plots from the greater NCR region and an additional 57 plots from The Peninsula in York County, Virginia (Grafton Ponds complex). Delaware examples contain *Quercus* spp. and *Magnolia virginiana*. In Maryland, *Clethra* is more prominent than *Leucothoe, Quercus phellos* less characteristic than *Nyssa sylvatica*.
Similar Associations:

- *Acer rubrum / Lindera benzoin - Alnus serrulata Forest* (CEGL006953).
- *Pinus serotina / Magnolia virginiana / Vaccinium corymbosum / Carex atlantica* Woodland (CEGL006470).
- *Populus heterophylla - Acer rubrum - Quercus palustris - Liquidambar styraciflua* Forest (CEGL006469).
- *Quercus (phellos, pagoda, michauxii) / Ilex opaca* var. *opaca / Clethra alnifolia / Woodwardia areolata* Forest (CEGL004644).
- *Quercus palustris - (Quercus bicolor) - Acer rubrum / Vaccinium corymbosum / Osmunda cinnamomea* Forest (CEGL006240).
- *Quercus phellos / Carex (albolutescens, intumescens, joorii) / Climacium americanum* Forest (CEGL007403)--of the Virginia Piedmont and more southerly areas, dominated by *Quercus phellos.*

Related Concepts:

- *Leucothoe racemosa* communities (Tyndall et al. 1990) ?
- *Liquidambar-Acer* hardwood swamp (Breden 1989) ?

SOURCES
Description Authors: L. A. Sneddon, mod. E. Largay and G. P. Fleming.
References: Bowman 2000, Breden 1989, Breden et al. 2001, Brush et al. 1980, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Hunt 1998, Sneddon and Anderson 1994, Sneddon et al. 1996, Thomson et al. 1999, Tyndall et al. 1990, VDNH 2003.

Figure 21. Upland Depression Swamp in Thomas Stone National Historic Park (plot THST.603). July 2006.

Figure 22. Upland Depression Swamp in Thomas Stone National Historic Park (plot THST.603). July 2006.

COMMON NAME (PARK-SPECIFIC): SEEPAGE SWAMP

SYNONYMS

USNVC English Name:	**Red Maple - Blackgum - Sweetbay / Southern Wild Raisin / Cinnamon Fern - Netted Chainfern Forest**
USNVC Scientific Name:	***Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest**
USNVC Identifier:	**CEGL006238**

LOCAL INFORMATION

Environmental Description: This association is a partially open- to closed-canopy wetland forest associated with hillside or toeslope seepage. At Thomas Stone National Historic Site, it occurs along the gently sloping bottoms of ravines of tributary streams to Hoghole Run, within a matrix of upland forest. Hydrology is dominated by groundwater, and the soil is saturated to the surface probably essentially year round, with patches of standing to slowly flowing water usually present, except perhaps under very dry conditions. Vegetated areas are interspersed with flowing channels and standing pools of water. Soils are typically alternately muck or nearly pure gravelly sand. Areas in which stands of this type occur are mapped as Aura gravelly sandy loam. The water is generally assumed to be acidic but apparently only mildly so at Thomas Stone National Historic Site (5.7 to 6.2 at the two examples studied).

Vegetation Description: Red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*) in the uppermost tree layer characterize this type, which may be quite open in some examples. This layer is characterized best as a subcanopy. A canopy, if present, is usually comprised of species of trees rooted outside of the community and overhanging it. The subcanopy layer is dominated by sweetbay (*Magnolia virginiana*). The shrub layer is characterized by northern spicebush (*Lindera benzoin*), highbush blueberry (*Vaccinium corymbosum*), white fringetree (*Chionanthus virginicus*), and common winterberry (*Ilex verticillata*). The herbaceous layer occurs on hummocks of higher ground and along the edges of pools of water and includes skunk-cabbage (*Symplocarpus foetidus*), netted chainfern (*Woodwardia areolata*), and a number of wetland sedges [prickly bog sedge (*Carex atlantica),* weak stellate sedge *Carex seorsa),*bent sedge *(Carex styloflexa),* white edge sedge (*Carex debilis),* shallow sedge (*Carex lurida),* and others]. Peatmoss (*Sphagnum* sp.) and other mosses are common, but generally do not form extensive mats.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum*
		Nyssa sylvatica
Tree subcanopy	Broad-leaved evergreen shrub	*Magnolia virginiana*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Chionanthus virginicus*
		Lindera benzoin

Characteristic Species: *Boehmeria cylindrica, Carex atlantica* ssp. *atlantica, Carex atlantica* ssp. *capillacea, Carex debilis, Carex laevivaginata, Carex lurida, Carex seorsa, Carex styloflexa, Chelone glabra, Impatiens capensis, Leersia virginica, Magnolia virginiana, Oxypolis rigidior, Symplocarpus foetidus, Vaccinium corymbosum, Viburnum nudum, Viola cucullata, Woodwardia areolata*.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	1	*Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest	Harrison 2004

Local Range: This association occurs on the tributary streams of Hog Hole Run.
Classification Comments: Information not available.
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: 221, 321.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Saturated cold-deciduous forest (I.B.2.N.g.)
Alliance	*Acer rubrum - Nyssa sylvatica* Saturated Forest Alliance (A.348)
Alliance (English name)	Red Maple - Blackgum Saturated Forest Alliance
Association	*Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest
Association (English name)	Red Maple - Blackgum - Sweetbay / Southern Wild Raisin / Cinnamon Fern - Netted Chainfern Forest
Ecological System(s):	Atlantic Coastal Plain Northern Basin Peat Swamp (CES203.522). Atlantic Coastal Plain Northern Pitch Pine Lowland (CES203.374). Atlantic Coastal Plain Northern Basin Swamp and Wet Hardwood Forest (CES203.520).

GLOBAL DESCRIPTION

Concept Summary: This acidic swamp forest of the eastern middle-latitude states is a nutrient-poor wetland forest occurring in groundwater-saturated stream bottoms and poorly drained depressions. Soils are typically moderately deep to deep muck over mineral soil, with pools of standing water at the surface. Acidic waters originate from groundwater seepage, with little to no overland seasonal flooding. Most sites can be characterized as "groundwater slope wetlands" (*sensu* Golet et al. 1993) with a flow-through hydrology. This community is characterized by *Acer rubrum* and *Nyssa sylvatica* in the canopy, which may be quite open in some examples. Canopy associates include *Magnolia virginiana, Liquidambar styraciflua*, and *Persea palustris*, plus occasional incidental *Liriodendron tulipifera* or *Pinus taeda*. Upland trees may occur on drier hummocks. The shrub layer is characterized by *Vaccinium corymbosum*, as well as *Clethra alnifolia, Ilex verticillata, Ilex opaca, Viburnum nudum* var. *nudum, Lindera benzoin*, and *Rhododendron viscosum*. The herbaceous layer varies from dense to sparse and may include *Symplocarpus foetidus, Triadenum virginicum, Osmunda regalis* var. *spectabilis, Woodwardia areolata, Carex folliculata, Carex lonchocarpa, Carex collinsii, Carex atlantica, Bartonia paniculata, Parnassia asarifolia, Helonias bullata, Chelone glabra, Oxypolis rigidior*, and *Osmunda cinnamomea*. *Sphagnum* spp. and other mosses are common.
Environmental Description: This association is generally restricted to groundwater-saturated stream bottoms, seeping toeslopes, and poorly drained depressions with seepage inputs. Most

sites can be characterized as "groundwater slope wetlands" (*sensu* Golet et al. 1993) with a flow-through hydrology. Sites typically have hummock-and-hollow microtopography with braided channels, *Sphagnum*-covered hummocks, mucky depressions, and areas of exposed sand and gravel. Soils are extremely acidic and low in base status.

Vegetation Description: Canopy closure ranges from closed to quite open. Plot data from 38 Virginia and Maryland stands indicate that *Acer rubrum* and *Nyssa sylvatica* are consistently dominant overstory species. *Magnolia virginiana* is a frequent overstory associate and usually dominant in a subcanopy layer or codominant with *Ilex opaca*. *Liriodendron tulipifera* is a frequent but minor overstory associate, and *Pinus taeda* is occasional in the canopy. Trees tend to be slow-growing and of less than optimal stature in the wet, unstable habitats. Shrub layers tend to be dense and diverse, characteristically containing *Viburnum nudum* var. *nudum, Vaccinium corymbosum, Smilax rotundifolia, Ilex verticillata,* and *Lindera benzoin*. In parts of the range, *Clethra alnifolia* is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* and *Gaylussacia frondosa* are present. Additional, less constant shrub associates are *Rhododendron viscosum, Leucothoe racemosa, Chionanthus virginicus, Viburnum dentatum, Toxicodendron vernix,* and *Carpinus caroliniana*. The herb layer varies from dense to sparse. *Osmunda cinnamomea* and *Woodwardia areolata* are generally the most constant and abundant herbs, but *Symplocarpus foetidus* is a patch-dominant in approximately two-thirds of the Virginia and Maryland stands. Additional characteristic herbs occurring at low cover include *Arisaema triphyllum* var. *pusillum, Carex atlantica, Carex debilis* var. *debilis, Carex folliculata, Carex intumescens, Carex lonchocarpa, Carex seorsa, Carex styloflexa, Chelone glabra, Impatiens capensis, Lycopus virginicus, Mitchella repens, Osmunda regalis* var. *spectabilis, Platanthera clavellata, Viola cucullata,* and *Viola X primulifolia*. Regionally uncommon or rare species that may be locally abundant in this type include *Helonias bullata, Parnassia asarifolia, Carex collinsii,* and *Bartonia paniculata*.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum*
		Liquidambar styraciflua
		Nyssa sylvatica
Tall shrub/sapling	Broad-leaved deciduous shrub	*Clethra alnifolia*
		Vaccinium corymbosum
Herb (field)	Fern or fern ally	*Osmunda cinnamomea*
		Osmunda regalis
		Woodwardia areolata

Characteristic Species: *Acer rubrum, Magnolia virginiana, Nyssa sylvatica, Osmunda cinnamomea*.

Other Noteworthy Species: *Helonias bullata* (G3).

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community ranges from southeastern New York and New Jersey to southeastern Virginia on the Coastal Plain. In Virginia, it extends into the extreme eastern portion of the Piedmont.

States/Provinces: DC, DE, MD, NJ:S4S5, NY, PA, VA:S3?

Federal Lands: NPS (Assateague Island, George Washington Parkway?, National Capital-East, Prince William?, Richmond, Thomas Stone).

CONSERVATION STATUS

Rank: G3? (30-Mar-2004).

Reasons: The type is restricted to an uncommon wetland habitat in a limited region. It is vulnerable to alteration or destruction by beavers and various anthropogenic activities, including hydrologic modifications.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Information not available.

Similar Associations:

- *Acer rubrum - Nyssa sylvatica - Betula alleghaniensis / Sphagnum* spp. Forest (CEGL006014).
- *Acer rubrum - Nyssa sylvatica / Ilex verticillata - Vaccinium fuscatum / Osmunda cinnamomea* Forest (CEGL007853).
- *Pinus taeda / Morella cerifera / Osmunda regalis* var. *spectabilis* Forest (CEGL006137).

Related Concepts:

- *Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest (Fleming pers. comm.) =
- *Acer rubrum - Nyssa sylvatica / Magnolia virginiana / Woodwardia areolata - Symplocarpus foetidus* Saturated Forest (Patterson pers. comm.) ?
- *Acer rubrum - Quercus nigra - Nyssa sylvatica* swamp (Harvill 1967) ?
- Broadleaf swamp forest (Heckscher 1994) ?
- Cape May lowland swamp (Breden 1989) B
- Inland red maple swamp (Breden 1989) ?
- Pine barrens hardwood swamp (Breden 1989) B
- Woodland fresh marsh community (Hill 1986) ?

SOURCES

Description Authors: G. Fleming.

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Harrison and Stango 2003, Harvill 1967, Heckscher 1994, Hill 1986, McCormick 1979, Patterson pers. comm., Robichaud and Buell 1973, Sipple and Klockner 1984, VDNH 2003, Windisch 1995.

Figure 23. Seepage Swamp in Thomas Stone National Historic Park (plot THST.221). July 2006.

Figure 24. Seepage Swamp in Thomas Stone National Historic Park (plot THST.321). July 2006.

COMMON NAME (PARK-SPECIFIC): DRY MEADOW

SYNONYMS
USNVC English Name: **(Tall Fescue, Meadow Fescue) Herbaceous Vegetation**
USNVC Scientific Name: ***Lolium (arundinaceum, pratense)* Herbaceous Vegetation**
USNVC Identifier: **CEGL004048**

LOCAL INFORMATION

Environmental Description: This is a broadly described association that represents infrequently mowed meadows and pastures. At Thomas Stone National Historic Site, it occurs where the management purpose for vegetation is to maintain the cultural agrarian landscape important to the purposes of the site or to maintain utility line corridors. Mowing frequency is probably annual or less often, in order to allow grasses to grow tall enough to give a pasture or hayfield appearance but to inhibit woody shrub invasion.
Vegetation Description: Tall exotic grasses, particularly tall fescue [(*Lolium arundinaceum* (= *Festuca arundinacea*)], with orchard grass (*Dactylis glomerata*) and timothy (*Phleum pratense*) also frequent, heavily dominate this type. Occasionally, patches of native grasses, such as little bluestem (*Schizachyrium scoparium*), broomsedge bluestem (*Andropogon virginicus*), beaked panicgrass (*Panicum anceps*), and poverty oatgrass (*Danthonia spicata*) are locally dominant, especially on drier areas. Such patches may represent associations different from that described here. Tall, native and exotic, mostly perennial forbs (old-field weeds) are frequent. Since surveys were conducted in mid-summer, fall-blooming species such as *Solidago* spp. (goldenrods) and Asteraceae spp. (asters) may be better represented than is indicated here.
Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Dactylis glomerata*
		Lolium arundinaceum

Characteristic Species: *Allium vineale, Andropogon virginicus, Anthoxanthum odoratum, Apocynum cannabinum, Asclepias syriaca, Cyperus echinatus, Dactylis glomerata, Daucus carota, Diospyros virginiana, Lespedeza cuneata, Liquidambar styraciflua, Lolium arundinaceum, Panicum anceps, Phleum pratense, Poa pratensis, Solanum carolinense, Tridens flavus*.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	.	[not crosswalked]	.

Local Range: This association occurs at scattered locations within the park, along roads and adjacent to lawns and structures.
Classification Comments: Information not available.
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: None.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
Alliance	*Lolium (arundinaceum, pratense)* Herbaceous Alliance (A.1213)
Alliance (English name)	(Tall Fescue, Meadow Ryegrass) Herbaceous Alliance
Association	*Lolium (arundinaceum, pratense)* Herbaceous Vegetation
Association (English name)	(Tall Fescue, Meadow Fescue) Herbaceous Vegetation
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association includes grassland pastures and hayfields, more-or-less cultural, though sometimes no longer actively maintained. The dominant species in this type are the European "tall or meadow fescues" of uncertain and controversial generic placement. Several other exotic grasses (*Agrostis gigantea, Dactylis glomerata, Holcus lanatus, Phleum pratense*, and *Poa pratensis*, for example) are common associates. These communities are sometimes nearly monospecific but can also be very diverse and contain many native as well as exotic species of grasses, sedges, and forbs. Exotic forbs include the legumes *Lespedeza cuneata, Trifolium campestre, Trifolium hybridum, Trifolium pratense*, and *Trifolium repens*, as well as *Achillea millefolium, Calystegia sepium, Daucus carota, Leucanthemum vulgare, Oxalis stricta*, and *Plantago lanceolata*. Common native herbs include *Apocynum cannabinum, Desmodium canescens, Dichanthelium clandestinum, Erigeron annuus, Fragaria virginiana, Potentilla simplex, Solanum carolinense, Solidago canadensis*, and *Verbesina occidentalis*. This vegetation is currently defined for the central and southern Appalachians, Ozarks, Ouachita Mountains, and parts of the Piedmont and Interior Low Plateau, but it is possible throughout much of the eastern United States and southern Canada.

Environmental Description: This vegetation occurs on soils that have been disturbed.

Vegetation Description: The dominant species in this association are the European "tall or meadow fescues" of uncertain and controversial generic placement. Although traditionally treated as *Festuca pratensis (= Festuca elatior)* and *Festuca arundinacea*, these two closely related species are now usually treated as either *Lolium pratense* and *Lolium arundinaceum* (Kartesz 1999) or as *Schedonorus pratensis* and *Schedonorus arundinaceus*. These communities are sometimes nearly monospecific but can also be very diverse and contain many native species of grasses, sedges, and forbs. In the Black Belt region of Alabama and Mississippi, it is commonly found in mixture with *Paspalum dilatatum* (dallisgrass) (Bransby n.d.). The exotics *Lespedeza cuneata* and *Bromus tectorum* may be present in stands.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Hocus lanatus*
		Phleum pratense
		Poa pratensis
		Agrostis spp.
		Dactylis glomerata

Characteristic Species: Information not available.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This community ranges from southeastern New York and New Jersey to southeastern Virginia on the Coastal Plain. In Virginia, it extends into the extreme eastern portion of the Piedmont.

States/Provinces: AL, AR, GA, KY, MD, MO, MS, NB?, NC, NS?, OK, QC?, SC, TN, VA, WV.

Federal Lands: NPS (Big South Fork, Blue Ridge Parkway, Buffalo River, Carl Sandburg Home, Chickamauga-Chattanooga, Cowpens, Cumberland Gap, Fort Donelson, Great Smoky Mountains, Guilford Courthouse, Kings Mountain, Lincoln Birthplace, Mammoth Cave, Natchez Trace, New River Gorge, Ninety Six, Obed, Russell Cave, Shiloh, Stones River, Thomas Stone, Vicksburg); USFS (Cherokee, Ouachita, Ouachita (Coastal Plain)?, Ouachita (Mountains), Ozark).

CONSERVATION STATUS

Rank: GNA (invasive) (5-Jan-2000).

Reasons: This vegetation is dominated by an exotic species, is of anthropogenic origin, and is thus not a conservation priority.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Information not available.

Similar Associations:

- *Dactylis glomerata* - *Phleum pratense* - *Festuca* spp. - *Solidago* spp. Herbaceous Vegetation (CEGL006107).
- *Schizachyrium scoparium* - *Solidago* spp. Herbaceous Vegetation (CEGL006333).

Related Concepts:

- Cleared Areas (Schmalzer and DeSelm 1982) B

SOURCES

Description Authors: A. S. Weakley.

References: Bransby n.d., Heath et al. 1973, Hoagland 2000, Kartesz 1999, NatureServe Ecology - Southeastern U.S. unpubl. data, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data.

COMMON NAME (PARK-SPECIFIC): WOOLGRASS MARSH

SYNONYMS
USNVC English Name: **Woolgrass Bulrush Seasonally Flooded Herbaceous Vegetation**
USNVC Scientific Name: ***Scirpus cyperinus* Seasonally Flooded Herbaceous Vegetation**
USNVC Identifier: **CEGL006349**

LOCAL INFORMATION

Environmental Description: This type is confined to the narrow, permanently wet (possibly saturated) zone along the edge of the single pond where it occurs. The pond and edges are not natural, but the type is likely maintained by inhibition of the invasion of woody species by permanent saturation of the soil; it can probably be regarded as semi-natural within the USNVC. This vegetation occurs in less frequently flooded zones than *Sparganium eurycarpum* Herbaceous Vegetation (CEGL003323).
Vegetation Description: The single occurrence at Thomas Stone National Historic Site consists of a variety of wetland herbs and is dominated by graminoids. Some species identified as typical for the association which occur at Thomas Stone National Historic Site are woolgrass (*Scirpus cyperinus*), blunt spikerush (*Eleocharis obtusa*), soft rush (*Juncus effusus*), other rushes (*Juncus* spp.), and meadowbeauties (*Rhexia virginica, Rhexia mariana*).
Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Scirpus cyperinus*

Characteristic Species: *Eleocharis obtusa, Hypericum mutilum, Juncus acuminatus, Juncus effusus, Panicum rigidulum, Polygonum punctatum, Rhexia mariana, Rhexia virginica, Scirpus cyperinus.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNR	1	*Scirpus cyperinus* Seasonally Flooded Herbaceous Vegetation	Harrison 2004

Local Range: Information not available.
Classification Comments: This vegetation arguably also might be assigned to *Juncus effusus* Herbaceous Vegetation (CEGL004112). Classification of common marshes require additional data collection and analysis to increase the confidence of the taxonomy.
Other Comments: Information not available.
Local Description Authors: C. Lea.
Plots: None.
Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
Alliance	*Scirpus cyperinus* Seasonally Flooded Herbaceous Alliance (A.1386)
Alliance (English name)	Woolgrass Bulrush Seasonally Flooded Herbaceous Alliance

Association	*Scirpus cyperinus* Seasonally Flooded Herbaceous Vegetation
Association (English name)	Woolgrass Bulrush Seasonally Flooded Herbaceous Vegetation
Ecological System(s):	Laurentian-Acadian Wet Meadow-Shrub Swamp (CES201.582). Laurentian-Acadian Freshwater Marsh (CES201.594). High Allegheny Wetland (CES202.069).

GLOBAL DESCRIPTION

Concept Summary: This seasonally flooded marsh occurs in the northeastern United States. It is dominated or characterized by *Scirpus cyperinus*, but composition is variable. Associates include *Glyceria* spp., *Thelypteris palustris*, as well as other species of *Scirpus* including *Scirpus microcarpus (= Scirpus rubrotinctus)* and *Scirpus atrovirens*.

Environmental Description: Seasonally flooded marshes.

Vegetation Description: This community is dominated or characterized by *Scirpus cyperinus*. Composition is variable. Associates include *Glyceria* spp., *Thelypteris palustris*, as well as other species of *Scirpus*, including *Scirpus microcarpus (= Scirpus rubrotinctus)* and *Scirpus atrovirens*.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Scirpus cyperinus*

Characteristic Species: *Scirpus cyperinus.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This seasonally flood marsh occurs throughout the northeastern U.S. from Maine to West Virginia.

States/Provinces: CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV.

Federal Lands: NPS (Cape Cod, Thomas Stone); USFWS (Assabet River?, Chincoteague, Great Meadows?).

CONSERVATION STATUS

Rank: GNR (1-Dec-1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: Information not available.

Similar Associations:

- *Calamagrostis canadensis* - *Scirpus* spp. - *Dulichium arundinaceum* Herbaceous Vegetation (CEGL006519).

Related Concepts:

- Shallow emergent marsh (Cowardin et al. 1979) ?

SOURCES

Description Authors: R. E. Zaremba and L. A. Sneddon.

References: Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Harrison 2004.

COMMON NAME (PARK-SPECIFIC): WET MEADOW

SYNONYMS

USNVC English Name:	**Steeplebush - Blackberry species / Reed Canarygrass Shrubland**
USNVC Scientific Name:	***Spiraea tomentosa* - *Rubus* spp. / *Phalaris arundinacea* Shrubland**
USNVC Identifier:	**CEGL006571**

LOCAL INFORMATION

Environmental Description: This type includes all infrequently mowed areas with a high water table. It is most extensive and is primarily situated along the powerline right-of-way and other wet, infrequently mowed meadows along the Hoghole Run floodplain but may also include small-patch damp depressions within the dry meadow type.

Vegetation Description: This type is dominated by mesic to hydric graminoid species, with a variety of light-demanding forbs also present. It is characterized by a large component of obligate to near-obligate wetland species, by which it is distinguished from the dry meadow type *Lolium (arundinaceum, pratense)* Herbaceous Vegetation (CEGL004048).

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	Dichanthelium clandestinum

Characteristic Species: *Carex crinita, Carex lurida, Carex scoparia, Dichanthelium clandestinum, Helenium autumnale, Rhexia mariana, Rhynchospora capitellata, Solidago gigantea, Verbesina alternifolia.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk data:

State	State Rank	Confidence	State Name	Reference
MD	SNA	.	[not crosswalked]	.

Local Range: This association occurs along the powerline right-of-way and in scattered areas along the Hog Hole Run floodplain.

Classification Comments: This is a broadly defined type that is widely variable in species composition and in physiognomy. The global name is insufficient to portray the variation of this type in all its manifestations.

Other Comments: Information not available.

Local Description Authors: C. Lea.

Plots: None.

Thomas Stone National Historic Site Inventory Notes: Information not available.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class	Shrubland (III)
Physiognomic Subclass	Deciduous shrubland (III.B.)
Physiognomic Group	Cold-deciduous shrubland (III.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
Formation	Seasonally flooded cold-deciduous shrubland (III.B.2.N.e.)
Alliance	Spiraea tomentosa - Rubus spp. Seasonally Flooded Shrubland Alliance (A.3022)
Alliance (English name)	Steeplebush - Blackberry species Seasonally Flooded Shrubland Alliance

Association	*Spiraea tomentosa* - *Rubus* spp. / *Phalaris arundinacea* Shrubland
Association (English name)	Steeplebush - Blackberry species / Reed Canarygrass Shrubland
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This wet meadow vegetation of the northeastern states occurs in a variety of settings, most frequently in low-lying areas of old fields or pastures, or beaver-impacted wetlands. The physiognomy is complex and variable, ranging from shrub thicket to herbaceous meadow with scattered shrubs. Shrub species usually include *Spiraea tomentosa, Spiraea alba var. alba, Rubus allegheniensis, Rubus hispidus, Lonicera morrowii, Salix* spp., and others. *Hypericum densiflorum* often occurs in the Central Appalachians. Associated herbaceous species are also variable in composition, depending on land-use history. Usually seen are *Phalaris arundinacea, Solidago rugosa, Solidago canadensis, Juncus effusus, Scirpus cyperinus, Leersia oryzoides, Carex scoparia, Carex folliculata, Carex lurida, Carex lupulina, Carex vulpinoidea, Vernonia noveboracensis, Eupatorium maculatum, Eleocharis* spp., and others.

Environmental Description: This wet meadow vegetation of the northeastern states occurs in a variety of settings, most frequently in low-lying areas of old fields or pastures, or beaver-impacted wetlands.

Vegetation Description: The physiognomy is complex and variable, ranging from shrub thicket to herbaceous meadow with scattered shrubs. Shrub species usually include Steeplebush (*Spiraea tomentosa*), White Meadowsweet (*Spiraea alba var. alba*), Allegheny Blackberry (*Rubus allegheniensis*), Bristly Dewberry (*Rubus hispidus*), Morrow's Honeysuckle (*Lonicera morrowii*), Willow (*Salix* spp.), and others. Bushy St. John's-wort (*Hypericum densiflorum*) often occurs in the Central Appalachians. Associated herbaceous species are also variable in composition, depending on land-use history. Usually seen are Reed Canarygrass (*Phalaris arundinacea*), Wrinkleleaf Goldenrod (*Solidago rugosa*), Canada Goldenrod (*Solidago canadensis*), Soft Rush (*Juncus effusus*), Woolgrass Bulrush (*Scirpus cyperinus*), Rice Cutgrass (*Leersia oryzoides*), Broom Sedge (*Carex scoparia*), Northern Long Sedge (*Carex folliculata*), Sallow Sedge (*Carex lurida*), Hop Sedge (*Carex lupulina*), Fox Sedge (*Carex vulpinoidea*), New York Ironweed (*Vernonia noveboracensis*), Spotted Joe-pyeweed (*Eupatorium maculatum*), Spikerush (*Eleocharis*) spp., and others.

Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Rubus allegheniensis*
		Spiraea alba var. *alba*
		Spiraea tomentosa
Herb (field)	Forb	*Solidago canadensis*
		Solidago rugosa
Herb (field)	Graminoid	*Leersia oryzoides*
		Phalaris arundinacea

Characteristic Species: *Rubus allegheniensis.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: Although this vegetation is widespread, its range has not been evaluated. It is known from the Central Appalachian ecoregion and the Lower New England / Northern Piedmont ecoregions, and is likely in others.

States/Provinces: NJ.

Federal Lands: NPS (Allegheny Portage Railroad, Delaware Water Gap, Johnstown Flood, Thomas Stone); USFWS (Great Swamp).

CONSERVATION STATUS
Rank: GNR (8-Jul-1999).
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: Information not available.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES
Description Authors: L. A. Sneddon.
References: Decker 1955, Eastern Ecology Working Group n.d., Fike 1999, Sneddon 2008.

Vegetation Map Production

Production of the formation-level map resulted in the identification of seven formations as well as three land use categories (Table 6) (Figure 25). Lowland or submontane cold-deciduous forest comprised the great majority of land cover, both within the park (66%) and in the surrounding study area. Medium-tall sod temperate or subpolar grassland contributed to just over 25% of the land cover inside the park. Natural and semi-natural vegetation together formed 95% of the park's land cover, with just 5% comprised of non-vegetated areas or cultural vegetation such as lawns.

In order to produce an association-level vegetation map, the formation-level vegetation map was edited and refined. Based on the vegetation data analysis, each polygon was assigned one of the 10 mappable vegetation association types (Table 7). Areas of two of the 12 associations identified within the project area were too small to be mapped. The vegetation types were assigned using information from plot data, field observations, aerial photography signatures, and topographic maps. Polygon boundaries were also revised based on these four information sources. Several polygons with Anderson Level II attributes were changed in the vegetation association-level map. All polygons labeled Transportation, Communications and Utilities except the paved road on the eastern boundary of the park are vegetated and were reclassified to associations. The polygons labeled Commercial and Services on the formation-level map were replaced with Residential, the description of which more accurately reflects their land use. The third change was the addition of Reservoir to the association-level map, since this polygon was not delineated in the formation-level map. One additional ad hoc map unit, "Storm Residue," was delineated to account for the disturbed vegetation resulting from an April 2002 tornado that cut a swath nearly 250 m wide at its broadest point, in an east-west orientation, through the center of the park. The resulting final vegetation association map is shown in Figure 26, and a summary of the vegetation associations' distribution and abundance is provided in Table 8.

Table 6. U.S. National Vegetation Classification formation-level vegetation and Anderson Level II land use/land cover categories mapped in and around Thomas Stone National Historic Site.

Vegetation or Other Land Use Code	Description	Number of Hectares Mapped	
		Within park	Total
U.S. National Vegetation Classification formation-level vegetation codes (FGDC 1997, Grossman, et al. 1998)			
I.A.8.N.b	Rounded-crowned temperate or subpolar needle-leaved evergreen forest	0	15.8
I.B.2.N.a	Lowland or submontane cold-deciduous forest	86.5	282.1
I.B.2.N.e	Seasonally flooded cold-deciduous forest	2.7	5.9
I.B.2.N.g	Saturated cold-deciduous forest	0.04	0.04
I.C.3.N.a	Mixed needle-leaved evergreen - cold-deciduous forest	0	17.1
III.B.2.N.a	Temperate cold-deciduous shrubland	0	0.6
V.A.5.N.c	Medium-tall sod temperate or subpolar grassland	33.5	36.0
Level II land use/land cover codes (Anderson, et.al. 1976)			
11	Residential	3.9	13.5
12	Commercial and services	0.9	0.9
14	Transportation, communications, and utilities	1.7	16.4
	Totals	129.2	388.3

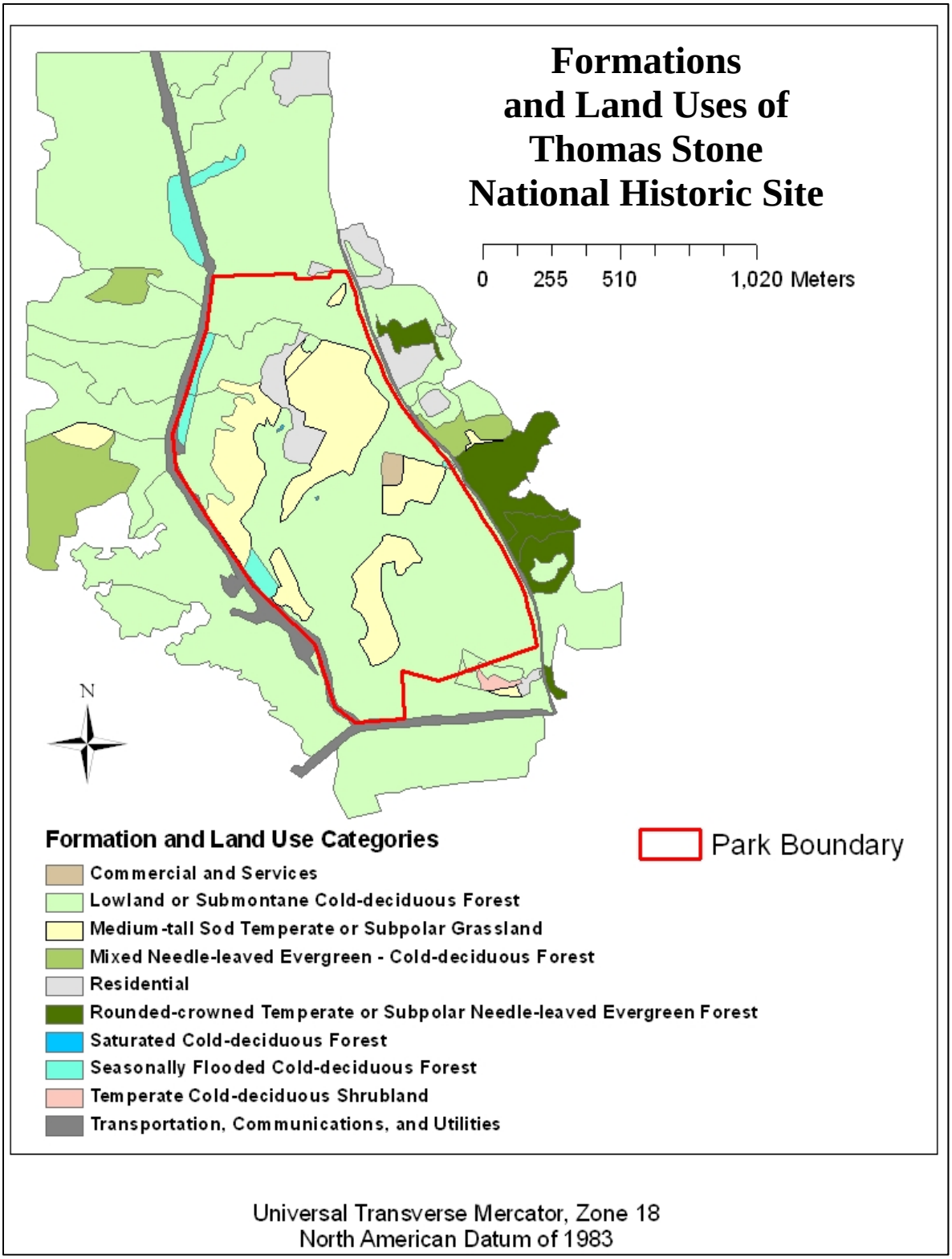


Figure 25. Formation map of Thomas Stone National Historic Site. Note: Mapped area outside the park is less than that of the association map (southwestern portion of project area was not mapped).

Table 7. U.S. National Vegetation Classification (USNVC) numbers and names, and plot numbers of associations identified at Thomas Stone National Historic Park (THST).

CEGL00 #	THST Common Name	USNVC Common Name	USNVC\ Scientific name	Plot numbers
2591	Pine - Oak Forest	Virginia Pine Successional Forest	*Pinus virginiana* Successional Forest	201, 211
6075	Dry Mesic Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	*Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / Polystichum acrostichoides* Forest	301, 311, 322
7216	Sweetgum Forest	Successional Sweetgum Forest	*Liquidambar styraciflua* Forest	None
7220	Early Succsessional Mesic Forest	Successional Tuliptree Forest (Circumneutral Type)	*Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest	202, 212, 401, 411
8521	Oak - Heath Forest	Mixed Oak / Heath Forest (Piedmont / Central Appalachian Low-Elevation Type)	*Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest	131, 402, 412, 422, 431, 501, 601, 602
6976	Depositional Bar	River Birch - (Sycamore) Forest	*Betula nigra - (Platanus occidentalis)* Forest	None
4418	Floodplain Forest	Piedmont / Ridge and Valley Small Stream Sweetgum - Tuliptree Forest	*Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* var. *triphyllum* Forest	222, 302, 312, 421, 502, 511
6110	Upland Depression Swamp	Red Maple - Sweetgum Swamp	*Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest	603
6238	Seepage Swamp	Southern Red Maple - Blackgum Swamp Forest	*Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest	221, 321
6571	Wet Meadow	Steeplebush – Blackberry spp. / Reed Canarygrass Shrubland	*Spiraea tomentosa – Rubus* spp. / *Phalaris arundinacea* Shrubland	None
4048	Dry Meadow	(Tall Fescue, Meadow Fescue) Herbaceous Vegetation	*Lolium (arundinaceum, pratense)* Herbaceous Vegetation	None
6349	Woolgrass Marsh	Woolgrass Bulrush Seasonally Flooded Herbaceous Vegetation	*Scirpus cyperinus* Seasonally Flooded Herbaceous Vegetation	None

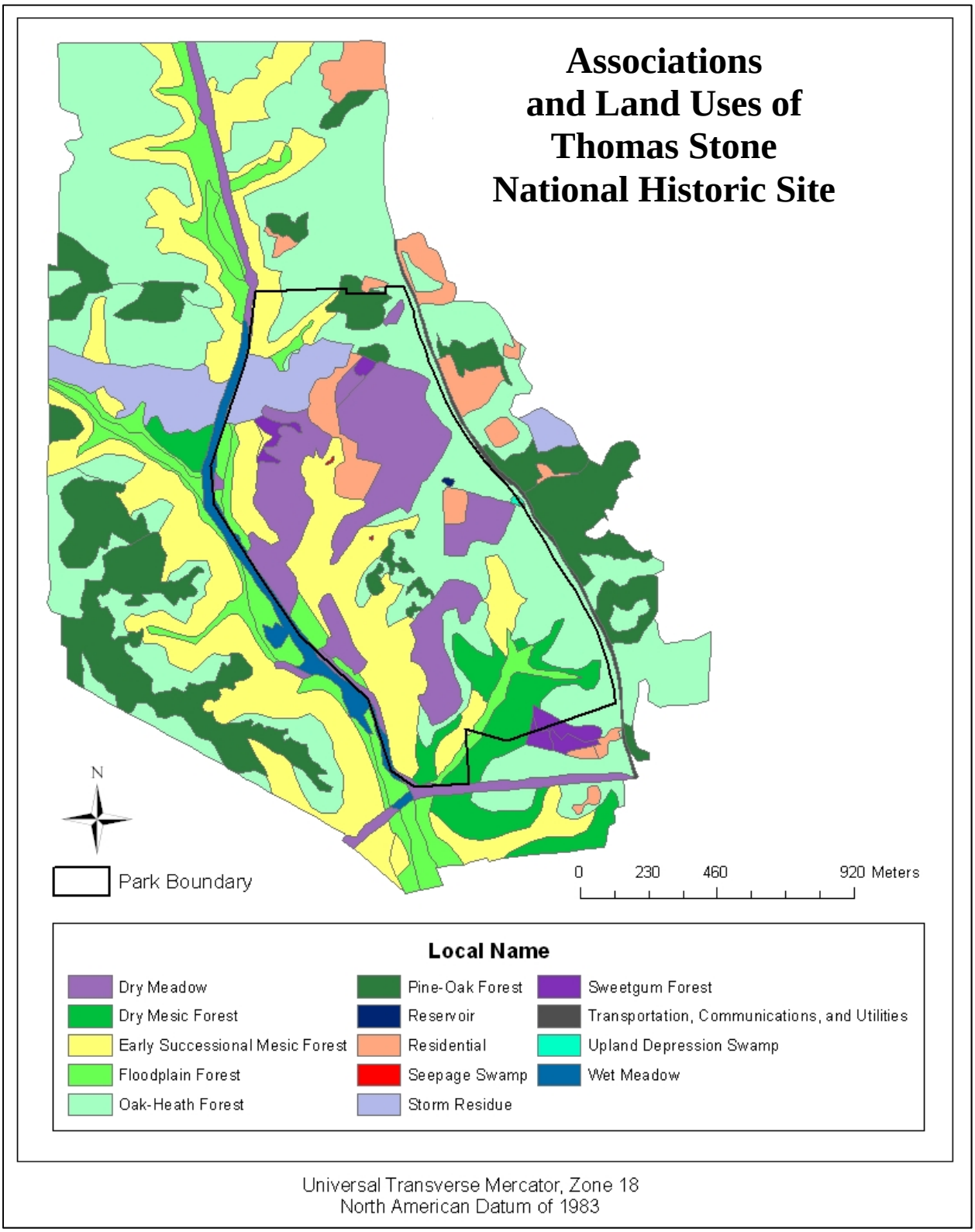


Figure 26. Vegetation association map of Thomas Stone National Historic Site. Note: Depositional Bar and Woolgrass Marsh associations are not depicted on this map. Storm Residue refers to the swath of disturbed vegetation caused by the April 2002 tornado.

Table 8. Mapped extent within the park and project area for vegetation associations and Anderson Level II land cover categories at Thomas Stone National Historic Site.

Map Class	Size of map class within park boundary (ha)	Size of map class in map project area (ha)	% of map class in project area represented within park boundaries
Dry Meadow	35.19	40.82	86.2%
Residential (Anderson type 11)	4.79	15.63	30.6%
Storm Residue	6.16	16.62	37.1%
Pine - Oak Forest	5.01	54.24	9.2%
Oak - Heath Forest	30.49	146.51	20.8%
Dry Mesic Forest	13.77	18.06	76.2%
Early Successional Mesic Forest	27.60	65.57	42.1%
Floodplain Forest	4.29	28.89	14.8%
Sweetgum Forest	1.89	3.46	54.7%
Seepage Swamp	0.04	0.04	100.0%
Upland Depression Swamp	0.11	0.11	100.0%
Wet Meadow	0.00	6.96	0.0%
Reservoir (Anderson type 53)	0.09	1.97	4.8%
Transportation, communications, and utilities (Anderson type 14)	0.00	1.89	0.0%
Depositional Bar	point locations only	point locations only	point locations only
Woolgrass Marsh	point locations only	point locations only	point locations only
ALL CLASSES	129.28	389.95	33.2%

Accuracy Assessment

Positional Accuracy

The final horizontal positional accuracy of the leaf-on and leaf-off orthophoto mosaics is 0.960 m and 0.987 m, respectively, both of which meet the Class 1 National Map Accuracy Standard (FGDC 1998b). A copy of each spreadsheet, containing the x and y coordinates for each ground control point and the accuracy calculation formula, is included in the air photo archive.

Thematic Accuracy

Overall accuracy for the vegetation association map (all accuracy assessment points pooled) was 82.8%, with a 90% confidence interval of 71.0 to 94.7%, and a Kappa statistic accuracy of 79.7%. If the user's accuracy rates for each class are weighted by the class areas in the map (excluding the two classes for which accuracy assessment data were not collected), then the overall map accuracy weighted by class area is 82.2%. The weighted accuracy rate is of some interest to the user because it better represents the probability that a given area on the ground will be correctly mapped, regardless of map class membership. Individual class producer and user accuracy rates, with 90% confidence intervals are summarized in Table 9.

Map classes representing managed vegetation (Dry Meadow and Residential) and the Storm Residue class (areas of downed trees felled by the 2002 tornado) were easily recognized, and had a high accuracy rate (100%). Map classes representing other vegetation (i.e., most natural vegetation corresponding to USNVC associations) had a 74.2% user's accuracy. Accuracy rates, confidence intervals, and Kappa statistics for these groups are depicted in Table 10.

Project Deliverables

Final products of the vegetation mapping project are shown in Table 11. All products have been delivered by NatureServe to the National Park Service with this report.

Table 9. Contingency table for thematic accuracy assessment for Thomas Stone National Historic Site vegetation map, showing producer's and user's accuracies and 90% confidence intervals by map class.

	DM	RE	SR	PO	OH	DM	ESM	FP	SG	SS	UD	**Total**	**Producer Accuracy (1-rate of errors of comission) (% correct)**	Upper limit, 90% confidence interval (% correct)	Lower limit, 90% confidence interval (% correct)
Dry Meadow (DM)	**29**											**29**	**100.0**	100.0	98.3
Residential (RE) Mosaic		**5**										**5**	**100.0**	100.0	90.0
Storm Residue (SR)			**11**									**11**	**100.0**	100.0	95.5
Pine - Oak Forest (PO)				**2**	3							**5**	**40.0**	86.0	0.0
Oak - Heath Forest (OH)					**23**	3	2		2			**30**	**76.7**	91.0	62.3
Dry Mesic Forest (DM)						**11**						**11**	**100.0**	100.0	95.5
Early Successional Mesic Forest (ESM)				1	1	5	**20**	3	1	1		**32**	**62.5**	78.1	46.9
Floodplain Forest (FP)								**4**				**4**	**100.0**	100.0	87.5
Sweetgum Forest (SG)									**4**			**4**	**100.0**	100.0	87.5
Seepage Swamp (SS)								1		**1**		**2**	**50.0**	100.0	0.0
Upland Depression Swamp (UD)											**1**	**1**	**100.0**	100.0	50.0
Total	**29**	**5**	**11**	**3**	**27**	**19**	**22**	**8**	**7**	**2**	**1**	**134**			
User Accuracy (1-rate of errors of omission) (% correct)	**100.0**	**100.0**	**100.0**	**66.7**	**85.2**	**57.9**	**90.9**	**50.0**	**57.1**	**50.0**	**100.0**				
Upper limit 90% confidence interval (% correct)	100.0	100.0	100.0	100.0	98.3	79.2	100.0	85.3	95.1	100.0	100.0				
Lower limit 90% confidence interval (% correct)	98.3	90.0	95.5	5.2	72.1	36.6	78.6	14.7	19.2	0.0%	50.0				

OVERALL ACCURACYs: 82.8 %
90% CONFIDENCE INTERVAL (71.0%–94.7%)
KAPPA STATISTIC: 79.7%

Table 10. Overall map classification accuracies, 90% confidence intervals, and Kappa statitsics for (1) all map classes, (2) natural vegetation classes, and (3) managed vegetation and storm residue classes for Thomas Stone National Historic Site vegetation map.

Map Classes	% Accuracy	Upper Limit 90% Confidence Interval	Lower Limit 90% Confidence Interval	Kappa Statistic
all map classes	82.8%	94.7%	71.0%	79.7%
natural vegetation	74.2%	82.4%	66.0%	66.5%
managed vegetation and storm residue	100.0%	100.0%	88.2%	100.0%

Table 11. Summary of products resulting from the Thomas Stone National Historic Site vegetation classification and mapping project.

Product	Spatial FGCD-complaint metadata
Aerial photos, including flight line map and photoindex	Yes
Othophoto mosaic as paper copy and in digital format	Yes
Annotated field forms with vegetation plot sampling data	Not applicable
Vegetation plot sampling data in the PLOTS 2.0 database	Not applicable
Differentially corrected GPS locations of vegetation plots	Yes
Annotated field forms with thematic accuracy assessment data	Not applicable
Thematic accuracy assessment data in the PLOTS 2.0 database	Not applicable
Differentially corrected GPS locations of thematic accuracy assessment sampling points	Yes
Digital photos representative of all vegetation types	Not applicable
Final map of vegetation associations as paper copy and in digital format	Yes
Final report as paper copy and in digital format	Not applicable

Discussion

Vegetation Classification and Characterization

The associations described for Thomas Stone National Historic Site generally appear to be equivalent to current (NatureServe Explorer 2001) USNVC associations, and it is expected that the descriptions and map units which represent them can be readily crosswalked into revised units, should such an update be necessary.

Thomas Stone National Historic Site lies in the Inner Coastal Plain (Western Shore District of the Coastal Zone of Shreve et al. (1910)) of Maryland. This area is floristically more related to the outer Piedmont than it is to the outer Coastal Plain, and types described at Thomas Stone National Historic Site follow vegetation patterns similar to those described at Rock Creek Park (The Nature Conservancy 1998), with identical or analogous types occurring in similar environmental situations. The highly dissected topography and hydrological conditions at Thomas Stone National Historic Site are largely responsible for the 12 natural/semi-natural vegetation types, a surprisingly high number occurring within only 93 ha of primarily natural vegetation. These include four forest types of dry environments and two forest types of mesic environments. Patterns of anthropogenic disturbance also contribute to this diversity by producing a gradient of forest seral stages. In general, the upland types appear to be fairly widespread types occurring in the Piedmont and perhaps other physiographic provinces, while floodplain and wetland types are more likely to be found to be characteristic of the Coastal Plain only in Maryland or the Coastal Plain and Piedmont in Virginia.

The three environmental factors determining vegetation type at Thomas Stone National Historic Site are (1) topographic position/slope/soil (all highly correlated), (2) hydrologic regime, and (3) seral stage. Table 12 shows the strong correlations between soil series and vegetation association.

Four dry forest associations dominate natural vegetation of the upland (interfluve) areas of Thomas Stone National Historic Site, which are primarily of low slope and underlain by soils of the Beltsville and Exum series (Hall and Mathews 1974). The four dry forest associations include two early successional forests, Pine – Oak Forest and Sweetgum Forest, and two mature dry forest types, Dry Mesic Forest and Oak – Heath Forest. A single small area with a seasonally flooded hydrology (upland depression) supports a small patch wetland association Upland Depression Swamp. An anthropogenic wetland supports two Natural/Semi-natural wetland associations, Woolgrass Marsh and Wet Meadow. Where the forest has been cleared for maintenance of the historic scene, two altered types are present: Residential (Anderson type 11), and Dry Meadow.

Two Natural/Semi-natural associations dominating moderate to steep upland slopes occupied by the Aura, Croom, Mattapex, or Sassafras soil series are the Early Successional Mesic Forest and the Dry Mesic Forest. The former association appears to be an early seral expression of the latter. Where lower parts of upland slopes merge with ravine bottoms, local areas of saturated surface hydrology (seepages) support a small patch Seepage Swamp association.

Table 12. Frequency of plots and observation points at Thomas Stone National Historic Site by soil series (see Figure 2) and topographic position.

Topographic Position →	**(LEVEL) UPLANDS**						
			SLOPES				
						BOTTOMLANDS	
Series → (% of park mapped as the series)	**Beltsville silt loams (57.5%)**	**Exum silt loams (5.2%)**	**Sassafras sandy loams (3.1%)**	**Aura gravelly sandy loams (24.4%)**	**Croom gravelly loams (3.8%)**	**Mattapex fine sandy loams (3.4%)**	**Bibb silt loams (2.6%)**
Oak - Heath Forest	18			2			
Pine - Oak Forest	9						
Dry Mesic Forest	2			13	2	1	
Early Successional Mesic Forest	2			17		1	
Floodplain Forest -hydric phase	1			7	2	1	
Floodplain Forest						1	6
Upland Depression Swamp	1						
Seepage Swamp				4			

Four Natural/Semi-natural associations occur on bottomlands (low to moderate slopes underlain by the Aura, Mattapex, or Bibb soil series). These are temporarily to seasonally flooded and occupy a gradient of less hydric to more hydric situations (e.g., from higher to lower order streams, from a topographically higher and less frequently flooded to a lower and more frequently flooded position on the same floodplain, and/or from a position over a water table deeper below the soil surface to one over a more shallow water table). The Floodplain Forest occurs along ravine bottoms of lower order streams and probably on relatively higher positions of the Hoghole Run floodplain. The Upland Depression Swamp association occurs along the floodplain of higher order streams (Hoghole Run), and the Depositional Bar occurs within the channel of higher order streams. In wet areas in which the floodplain has been cleared for utility line corridors, small patches of Wet Meadow occur.

For some forest associations, all or most of the stands present at Thomas Stone National Historic Site are relatively early seral examples, due to relatively recent land clearing. They are identifiable to existing USNVC types, but, as early successional examples, are somewhat atypical.

Because of the historic importance of American chestnut (*Castanea dentata*) in dry upland forests of the Western Shore noted by Shreve et al. (1910), it is possible that this species was once a component of drier forests at Thomas Stone National Historic Site. Floristic studies

should search for American chestnut saplings or other evidence of the possible former frequency of this species.

Vegetation Map Production

The final vegetation association map for lands within and adjacent to Thomas Stone National Historic Site includes ten associations (seven semi-natural types and three types of recent anthropogenic origin), as well as three Anderson Level II categories and a Storm Residue map class. This map is based on aerial photography that was flown in the spring and fall of 2003. Since that time, the vegetation in and around the park has continued to change due to succession and management. Despite these changes, the vegetation map produced by this project provides crucial baseline data for park resource managers.

Accuracy Assessment

All classes for which at least 20 accuracy assessment points were collected exceeded the Vegetation Mapping Program program target of 80%. Among classes with more than 10 accuracy assessment points, the Dry Mesic Forest class was most problematic, with a 57.9% user's accuracy (11 of 19 points correct), with the upper confidence interval limit slightly below 80%. This class was under-mapped and confused with two similar, and often adjacent, classes: the Early Successional Mesic Forest class (5 of 19 points) and Oak - Heath Forest (3 of 19 points). If the Dry Mesic class is combined with the former class, user's accuracy increases to 87.8%, and, if combined with the latter class, user's accuracy increases to 80.4%. Confusion of the Dry Mesic class with the Early Successional Mesic Forest class is understandable because the abundance of *Liriodendron tulipifera* can be quite high in the former, and is always high in the latter. It was noted during the accuracy assessment that stands that had high canopy abundance of *L. tulipifera* (and, therefore, appeared to be the Early Successional Mesic Forest), but had understory and herbaceous layers more characteristic of the drier Dry Mesic Forest, often occurred on sites more exposed to solar radiation (convex versus concave slopes). Some spatial analysis suggested that the two types might be effectively modeled from stands with strong canopy dominance by *L. tulipifera* in future mapping efforts by applying a hillshade or other solar radiation model to *L. tulipifera* dominated stands in order to better predict the floristic composition below the canopy.

T-tests on accuracy rates, as recommended by the USGS/NPS VMP protocols were not computed. The protocols were written before any National Park Service vegetation mapping projects using the USNVC were attempted. Consequently, the difficulty of mapping at the USNVC association level was not fully appreciated, nor was the tradeoff between thematic resolution and thematic accuracy (classes can be merged to achieve higher accuracy, but at a consequential loss of thematic resolution). Class accuracy rates with confidence intervals and the map class (vegetation) descriptions should be adequate information for a user to construct his/her own map that contains map classes that represent the most informed balance between thematic resolution and accuracy for a particular application. It may be desirable to merge map classes to achieve 80% or greater accuracy when portraying all park vegetation for general perspective (a traditional map).

Recommendations for Future Projects

Invasive exotic plant species are the main threat to the native vegetation at Thomas Stone National Historic Site, particularly in the abandoned agricultural fields, on forest edges, and along trails and roads. The most common and problematic species include multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), and Japanese stilt grass (or Nepalese browntop) (*Microstegium vimineum*). The park is served by the NER Exotic Plant Management Team based out of Shenandoah National Park and efforts should continue to provide invasive species management through this venue.

The Dry Meadow association contains particularly high abundances of invasive shrub and herb species. These fields maintain historic spatial significance contributing to the cultural landscapes of the park, and as such, will not be managed to allow succession to native forest types. Current management plans recommend transitioning to native warm-season grasses.

This mapping project relied on NPS park staff at Thomas Stone National Historic Site for vegetation sampling. This proved to be an efficient way to collect and synthesize data for the project. Where time and expertise allow, we recommend this strategy for future vegetation classification and mapping projects.

Literature Cited

Anderson, J. R., E. E. Hardy, and J. T. Roach. 1976. Land use and land cover classification system for use with remote sensing data. Geological Survey Professional Paper 964. United States Government Printing Office, Washington, DC.

Becking, R. W. 1957. The Zurich-Montpelier School of Phytosociology. Botanical Review 23:411–488.

Braun, E. L. 1950. Deciduous forests of eastern North America. Macmillan Publishing Co, New York, NY.

Bray, J. R.. and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27:325–349.

Chambers, A. 1994. Now available: ERDAS IMAGINE ® V8.7 from Leica Geosystems. Atlanta, GA. http://www.erdas.com/Company/News/NewsReleases/04-12-17/Now_Available_ERDAS_IMAGINE%c2%ae_V8_7_from_Leica_Geosystems.aspx.

Chambers, A. 2004. Directly create and update content for a geodatabase with Stereo Analyst for ArcGIS. Atlanta, GA. http://www.erdas.com/Company/News/NewsReleases/04-05-05/Directly_Create_and_Update_Content_for_a_Geodatabase_with_Stereo_Analyst_for_ArcGIS.aspx.

Cleaves, E. T., J. Edwards, Jr., and J. D. Glaser, eds. and compilers. 1968. Geologic map of Maryland. Maryland Geological Survey, Annapolis, MD.

DeNadai, M. W., J. D. Milner, J. R. Rivoire, E. Brabec, and K. Kirby. 1994. Cultural landscape report, National Park Service, Thomas Stone National Historic Site. Unpublished report to the National Park Service.

Environmental Systems Research Institute, National Center for Geographic Information and Analysis, and The Nature Conservancy (ESRI, NCGIA, and TNC). 1994. Accuracy assessment procedures, NBS/NPS VMP. Retrieved October 2001 from http://biology.usgs.gov/npsveg/aa/aa.html.

Environmental Systems Research Institute, Inc. (ESRI). 2001–2005. ArcMap 9.1. Environmental Systems Research Institute, Inc., 380 New York St., Redlands, CA 92373.

Environmental Systems Research Institute, Inc. (ESRI). 2003. ArcGIS 8: The complete geographic information system. An ESRI® White paper. ESRI, Redlands, CA. 32 pp.

Eyre, F. H. 1980. Forest Cover Types of the United States and Canada: Society of American Foresters, Washington, DC. 148 pp.

Federal Geographic Data Committee--Vegetation Subcommittee. 1997. Vegetation Classification Standard. FGDC-STD-005. June 1997. Available: http://biology.usgs.gov/fgdc.veg.

Federal Geographic Data Committee (FGDC). 1998a. Content standard for digital geospatial metadata (FGDC-STD-001-1998). Retrieved October 2001 from http://www.fgdc.gov/metadata/contstan.html.

Federal Geographic Data Committee (FGDC). 1998b. Geospatial positioning accuracy standards, Part 3: National Standard for Spatial Data Accuracy. (FGDC-STD-007.3-1998). Retrieved October 2001 from http://www.fgdc.gov/standards/status/sub1_3.html.

Fleming, G. P., P. P. Coulling, D. P. Walton, K. M. McCoy, and M. R. Parrish. 2001. The natural communities of Virginia: classification of ecological community groups. First approximation. Natural Heritage Technical Report 10-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.

Fleming, G. P., K. Taverna, and P. Coulling. 2007. Classification of natural communities for National Capital Parks – East Region. Unpublished report. Virginia Department of Conservation and Recriation, Division of Natural Heritage. Richmond, VA.

Foody, G. M. 1992. On the Compensation for Chance Agreement in Image Classification Accuracy Assessment. Photogrammetric Engineering and Remote Sensing, 58:1459–1460.

Gailey, D. W. and J. Shrout. 1993. Forest stewardship plan for Thomas Stone National Historic Site. Unpublished report to the National Park Service.

Garmin. 2006. GPSMAP76 Owner's manual. Garmin International, Inc. Olathe, KS. 78 pp.

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: Terrestrial vegetation of the United States (draft). The Nature Conservancy, Arlington VA.

Hall, R. L., and E. D. Mathews. 1974. Soil survey of Charles County, Maryland. U. S. Department of Agriculture Soil Conservation Service. Washington, DC.

Hill, M. O. 1979. TWINSPAN - A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Cornell University, Ithaca, NY.

Jennings, M., D. Faber-Langendoen, R. Peet, O. Loucks, A. Damman, M. Barbour, D. Glenn-Lewin, D. Roberts, D. Tart, R. Pfister, S. Talbot, J. Walker, G. Hartshorn, G. Waggoner, M. Abrams, D. Grossman, A. Hill, M. Rejmanek, and M. Walker. 2004. Guidelines for describing associations and alliances of the U.S. National Vegetation Classification. Version 4.0 The Ecological Society of America Vegetation Classification Panel.

Lance, G. N., and W. T. Williams. 1966. A generalized sorting strategy for computer classifications. Nature 212:218.

Lance, G. N., and W. T. Williams. 1967. A general theory of classification sorting strategies. The Computer Journal 9:373–380.

Lea, C., NatureServe, Virginia Natural Heritage Program, West Virginia Natural Heritage Program, Maryland Natural Heritage Program, and National Park Service (S. C. Gawler, ed.). 2003. Vegetation types in National Capital Region parks. Draft report to National Park Service.

Ludwig, J. A., and J. F. Reynolds. 1988. Statistical ecology: a primer on methods and computing. John Wiley and Sons, New York, NY.

McCune, B., and M. J. Mefford. 1999. PC-ORD. Multivariate Analysis of Ecological Data, Version 3.04. MjM Software Design, Gleneden Beach, OR.

Meininger, J., and K. McCarthy. 1998. Forest communities of Zekiah Swamp nontidal wetland of special state concern. Maryland Department of Natural Resources Wildlife and Heritage Division. Annapolis, MD. Unpublished report.

Minnesota Governor's Council on Geographic Information and Minnesota Land Management Information Center. October 1999. Positional accuracy handbook, using the National Standard for Spatial Data Accuracy to measure and report geographic data quality. http://server.admin.state.mn.us/resource.html?Id=1852 (October 2001).

National Park Service (NPS). 1990a. General management plan recommended development actions – Thomas Stone National Historic Site, Maryland.

National Park Service (NPS). 1990b. Interpretive prospectus – Thomas Stone National Historic Site, Maryland.

NatureServe Explorer: an online encyclopedia of life [web application]. 2001. Version 1.6. Arlington, VA: NatureServe. Available: http://www.natureserve.org (Accessed November 30, 2004).

Schmidt, M. F., Jr. 1993. Maryland's geology. Tidewater Publishers, Centreville, MD.

Shreve, F., M. A. Chrysler, F. H. Blodgett, and F. W. Besley. 1910. The Plant Life of Maryland. Maryland Weather Service. Special Publication, Vol. III. Johns Hopkins Press, Baltimore, MD.

Skiffington, J. 2010. LizardTech's MrSID Technology. LizardTech, Seattle, Washington. 20 pp. http://www.lizardtech.com/files/geo/datasheets/MG4_White_Paper.pdf

Sneddon, L. A. (ed.) 1993. Field form instructions for the description of sites and terrestrial, palustrine, and vegetated estuarine communities. Version 2. The Nature Conservancy. Eastern Heritage Task Force, 201 Devonshire Street, Boston, Massachusetts 02110

Snedecor, G. W., and W. G. Cochran. 1976. Statistical Methods. Ames, Iowa: The Iowa State University Press.

Steury, B. 2002. A brief survey of the vascular plants of the Thomas Stone National Historic Site (with some natural history notes on butterflies, dragonflies, birds, reptiles, and amphibians). Report to the National Park Service.

The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994a. NBS/NPS Vegetation Mapping Program: field methods for vegetation mapping. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA.

The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994b. NBS/NPS Vegetation Mapping Program: standardized national vegetation classification system. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA.

The Nature Conservancy (TNC). 1998. NBS/NPS Vegetation Mapping Program: Vegetation Classification of Rock Creek Park. The Nature Conservancy, Eastern Regional Office, Boston MA.

Thomson, D., A. M. A. Gould, and M. A. Berdine. 1999. Identification and protection of reference wetland communities in Maryland: Potomac watershed floodplain forests. Report to the U. S. Environmental Protection Agency. Maryland Department of Natural Resources, Wildlife and Heritage Division, Annapolis, MD.

Trimble Publications Group. 2002. GPS Pathfinder Office Getting Started Guide, version 2.90, Revision A. Trimble Navigation Limited, Sunnyvale, CA. 156 pp.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2006. Soil survey tabular database for Charles County, Maryland. U.S. Department of Agriculture, Natural Resouces Conservation Service, Fort Collins, Colorado. http://SoilDataMart.nrcs.usda.gov

United States Geological Survey (USGS). 1994. Standardized national vegetation classification system. USGS-NPS Vegetation Mapping Program. 30 March 2006. http://biology.usgs.gov/npsveg/classification/sect5.html.

United States Geological Survey (USGS). 2004. Tools for creation of formal metadata, a compiler for formal metadata. Retrieved June 2004 from http://geology.usgs.gov/tools/metadata/tools/doc/mp.html.

Appendix A. Summary of key information for Thomas Stone National Historic Site leaf-off (spring) orthophoto mosaic.

Title of metadata record	Thomas Stone National Historic Site Color Infrared Orthorectified Photomosaic-Leaf-off (ERDAS Imagine IMG and MrSID formats)
Publication date of orthophoto mosaic (from metadata)	October 2003
Date aerial photography was acquired	February 18, 2002
Vendor that provided aerial photography	Kucera International
Scale of photography	1:6,000
Type of photography	Color infrared, stereo pairs
Number of air photos delivered	10
Archive location of air photos, airborne GPS and IMU files, and camera calibration certificate	USGS Earth Resources Observation and Science (EROS) Center
Scanning specifications	600 dpi, 24-bit color depth
Horizontal positional accuracy of orthophoto mosaic	0.987 m, meets Class 1 National Map Accuracy Standard
Number of ground control points upon which estimated accuracy is based	23
Method of calculating positional accuracy	Root mean square error
Archive location of orthophoto mosaic and metadata	North Carolina State University, Center for Earth Observation
Formats of archived orthophoto mosaic	.img (uncompressed) and MrSID (20:1 compression)

Appendix B. Summary of key information for Thomas Stone National Historic Site leaf-on (fall) orthophoto mosaic.

Title of metadata record	Thomas Stone National Historic Site Color Infrared Orthorectified Photomosaic-Leaf-on (ERDAS Imagine IMG and MrSID formats)
Publication date of orthophoto mosaic (from metadata)	October 2003
Date aerial photography was acquired	November 8, 2002
Vendor that provided aerial photography	Kucera International
Scale of photography	1:6,000
Type of photography	Color infrared, stereo pairs
Number of air photos delivered	10
Archive location of air photos, airborne GPS and IMU files, and camera calibration certificate	USGS Earth Resources Observation and Science (EROS) Center
Scanning specifications	600 dpi, 24-bit color depth
Horizontal positional accuracy of orthophoto mosaic	0.960 m, meets Class 1 National Map Accuracy Standard
Number of ground control points upon which estimated accuracy is based	23
Method of calculating positional accuracy	Root mean square error
Archive location of orthophoto mosaic and metadata	North Carolina State University, Center for Earth Observation
Formats of archived orthophoto mosaic	.img (uncompressed) and MrSID (20:1 compression)

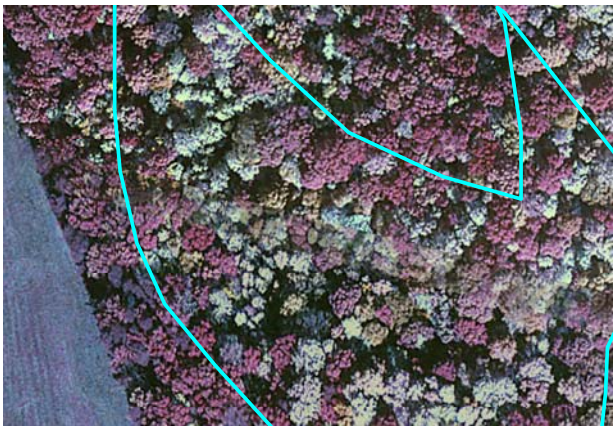
Appendix C. Summary of key information for Thomas Stone National Historic Site formation-level vegetation dataset.

Title of metadata record:	Thomas Stone National Historic Site Formation-Level Vegetation and Fire Fuel Models
Publication date (from metadata):	October 2003
Archive location of dataset and metadata:	North Carolina State University, Center for Earth Observation
Formats of archived dataset:	ESRI personal geodatabase and ESRI shapefile

Appendix D. Aerial photograph interpretation keys to selected formation- and association-level vegetation types at Thomas Stone National Historic Site. Approximate easting and northing coordinates in UTM meters (NAD-83) are given for the northeast and southwest corners of each image; image scale is approximately 1:2400

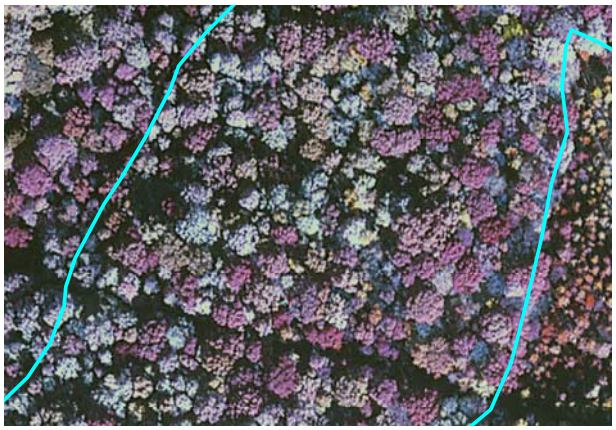
Dry Mesic Forest

322700 E 4266165 N



322522 E 4266037 N

322829 E 4265953 N



322642 E 4265815 N

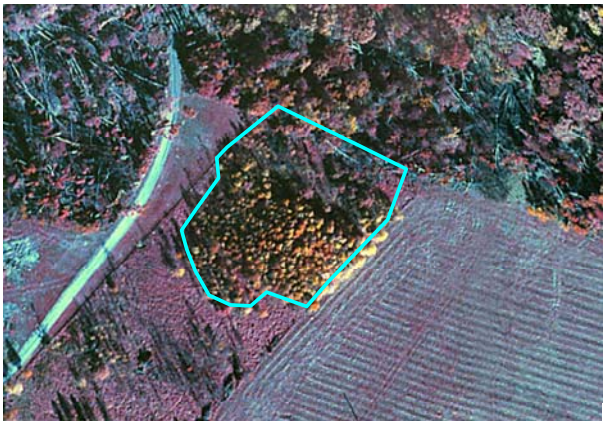
Figure 27. Comparison of Oak - Heath Forest (on left) with Dry Mesic Forest (on right).

Description:

Mixed crown signatures, with very light tuliptree (*Liriodendron tulipifera*), and pink to red signature indicates white oak (*Quercus alba*) and northern red oak (*Q. rubra*), with occasionalsweetgum (*Liquidambar styraciflua*). Fairly readily distinguished from Oak - Heath Forest, which has mixed color crowns, but without the lighter-colored species (*L. tulipifera* and *L. styraciflua*) and with occasional dark Virginia Pine (*Pinus virginiana*) crowns, and is generally restricted to the level uplands, rather than ravine slopes. The Dry Mesic Forest intergrades with the Early Successional Mesic Forest (see description for that map unit), and the two can be difficult to distinguish.

Sweetgum Forest

322354 E 4267149 N



322168 E 4267012 N

322939 E 4265929 N

322753 E 4265800 N

Figure 28. Two examples of Sweetgum Forest (upper polyon in photo on right).

Description:
Most stands are comprised of saplings. The combination of the characteristic yellow-orange color of sweetgum crowns and the pattern of dense, small crowns (in sapling stands) makes this class easily identified.

Early Successional Mesic Forest

322198 E 4266435 N

322044 E 4266303 N

322049 E 4266066 N

321866 E 4265928 N

Figure 29. Two examples of Early Successional Mesic Forest.

Description:
The signature is similar to that of the Dry Mesic Forest, but with a generally higher proportion of the light-colored crowns of tuliptree (*Liriodendron tulipifera*), and generally with smaller, more even-sized crowns. Its typical position on sites with less solar exposure than the Dry Mesic Forest is a moderately useful identifier.

Oak - Heath Forest

322485 E 4266099 N

322299 E 4265961 N

322543 E 4266561 N

322357 E 4266423 N

Figure 30. Two examples of Oak - Heath Forest.

Description:

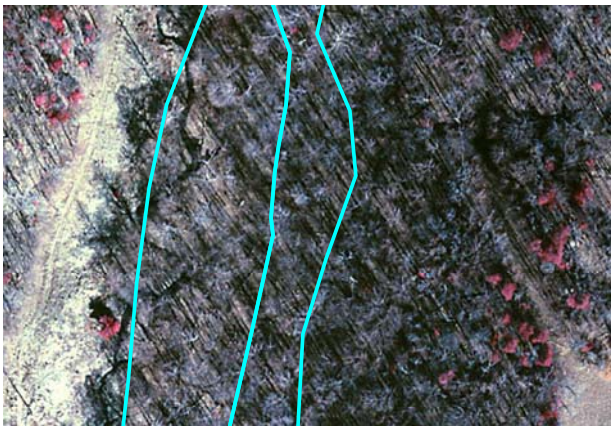
Dominated by pink colored crowns of white oak (*Quercus alba*) and and darker red crowns of scarlet (*Quercus coccinea*), southern red (*Q. falcata*), and black (*Q. velutina*) oaks. Some American beech (*Fagus grandifolia*) crowns should be visible, but could not be distinguished with certainty (color is likely similar to white oak). Occasional Virginia pine (*Pinus virginiana*) crowns have a dark red signature and this species dominates much of the level upland area that is not cleared.

Floodplain Forest

321912 E 4266879 N

321726 E 4266741 N

321912 E 4266879 N



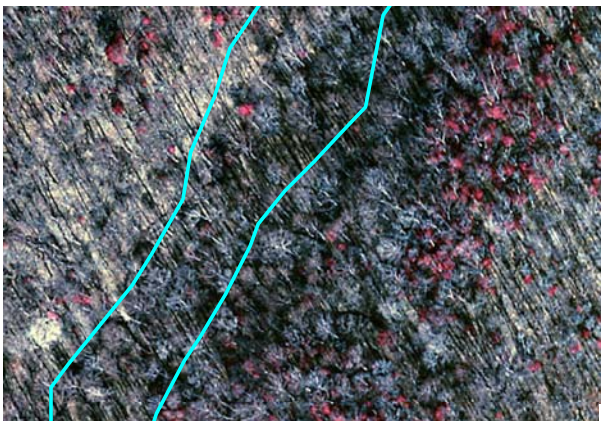
321726 E 4266741 N

Figure 31. Floodplain Forest, (compared to Early Successional Mesic Forest (right-most polygon): October imagery at left, February imagery at right. Note: second polygon from left is a longer hydroperiod, and third polygon from left has a shorter hydroperiod.

322800 E 4266006 N

322614 E 4265868 N

322800 E 4266006 N



322614 E 4265868 N

Figure 32. Floodplain Forest (middle polygon depicts shorter hydroperiod) compared to Early Successional Mesic Forest (left-most polygon); October imagery at left, February imagery at right.

Description:

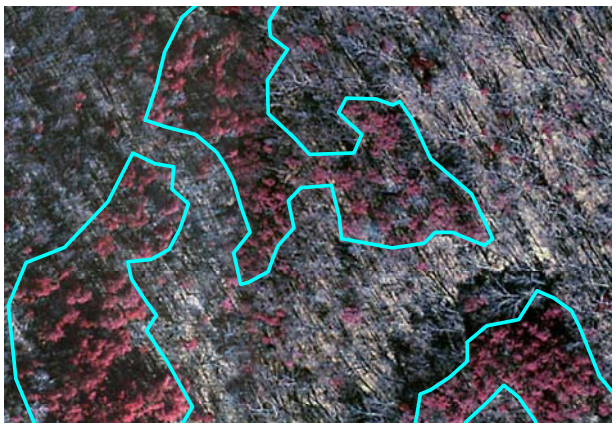
Signature is very similar to that of Early Successional Mesic Forest, but with less dominance by the light-colored tuliptree (*Liriodendron tulipifera*). Best delineation is by topographic position along stream bottoms; winter scenes on the right allow the type to be delineated by the difference in shading of the ground between stream bottoms and adjacent slopes. Red (evergreen) crowns visible in winter scenes are likely American holly (*Ilex opaca*). The upper pair of photos is from a stand along Hoghole Run. The lower pair of photos is from a stand along a small tributary to Hoghole Run.

Pine - Oak Forest

322455 E 4266471 N

322270 E 4266333 N

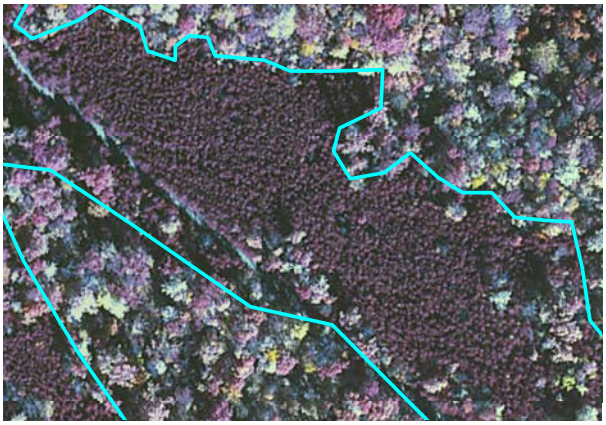
322455 E 4266471 N



322270 E 4266333 N

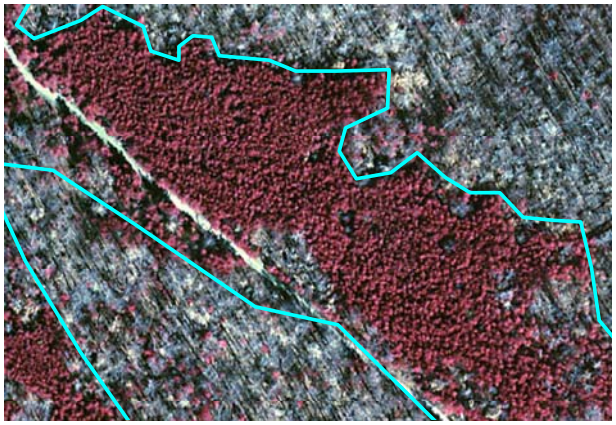
Figure 33. Pine - Oak Forest (three polygons in upper central and lower corners of photo) compared to Oak - Heath Forest (large contiguous polygon), October imagery; Pine - Oak Forest, February imagery (on right).

322065 E 4265886 N



321878 E 4265750 N

322065 E 4265886 N



321878 E 4265750 N

Figure 34. Pine - Oak Forest, second example, depicted by dark red signature, October imagery, and February imagery on right.

Description:

Easily distinguished in winter scenes by the small,dense crowns of red (evergreen) Virginia pine (*Pinus virginiana*). In fall scenes, Virginia pine is evident as small, purple crowns among the reddish to pink hardwood crowns. Transitional stands are distinguished from the Oak - Heath Forest by the higher frequency of Virginia pine in the canopy and by generally smaller average crown size of both pines and hardwoods. In the upper pair of images, older Virginia pines occur in the canopy over a subcanopy dominated by young hardwoods (a mixed deciduous-evergreen stand). The lower pair of images depicts a presumably younger stand that is strongly dominated by Virginia pine (evergreen stand).

Appendix E. Plot data collection form.

A. General Information

Plot Number:_____ Park Name:_____

Survey date: _____ Surveyors:_____

Easting: _ _ _ _ _ _ _ E Northing:_ _ _ _ _ _ _ _ N EPE/APE:_____ DOP:_____ Map datum: _____ Zone:_____

B. Environmental Description

Representative sketch of stand and landscape position

Picture No.:_____

Slope: _____

Aspect: _____

Elevation: _____

Stoniness:

__ Stone free <0.1%
__ Moderately stony 0.1-1%
__ Stony 3-15%
__ Very stony 15-50%
__ Exceedingly stony 50-90%
__ Stone piles >90%

Topographic position:

___ Interfluve (ridgetop) ___ Low slope
___ High slope ___ Toe slope
___ High level ___ Low level
___ Midslope ___ Channel wall
___ Backslope ___ Channel bed
___ Step in slope ___ Basin Floor
___ Other: _____

Hydrologic regime:

___ Permanently flooded
___ Semi-permanently flooded
___ Seasonally flooded
___ Intermittently flooded
___ Temporarily flooded
___ Artificially flooded
___ Saturated (wet, but never flooded)

Average soil texture:

___ sand ___ clay loam
___ sandy loam ___ clay
___ loam ___ peat
___ silt loam ___ muck
___ other:_____

Soil drainage:

___ Rapidly drained
___ Well drained
___ Moderately well drained
___ Somewhat poorly drained
___ Poorly Drained
___ Very poorly drained

Soil profile description: note depth, texture, and color of each horizon. Note significant changes such as depth to mottling, depth to water table, root penetration depth

Horizon	Depth	Texture	Color	pH	Comments

Unvegetated surface:

_____ % Bedrock
_____ % Litter, duff
_____ % Large rocks (> 10 cm)
_____ % Wood (> 1 cm)
_____ % Small rocks (0.2-10 cm)
_____ % Water
_____ % Sand (0.1-2 mm)
_____ % Bare soil
_____ % Other:_____

Plot representativeness: Note homogeneity of vegetation in plot versus rest of community

Environmental Comments: Note surrounding vegetation, landscape context, herbivory, stand health, recent/historic anthropogenic evidence, etc.

C. Vegetation 38. System: _____Terrestrial _____Palustrine _____Estuarine 39. Plot number:_____ 40. Plot dimersions__ _____

41. Leaf type:
__Broad-leaf
__Semi-broad leaf
__Semi-needle leaf
__Needle-leaf
__Graminoid
__Broad-leaf herbaceous
__Pteridophyte

42. Leaf phenology:
__Decidous
__Semi-decidous
__Semi-Evergreen
__Evergreen
__Perennial
__Annual

43. Physiognomic type:
__Forest
__Sparse woodland
__Shrubland
__Dwarf shrublnad
__Sparse dwarf shrubland
__Non-vascular
__Woodland
__Scrub thicket
__Sparse shrubland
__Dwarf scrub thicket
__Herbaceous
__Sparsely vegetated

44.

	height	% cover
TI Emergent tree		
T2 Tree canopy		
T3 Tree sub-canopy		
S1 Tall shrub		
S2 Short shrub		
H Herbaceous		
N Non-vascular		
E Epiphyte		
V Vine / liana		

45. Species / Percent cover: starting with uppermost stratum, list all species and % cover for each in the stratum. For forests and woodlands, list on a separate line below each tree species the DBH of all trees about 10 cm diameter. Separate the measurements with a comma and note whether in cm or inches.

Appendix F. Plots 2.0 database metadata.

These metadata describe the primary tables and their variables in the Plots 2.0 database holding the vegetation plots data.

Table	Field	Meaning	Comment re THST
Plots	Plot Code	unique identifier assigned by PLOTS using 4-letter park code and sequential numbers	
Plots	Field Plot Name	plot as identified on field form	
Plots	County		
Plots	SubPlot	was plot a sub-unit of a larger plot?	
Plots	SubPlot Parent Code	identifier of larger plot if this is a subplot	n/a for THST
Plots	Air Photo Number	reference number for aerial photo that covers the plot area	
Plots	Polygon Code	identifier of polygon on vegetation map in which plot falls	
Plots	Map Unit	name of map class for polygon in which plot falls	
Plots	Classified Community Name	standard association name from the National Vegetation Classification	
Plots	USNVC ELCODE	standard element code from the National Vegetation Classification	
Plots	Sublocation	narrative for location of plot within the park	
Plots	Quad Name	name of USGS 7.5' quadrangle in which plot falls	
Plots	Quad Code	standardized code for USGS quadrangle	
Plots	Coord System	coordinate system used for geographic location of plots: "1" if UTM, "2" if latitude/longitude	
Plots	GPS File	name of file in which coordinates are stored	
Plots	GPS Techniques	type of GPS unit used to secure location plus any applicable comments	
Plots	Field UTM X	X UTM coordinate as recorded in field	
Plots	Field UTM Y	Y UTM coordinate as recorded in field	
Plots	Corrected UTM X	corrected X UTM coordinate if post-processing is used	n/a for THST as no post-processing was used
Plots	Corrected UTM Y	corrected Y UTM coordinate if post-processing is used	n/a for THST as no post-processing was used
Plots	UTM Zone	UTM zone	
Plots	Survey Date	date field data were taken	
Plots	Surveyors	field personnel	
Plots	Plot Directions	detailed directions to plot using ground landmarks	
Plots	X Dimension	length of side of plot in m	
Plots	Y Dimension	width of plot in m	

Table	Field	Meaning	Comment re THST
Plots	Plot Shape	square, rectangular, round, etc.	Combination for THST
Plots	Photos	yes/no	
Plots	Roll Number	roll number for film photos	
Plots	Frame Number	frame number for film photos; file name for digital photos	
Plots	Permanent	is plot permanent? Yes/No	
Plots	Representativeness	narrative for how representative of community plot seems to be	
Plots	Elevation	plot average elevation above mean sea level	in meters
Plots	Elevation Units	"1" = meters, "2" = feet	
Plots	GPS Datum	Datum used by GPS	NAD83 for THST
Plots	GPS Accuracy	as recorded in field	
Plots	Slope	slope category (pick-list)	Flat = 0º; Gentle = 0–5º; Moderate = 6–14º; Somewhat steep = 15–25º; Steep = 27–45º; Very steep = 45–69º; Abrupt = 70–100º; Overhanging/sheltered = 100º
Plots	Precise Slope	slope measurement	in degrees
Plots	Sope range	range of slope, where uphill and downhill values are given	
Plots	Aspect	aspect category (pick-list)	Flat; Variable; N 338–22º; NE 23–67º; E 68–112º; SE 113–157º; S 158–202º; SW 203–247º; W 248–292º; NW 293–337º
Plots	Precise Aspect	measured aspect in True degrees	
Plots	Topo Position	topographic position of plot (pick-list)	Crest/Summit/Ridge ; Upper/Shoulder Slope ; High Plateau ; Middle Slope ; Slope step (terracette) ; Lower Slope ; Toe slope ; Low level/terrace ; Channel wall ; Channel bed ; Depression
Plots	Landform	landform on which plot occurs (pick-list)	Bar ; Basin ; Beach. ; Bluff/bank ; Channel ; Cliff ; Cove ; Delta ; Dome ; Drumlin ; Dune ; Escarpment ; Esker ; Estuary ; Flat ; Floodplain ; Gorge ; Hill ; Kame ; Kettle ; Lake /pond; Ledge ; Moraine ; Mountain ; Outwash plain ; Oxbow ; Plain ; Plateau ; Ravine ; Ridge ; Saddle ; Swale ; Talus ; Terrace ; Valley ; Other
Plots	Surficial Geology	geologic setting (pick-list)	Bedrock ; Talus ; Glacial till; Moraine; Esker/outwash; Glacial delta; Lacustrine/; fluvial; Marine; Aeolian ; Other
Plots	Cowardin System	broad wetland classification from Cowardin 1979	Upland, Palustrine, Estuarine, Riverine, Lacustrine

Table	Field	Meaning	Comment re THST
Plots	Hydro Regime	hydrologic regime (wetlands only)	Permanently Flooded ; Semipermanetly Flooded ; Seasonally Flooded ; Saturated ; Temporarily Flooded ; Intermittently Flooded ; Tidally Flooded
Plots	Salinity/Halinity		
Plots	Hydrology Evidence	notes on evidence used to deduce hydrologic regime	
Plots	Environmental Comments	narrative description of the habitat	
Plots	Landscape Comments	narrative description of the surrounding area	
Plots	Soil Taxon/Description	narrative of soil profile	
Plots	Soil Texture	soil texture class	sand ; sandy loam ; loam ; silt loam ; silt ; clay loam ; clay ; peat ; muck
Plots	Soil Depth	depth to obstruction	
Plots	Soil Depth Units	1=meters, 2=cm, 3=feet, 4=inches	cm
Plots	Soil Drainage	drainage category (pick-list)	rapidly drained ; well drained ; moderately well drained ; somewhat poorly drained ; poorly drained ; very poorly drained
Plots	% Bedrock	% unvegetated ground surface covered	
Plots	% Large Rocks	% unvegetated ground surface covered	
Plots	% Small Rocks	% unvegetated ground surface covered	
Plots	% Sand	% unvegetated ground surface covered	
Plots	% Litter, Duff	% unvegetated ground surface covered	
Plots	% Wood	% unvegetated ground surface covered	
Plots	% Water	% unvegetated ground surface covered	
Plots	% Bare Soil	% unvegetated ground surface covered	
Plots	% Other	if "other" is used as a ground surface cover category	
Plots	% Other Description	if "other" is used as a ground surface cover category	
Plots	Leaf Phenology	Of dominant stratum	Evergreen, Cold-deciduous, Mixed evergreen-cold-deciduous, Herb - annual, Herb - perennial
Plots	Leaf Type	Of dominant stratum	Broad-leaved, Needle-leaved, Microphyllous, Graminoid, Broad-leaved herbaceous, Pteridophyte, Nonvascular

Table	Field	Meaning	Comment re THST
Plots	Physio Class	physiognomic Class according to USNVC hierarchy; applies to dominant stratum (highest stratum with at least 25% cover)	Forest (>60% tree canopy -crowns overlapping), Woodland (25%–60% open tree canopy), Shrubland (<25% trees, and shrubby cover >0.5 m tall greater than other strata), Dwarf Shrubland (<25% trees, and shrubby cover <0.5 m tall greater than other strata), Herbaceous (herb cover exceeds that of other strata), Nonvascular (nonvascular cover exceeds that of other strata), or Sparse vegetation (total vegetation <25%)
Plots	T1 Hgt	height of emergent tree layer	in meters if applicable
Plots	T1 Cover	% cover of emergent tree layer	cover classes (for all strata): 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%
Plots	T2 Hgt	height of tree canopy layer	
Plots	T2 Cover	% cover of tree canopy layer	
Plots	T3 Hgt	height of tree subcanopy layer	
Plots	T3 Cover	% cover of tree subcanopy layer	
Plots	S1 Hgt	height of tall shrub layer	
Plots	S1 Cover	% cover of tall shrub layer	
Plots	S2 Hgt	height of short shrub layer	
Plots	S2 Cover	% cover of short shrub layer	
Plots	S3 Hgt	height of dwarf shrub layer	
Plots	S3 Cover	% cover of dwarf shrub layer	
Plots	H Hgt	height of herb layer	
Plots	H Cover	% cover of herb layer	
Plots	N Cover	% cover of non-vascular layer	
Plots	V Hgt	height of vine layer, if present	
Plots	V Cover	% cover of vine layer	
Plots	Other Measure1 Defined	Explanation of other measure of species presence	
Plots	Other Measure2 Defined	Explanation of other measurement used for species presence	
Plots	Animal Use Evidence		
Plots	Disturbance Comments	narrative on natural and anthropogenic disturbance	
Plots	Other Comments		
Plots	Update	When record was last updated (using Plots 2.0 interface)	does not apply to values directly manipulated in tables
Plots	User	initials of person entering record	

Table	Field	Meaning	Comment re THST
Plots	Species Counter	number of plant species recorded in plot	
Plots	Optional Fields Defined	narrative defining any optonal fields that are used	Opt1: Basal area in m2/ha, rounded
Plots	Opt1	for MABI, basal area (m2/ha, rounded)	
Plots	Provisional Community Name	community name assigned in field or before final analyses	
Plots-Species	Plot Code	unique identifier assigned by PLOTS using 4-letter park code and sequential numbers	provides link to Plots table
Plots-Species	Plot Species Counter	Unique integer sequence for species within this plot	
Plots-Species	Plant Symbol	from USDA Plants db table	
Plots-Species	Scientific Name	Accepted Latin name of the plant species	
Plots-Species	Common Name		
Plots-Species	Family		
Plots-Species	Specimen Number	if collected	
Plots-Species	Used PLANTS	Yes if name came from the PLANTS database	
Plots-Species	Source	From Plant List table: SS or NS	
Plots-Species	Within Plot	yes/no: Species is present within the Plot boundaries	
Plots-Species	Stratum Sort	Major sort order of strata	to sort from highest to lowest or vice versa
Plots-Species	Stratum	Stratum this species being recorded in	T1 = Emergent; T2 = Tree Canopy; T3 = Tree Subcanopy; S1 = Tall Shrub; S2 = Short Shrub; H = Herbaceous; N = Nonvascular plant; V = Vine/liana
Plots-Species	Strat-Simple	simplified stratum	Tree, Shrub, Herb, Non-vasc, Vine
Plots-Species	Diagnostic	yes/no: Species is a known diagnostic for the community	
Plots-Species	Range Cover	midpoint of cover class	cover classes (for all strata): < 1 / 1–5% / 6–10% / 11–25% / 26–50% / 51–75% / 76–100%
Plots-Species	Real Cover	if % cover measured directly	not used at THST
Plots-Species	Other Measure1	Other measure of species presence	CalculatedCover: from relativized basal area (Keeton data) * total canopy cover
Plots-Species	Other Measure2	Other measure of species presence	not used at THST
Plots-Species	DBH	Diameter at breast height for all trees above 10 cm diameter (comma delimited)	recorded on field forms
Plots-Species	Update	When record was last updated (using Plots 2.0 interface)	does not apply to values directly manipulated in tables
Plots-Species	User	initials of person entering record	
Plots-Species	SciName-Field	scientific name used on field form	names standardized to Kartesz 1999 (updated NPS names are in "Scientific Name" field)

Appendix G. Dichotomous field key to the vegetation associations of Thomas Stone National Historic Site.

Note: for each couplet, pick the best-fitting set of statements of the pair. Associations are listed by common name, Latin name, and synonym. Go to #:

1a. Uppermost vegetation layer is dominated by herbaceous vegetation, primarily grasses and grass-like plants **2**
1b. Uppermost vegetation layer is dominated by full-sized or sapling trees **5**

2a. Vegetation never flooded; wetland species not a significant component of the flora. Vegetation dominated by exotic grasses **3**
2b. Vegetation flooded at least a portion of year; wetland species are a significant component of the flora. Vegetation dominated by either exotic grasses or by native grasses and grass-like plants **4**

3a. Vegetation dominated by tall (more than 20 cm tall), unmowed grasses. Tall, native grasses and forbs frequent and diverse ..... **Dry Meadow *Lolium (arundinaceum, pretense)* Herbaceous Vegetation (CEGL004048)**
3b. Vegetation mowed frequently and generally less than 20 cm tall. Native grasses and forbs restricted to a few species ..... **Residential**

4a. Vegetation associated with seepages (not with a pond). Vegetation comprised of a mixture of obligate wetland species and facultative or upland species ..... **Wet Meadow *Dichanthelium clandestinum - Onoclea sensibilis* Herbaceous Vegetation (CEGL006485)**
4b. Vegetation associated with a permanently high water table, situated at edge of a pond; Vegetation dominated by of obligate or near obligate wetland species ..... **Woolgrass Marsh *Scirpus cyperinus* Herbaceous Vegetation (CEGL006439)**

5a. Shrubland, woodland or forest with uppermost layer dominated by small (sapling or pole-sized) trees. Canopy layer either mostly closed or partially open **6**
5b. Forest with uppermost layer dominated by large trees and canopy mostly closed **7**

6a. Uppermost layer strongly dominated by sweetgum (*Liquidambar styraciflua*). Vegetation of uplands, slopes, or floodplain ..... **Sweetgum Forest *Liquidambar styraciflua* Forest (CEGL007216)**

6b. Uppermost layer dominated by river birch (*Betula nigra*). Vegetation of depositional bars within channel of Hoghole Run ..... **Depositional Bar *Betula nigra* Woodland (CEGL006976)**

7a. Obligate wetland species not a significant component of vegetation. Wetland hydrology obscure or not evident, except in small inclusions within stands. Vegetation of ravine slopes or upland flats **8**

7b. Obligate wetland species a significant component of vegetation. Vegetation of seepages, floodplains, small stream bottoms, or depressions in upland flats. Wetland hydrology (water standing or flowing at surface in dry weather, high water marks, gleyed or mottled soils, etc.) evident **12**

8a. Neither tuliptree (*Liriodendron tulipifera*) nor sweetgum (*Liquidambar styraciflua*) a strong component of tree canopy (may be present as sapling-sized trees). Northern red oak (*Quercus rubra*) absent, as are American hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), and northern spicebush (*Lindera benzoin*) absent in shrub or subcanopy tree layers. Scarlet oak (*Quercus coccinea*) present. Shrub layer dominated by ericaceous species [huckleberry (*Gaylusaccia baccata*), deerberry (*Vaccinium stamineum*), low blueberry (*V. pallidum*), mountain laurel (*Kalmia latifolia*)]. Vegetation of upland flats with low slope **9**

8b. Tuliptree (*Liriodendron tulipifera*) and/or sweetgum (*Liquidambar styraciflua*) frequent in tree canopy. Scarlet oak (*Quercus coccinea*) absent. Northern red oak (*Quercus rubra*) present or absent. At least one of the three: American Hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), and northern spicebush (*Lindera benzoin*) present in shrub or subcanopy tree layers. Ericaceous shrubs absent from shrub layer, or if present, not dominant. Vegetation of ravine slopes and small stream bottoms **10**

9a. Virginia pine (*Pinus virginiana*) leading canopy dominant, cover >50%. White oak (*Quercus alba*) present at < 25% cover. Most hardwoods reaching tree layer (excluding isolated large trees) consist of sapling to pole-sized trees mostly in the subcanopy. Saplings of sweetgum (*Liquidambar styraciflua*), bigtooth aspen (*Populus grandidentata*), pignut hickory (*Carya glabra*), and/or eastern red cedar (*Juniperus virginiana*) frequent ..... **Pine - Oak Forest *Pinus virginiana* Successional Forest (CEGL002591)**

9b. Virginia pine (Pinus virginiana) not dominant in canopy (less than 30% cover), and, if present, scattered among hardwoods of equal or greater height. Most hardwoods reaching the canopy are of mature full-sized trees (mostly greater than 30 cm in diameter at breast height). Saplings of sweetgum (Liquidambar styraciflua), bigtooth aspen (Populus grandidentata), pignut hickory (Carya glabra), and/or eastern red cedar (Juniperus virginiana) rare ..... **Oak - Heath Forest *Quercus alba – Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest (CEGL008521)**

10a. White oak (Quercus alba) frequent to codominant (more than 5% cover). American beech (Fagus grandifolia) codominant in tree layer and more than 25% cover. Mockernut hickory (Carya alba) frequent in canopy (more than 5% cover). Northern spicebush (Lindera benzoin) absent from shrub layer (may be present as seedlings); ferns rare except for Christmas fern (Polystichum acrostichoides). Lowbush blueberry (Vaccinium pallidum) present (at low cover). Enchanter's nightshade (Circaea lutetiana) absent ..... **Dry Mesic Forest *Fagus grandifolia – Quercus (alba, rubra) – Liriodendron tulipifera / Polystichum acrostichoides* Forest (CEGL006075)**

10b. White oak (*Quercus alba*) absent or rare (less than 5% cover). If present, American beech (*Fagus grandifolia*) not codominant in tree layer and less than 10% cover. Mockernut hickory (*Carya alba*) rare to absent in canopy. Northern spicebush (*Lindera benzoin*) frequent to abundant (more than 5% cover) in shrub layer; ferns, usually of several species, frequent. Low blueberry (*Vaccinium pallidum*) absent. Enchanter's nightshade (*Circaea lutetiana*) present and usually frequent **11**

11a. Canopy strongly dominated by tuliptree (Liriodendron tulipifera) or tuliptree (Liriodendron tulipifera) codominant in canopy with other species. Red maple (Acer rubrum) is present at less than 10% in subcanopy. Flowering dogwood (Cornus florida) frequent (usually at more than 5% cover) in subcanopy or tall shrub layer. New York fern (Thelypteris noveboracensis) absent or rare. Vegetation of ravine slopes..... **Early Succesional Mesic Forest *Liriodendron tulipifera / (Cercis canadensis) / Lindera benzoin* Forest (CEGL007220)**

11b. Tuliptree (*Liriodendron tulipifera*) codominant in canopy with other species. Red maple (*Acer rubrum*) is present at more than 10% in subcanopy. Flowering dogwood (*Cornus florida*) usually absent, or if present, rare (less than 5% cover) to infrequent in subcanopy or tall shrub layer. New York fern (*Thelypteris noveboracensis*) absent to abundant. Vegetation of ravine bottoms along small streams .....**Floodplain Forest *Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* Forest (CEGL004418)**

12a. Vegetation situated in depression in upland flat and associated with a seasonal pool. Herbaceous layer very sparse (less than 3% total cover) and depauperate (fewer than 15 species/100 m^2). False-nettle (*Boehmeria cylindrica*), American hornbeam (*Carpinus caroliniana*), northern spicebush (*Lindera benzoin*), and jack-in-the-pulpit (*Arisaema triphyllum*) absent. Willow oak (*Quercus phellos*) present ..... **Upland Depression Swamp *Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest (CEGL006110)**

12b. Vegetation situated along stream at or near bottom of a slope. Herbaceous layer fairly dense (more tham 10% total cover) and diverse (more than 20 species/100 m^2). False-nettle (*Boehmeria cylindrica*), American hornbeam (*Carpinus caroliniana*), northern spicebush (*Lindera benzoin*), and Jack-in-the-pulpit (*Arisaema triphyllum*) present and sometimes frequent.....**13**

13a. At least two of the following seven species present: fringe tree (*Chionanthus virginicus*), sweetbay (*Magnolia virginiana*), stiff cowbane (*Oxypolis rigidior*), common winterberry (*Ilex verticillata*), skunk cabbage (*Symplocarpus foetidus*), withrod (*Viburnum nudum*), prickly bog sedge (*Carex atlantica*). Vegetation of seepages from upland slopes, with surface water more or less continuously present and soil surface permanently saturated. Soil comprised of a combination of muck and gravelly sand, without discernible layering ..... **Seepage Swamp**
Acer rubrum – Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum* / *Osmunda cinnamomea – Woodwardia areolata
Forest (CEGL006238)

13b. No more than one of the following seven species present: white fringetree (Chionanthus virginicus), sweetbay (Magnolia virginiana), stiff cowbane (Oxypolis rigidior), common winterberry (Ilex verticillata), skunk cabbage (Symplocarpus foetidus), witherod (Viburnum nudum), prickly bog sedge (Carex atlantica). Soil surface flooded only by overbank flow from streams or by major precipitation events. Soil surface not permanently saturated. Soil comprised of clay loams, silt loams, or sandy loams (sometimes with gravel), with a darker upper organic/mineral horizon evident (may be narrow) ..... **Floodplain Forest**
Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum
Forest (CEGL004418)

Appendix H. Accuracy assessment data form.

Revised September 2003

Accuracy Assessment Form
USGS-NPS Vegetation Mapping Program

1. Plot (waypoint) Number _____ 2. Park Code THST

3. Date _____

4. Observer(determined association) _____

5. Observer (assisting) _____

6. Accuracy of Navigation (meters) _____ 7. How Determined _____

8. UTM Easting _____ 9. UTM Northing _____

10. UTM Zone 18 11. Datum NAD83___

12. Offset from Waypoint (if applicable) _____ meters _____ degrees bearing

13. Vegetation Association dominating Plot _____

14. 2nd Association present in plot (if applicable) _____

15. 3rd Association present in plot (if applicable) _____

16. Dominant/characteristic species in tree layer (~ 1 – 5 species) _____

_____

17. Dominant/characteristic species in shrub layer (~ 1 – 5 species) _____

_____

18. Dominant/characteristic species in herbaceous layer (up to 10 species) _____

_____

19. Rationale for choice of dominant association / Other comments _____

_____

_____

Appendix I. TWINSPAN (Hill 1979; McCune and Mefford 1997) output tables for analysis of 23 vegetation plots at Thomas Stone National Historic Site, showing abundance scores for 100 most frequent species and final plot assignment.

COLOR LEGEND (PLOTS AND SPECIES SCORES)
Floodplain Early Suc. Mesic Dry Mesic Oak - Heath Pine - Oak

```
                                Plot number (read down)
Plot                            35542234333424422461456
Number (read down)→                00120110012120101203300
                                22112221112122211211112
Species
Vitis vulpina                        -1-422-2---2------1----  000000
Asplenium platyneuron                ---23222---2-----------  000001
Botrychium dissectum                 2---2221---11----------  000001
Botrychium virginianum               --222222---2-----------  000001
Campsis radicans                     -2-22212---2-----------  000001
Circaea lutetiana                      1-223222---2-----------  000001
Duchesnea indica                       --211-22---------------  000001
Elymus virginicus                      ----21-2---------------  000001
Erechtites hieraciifolia       -----2-21--------------  000001
Oxalis stricta                       --22-212---------------  000001
Platanus occidentalis                -5-4--44---------------  000001
Sanicula canadensis            --222221---2-----------  000001
Carex radiata                        6232-332----2----------  000010
Cryptotaenia canadensis              --21---2---------------  000010
Geum canadense                       -12221-----1-----------  000010
Onoclea sensibilis                   2222222----------------  000010
Dichanthelium boscii                 2----31----------------  000010
Dichanthelium clandestinum     -2222------------------  000010
Polygonum cespitosum                 4--2--23---1-----------  000010
Polygonum virginianum                -22222-----2-----------  000010
Rubus hispidus                       22-23222-2----1--------  000010
Viola sororia                        2-2222-3-2-------------  000010
Betula nigra                         -66--------------------  000011
Boehmeria cylindrica                 6432--2----------------  000011
Carex lurida                         -222-------------------  000011
Carex tribuloides                    2332--2----------------  000011
Glyceria striata                     262--------------------  000011
Arisaema triphyllum                  32332225-2223----------  000100
Festuca subverticillata              2-223322-2221----------  000100
Galium tinctorium                    22222212--22-----------  000100
Juglans nigra                        ---32------2-----------  000100
Lindera benzoin                      67767868-2253----------  000100
Lonicera japonica                    22233222-2-22----------  000100
Galium circaezans                    ----22-3-2-2-----------  000101
Microstegium vimineum                 -1-2---2--12-----------  000101
Athyrium felix-femina                 3222--2-----3----------  000110
Carex debilis                         -42-22--1---2----------  000110
Carex intumescens                     -33----2----2----------  000110
Carex seorsa                   --22--------2----------  000110
Carpinus caroliniana           677216464444-12--------  000110
Cinna arundinacea                     27----------2----------  000110
Impatiens capensis                    212---------2----------  000110
```

```
Leersia virginica                  34----2-----2----------  000110
Lycopus virginicus                 222-------1-1----------  000110
Muhlenbergia schreberi             2-22--1-3--------------  000110
Dichanthelium dichotomum      2122----2---2----------  000110
Solidago rugosa                    -222--------2----------  000110
Ulmus americana                    54--3-1-1--2-----------  000110
Symphyotrichum lanceolatum   1222--------1-1--------  000111
Carex laxiculmis                   2-2---2--2----1--------  000111
Carya cordiformis            6251---6---41-3--------  000111
Carex albolutescens          21--21----2-3----------  001000
Polystichum acrostichoides    4222222222322----------  001000
Thelypteris noveboracensis    5433------6-7----------  001000
Vitis labrusca               -12---1--2--2----------  001000
Quercus rubra                   4----1174612-----------  001001
Luzula echinata              --2-----2---2----------  001010
Lycopodium digitatum         ----------2-3----------  001010
Carex digitalis                    ------2-222------------  001011
Desmodium nudiflorum         --------122-----------  001011
Goodyera pubescens           --------222-1----------  001011
Cornus florida               ---562-64437--33-------  0011
Liriodendron tulipifera      667789764757312343 21---  0011
Euonymus americana           222-2--2-2212--2-2-----  0100
Asimina triloba              42-7326343542222122 2-2-  01010
Liquidambar styraciflua      866556265647715654 2-31-  01010
Parthenocissus quinquefolia  2223222322222222-2121--  01010
Toxicodendron radicans       -32222222212-22-1------  01010
Smilax rotundifolia          232622222222324--212-22  01011
Sassafras albidum            ---23--132-24-1121-211-  011
Carex albicans (*sensu lato*)  ---22-1-222--12--222---  1000
Carex swanii                 22-2222222223222122---  1000
Mitchella repens             -1---2-22-213--2222----  1000
Prunus serotina                         -1-3211---131--312-2---  1000
Acer rubrum                             784654637654756555 67256  1001
Ilex opaca                              513235327246522444 52474  1001
Smilax glauca                           2-22-2222222222222222-1  1001
Carya alba                              ----222-462---6-336----  101
Fraxinus americana           -2--311-------6--------  101
Monotropa uniflora           ---------22--21--------  101
Uvularia sessilifolia        -----2--22-----22-1----  101
Diospyros virginiana         ------------4-2--12----  1100
Quercus falcata                         ---2------5-446-25-----  1100
Quercus stellata                        -----------4-6---------  1100
Danthonia spicata                       --------3---22-2121----  1101
Fagus grandifolia                       4---344-777758789666627  1101
Juniperus virginiana               -1-1----1--33-322-21--2  1101
Nyssa sylvatica                         ------4-365352322474775  1101
Chimaphila maculata                     -----2--1-2--21222-222-  11100
Quercus alba                 --4-----654-1774-778877  11100
Quercus velutina                        ----4---4----2655-2256-  11100
Vaccinium pallidum                      --------2-2--2222222--2  11100
Amelanchier arborea          --------1-------2212-2-  111010
Gaylussacia baccata          -------------3-22224787  111010
```

```
Quercus coccinea            ---------------55--4626  111010
Vaccinium stamineum         --------------22222-342  111010
Kalmia latifolia            -------------------2-7-3  111011
Pinus virginiana            -------------2-8854-662  111100
Carya glabra                ----2----------34-51---  111101
Carex willdenowii           -------------2--123----  11111
                            00000000000001111111111

00000000111110000011111  Final
                                                00011111000010011101111
                                 01111

                            00000000000001111111111

00000000111110000011111  Initial
                                                00011111000010011101111
                                 01111
```

Three plots (221, 321, and 603) were excluded as outliers. Plots 221 and 321 were classified as Seepage Swamp, and plot 603 was classified as Upland Depression Swamp, through direct comparison to the USNVC.

Appendix J. Index of representative photographs of vegetation classification sampling plots in Thomas Stone National Historic Site.

Indexes of Photographs

By Association

Page

Pine - Oak Forest
Figure 11. THST.211 41
Figure 12. THST.201 42

Dry Mesic Forest
Figure 13. THST.311 48
Figure 14. THST.301 48

Sweetgum Forest - No plots were completed in this community type; No images available.

Early Successional Mesic Forest
Figure 15. THST.202 57
Figure 16.THST.212 57

Oak - Heath Forest
Figure 17. THST.501 63
Figure 18. THST.431 64

Depositional Bar - No plots were completed in this community type; No images available.

Floodplain Forest
Figure 19. THST.421 72
Figure 20. THST.502 73

Upland Depression Swamp
Figure 21. THST.603 79
Figure 22. THST.603 79

Seepage Swamp
Figure 23. THST.221 85
Figure 24. THST.321 85

Wet Meadow - No plots were completed in this community type; No images available.

Woolgrass Marsh - No plots were completed in this community type; No images available.

Index of Photographs
By Plot Number

Page

THST.201 Pine - Oak Forest (Figure 12) 41
THST.202 Early Successional Mesic Forest (Figure 15) 57
THST.211 Pine - Oak Forest (Figure 11) 41
THST.212 Early Successional Mesic Forest (Figure 16) 57
THST.221 Seepage Swamp (Figure 23) 85
THST.301 Dry Mesic Forest (Figure 14) 48
THST.311 Dry Mesic Forest (Figure 13) 48
THST.321 Seepage Swamp (Figure 24) 85
THST.421 Floodplain Forest (Figure 19) 72
THST.431 Oak - Heath Forest (Figure 18) 64
THST.501 Oak - Heath Forest (Figure 17) 63
THST.502 Floodplain Forest (Figure 20) 73
THST.603 Upland Depression Swamp (Figures 21 and 22) 79

Appendix K. Plants observed in Thomas Stone National Historic Site during vegetation plot and thematic accuracy assessment sampling.

Nomenclature follows *the PLANTS 3.5 Database* developed by the Natural Resource Conservation Service in cooperation with the Biota of North America Program (United States Department of Agriculture, National Resources Conservation Service 2004). Some common names listed in the Database were changed to reflect the common names typically used in this region. Species marked with an asterisk (*) were not measured in quantitative plot sampling, but noted during polygon observations.

Family	Scientific Name	Common name
Aceraceae	*Acer rubrum*	red maple
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
Annonaceae	*Asimina triloba*	pawpaw
Apiaceae	*Cicuta maculata*	spotted water hemlock
	Cryptotaenia canadensis	Canadian honewort
	Osmorhiza claytonii	Clayton's sweetroot
	Osmorhiza longistylis	longstyle sweetroot
	Oxypolis rigidior	stiff cowbane
	Sanicula canadensis	Canadian black snakeroot
Apocynaceae	*Apocynum cannabinum*	Indianhemp*
Aquifoliaceae	*Ilex opaca*	American holly
	Ilex verticillata	common winterberry
Araceae	*Arisaema triphyllum*	Jack in the pulpit
	Symplocarpus foetidus	skunk cabbage
Araliaceae	*Aralia spinosa*	devil's walkingstick
Asclepiadaceae	*Asclepias syriaca*	common milkweed*
Aspleniaceae	*Asplenium platyneuron*	ebony spleenwort
Asteraceae	*Cirsium* sp.	thistle
	Daucus carota	Queen Anne's lace*
	Erechtites hieraciifolia	burnweed
	Eupatorium perfoliatum	common boneset
	Eurybia divaricata	white wood aster
	Helenium autumnale	common sneezeweed*
	Hieracium paniculatum	Allegheny hawkweed
	Solidago gigantea	giant goldenrod
	Solidago rugosa	wrinkleleaf goldenrod
	Symphyotrichum lanceolatum ssp. *lanceolatum* var. *lanceolatum*	white panicle aster
	Verbesina alternifolia	wingstem
Balsaminaceae	*Impatiens capensis*	jewelweed
Berberidaceae	*Berberis thunbergii*	Japanese barberry
	Podophyllum peltatum	mayapple
Betulaceae	*Betula nigra*	river birch
	Carpinus caroliniana	American hornbeam
Bignoniaceae	*Campsis radicans*	trumpet creeper
Blechnaceae	*Woodwardia areolata*	netted chainfern

Family	Scientific Name	Common name
Campanulaceae	*Lobelia cardinalis*	cardinalflower
	Lobelia inflata	Indian tobacco
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle
	Sambucus nigra var. *canadensis*	common elderberry
	Viburnum acerifolium	mapleleaf viburnum
	Viburnum dentatum	southern arrowwood
	Viburnum nudum	possumhaw
	Viburnum prunifolium	blackhaw
Caryophyllaceae	*Stellaria pubera*	great chickweed
Celastraceae	*Euonymus americana*	American strawberrybush
Clethraceae	*Clethra alnifolia*	coastal sweetpepperbush
Clusiaceae	*Hypericum mutilum*	dwarf St. Johnswort*
	Hypericum punctatum	spotted St. Johnswort
Cornaceae	*Cornus florida*	flowering dogwood
Cupressaceae	*Juniperus virginiana*	eastern redcedar
Cyperaceae	*Carex albicans* var. *albicans*	whitetinge sedge
	Carex albicans var. *emmonsii*	Emmon's sedge
	Carex albolutescens	greenwhite sedge
	Carex amphibola	eastern narrowleaf sedge
	Carex atlantica	prickly bog sedge
	Carex atlantica ssp. *atlantica*	prickly bog sedge*
	Carex atlantica ssp. *capillacea*	prickly bog sedge*
	Carex cephalophora	ovalleaf sedge
	Carex complanata	blue sedge
	Carex crinita	fringed sedge*
	Carex debilis	white edge sedge
	Carex digitalis	slender woodland sedge
	Carex intumescens	greater bladder sedge
	Carex laevivaginata	woolly sedge
	Carex laxiculmis	spreading sedge
	Carex laxiflora	broad looseflower sedge
	Carex longii	Long's sedge
	Carex lurida	shallow sedge
	Carex radiata	eastern star sedge
	Carex scoparia	broom sedge*
	Carex seorsa	weak stellate sedge
	Carex squarrosa	squarrose sedge
	Carex styloflexa	bent sedge
	Carex swanii	Swan's sedge
	Carex tribuloides	blunt broom sedge
	Carex willdenowii	Willdenow's sedge
	Cyperus echinatus	globe flatsedge*
	Rhynchospora capitellata	brownish beaksedge*
	Scirpus cyperinus	woolgrass
	Scirpus polyphyllus	leafy bulrush
Dennstaedtiaceae	*Dennstaedtia punctilobula*	eastern hayscented fern
Dioscoreaceae	*Dioscorea villosa*	wild yam

Family	Scientific Name	Common name
Dryopteridaceae	*Athyrium filix-femina*	common ladyfern
	Cystopteris protrusa	lowland bladderfern
	Onoclea sensibilis	sensitive fern
	Polystichum acrostichoides	Christmas fern
Ebenaceae	*Diospyros virginiana*	common persimmon
Ericaceae	*Gaultheria procumbens*	eastern teaberry
	Gaylussacia baccata	black huckleberry
	Kalmia latifolia	mountain laurel
	Rhododendron periclymenoides	pink azalea
	Vaccinium corymbosum	highbush blueberry
	Vaccinium pallidum	Blue Ridge blueberry
	Vaccinium stamineum	deerberry
Euphorbiaceae	*Chamaesyce maculata*	spotted sandmat
Fabaceae	*Amphicarpaea bracteata*	American hogpeanut
	Desmodium nudiflorum	nakedflower ticktrefoil
	Lespedeza cuneata	Chinese lespedeza*
	Robinia pseudoacacia	black locust
Fagaceae	*Fagus grandifolia*	American beech
	Quercus alba	white oak
	Quercus coccinea	scarlet oak
	Quercus falcata	southern red oak
	Quercus marilandica	blackjack oak
	Quercus michauxii	swamp chestnut oak*
	Quercus palustris	pin oak
	Quercus phellos	willow oak
	Quercus rubra	northern red oak
	Quercus stellata	post oak
	Quercus velutina	black oak
Hamamelidaceae	*Liquidambar styraciflua*	sweetgum
Iridaceae	*Sisyrinchium angustifolium*	narrowleaf blueeyed grass
Juglandaceae	*Carya alba*	mockernut hickory
	Carya cordiformis	bitternut hickory
	Carya glabra	pignut hickory
	Juglans nigra	black walnut
Juncaceae	*Eleocharis obtusa*	blunt spikerush*
	Juncus acuminatus	tapertip rush*
	Juncus effusus	common rush
	Juncus tenuis	poverty rush
	Luzula echinata	hedgehog woodrush
Lamiaceae	*Lycopus americanus*	American waterhorehound
	Lycopus virginicus	Virginia waterhorehound
	Scutellaria integrifolia	helmet flower
	Scutellaria lateriflora	blue skullcap
Lauraceae	*Lindera benzoin*	northern spicebush
	Sassafras albidum	sassafras

Family	Scientific Name	Common name
Liliaceae	*Allium vineale*	wild garlic*
	Maianthemum racemosum ssp. *racemosum*	feathery false lily of the valley
	Medeola virginiana	Indian cucumberroot
	Uvularia sessilifolia	sessileleaf bellwort
Lycopodiaceae	*Lycopodium digitatum*	fan clubmoss
	Lycopodium obscurum	rare clubmoss
Magnoliaceae	*Liriodendron tulipifera*	tuliptree
	Magnolia virginiana	sweetbay
Melastomataceae	*Rhexia mariana*	Maryland meadowbeauty*
	Rhexia virginica	handsome Harry*
Menispermaceae	*Menispermum canadense*	common moonseed
Monotropaceae	*Monotropa hypopithys*	pinesap
	Monotropa uniflora	Indianpipe
Nyssaceae	*Nyssa sylvatica*	blackgum
Oleaceae	*Chionanthus virginicus*	white fringetree
	Fraxinus americana	white ash
Onagraceae	*Circaea lutetiana*	broadleaf enchanter's nightshade
	Ludwigia palustris	marsh seedbox
Ophioglossaceae	*Botrychium dissectum*	cutleaf grapefern
	Botrychium virginianum	rattlesnake fern
	Ophioglossum vulgatum	southern adderstongue
Orchidaceae	*Cypripedium acaule*	pink lady’s slipper
	Goodyera pubescens	downy rattlesnake plantain
	Tipularia discolor	crippled cranefly
Orobanchaceae	*Epifagus virginiana*	beechdrops
Osmundaceae	*Osmunda cinnamomea*	cinnamon fern
	Osmunda claytoniana	interrupted fern
Oxalidaceae	*Oxalis stricta*	common yellow oxalis
Passifloraceae	*Passiflora lutea*	yellow passionflower
Phytolaccaceae	*Phytolacca americana*	American pokeweed
Pinaceae	*Pinus virginiana*	Virginia pine
Platanaceae	*Platanus occidentalis*	American sycamore
Poaceae	*Andropogon virginicus*	broomsedge bluestem*
	Anthoxanthum odoratum	sweet vernalgrass*
	Chasmanthium laxum	slender wood oats
	Cinna arundinacea	sweet woodreed
	Dactylis glomerata	orchardgrass*
	Danthonia spicata	poverty danthonia
	Dichanthelium boscii	Bosc's panicgrass
	Dichanthelium clandestinum	deertongue grass
	Dichanthelium commutatum	variable panicgrass
	Dichanthelium dichotomum	cypress panicgrass
	Elymus hystrix	eastern bottlebrush grass
	Elymus villosus	hairy wildrye
	Elymus virginicus	Virginia wild rye
	Festuca subverticillata	nodding fescue
	Glyceria striata	fowl mannagrass
	Leersia virginica	whitegrass

Family	Scientific Name	Common name
Poaceae cont.	*Lolium arundinaceum*	tall fescue*
	Microstegium vimineum	Nepalese browntop
	Muhlenbergia schreberi	nimblewill muhly
	Panicum anceps	beaked panicgrass*
	Panicum rigidulum	redtop panicgrass*
	Phleum pratense	timothy*
	Poa cuspidata	early bluegrass
	Poa pratensis	Kentucky bluegrass*
	Schizachyrium scoparium	little bluestem*
	Tridens flavus	purpletop tridens*
Polygonaceae	*Polygonum caespitosum*	oriental ladys thumb
	Polygonum punctatum	dotted smartweed
	Polygonum sagittatum	arrowleaf tear thumb
	Polygonum virginianum	jumpseed
Polypodiaceae	*Polypodium virginianum*	rock polypody
Pyrolaceae	*Chimaphila maculata*	striped prince's pine
Ranunculaceae	*Clematis virginiana*	devil's darning needles
	Ranunculus abortivus	littleleaf buttercup
	Ranunculus recurvatus	blisterwort
	Agrimonia parviflora	harvestlice
	Amelanchier arborea	common serviceberry
	Amelanchier canadensis	Canadian serviceberry
	Duchesnea indica	Indian strawberry
	Geum canadense	white avens
	Geum vernum	spring avens
	Potentilla simplex	common cinquefoil
	Prunus serotina	black cherry
	Rosa multiflora	multiflora rose
	Rosa argutus	sawtooth blackberry
	Rubus hispidus	bristly dewberry
	Rubus occidentalis	black raspberry
	Rubus pensilvanicus	Pennsylvania blackberry
	Rubus phoenicolasius	wine raspberry
Rubiaceae	*Galium aparine*	stickywilly
	Galium asprellum	rough bedstraw
	Galium circaezans	licorice bedstraw
	Galium lanceolatum	lanceleaf wild licorice
	Galium pilosum	hairy bedstraw
	Galium tinctorium	stiff marsh bedstraw
	Galium triflorum	fragrant bedstraw
	Houstonia caerulea	azure bluet
	Mitchella repens	partridgeberry
Salicaceae	*Populus grandidentata*	bigtooth aspen
Scrophulariaceae	*Chelone glabra*	white turtlehead
	Mimulus ringens	Allegheny monkeyflower
Smilacaceae	*Smilax glauca*	cat greenbrier
	Smilax rotundifolia	roundleaf greenbrier
Solanaceae	*Solanum carolinense*	Carolina horsenettle*

Family	Scientific Name	Common name
Sphagnaceae	*Sphagnum* sp.	sphagnum*
Thelypteridaceae	*Thelypteris noveboracensis*	New York fern
Tiliaceae	*Tilia americana*	American basswood
Ulmaceae	*Ulmus americana*	American elm
Urticaceae	*Boehmeria cylindrica*	smallspike false nettle
	Pilea pumila	Canadian clearweed
Verbenaceae	*Phryma leptostachya*	American lopseed
	Verbena urticifolia	white vervain
Violaceae	*Viola* x *primulifolia*	violet
	Viola cucullata	marsh blue violet
	Viola pubescens	downy yellow violet
	Viola sororia	common blue violet
Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper
	Vitis labrusca	fox grape
	Vitis vulpina	frost grape

Appendix L. Field definitions for local and global vegetation descriptions.

LOCAL DESCRIPTION

Common Name (Park-specific)

A common or colloquial name used by the park for the Association.

Environmental Description

A summary of available information on the environmental conditions associated with the Association and any other important aspects of the environment which affect this particular type within the park, including elevation ranges and, where relevant, information on large landscape context, geology and soils.

Vegetation Description

A summary of available information on the vegetation, species composition (including dominant and diagnostic taxa, as well as problematic exotic species), structure (defining strata and their heights and percent cover), and variability of the vegetation of this Association as it occurs on the park.

Floristic Composition

Most Abundant Species

Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the community type as it occurs in the park.

Stratum

For each component plant species, the stratum (or strata) in which it occurs in the community within the park. Values for Stratum are:

Tree (canopy & subcanopy)	Short shrub/sapling
Tree canopy	Herb (field)
Tree subcanopy	Nonvascular
Shrub/sapling (tall & short)	Float aquatic
Tall shrub/sapling	Submerged aquatic

Lifeform

The lifeform of each component plant species that is present within each designated stratum of the community as it occurs within the park. Lifeform definitions are from Table 3.1, page 37, of Whittaker (1975). Values for Lifeforms are:

Needle-leaved tree	Semi-shrub
Broad-leaved deciduous tree	Succulent shrub
Broad-leaved evergreen tree	Ephiphyte
Thorn tree	Vine/Liana
Evergreen schlerophyllous tree	Forb
Succulent tree	Graminoid
Palm tree	Succulent forb
Tree fern	Aquatic herb (floating & sub mergent)
Bamboo	Moss
Needle-leaved shrub	Alga
Broad-leaved deciduous shrub	Lichen
Broad-leaved evergreen shrub	Fern or fern ally
Thorn shrub	Other/unknown
Evergreen schlerophyllous shrub	Other shrub
Palm shrub	Other herbaceous
Dwarf-shrub	Liverwort/hornwort

Species Name
Global scientific name (and common name) for each floristic component species of the community as it occurs within the park.
Characteristic Species
Component plant species that are characteristic for the community type as it occurs within the park.
Other Noteworthy Species
Other noteworthy species (i.e., species that are not necessarily diagnostic of the community, but that are worth noting for some other reasons, such as those that are rare species or exotic invasives) that are found within the community in the park.
DISTRIBUTION
State
The two-letter postal code of the for U.S. state(s) in which the park occurs.
State Rank
The Heritage Conservation Subnational Rank that best characterizes the relative rarity or endangerment of the Association within the specified state. See **Global Rank** for equivalent values. A star (*) indicates that the Subnational Rank is for the NHP/CDC Element (nonstandard) not the IVC Association (standard) (see below).
Relationship
The **State Name** (see below) is the name that the state Natural Heritage Program applies to their community Element. The **Relationship to Standard** is a value that indicates the relationship between the NHP (**Nonstandard)** Element and the related **Standard** Association (IVC). Values for Relationship to Standard are:
= - Equivalent = NHP community is equivalent to the standard Association
B - Broader = the NHP community is more broadly classified than the standard Association
F - Finer = the NHP community is more finely classified than the standard Association
I - Intersecting = the NHP community is not clearly broader or finer than this standard Association; the standard and NHP communities are related in a way that is more complex than a simple broader/finer relationship
? - Undetermined = the relationship between the NHP community and this standard Association is unknown
State Name
If the IVC Association has been crosswalked to a state classification type and it is equivalent to the IVC type, the **State Name** is the name that the Natural Heritage Program applies to the same community. A value of [gname] indicates that the **State Name** is the same as the **Global Name**. A value of [not crosswalked] indicates that no state type representing the concept of the IVC Association has been identified. If a state type has been identified that is NOT equivalent to the IVC Association (**Standard**), then the subnational type is considered a **Nonstandard** community. In this case, the **State Name** is the name of the nonstandard community.
Reference
This is the primary reference for the Natural Heritage Program classification that contains the **State Name** and confirms the presence of the Association in the state.
Local Range
A description of the total range (including present and historic, if known) of the Association within the park.

ADDITIONAL INFORMATION

Classification Comments

Comments about classification criteria used to define the community or description of any remaining issues associated with its classification on the park.

Other Comments

Additional comments about the community within the park.

Local Description Authors

Name(s) of the person(s) primarily responsible for authorship of the current description of this community on the park.

Plots

List of plot codes for plots used in the identification and classification of the community on the park.

Inventory Notes

Information regardin the sampling of the community on the park.

GLOBAL INFORMATION

USNVC CLASSIFICATION

Physiognomic Class

Class designates the growth form and structure of the vegetation of a community.

Physiognomic Subclass

Subclass designates growth form characteristics (e.g., leaf phenology) of a community.

Physiognomic Group

Group designates the leaf type of a community, corresponding to climate.

Physiognomic Subgroup

Subgroup designates the relative human impact (natural/semi-natural or cultural) on a community.

Formation

Formation designates additional physiognomic and environmental factors, including hydrology, of a community.

Classification Code

The International Vegetation Classification (IVC) Standard Classification code for the respective level of the hierarchy. Classification codes for the different levels are comprised of the following:

Class: Roman numerals (I–VII)

Subclass: Class code plus an uppercase letter (A–Z)

Group: Subclass code plus an Arabic number

Subgroup: Group code plus either the uppercase letter N (Natural/Semi-natural) or the uppercase letter C (Planted/Cultivated)

Formation: Subgroup code plus a lowercase letter (a–z)

Alliance

The names of dominant and diagnostic species are the foundation of the **Alliance Name**. At least one species from the dominant and/or uppermost stratum is included. In rare cases where the combination of species in the upper and lower strata is strongly diagnostic, species from other strata are included in the name. Species occurring in the same stratum are separated by a hyphen (-), and those occurring in a different strata are separated by a slash (/). Species occurring in the uppermost stratum are listed first, followed successively by those in lower strata. In

physiognomic types where there is a dominant herbaceous layer with a scattered woody layer, alliance names can be based on species found in the herbaceous layer and/or the woody layer, whichever is more diagnostic of the type.

Species less consistently found in all associations of the alliance may be placed in parentheses, and these parenthetical names are generally listed alphabetically. In cases where a particular genus is dominant or diagnostic, but the presence of individual species of the genus may vary among associations, only the specific epithets are placed in parentheses.

Nomenclature for vascular plant species follows a nationally standardized list (Kartesz 1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990), Anderson et al. (1990), Esslinger and Egan (1995), and Stotler and Crandall-Stotler (1977).

Alliance Key

A unique identifier for each Alliance that begins with the string "A." followed by a unique 3- or 4-digit number.

Alliance (English name)

A repeat of the **Alliance Name** with a translation of the scientific names using standard Central Ecology-accepted common names for the plant taxa in the name.

Association

The **Association Name** includes the scientific names of dominant and diagnostic species. Species occurring in the same stratum are separated by a hyphen (-), and those occurring in different strata are separated by a slash (/). Species occurring in the uppermost strata are listed first, followed successively by those in lower strata. Within the same stratum, the order of species names generally reflects decreasing levels of dominance, constancy, or indicator value. In physiognomic types where there is a dominant herbaceous layer with a scattered woody layer, Association names can be based on species found in either the herbaceous layer or the woody layer, whichever is more diagnostic of the type. If both layers are used, then the uppermost layer is always listed first, regardless of which may be more diagnostic.

Species less consistently found in all occurrences of the Association are placed in parentheses (). In cases where a particular genus is dominant or diagnostic, but individual species of the genus may vary among occurrences, only the specific epithets are placed in parentheses. Association names conclude with the **Class Name** in which they are classified.

In cases where diagnostic species are unknown or in question, a more general term may be used as a species placeholder (e.g., *Sphagnum* spp., Mixed Herbs, Mesic Graminoids). An environmental or geographic term, or one that is descriptive of the height of the vegetation (e.g., Dwarf Forest, Northern Shrubland), can also be used as a modifier when such a term is necessary to adequately characterize the Association. For reasons of standardization and brevity, however, this is kept to a minimum. For **Provisional** Associations, [Provisional] is added at the end of the name (ex. *Salix wolfii* Shrubland [Provisional]).

Vascular plant species nomenclature for Association and Alliance names follows the nationally standardized list of Kartesz (1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990,

1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts.

Association (English name)

A repeat of the **Association Name** but with a translation of the scientific names using standard Central Ecology-accepted common names for the plant taxa used in the name. Unlike **Global Name**, names in parentheses should be fully contained within the parentheses, and [Provisional] is not added at the end of name.

Ecological System(s)

A list of the Ecological Systems (**Association Name** and **Elcode**) of which the Association is a member. Ecological Systems are groups of plant associations unified by similar ecological conditions and processes (e.g., fire, riverine flooding), underlying environmental features (e.g., shallow soils, serpentine geology), and/or environmental gradients (e.g., elevation, hydrology in coastal zones). They should form relatively robust, cohesive, and distinguishable units on the ground. In most landscapes, the Ecological System will manifest itself on the ground as a spatial aggregation at an intermediate scale (e.g., between the IVC Alliance and Formation scales).

Global Description

Elcode (Identifier)

For IVC ecological units, a unique identifier code. Associations have a code that begins with the string "CEGL" (Community Element GLobal) followed by a unique 6-digit number; Ecological Systems have codes that begin "CES" (Community Ecological System) followed by the 3-digit primary division code, followed by a 3-digit number.

Concept Summary

A description of the range, structure, composition, environmental setting and dynamics associated with the community. Information includes a general understanding of the type, often with some concept of its distribution; environmental setting in which the type occurs and a summary of the important disturbance regimes, successional status, and temporal dynamics for this community rangewide; community structure/physiognomy; species by strata (dominant and diagnostic taxa); and key diagnostic characteristics that distinguishes it from similar types.

Environmental Description

A summary of available information on the environmental conditions of the Association rangewide and any other important aspects of the environment which affect this particular type, including elevation ranges and, where relevant, information on large landscape context, geology and soils.

Vegetation Description

A summary of available information on the leaf type and phenology, species composition (including dominant and diagnostic taxa, as well as problematic exotic species), structure (defining strata and their heights and percent cover), and variability of the vegetation of this Association range-wide and any additional comments relating to the vegetation.

Floristic Composition

Most Abundant Species

Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the community type as it occurs rangewide.

Stratum
For each component plant species, the stratum (or strata) in which it occurs in the community rangewide.

Values for Stratum are

Tree (canopy & subcanopy)	Short shrub/sapling
Tree canopy	Herb (field)
Tree subcanopy	Nonvascular
Shrub/sapling (tall & short)	Floating aquatic
Tall shrub/sapling	Submerged aquatic

Lifeform
The lifeform of each component plant species that is present within each designated stratum of the community as it occurs rangewide. Lifeform definitions are from Table 3.1, page 37, of Whittaker (1975).

Values for Lifeforms are

Needle-leaved tree	Semi-shrub
Broad-leaved deciduous tree	Succulent shrub
Broad-leaved evergreen tree	Ephiphyte
Thorn tree	Vine/Liana
Evergreen schlerophyllous tree	Forb
Succulent tree	Graminoid
Palm tree	Succulent forb
Tree fern	Aquatic herb (floating & submergent)
Bamboo	Moss
Needle-leaved shrub	Alga
Broad-leaved deciduous shrub	Lichen
Broad-leaved evergreen shrub	Fern or fern ally
Thorn shrub	Other/unknown
Evergreen schlerophyllous shrub	Other shrub
Palm shrub	Other herbaceous
Dwarf-shrub	Liverwort/hornwort

Species Name
Global scientific name (and common name) for each floristic component species of the community as it occurs rangewide.

Characteristic Species
Component plant species that are characteristic for the community type as it occurs rangewide.

Other Noteworthy Species
Other noteworthy species (i.e., species that are not necessarily diagnostic of the community, but that are worth noting for some other reasons, such as those that are rare species or exotic invasives) that are found within the community rangewide.

USFWS Wetland System
Systems developed for the classification of wetlands by the U.S. Fish and Wildlife Service to classify. System refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphic, chemical, or biological factors. As defined in Cowardin et al. (1979), the values are:

Marine - consists of open ocean overlying the continental shelf and its associated high-energy coastline.

Estuarine - consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Riverine - includes all wetlands and deepwater habitats contained with a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5%.
Lacustrine - includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 ha (20 ac).
Palustrine - includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%.

DISTRIBUTION

Range

A description of the total range (present and historic, if known) of the Association rangewide, using names of nations, subnations or states, ecoregions, etc.

States/Provinces

The two-letter postal codes for U.S. states and Canadian provinces in which the Association occurs. Mexican two-letter state abbreviations are preceded by "MX". When the occurrence of the Association in a state/province is uncertain, a ? is appended. The state code may be followed by the **State Rank** when known.

Federal Lands

List of federal lands where the Association occurs or is believed to occur. Names used are shortened versions of the official name of the Federal land unit with "National Park, National Forest," etc. dropped from the name. A ? indicates that presence is uncertain. Federal Agency Abbreviations are:
BIA = Bureau of Indian Affairs
BLM = Bureau of Land Management
COE = U.S. Army Corps of Engineers
DOD = Department of Defense
DOE = Department of Energy
NPS = National Park Service
PC = Parks Canada
TVA = Tennessee Valley Authority
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service

CONSERVATION STATUS

Global Rank

The Heritage Conservation Status **Global Rank** which best characterizes the relative rarity or endangerment of the Association worldwide. Values for Global Rank are:
G1 = Critically imperiled globally = Generally 5 or fewer occurrences and/or very few remaining ac or very vulnerable to elimination throughout its range due to other factor(s)
G2 = Imperiled globally = Generally 6–20 occurrences and/or few remaining ac or very vulnerable to elimination throughout its range due to other factor(s)
G3 = Rare or uncommon = Generally 21–100 occurrences; either very rare and local throughout its range or found locally, even abundantly, within a restricted range or vulnerable to elimination throughout its range due to specific factor(s)

G4 = Widespread, abundant, and apparently secure, but with cause for long-term concern = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery); apparently not vulnerable in most of its range
G5 = Demonstrably widespread, abundant and secure = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery); not vulnerable in most of its range
G#G# = Numeric range rank (range no greater than 2) = Greater uncertainty about a rank is expressed by indicating the full range of ranks which may be appropriate; for example, a G1G3 rank indicates the rank could be G1, G2, or G3
GNR = Not yet ranked = Status has not yet been assessed
GNA = Rank not applicable
GH = Historical = Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with potential for restoration (e.g., *Castanea dentata* Forest)
GX = Extirpated = Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species
GU = Unrankable = Status cannot be determined at this time
Qualifiers:
? = Inexact numeric rank = A question mark added to a rank expresses an uncertainty about the rank in the range of 1 in either way on the 1–5 scale; for example, a G2? rank indicates that the rank is thought to be G2, but could be G1 or G3 (Note: G1? and G5? are both valid ranks)
Q = Questionable taxonomy = A "Q" added to a rank denotes questionable taxonomy; it modifies the degree of imperilment and is only used in cases where the type would have a less imperiled rank if it were not recognized as a valid type (i.e., if it were combined with a more common type); a GUQ rank often indicates that the type is unrankable because of daunting taxonomic questions

For non-natural types, a **Global Rank** of **GNA** = **Rank not applicable** is assigned. They are further identified as one from the following:
Cultural - indicates that the Association is cultivated. Planted/cultivated areas are defined as being dominated by vegetation that has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. The majority of these areas are planted and/or maintained for the production of food, feed, fiber, or seed.
Ruderal - indicates that the Association is considered ruderal. Ruderal communities are vegetation resulting from succession following anthropogenic disturbance of an area. They are generally characterized by unnatural combinations of species (primarily native species, though they often contain slight to substantial numbers and amounts of species alien to the region as well). In many landscapes, ruderal communities occupy large areas - sometimes more than any other category of communities - and can provide important biodiversity functions.
Modified/Managed - indicates that the Association is modified or managed. Modified/managed communities are vegetation resulting from the management or modification of natural/near-natural vegetation, but producing a structural and floristic combination not clearly known to have a natural analogue. Modified vegetation may be easily restorable by either management, time, or restoration of ecological processes. It is not yet clear how to deal with these communities in the IVC.

Invasive - indicates that the Association is weedy and invasive. Invasive communities are dominated by invasive alien species. Although these communities are often casually considered as "planted/cultivated," they are spontaneous, self-perpetuating, and not the (immediate) result of planting, cultivation, or human maintenance. Land occupied by invasive communities is generally permanently altered (converted) unless restoration efforts are undertaken. It is also important to recognize that these communities are novel; they are not merely a community "transplanted" from the native range of the dominant species. *Melaleuca* in south Florida, kudzu in the southeastern United States, tamarisk in the western United States, and red mangrove in Hawaii all form communities which have no equivalent in the native range of the dominant species (associated species, processes, landscape context, fauna, etc. are all significantly different).

Global Rank Date

The date the **Global Rank** was last ***reviewed*** (regardless of whether the rank was changed).

Global Rank Reasons

Reasons that the Heritage Conservation Status **Global Rank** for the Association was assigned, including key ranking variables and other considerations used.

Classification Information

Classification Status

The status of the Association in relation to the standard IVC. Values for Classification Status are:

Standard – the Association has been formally recognized, described, and accepted by NatureServe Central Ecology as a standard Association in the IVC.

Nonstandard – the Association has not been accepted by NatureServe Central Ecology as a standard Association (i.e., it does not follow the standard classification).

Provisional* – the Association is a candidate for acceptance into the standard classification but has not yet been comprehensively reviewed by Central Ecology.

Circumscription Confidence

The degree of confidence associated with the classification of the Association. This confidence is based on the quality and type of data used in the analysis, as well as the extent to which the entire (or potential) range of the Association was considered. Values for Circumscription Confidence are:

1 – Strong: Classification is based on quantitative analysis of verifiable, high-quality field data (species lists and associated environmental information) from plots that are published in full or are archived in a publicly accessible database. A sufficient number of high-quality plots covering the expected geographic distribution and habitat variability of the vegetation type, as well as plots from related types across the region, have been used in the analysis.

2 – Moderate: Classification is based either on quantitative analysis of a limited data set of high-quality, published/accessible plots and/or plots from only part of the geographic range, or on a more qualitative assessment of published/accessible field data of sufficient quantity and quality.

3 – Weak: Classification is based on limited, or unpublished/inaccessible plot data or insufficient analysis, anecdotal information, or community descriptions that are not accompanied by plot data. These types have often been identified by local experts. Although there is a high level of confidence that these types represent recognized vegetation entities, it is not known whether they would meet national standards for floristic types in concept or in classification approach if sufficient data were available.

Classification Comments
Comments about classification criteria used to define the Association, or to describe any remaining issues associated with the classification. Any potentially confusing relationships with other existing Associations should be indicated if there is a potential that further scrutiny may result in a change in the classification of the Association. Discussion of any atypical occurrences and why they are included in this Associationconcept may also be addressed. In addition, rationale for choosing nominal species that are not dominant and other comments about nominal species pertaining to the classification of the community should be included. Comments may explain confusion about the similarity between types that may not be distinguishable.
Similar Associations
The **Global Name** and **Elcode** of any closely related or apparently similar IVC association(s) which may be mistaken for this Association. They may be in the same or different Formation or Alliance. This includes only types whose classification is not at issue (e.g., two types have similar sounding names but are differentiated by the degree of canopy closure and lower frequency of associated light-requiring species). **Notes** regarding the relationship and/or distinction of each particular Similar Association may follow.
Related Concepts
Name used by agencies or other published or unpublished classification systems to describe community types that may be related to this Association. These might include Society of American Foresters (SAF) cover types, Kuchler PNV types, U.S. Fish and Wildlife Service (USFWS) wetland types, or other local or regional vegetation classifications. The **Other Community Name** is followed by the associated **Reference** and **Relationship**. The **Related Concept Reference** is the source reference for the **Related Concept**. **Relationship** indicates whether the type designated in **Other Community Name** is more, less, or equally inclusive of the IVC Association concept. Values for Relationship are:
B – Broader: the concept of the Other Community is broader than the Association concept
F – Finer: the concept of the Other Community is finer (more narrow) than the Association concept
I – Intersects: the concepts of the Other Community and the Association overlap (i.e., neither fully includes the other) and are related in a way that is more complex than a simple "broader/finer" relationship
= - Equivalent: concept designated in Other Community Name is equivalent to the Association concept
? – Unknown: the relationship of the Other Community to the Association has not been determined

Note: Names used by Heritage Programs/CDCs are listed in the section entitled **Subnational Distribution with Crosswalk data**.
SOURCES
Description Authors
Name(s) of the person(s) primarily responsible for authorship of the current version of the Association's *description* and *characterization* including descriptions in **Environment, Vegetation**, and **Dynamics**. The abbreviation mod. before a name indicates that modifications were subsequently made to the original description by the person(s) listed.

References
Short citations of all references used in documenting the classification/concept and characterization of this Association.

Literature Cited

Anderson L. E., H.A. Crum, and W. R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448–499.

Anderson, L. E. 1990. A checklist of sphagnum in North America north of Mexico. The Bryologist 93(4):500–501.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.

Egan, R. S. 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. The Bryologist 90:77–173.

Egan, R. S. 1989. Changes to the "Fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada," edition I. The Bryologist 92:68–72.

Egan, R. S. 1990. Changes to the "Fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada," edition II. The Bryologist 93:211–219.

Egan, R. S. 1991. Changes to the "Fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada," edition III. The Bryologist 94:396–400.

Esslinger T. L., and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467–549.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: Kartesz, JT and CA Meacham. Synthesis of the North American flora [computer program]. Version 1.0. North Carolina Botanical Garden: Chapel Hill, NC.

Stotler R., and B.Crandall-Stotler. 1977. A checklist of the liverworts and hornworts of North America. The Bryologist 80(3):405–428.

Stotler, R. E., and B. Crandall-Stotler. 2005. A revised classification of the Anthocerotophya and a checklist of the Hornworts of North America, north of Mexico. Bryologist 108(1): 16–26.

Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Appendix M. Bibliography for global vegetation descriptions from the U. S. National Vegetation Classification.

Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.

Ambrose, J. 1990a. Georgia's natural communities--A preliminary list. Unpublished document. Georgia Natural Heritage Inventory. 5 pp.

Andreu, M. G., and M. L. Tukman. 1995. Forest communities of the Tellico Lake Area, East Tennessee. M.F. project report, Duke University, School of the Environment. Durham, NC. 66 pp. plus appendices.

Berdine, M. A. 1998. Maryland vegetation classification. Maryland Department of Natural Resources, Annapolis, MD.

Bernard, J. M., and F. A. Bernard. 1971. Mature upland forests of Cape May County, New Jersey. Bulletin of the Torrey Botanical Club 98:167–171.

Bowman, P. 2000. Draft classification for Delaware. Unpublished draft. Delaware Natural Heritage Program.

Bransby, D .L. No date. Herbaceous biomass sources for the southeastern United States: Have all the options been properly evaluated? Department of Agronomy and Soils, Auburn University. [Abstract]

Breden, T. F. 1989. A preliminary natural community classification for New Jersey. Pages 157–191 in: E. F. Karlin, editor. New Jersey's rare and endangered plants and animals. Institute for Environmental Studies, Ramapo College, Mahwah, NJ. 280 pp.

Breden, T. F., Y. R. Alger, K. S. Walz, and A. G. Windisch. 2001. Classification of vegetation communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry, New Jersey Department of Environmental Protection, Trenton.

Brush, G. S., C. Lenk, and J. Smith. 1980. The natural forests of Maryland: An explanation of the vegetation map of Maryland. Ecological Monographs 50:77–92.

Clancy, K. 1993b. A preliminary classification of the natural communities of Delaware. Unpublished draft, Delaware Natural Heritage Inventory, Division of Parks and Recreation, Dover. 30 pp.

Clancy, K. 1996. Natural communities of Delaware. Unpublished review draft. Delaware Natural Heritage Program, Division of Fish and Wildlife, Delaware Division of Natural Resources and Environmental Control, Smyrna, DE. 52 pp.

Collins, B. R., and K. H. Anderson. 1994. Plant communities of New Jersey. Rutgers University Press, New Brunswick, NJ. 287 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.

Davis, A. F., et al. 1992. A natural areas inventory of Delaware County, Pennsylvania. Pennsylvania Science Office of The Nature Conservancy. Middletown, PA. 110 pp.

Decker, E. 1955. The Conneaut Marsh: marsh and waterfowl investigations. MS Thesis. Pennsylvania State University Graduate School, School of Forestry. 108 pp.

Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boston, MA.

Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero, editors. 2002. Ecological communities of New York state. Second edition. A revised and expanded edition of Carol Reschke's ecological communities of New York state. (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

Ehrenfeld, J. G., and M. Gulick. 1981. Structure and dynamics of hardwood swamps in the New Jersey Pine Barrens: Contrasting patterns in trees and shrubs. American Journal of Botany 68:471–481.

Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.

Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Pennsylvania Department of Conservation and Recreation. Bureau of Forestry. Harrisburg, PA. 86 pp.

Fleming, G. P. 2001. Community types of Coastal Plain calcareous ravines in Virginia. Preliminary analysis and classification. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 4 pp.

Fleming, G. P., P. P. Coulling, D. P. Walton, K. M. McCoy, and M. R. Parrish. 2001. The natural communities of Virginia: Classification of ecological community groups. First approximation. Natural Heritage Technical Report 01-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report. January 2001. 76 pp.

Fleming, G. P., P. P. Coulling, K. D. Patterson, and K. M. McCoy. 2004. The natural communities of Virginia: Classification of ecological community groups. Second approximation. Natural Heritage Technical Report 04-01. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. [http://www.dcr.virginia.gov/dnh/ncintro.htm]

Fleming, G. P., and P. P. Coulling. 2001. Ecological communities of the George Washington and Jefferson national forests, Virginia. Preliminary classification and description of vegetation types. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 317 pp.

Fleming, G. P., and W. H. Moorhead, III. 2000. Plant communities and ecological land units of the Peter's Mountain area, James River Ranger District, George Washington and Jefferson national forests, Virginia. Natural Heritage Technical Report 00-07. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the USDA Forest Service. 195 pp. plus appendices.

Fleming, Gary P. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.

Gawler, S. C. 2002. Natural landscapes of Maine: A guide to vegetated natural communities and ecosystems. Maine Natural Areas Program, Department of Conservation, Augusta, ME. [in press]

Golet, F.C., A.J.K. Calhoun, W.R. DeRagon, D.J. Lowry, and A.J. Gold. 1993. Ecology of red maple swamps in the glaciated northeast. A community profile. Biological Report 12. US Fish and Wildlife Service, Washington , D.C. 151 pp.

Hall, R. L., and E. D. Mathews. 1974. Soil survey of Charles County, Maryland. U.S. Department of Agriculture Soil Conservation Service. Washington, DC.

Harbor, D. J. 1996. Classification and mapping of geomorphology in the Peters Mountain, Laurel Fork, and Upper Piney River areas, George Washington National Forest. Unpublished report to the USDA Forest Service. Washington and Lee University, Lexington, VA. 25 pp.

Harrison, J. W., and P. Stango, III. 2003. Shrubland tidal wetland communities of Maryland's Eastern Shore: Identification, assessment and monitoring. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis. 118 pp.

Harrison, J. W., compiler. 2004. Classification of vegetation communities of Maryland: First iteration. A subset of the International Classification of Ecological Communities: Terrestrial Vegetation of the United States, NatureServe. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis. 243 pp.

Harvill, A. M., Jr. 1967. The vegetation of Assateague Island, Virginia. Castanea 32:105–108.

Heath, M. E., D. S. Metcalfe, and R. E. Barnes. 1973. Forages: the science of grassland agriculture. Iowa State University Press, Ames.

Heckscher, S. 1994. The vegetation of the Glades Region, Cumberland County, New Jersey. Bartonia 58:101–113.

Hill, S. R. 1986. An annotated checklist of the vascular flora of Assateague Island (Maryland and Virginia). Castanea 5:265–305.

Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. The Southwestern Naturalist 45(4):385–420.

Hunt, D. 1998. Official NY designation of red maple - sweetgum swamp community. Unpublished memorandum. New York Natural Heritage Program, Latham, NY. 1 p. plus attachments.

Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J. T. Kartesz and C. A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Lea, C. 2000. Plant communities of the Potomac Gorge and their relationship to fluvial factors. M.S. thesis, George Mason University. Fairfax, VA. 219 pp.

Lea, C. 2003. Vegetation types in the National Capital Region Parks. Draft for review by NatureServe, Virginia Natural Heritage, West Virginia Natural Heritage, Maryland Natural Heritage, and National Park Service. March 2003. 140 pp.

Martin, W. H. 1989. Forest patterns in the Great Valley of Tennessee. Journal of the Tennessee Academy of Science 64:137–144.

McCormick, J. 1979. The vegetation of the New Jersey Pine Barrens. In: R. T. T. Formann, editor. Pine Barrens: Ecosystem and landscape. Academic Press, New York.

McCoy, K. M., and G. P. Fleming. 2000. Ecological communities of U.S. Army Garrison, Fort Belvoir, Fort Belvoir, Virginia. Natural Heritage Technical Report 00-08, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the U.S. Army. 156 pp. plus appendices.

Meininger, J., and K. McCarthy. 1998. Forest communities of Zekiah Swamp nontidal wetland of special state concern. Unpublished report. Maryland Department of Natural Resources Wildlife and Heritage Division, Annapolis.

Metzler, K. J., and J. P. Barrett. 2001. Vegetation classification for Connecticut. Draft 5/21/2001. Connecticut Department of Environmental Protection, Natural Resources Center, Natural Diversity Database, Hartford.

Naczi, R. F. C., C. T. Bryson, and T. S. Cochrane. 2002. Seven new species and one new combination in Carex (Cyperaceae) from North America. Novon 12:508–532.

NatureServe Ecology - Southeastern United States. No date. Unpublished data. NatureServe, Durham, NC.

Nelson, J. B. 1986. The natural communities of South Carolina: Initial classification and description. South Carolina Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries, Columbia, SC. 55 pp.

Patterson, K. D., C. J. Ulrey, and J. Drake. 1999. Vegetation classification of Great Smoky Mountains National Park: Cades Cove and Mount Le Conte quadrangles. Unpublished report submitted to BRD-NPS Vegetation Mapping Program. The Nature Conservancy, Chapel Hill, NC.

Patterson, Karen D. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.

Peet, R. K., T. R. Wentworth, M. P. Schafale, and A.S. Weakley. 2002. Unpublished data of the North Carolina Vegetation Survey. University of North Carolina, Chapel Hill.

Pyne, M. 1994. Tennessee natural communities. Unpublished document. Tennessee Department of Conservation, Ecology Service Division, Nashville. 7 pp.

Rawinski, T. 1984. Natural community description abstract - southern New England calcareous seepage swamp. Unpublished report. The Nature Conservancy, Boston, MA. 6 pp.

Rawinski, T. J., K. N. Hickman, J. Waller-Eling, G. P. Fleming, C. S. Austin, S. D. Helmick, C. Huber, G. Kappesser, F. C. Huber, Jr., T. Bailey, and T. K. Collins. 1996. Plant communities and ecological land units of the Glenwood Ranger District, George Washington and Jefferson national forests, Virginia. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report 96-20. Richmond. 65 pp.

Robichaud, B., and M. F. Buell. 1973. Vegetation of New Jersey. Rutgers University Press, New Brunswick, NJ. 340 pp.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina. Third approximation. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh. 325 pp.

Schmalzer, P. A., and H. R. DeSelm. 1982. Vegetation, endangered and threatened plants, critical plant habitats and vascular flora of the Obed Wild and Scenic River. Unpublished report. USDI National Park Service, Obed Wild and Scenic River. 2 volumes. 369 pp.

Schotz, Al. Personal communication. Community Ecologist. Alabama Natural Heritage Program. Huntingdon College, Massey Hall, 1500 East Fairview Avenue, Montgomery, AL 36106-2148.

Shreve, F., M. A. Chrysler, F. H. Blodgett, and F. W. Besley. 1910. The plant life of Maryland. Maryland Weather Service. Special Publication, Volume III. Johns Hopkins Press. Baltimore, MD.

Sipple, W. S., and W. A. Klockner. 1984. Uncommon wetlands in Coastal Plain of Maryland. Pages 111–137 in: A. W. Norden, et al., editors. Threatened and endangered plants and animals of Maryland. Special Publication 84-I. Maryland Natural Heritage Program.

Smith, T. L. 1983. Natural ecological communities of Pennsylvania. Draft, revised 1991. Pennsylvania Natural Diversity Inventory, Middletown, PA.

Sneddon, L. A., and M. G. Anderson. 1994. A classification scheme for Coastal Plain pondshore and related vegetation from Maine to Virginia. Supplement to Bulletin of the Ecological Society of America 77 (Abstract).

Sneddon, L., M. Anderson, and K. Metzler. 1996. Community alliances and elements of the Eastern Region. Unpublished report. The Nature Conservancy, Eastern Heritage Task Force, Boston, MA. 235 pp.

Sneddon, L.A. 2008. Vegetation classification and mapping of Great Swamp National Wildlife Refuge. NatureServe, Eastern Regional Office, NatureServe, Boston, MA. 28pp. plus appendices.

Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC.

TDNH [Tennessee Division of Natural Heritage] Unpublished data. Tennessee Division of Natural Heritage, 14th Floor, L&C Tower, 401 Church Street, Nashville, TN 37243-0447. 615-532-0431

TNC [The Nature Conservancy] 1998. Vegetation Classification of Rock Creek Park. Report for the NBS/NPS Vegetation Mapping Program. The Nature Conservancy, Boston. 50 pp.

Thomson, D., A. M. Gould, and M. A. Berdine. 1999. Identification and protection of reference wetland natural communities in Maryland: Potomac watershed floodplain forests. The Biodiversity Program, Maryland Department of Natural Resources, Wildlife and Heritage Division. Annapolis, MD. 119 pp.

Tyndall, R. W., K. A. McCarthy, J. C. Ludwig, and A. Rome. 1990. Vegetation of six Carolina bays in Maryland. Castanea 55:1–21.

United States Department of Agriculture, National Resources Conservation Service. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center. Baton Rouge, LA 70874-4490 USA.

VDNH [Virginia Division of Natural Heritage]. 2003. The natural communities of Virginia: Hierarchical classification of community types. Unpublished document, working list of November 2003. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Ecology Group, Richmond.

VDNH [Virginia Division of Natural Heritage]. No date. Unpublished data. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond.

Vanderhorst, J. 2001a. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Natural Heritage Program, West Virginia Division of Natural Resources, Elkins. 101 pp.

WVNHP [West Virginia Natural Heritage Program]. No date. Unpublished data. West Virginia

Windisch, A. G. 1995b. Natural community inventory of Fort Dix, New Jersey. The Nature Conservancy report. New Jersey Natural Heritage Program, Office of Natural Lands Management. Trenton, NJ. 81 pp.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 477/112894, February 2012

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov