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Vegetation Classification and Mapping at Richmond National Battlefield Park, Virginia

Technical Report NPS/NER/NRTR—2008/128

ON THE COVER
Upper left: Coastal Plain Mixed Oak / Heath Forest. Upper right: Coastal Plain / Piedmont Acidic Seepage Swamp.
Lower left: Cultural Meadow with cannon. Photographs by: Gary P. Fleming. Lower right: Open Earthworks.
Photograph by: Karen D. Patterson.

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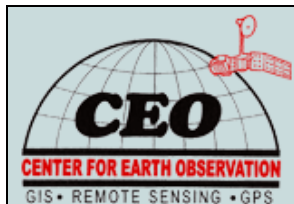
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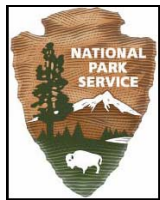
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Acknowledgments

Summary

Accurate and up-to-date vegetation maps are recognized by the National Park Service (NPS) Inventory and Monitoring Program as one of twelve basic data sets for every national park with significant natural resources. The National Park Service (NPS) and the U.S. Geological Survey (USGS) have put forth standards and protocols for classification and mapping of vegetation communities on NPS lands. The USGS-NPS Vegetation Mapping Program recognizes the United States National Vegetation Classification (USNVC) as the standard vegetation classification to be used in these mapping projects.

Vegetation data collected from seven national parks in Virginia were combined with over 2,000 existing plot samples from throughout the Mid-Atlantic Piedmont and Coastal Plain and used to refine the USNVC for the mid-Atlantic region. This classification was used to map and describe the vegetation at the seven national parks in Virginia.

This report documents the classification and mapping of vegetation at Richmond National Battlefield Park. Twenty-one map classes representing 13 USNVC associations, five nonstandard, park-specific vegetation classes, and three Anderson Level II land-use categories were used to map the 570 ha (1407 ac) park. Vegetation map classes were determined through extensive field reconnaissance, data collection, and analysis. Aerial photography from 2001 served as the base map, and field sampling was conducted from 2002–2006. Spatial data were digitized onscreen over digital orthophoto mosaics created from scanned color infrared, stereo pair 1:6,000 scale aerial photography using a 0.5 hectare minimum mapping unit.

Early successional or transitional vegetation covers 32% of the land in the park (180 ha; 444 ac). Cultural map classes cover 25% (144 ha; 355 ac) of the park and include the Anderson land-use categories and other man-made or maintained areas in the park. Seven map classes representing later successional vegetation cover 43% of the land in the park (243 ha; 600 ac). The seven map classes can be broadly characterized based on different environmental settings as upland forests (3 map classes) and forested wetlands (4 map classes).

A vegetation map of Richmond National Battlefield Park was created following the USGS-NPS Vegetation Mapping Program protocols. Vegetation map classes were crosswalked to the natural communities of Virginia and to the USNVC in order to provide a regional and global context for the park's vegetation. Seventy-one randomly selected accuracy assessment sampling points were collected throughout the park and used to assess the thematic accuracy of the map. The Kappa Index for the final vegetation map was $84.4 \pm 10.2\%$, with an overall accuracy of 85.9%.

A field key to the map classes, and detailed descriptions for map classes, or associations within a map class, were developed to assist with field recognition and classification. Additional products associated with this project include leaf-on and leaf-off orthophoto mosaics, a database of vegetation plot data and accuracy assessment data, digital photos of vegetation associations, and spatial data files for the vegetation map, plot sample points, and accuracy assessment sample points with associated Federal Geographic Data Committee (FGDC)-compliant metadata.

Products for Richmond National Battlefield Park and similar national park vegetation mapping projects can be accessed at the USGS-NPS Vegetation Mapping Program website: http://biology.usgs.gov/npsveg/.

Keywords: vegetation association, vegetation classification, vegetation mapping, Richmond National Battlefield Park.

Introduction

General Background

Effective management of natural resources in our national parks depends on park managers having access to comprehensive, scientifically credible information on species and habitats found in their parks. Accurate and up-to-date vegetation maps can form the foundation for resource management activities in the national parks and are recognized by the National Park Service (NPS) Inventory and Monitoring Program as one of twelve basic data sets for every park with significant natural resources (NPS 2003). Activities as diverse as park planning, fire management, wildlife research, habitat conservation/restoration, and visitor interpretation all can be informed by current maps of vegetation distribution. Additionally, a vegetation map attributed to a standard, nationally used classification system provides a way to assess how an individual park's biodiversity fits into the context of the entire region.

Since the early 1990's, the National Park Service and the U.S. Geological Survey (USGS) have worked cooperatively to classify, describe, and map vegetation communities in more than 250 national park units across the United States. At its inception, the USGS-NPS Vegetation Mapping Program (USGS-NPS VMP) put forth standards and protocols for classification and mapping of vegetation communities on NPS lands. These standards are outlined in four documents written by The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI 1994a, b, c, d) and available at http://biology.usgs.gov/npsveg/standards.html.

Products produced as part of the USGS-NPS VMP must meet Federal Geographic Data Committee (FGDC) standards for vegetation classification and metadata, and national standards for spatial accuracy and data transfer. Standard spatial data products include aerial photography, map classification, a spatial database of vegetation communities, hardcopy maps of vegetation communities, metadata for spatial databases, and a complete accuracy assessment of the vegetation map. Vegetation information includes vegetation classification, dichotomous field key of vegetation classes, formal description of each vegetation class, ground photos of vegetation classes, and field data in database format. Mapping standards include a minimum mapping unit of 0.5 hectares (ha) and classification accuracy of 80% for each map class. The spatial databases are required to have a horizontal positional accuracy that meets National Map Accuracy Standards at the 1:24,000 scale. This means that each well-defined object in the spatial database will be within 1/50 of an inch of its actual location on the map or 12.2 m (40 ft) on the ground.

The FGDC standard for vegetation classification is the United States National Vegetation Classification (USNVC). Over the past twenty years, the USNVC has been developed and implemented by The Nature Conservancy (TNC), the network of Natural Heritage Programs, and more recently, NatureServe. The USNVC is a subset of the larger International Vegetation Classification (IVC). In North America, the IVC consists of the U.S. National Vegetation Classification (USNVC) and the Canadian National Vegetation Classification (CNVC). The IVC has also been developed for the Caribbean region. Further developments are under way through various Latin American projects.

The USNVC is currently maintained and updated by NatureServe. Additional support has come from federal agencies, the FGDC, and the Ecological Society of America. Refinements to the classification occur in the process of application, leading to ongoing proposed revisions that are reviewed both locally and nationally. A two volume publication (Grossman et al. 1998) presenting the standardized classification, and providing a thorough introduction to the classification, its structure, and the list of vegetation types found across the United States as of April 1997 can be found on the Internet at: http://www.NatureServe.org/publications/library.jsp. Volume II of this publication (the classification listing) has been superceded by the online database server, NatureServe Explorer®, http://www.NatureServe.org/explorer[1], which provides regular updates to ecological communities in the United States and Canada.

The USNVC is a hierarchical system that classifies vegetation using physiognomic (structural) features at the highest levels of the hierarchy and floristic features at the lower levels. The physiognomic units have a broad geographic perspective and the floristic units have local and site-specific perspectives (TNC and ESRI 1994a; Grossman et al. 1998). The USNVC includes most existing vegetation, whether natural or cultural, but attention is focused on natural vegetation types. Natural vegetation, as defined in TNC and ESRI (1994a), includes types that "occur spontaneously without regular management, maintenance, or planting and have a strong component of native species". Cultural vegetation includes planted/cultivated vegetation types such as orchards, pastures, forestry plantations, and vineyards.

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 (Table 1). The basic unit of the physiognomic portion of the classification is the formation, a type defined by dominance of a given growth form in the uppermost stratum and characteristics of the environment (e.g., cold-deciduous alluvial forests). The physiognomic portion of the classification is based upon the United Nations Educational, Scientific, and Cultural Organization world physiognomic classification of vegetation, which was modified to provide greater consistency at all hierarchical levels and to include additional types (UNESCO 1973).

The floristic levels include alliances and associations. The alliance is a physiognomically uniform group of plant associations that share dominant or diagnostic species, usually found in the uppermost strata of the vegetation. The association is the finest level of the USNVC. An association is defined as a plant community type that is relatively homogeneous in composition and structure and occurs in a uniform habitat. For example, Mid-Atlantic Mesic Mixed Hardwood Forest (*Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest) is a common forest type on well drained, acidic midslopes in the Piedmont and Coastal Plain of Virginia. Associations are also assigned global rarity ranks that indicate their conservation status and relative risk of extirpation (Grossman et al. 1998). Associations from the USNVC are cross-referenced to communities in

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[1] As of this writing, cultural, early successional / ruderal, and exotic (i.e. nonnative plot species) dominated vegetation units defined in the USNVC are not served on NatureServe Explorer. Additional information on these types can be obtained from a NatureServe regional or national vegetation ecologist.

Table 1. United States National Vegetation Classification System physiognomic-floristic
hierarchy for terrestrial vegetation (from Grossman et al. 1998).

Level	Primary Basis For Classification	Example
Class	Growth form and structure of vegetation	Forest
Subclass	Growth form characteristics (e.g., leaf phenology)	Deciduous forest
Group	Leaf types, corresponding to climate	Cold-deciduous forest
Subgroup	Relative human impact (natural/semi-natural or cultural)	Natural/semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Lowland or submontane cold-deciduous forest
Alliance	Dominant/diagnostic species of uppermost or dominant stratum	White Oak - (Northern Red Oak, Hickory species) Forest Alliance
Association	Additional dominant/diagnostic species from any strata	Northern Red Oak / Umbrella Magnolia - Eastern Redbud / Black Cohosh - Heartleaf Foamflower Forest

state-specific vegetation classifications such as the Natural Communities of Virginia (Fleming et
al. 2006), as well as to other regional and national classification systems.

In 2001, the Northeast Region of NPS contracted separately with the Virginia Department of
Conservation and Recreation, Division of Natural Heritage (VADNH), NatureServe, and North
Carolina State University's Center for Earth Observation (NCSU-CEO) to apply the USGS-NPS
VMP standards to the vegetation in seven NPS units in Virginia. These parks are within two
NPS Inventory and Monitoring networks: the mid-Atlantic Network and the Northeast Coastal
and Barrier Network.

The goal of the study was to accurately map and classify at least to the alliance level of the
USNVC, the vegetation in Appomattox Court House National Historical Park, Booker T.
Washington National Monument, Colonial National Historical Park, Fredericksburg and
Spotsylvania National Military Park, George Washington Birthplace National Monument,
Petersburg National Battlefield, and Richmond National Battlefield Park. The classification used
to map these parks was developed regionally, using quantitative data that was collected from all
seven park units and combined with existing data from throughout the Mid-Atlantic Piedmont
and Coastal Plain.

The goal of the mapping effort at Richmond National Battlefield Park was to produce an up-to-
date digital geospatial vegetation database for the park and to provide a plant species list, a
dichotomous key to the vegetation, and descriptions of the vegetation in the park. Baseline
information on plant community composition and rarity is critical to developing desired
conditions and park management goals relating to native plant communities, nonnative plant and
insect species, and effects of deer browse and other disturbances. Identification and description
of plant communities also provide habitat information important to understanding associated

organisms, including animals, protozoa, bacteria, and fungi. A vegetation map can also allow inferences about the location and abundance of species that are characteristic of each community. This report also describes the park's vegetation in the context of a national and regional vegetation classification, the USNVC. Having the park's vegetation mapped and attributed to this standard will facilitate the comparison of vegetation types among other NPS units in the region and throughout the United States.

The success of this study depended on cooperative efforts of several government and private entities. VADNH and NatureServe worked cooperatively to develop the vegetation classification, the vegetation descriptions, and field keys to the map classes, and to ensure that the vegetation units were properly crosswalked to the USNVC. NCSU-CEO produced the photo mosaics, assessed their positional accuracy, and developed preliminary vegetation maps. VADNH took lead responsibility for field validation of the preliminary maps, editing the vegetation maps and labeling features with USNVC units, vegetation data collection and analysis, thematic accuracy assessment, and writing the final reports. The Northeast Region of NPS funded the project and provided technical specifications and guidance.

Park-specific Information

Richmond National Battlefield Park is located in central Virginia, approximately 161 km (100 mi) south of Washington D.C. Richmond National Battlefield Park is one of four parks of the National Park System commemorating and preserving battlefields of the 1864 - 65 United States Civil War campaigns in Virginia. The park protects and interprets resources associated with the siege of Richmond, the Confederate capital during the Civil War, and the many Civil War battles fought in the vicinity of Richmond, Virginia. As of June 2004, the park consisted of 570 ha (1,407 ac) in ten units spread out over three counties and the city of Richmond (Figure 1). The Chimborazo Park unit contains a visitor center and administrative offices and is the only park owned unit within the city of Richmond. The remaining units lie north, east, and south of the city, in Henrico, Hanover, and Chesterfield counties. Lands surrounding park boundaries are primarily residential developments, industrial, rural homes and farmland. In 2007, over 132,500 people visited Richmond National Battlefield Park.

Park Units

1. Chickahominy Bluff
2. Beaverdam Creek
3. Watt House
4. Cold Harbor
5. Garthright House
6. Chimborazo Park
7. Fort Darling
8. Fort Harrison
9. Malvern Hill
10. Parker's Battery
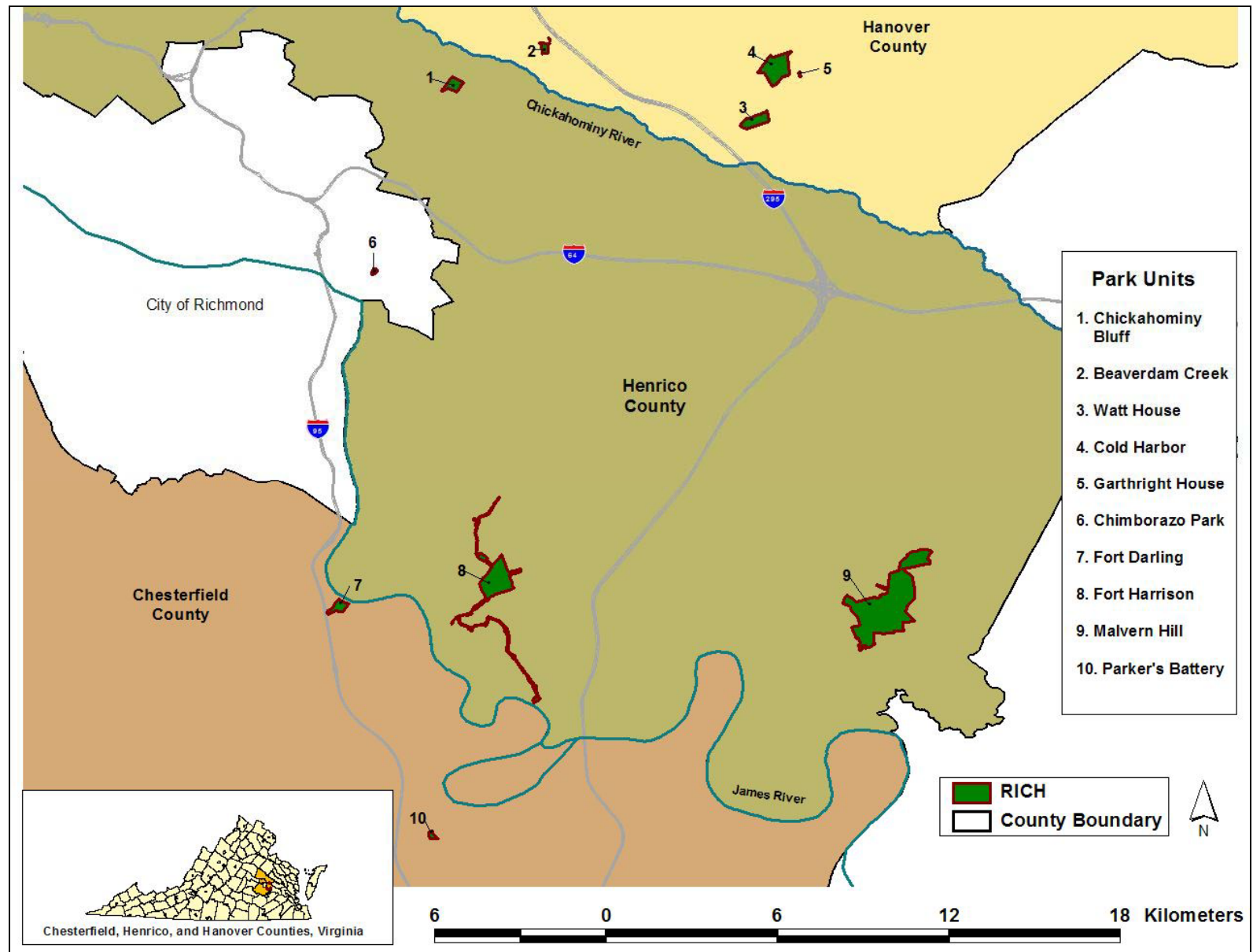
Figure 1. Location of Richmond National Battlefield Park (RICH), Virginia.

Project Area

Location and Regional Setting

The various units of Richmond National Battlefield Park straddle the boundary between the southern Piedmont and northern Coastal Plain of Virginia (Figure 2), an area known as the "Fall Line". The Fall Line is a zone of geologic transition that marks the boundary between the older, resistant, metamorphic rocks of the Piedmont and younger, softer, mostly unconsolidated sediments of the Coastal Plain. In Virginia, this boundary roughly corresponds to the route of Interstate 95 between Washington D.C. and Emporia. The park boundaries fall within six USGS quadrangle maps: Richmond, Seven Pines, Drewrys Bluff, Dutch Gap, Roxbury, and Chester (Figure 3).

Fort Darling and Parker's Battery are located in the Piedmont, while the other park units are in the northern Coastal Plain. This portion of Piedmont is known as the Western Coastal Plain-Piedmont Transition subsection (Keys et al. 1995) and consists of irregular plains with elevations ranging from 30 to 91 m (100 to 300 ft). The Coastal Plain units of Richmond National Battlefield Park lie in the Atlantic Southern Loam Hills subsection which is characterized by smooth plains ranging from 30 to 91 m (100 to 300 ft) (Keys et al. 1995). Historic climate data from Richmond, Virginia (37°30'N / 77°20'W) from the years 1948 through 2007 report mean monthly minimum temperature as 8.4º C (47.2º F), and the mean monthly maximum temperature is 20.5º C (69.0º F). The mean January minimum temperature is –2.3º C (27.8º F), and the mean July maximum temperature is 31.5º C (88.8º F). Annual precipitation averages 111.2 cm (43.8 in).(SRCC 2008).

The vegetation of the Piedmont Plateau has been severely altered by a long history of clearing, agriculture, logging, and other anthropogenic disturbances. Except in the increasingly large urban and suburban areas, the province currently has a patchwork of secondary forests, pastures, and fields used for the production of feed grains or tobacco. Most Piedmont forests have a history of repeated cutting, or have regenerated on former agricultural lands, some of which were abandoned more than 150 years ago. Recently disturbed Piedmont forests tend to have a large component of pines, Virginia pine (*Pinus virginiana*) and/or shortleaf pine (*Pinus echinata*), and shade-intolerant hardwoods such as tuliptree (*Liriodendron tulipifera*) and sweetgum (*Liquidambar styraciflua*). The composition of more mature hardwood forests varies with soils and topography. Dry, acidic soils support oak / heath forests, while more basic upland soils usually support oak-hickory forests. White oak (*Quercus alba*) is a ubiquitous dominant in both forests. Mixed forests of American beech (*Fagus grandifolia*), oaks (*Quercus* spp.), and tuliptree are common in mesic, acidic ravines throughout the Piedmont. More local are rich mesophytic forests, which are generally confined to ravines and river slopes underlain by mafic rocks such as amphibolite, diabase, or gabbro. Upland forests of the western monadnocks resemble those of the Blue Ridge. Forests of silver maple (*Acer saccharinum*), American sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), boxelder (*Acer negundo*), and other flood-tolerant trees are well developed along the larger rivers that cross the Piedmont, particularly the Potomac, the Rappahannock, the James, and the Roanoke (Fleming et al. 2006). The upland forests that originally covered much of the Virginia Coastal Plain have been extensively cleared or altered, so that it is now difficult to determine which species and natural
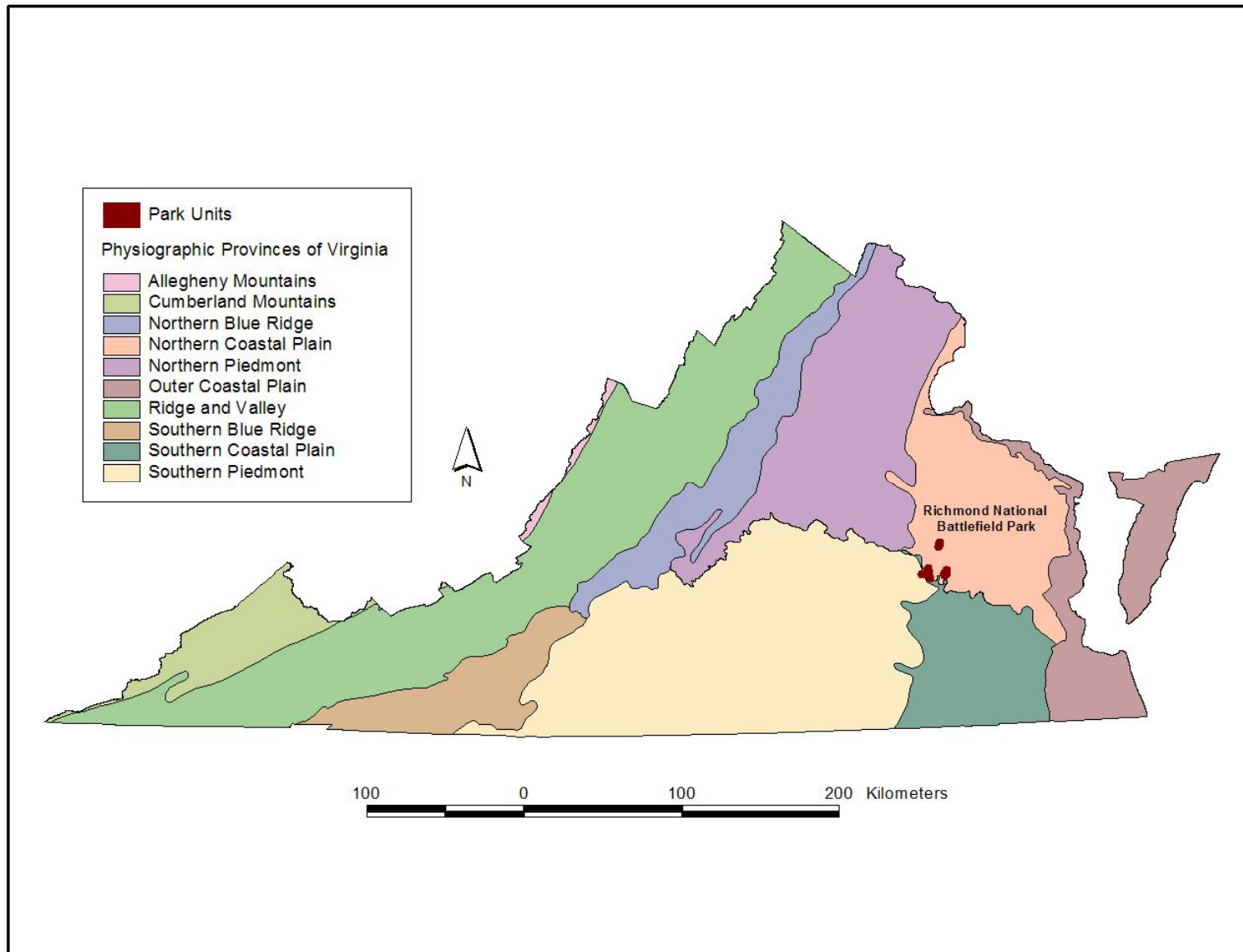
Figure 2. Physiographic provinces of Virginia showing the location of Richmond National Battlefield Park.
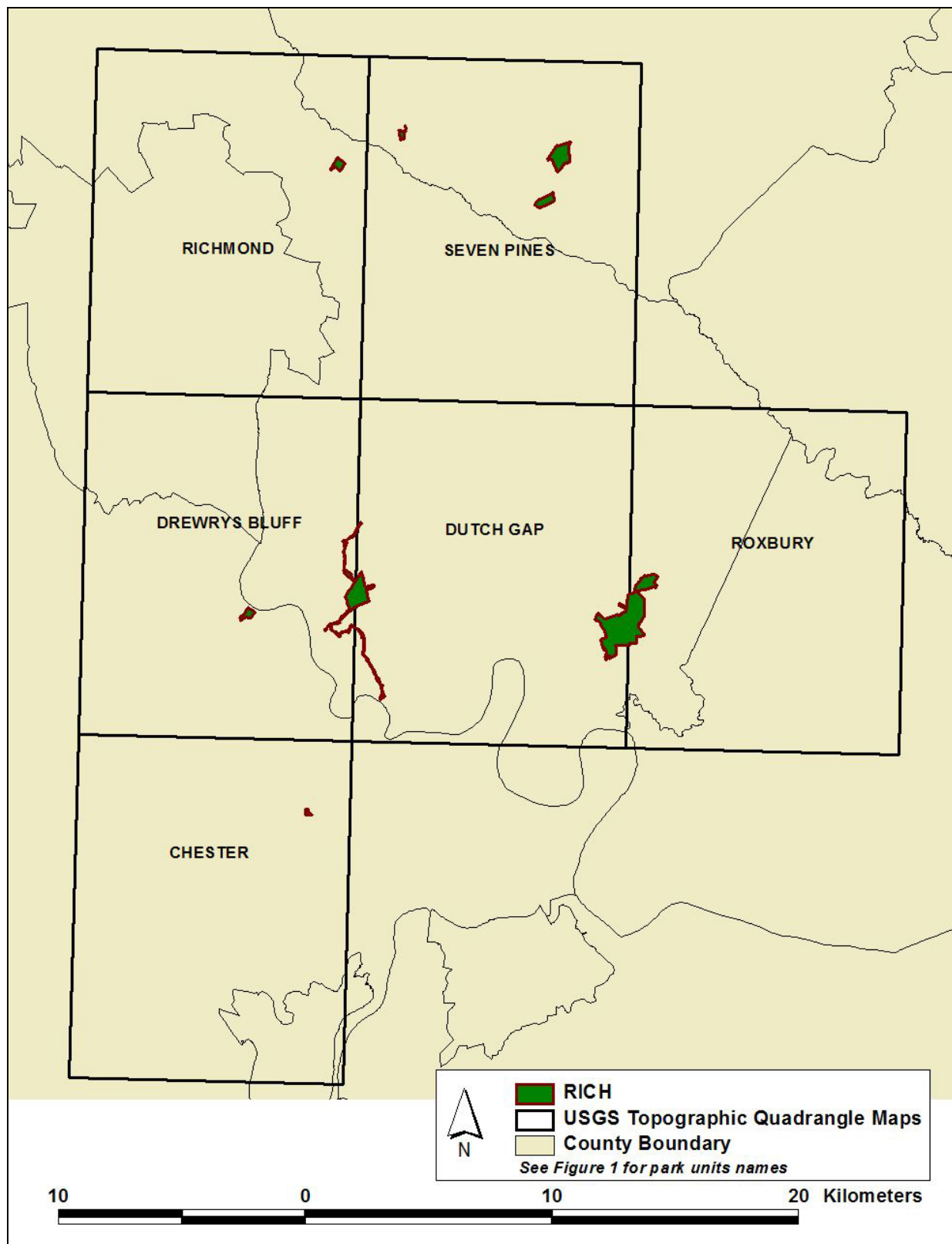
Figure 3. Location of Richmond National Battlefield Park (RICH), Virginia, on six 1:24000 USGS topographic quadrangle maps.

communities were prevalent. Much of the contemporary forest consists of successional or silvicultural stands of loblolly pine (*Pinus taeda*), and secondary pine-hardwood forests that have developed after repeated cutting or agricultural abandonment. The most mature remnant stands on mesic uplands are characterized by associations of American beech, several oaks, and American holly (*Ilex opaca* var. *opaca*), representing what once was the common, matrix-forming forest type in region. Patches of drier oak-dominated forest and steep bluffs with forests of chestnut (*Quercus prinus*), American beech, and dense mountain laurel (*Kalmia latifolia*) are fairly common in the dissected inner Coastal Plain, especially north of the James River. South of the James River, fire-maintained forests and woodlands dominated by longleaf pine (*Pinus palustris*) may have been prevalent prior to European settlement (Frost 1995), but little trace of these now remain. Wetlands of the Coastal Plain are extensive and have fared somewhat better than the province's upland forests, supporting a great variety of natural communities. The diversity of wetlands in this region spans a range of freshwater to saline, lunar-tidal estuaries; tidal and palustrine swamps; nonriverine, groundwater-saturated flats; seasonally flooded ponds and depressions; seepage slope wetlands; and various tidal and non-tidal aquatic habitats.

Park Environmental Attributes

Many environmental factors, such as geology, soils, hydrology and topography, affect the types and distribution of vegetation within Richmond National Battlefield Park. The majority of the park is underlain by five geologic units representing ancient marine and fluvial deposits: Bacons Castle Formation, Chesapeake Group, Chuckatuck Formation, Potomac Formation, and the Winsor Formation (VADMR 1993). The area including Cold Harbor is mapped as having surficial deposits of Pliocene sand and gravel (Virginia Division of Mineral Resources 1993).

Three different soil surveys cover Richmond National Battlefield Park (Clay 1975; Hodges 1978; Hodges et al. 1980). The Soil Survey Geographic (SSURGO) databases for Chesterfield County, Virginia (USDA, NRCS 2004a), Hanover County, Virginia (USDA, NRCS 2004b), and Henrico County, Virginia (USDA, NRCS 2004c) map 39 unique soil series within the boundary of Richmond National Battlefield Park. The soils in the park are primarily Ultisols, with small areas mapped as Inceptisols (four series), Entisols (one series), and Alfisols (one series). The upland soils of the park are deep, moderately well drained to excessively drained soils that formed in interbedded layers of sandy, loamy, and gravelly fluvial or marine Coastal Plain sediments or from felsic crystalline rocks of the Piedmont region. These soils are typically strongly to extremely acid in reaction (pH values less than 5.0). The majority of the upland soils in Richmond National Battlefield Park are not mapped as specific soil series, but are mapped generally as the suborders Orchrepts and Udults or complexes of these soils. These soils occur on sloping to steep areas along the larger, more deeply incised drainageways and between uplands and floodplains and terraces along the larger streams. Other uplands soils of ridges and side slopes that cover at least 5% of the park area include the series Caroline, Kempsville, Ruston, State, Suffolk and Turbeville. Soils of well drained to somewhat poorly drained stream terraces include the Altavista, Angie, Bertie, Lenoir and Pamunkey series. These soils are not considered hydric, but are found on broad stream terraces often associated with wetland vegetation. Of the seven series considered hydric soils in the park, the Rains and Coxville series are associated with upland depressions and flats, while Chastain, Chewacla, Kinston, Myatt, and Roanoke series are found on floodplains, bottomlands, and low-lying stream terraces.

All ten units of Richmond National Battlefield Park are located within the lower James River drainage basin. The James River spans nearly the entire state of Virginia, originating in the mountains of western Virginia, and ultimately emptying into the Chesapeake Bay. The park units Chimborazo Park, Fort Harrison, and Fort Darling all have bluffs overlooking the James River. The park's other units contain smaller streams that ultimately serve as tributaries to the James River. Beaverdam Creek, Boatswain Creek and Bloody Run, all located in the park's northern-most units, empty into the Chickahominy River, which in turn, empties into the James River. Crewes Channel and Western Run, both located in the Malvern Hill unit, empty directly into the James River. Beaver activity and the low relief of the land create many ponds and backwater areas along park streams. These factors, along with the variable gradients of the streams themselves, provide a range of aquatic habitats, from swift moving water to shallow marshes (Rice et al. 2003).

The topographic relief in the park is mostly gentle; typical of the rolling uplands of the southern Piedmont and smooth plains of the Coastal Plain. Steep bluffs are typical along the major rivers. Elevations range from a low point of 2 m (5 ft) along the James River at Fort Harrison to a high point of 52 m (170 ft) at Chickahominy Bluff.

Methods

Project Scoping and Planning

In early 2001, the Northeast Region of the National Park Service approached VADNH to help develop a vegetation classification and maps for seven NPS units in the Piedmont and Coastal Plain of Virginia (Appomattox Court House National Historical Park, Booker T. Washington National Monument, Colonial National Historical Park, Fredericksburg and Spotsylvania National Military Park, George Washington Birthplace National Monument, Petersburg National Battlefield, and Richmond National Battlefield Park). Later that year a meeting was convened with representatives from the NPS Northeast Region Inventory and Monitoring Program, NatureServe (then the Association of Biodiversity Information), NCSU-CEO and VADNH to identify the scope of the project and clarify roles and responsibilities.

The three entities worked cooperatively and with the NPS to develop accurate vegetation maps and a regional vegetation classification to apply to the vegetation of all seven parks. Ecologists at VADNH took the primary role in field data collection, data analysis, regional classification development, map editing, and accuracy assessment. They developed the local association descriptions, the field key to map classes, and wrote the final reports. NatureServe reviewed the vegetation classification developed by VADNH and ensured that the USNVC standard was followed. They also took responsibility for entering all new information into the USNVC databases and completed global association descriptions. They assisted in the development of or reviewed field keys to the mapping units on the parks, and provided in-the-field consultation on problematic vegetation types. Researchers at NCSU-CEO were responsible for aerial photography acquisition and processing, and preliminary photo interpretation. They also wrote the corresponding sections of the final reports.

Preliminary Data Collection and Review of Existing Information

Previous studies conducted at Richmond National Battlefield Park were reviewed for information pertinent to the park's vegetation. These studies included a floristic survey (Hayden and Johnson 1986, Hayden et al. 1989) and a previous inventory by VADNH (Ludwig and Pague 1993). Existing aerial photography (Virginia Geographic Information Network 2002), topographic maps, digital raster graphics (DRGs), National Wetland Inventory maps, the soil survey for Hanover, Henrico, and Chesterfield counties, Virginia, and digital soil survey data (SSURGO) were gathered for use in planning fieldwork and to use as ancillary data layers. A preliminary classification of vegetation in Virginia's Piedmont and inner Coastal Plain (Fleming 2001) was used to develop a list of vegetation likely to occur in the park. Lists of the USNVC formations and alliances likely to occur in the park were generated from NatureServe databases.

Aerial Photography Acquisition and Processing

Two sets of digital orthophoto mosaics, leaf-on (fall) and leaf-off (spring), were created for Richmond National Battlefield Park. To achieve manageable file sizes, each set is made up of six files that, together, cover the entire geographic extent of the park. Kucera International acquired color infrared, stereo pair 1:6,000 scale aerial photography for the leaf-on mosaics on October 23, 2001 and for the leaf-off mosaics on February 28, 2002. The photography was

delivered to the NPS, quality checked, accepted as provided, and sent to NCSU-CEO. Upon receipt at NCSU-CEO, the air photos were counted to make sure that none were missing, scanned and saved in .tif format, and placed in the data archive maintained at NCSU-CEO for the NPS Northeast Region Inventory and Monitoring Program. Associated data and information provided by Kucera International that are also stored in the data archive include the airborne global positioning system (GPS) and inertial mapping unit (IMU) data files, the camera calibration certificates for the cameras, and the hardcopy flight reports for the photography that crosswalk the airborne GPS and IMU data to the photo frame numbers.

The leaf-on and leaf-off mosaics were produced from 109 and 85 color infrared air photos, respectively, scanned at 600 dpi with 24-bit color depth. For each of the 12 mosaics (six leaf-on and six leaf-off), scanned .tif images of the relevant air photos were imported into ERDAS IMAGINE (.img) 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 1. At this point, single frame orthophotos (one for each air photo) were generated within IMAGINE and exported to IMAGINE .lan format. Then the .lan files were imported into ER Mapper's native (.ers) format, and an ER Mapper algorithm was created which 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 software with a 20:1 compression ratio. The final mosaics, in both .img and MrSID formats, are stored in the NCSU-CEO data archive.

Preliminary Photointerpretation

A preliminary vegetation dataset for Richmond National Battlefield Park was created by interpreting the digital orthophoto mosaics to delineate vegetation polygons to the formation level defined in the National Vegetation Classification System (FGDC 1997, Grossman, et al. 1998). To create the formation level vegetation dataset, a photo interpreter, viewing the leaf-off and leaf-on mosaics in two dimensions, delineated visible areas of homogenous vegetation, land cover, and land use using ArcMap's onscreen digitizing tools. The minimum mapping unit was 0.5 hectares (1.25 acres); however, the photo interpreter was able to delineate polygons as small as 0.2 hectares (0.5 acres). After polygons were delineated for the entire park area, the photo interpreter 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. In accordance with USGS-NPS VMP protocols, the Level II land use and land cover classification scheme developed by Anderson et al. (1976) was used to attribute non-vegetated land cover. In addition, user-defined codes were used to attribute agricultural areas and tidal mud flats. Next, the photo interpreter examined each formation-level vegetation polygon in three dimensions using ERDAS IMAGINE's Stereo Analyst software, checked the vegetation class code entered in the attribute table, and entered a corrected vegetation class code if appropriate. The final formation-level vegetation dataset is archived in ESRI personal geodatabase and shapefile formats in the NCSU-CEO data archive.

Field Data Collection

Leaf-on and leaf-off photomosaics and the formation-level line work were obtained from NCSU-CEO in May 2004. Ecologists from VADNH conducted field data collection in Richmond National Battlefield Park in April, May and July 2002, July 2003, June and July 2004, July and September 2005, and April 2006. The objectives of the fieldwork were to evaluate the formation-level line work and to collect information to help attribute and edit the line work to reflect the alliance level of the USNVC. Additionally, detailed quantitative data from the least disturbed areas of the park were needed to augment data available for a regional vegetation classification.

The evaluation and editing of the line work required extensive field reconnaissance throughout the park. Ecologists navigated to vegetation polygons represented on the formation-level map using a GarminMap76S GPS. Once within the target polygon, qualitative observations were made that described any variation of vegetation or environment within the polygon. The dominant vegetation class and any inclusion communities were noted following Fleming (2001). Dominant and characteristic vascular plant species were listed by strata with an indication of their prevalence in the stand (i.e. dominant, common, or rare). When possible, the entire polygon was traversed and additional GPS points were collected to mark significant vegetation change within a polygon. Only areas within the park boundary were surveyed.

Additional detailed quantitative data were collected only in the highest quality stands of floristically and structurally homogeneous vegetation. These were middle-to-late successional stands with a composition of mostly native species and with a consistent environmental setting. Within these areas, specific plot locations were chosen subjectively in order to distribute plots across a range of site conditions and to capture vegetation types that were relatively dominant, homogenous, and covered at least the minimum mapping unit area of 0.5 ha (1.24 ac). An attempt was made to find at least one undisturbed sampling location for each middle-to-late successional community type in the park. Early-successional forests and heavily disturbed areas within the park were not sampled using quantitative methods. These areas are spatially, temporally, and compositionally dynamic. Since their floristics are often in flux and subject to stochastic factors, groups of plots of heavily modified vegetation (even groups dominated by the same species) usually lack the compositional consistency to allow for ecologically meaningful patterns to be found using quantitative data analysis. Thus, sample plots from these types often perform as statistical outliers in quantitative analyses and frequently fail to aggregate into convincing groups by accepted statistical standards. Instead, qualitative data collected from vegetation polygons were used to describe and map early-successional forests and heavily disturbed areas within the park.

In order to be maximally compatible with existing regional plot data, plots were sampled using the relevé method (sensu Peet et al. 1998), following standard procedures employed by VADNH and modified slightly to accommodate entry into the PLOTS database (NatureServe 2004). As a rule, 100 m^2 plots with 10×10 m, or 5×20 m configurations were used to sample shrubland or herbaceous vegetation and 400 m^2 plots were used to sample forested vegetation. The configuration of the plot is flexible (e.g. 20×20 m, 16×25m, 13.33×30 m, 10×40 m) to accommodate special site conditions and vegetation pattern. If a forest had particularly large

diameter trees or a diverse canopy composition, a 1000 m^2 plot (20 x 50m) was used to fully capture tree species composition.

Within each plot, the percent cover of each vascular plant taxon was visually estimated as a vertical projection of above-ground biomass onto the full plot area and assigned to one of nine numerical cover classes (Table 2). In addition to this total cover value, cover was estimated for each species in the following height/lifeform classes:

- herb (field) layer (all herbaceous plants, woody plants <0.5 m)
- short shrub layer (woody plants 0.5–1 m)
- tall shrub layer, >1–6 m
- tree layer, >6–10 m
- tree layer, >10–20 m
- tree layer, >20–35 m
- tree layer, >35 m

The overall cover of mosses, lichens, and liverworts was estimated, but the individual cover of non-vascular taxa was not estimated. The cover of vines climbing into the canopy or subcanopy was recorded in the maximum height stratum attained by the plant. Vascular plants thought to be characteristic of the sampled community, but located outside the plot, were recorded parenthetically if visible from the boundary, and assigned a cover class of 1.

Additional vegetation information collected included the estimated height and total vegetative coverage of each stratum, the leaf type and leaf phenology of each stratum, and the physiognomic class represented by the stand. The maximum canopy height was measured using a clinometer.

Table 2. Cover-class scores used in field sampling and data analysis.

Cover Class	Percent Cover Range	Area of Coverage for a 400 m^2 plot	Cover Class Percent Cover Midpoint
1	<0.1%	<20 cm^2	0.05%
2	0.1–1%	20 cm^2–4 m^2	0.55%
3	1–2%	4–8 m^2	1.50%
4	2–5%	8–20 m^2	3.50%
5	5–10%	20–40 m^2	7.50%
6	10–25%	40–100 m^2	17.50%
7	25–50%	100–200 m^2	37.50%
8	50–75%	200–300 m^2	62.50%
9	75–100%	300–400 m^2	87.50%

A standard set of environmental data was measured or estimated at each plot (Table 3). Slope inclination was measured with a clinometer, and slope direction (aspect) was evaluated using a compass. Both measurements were taken to the nearest degree from the plot center. In plots with variable microtopography, slope was measured at several points and averaged. The percent cover of different surface substrates was estimated visually, with precision varying such that values sum to 100%. Topographic position, slope shape (both horizontally and vertically), soil drainage class, soil moisture regime, and inundation were assessed using scalar values. Landform was assessed at the landscape level using a topographic map and assigned to values from a standard landform classification (Driscoll et al. 1984). When conditions permitted, a digital photo was taken of each sampling location. Each vegetation sample was georeferenced using a GarminMap76s global positioning system (GPS), when possible. If a satellite reading could not be obtained, UTM coordinates were derived from the estimated position on a topographic quadrangle map. Elevation was also derived from the position on a topographic quadrangle map.

When possible, soil samples were collected from the top 10 cm (4 in) of mineral soil (below the surficial litter and humus). Depth of surface duff, soil color, and texture were evaluated in the field and recorded on the plot forms.

Evidence of any past or ongoing vegetation disturbance was carefully recorded at each sampling site. Other information was recorded in the form of a narrative qualitative assessment and notes. This narrative could include information concerning landscape context, estimated size of stand, hydrologic condition, approximate distance and direction to proximate water sources, spatial variation of vegetation pattern, or any other unusual features of the vegetation.

The plot survey form used to collect quantitative vegetation samples is provided in Appendix A.

All field data for quantitative vegetation samples were entered into the PLOTS database version 2.0 (NatureServe 2004) and are provided as a supplement to this report. 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).

In the context of this report a nonnative species (sometimes referred to as an exotic or alien species) is a species that is not thought to be a native component of Virginia's flora (Townsend 2007). Native species are those that occur in the region in which they evolved, changing over time in response to physical and biotic processes characteristic of a region. Plants that exhibit invasive tendencies and threaten rare native plants and natural communities are referred to as invasive. For this report, invasive nonnative plant species include those on the VADNH list of Invasive Exotic Plant Species in Virginia (Heffernan et al. 2001, VADCR 2003).

Vegetation Classification and Characterization

The vegetation classification used to map seven mid-Atlantic NPS parks in Virginia was developed through successive approximations. The initial classification from 2001 (Fleming 2001) was improved upon by two additional analyses, in 2003 and in 2006, each progressively using a larger regional dataset, with the objective of producing a more robust classification.

Table 3. Topographic / hydrologic environmental data recorded at each plot sample location.

Topographic Position:
    crest
    upper slope
    middle slope
    lower slope
    toe slope
    plain/level/bottom
    basin/depression
	Soil Drainage Class:
	    very poorly drained
	    poorly drained
	    somewhat poorly drained
	    moderately well drained
	    well drained
	    rapidly drained

Surface Substrate (% cover):
    bedrock
    boulders and stones
    gravel and cobbles
    litter / organic matter
    decaying wood
    water
    mineral soil / sand
    other
	Inundation:
	    never
	    infrequently
	    regularly; for <6 months
	    regularly; for >6 months
	    always submerged by shallow water (<30cm)
	    always submerged by deep water (>30 cm)

Measured Aspect (degrees)
Measured Slope (degrees)
Slope Shape:
    vertical
      concave
      convex
      straight
    horizontal
      concave
      convex
      straight
    hummock and hollow microtopography
    irregular craggy/bouldery microtopography
Hydrologic Regime:
    terrestrial (i.e. not a wetland)
    non-tidal
      permanently flooded
      semipermanently flooded
      seasonally flooded
      intermittently flooded
      temporarily flooded
      saturated
    tidal
      irregularly exposed (< diurnally)
      regularly flooded (diurnally)
      irregularly flooded (< diurnally)
      wind tidally flooded
      unknown hydrology
	Soil Moisture Regime:
	    very xeric (moist for negligible time after precipitation)
	    xeric (moist for brief time)
	    somewhat xeric (moist for short time)
	    submesic (moist for moderately short time)
	    mesic (moist for significant time)
	    subhygric (wet for significant part of growing season; mottle <20cm)
	    hygric (wet for most of growing season; permanent seepage/mottling)
	    subhydric (water table at or near surface for most of the year)
	    hydric (water table at or above surface year round)

All plot data collected in mid-Atlantic national parks as of November 2002 were combined into a regional data set of 1,342 plots from throughout the Virginia Piedmont and Coastal Plain and from selected NPS units in Maryland and the District of Columbia. The resulting preliminary vegetation classification was reviewed by NPS ecologists and Natural Heritage Program ecologists from Virginia, Maryland, and West Virginia. In December 2006, with the addition of plot data collected since 2002 from Virginia, Maryland, and West Virginia, a regional dataset of 2,250 plots was used to develop the final vegetation classification for the project.

All data were examined using a combination of cluster analysis, ordination, and tabular (statistical) analysis. In general, the analytical process was designed to progressively fragment the large datasets into more workable subsets, using cluster analysis to identify groups, statistical analysis to validate those groups, and lastly ordination studies to examine compositional gradients between groups and correlations with important environmental gradients. In practice, the process was iterative as increasingly finer groups were identified and analyzed.

The general steps included 1) data preparation and transformation, 2) numerical classification (cluster analysis), 3) summary statistics, 4) gradient analysis (ordination), and 5) assignment of classification units to the standard (crosswalking to USNVC). Each of these steps is outlined below.

Data Preparation and Transformation

Plot data collected during field work were combined with existing data from throughout the Mid-Atlantic Coastal Plain and Piedmont using databases created with Microsoft Access 2000. The final dataset consisted of 2,250 plots (1,452 upland and palustrine wetland + 798 tidal).

Since individual plant taxa are not always identified to the same taxonomic level in plot sampling, botanical nomenclature for the whole analysis dataset was reviewed and standardized. As a rule, taxa were treated at the highest level of resolution possible, but treatment at the subspecific level was not always possible and a few groups of species had to be merged into "pseudospecies." For example, various plots had *Polygonatum biflorum*, *Polygonatum biflorum* var. *biflorum*, or *Polygonatum biflorum* var. *commutatum*; these were merged at the species level. Species richness was calculated for each plot using all taxa (including unidentified species) rooted within plot boundaries. However, taxa identified only at generic or higher levels (e.g., *Carex* sp. or unidentified woody seedling) were deleted from the dataset prior to analysis to eliminate "noise" and potentially erroneous correlations between generic entities.

Prior to analysis, most environmental variables were transformed, either to normalize frequency distributions or to assign numeric values to categorical variables. Topographic position and slope were converted to ordinal variables (Table 4). Aspect was transformed using the cosine method of Beers et al. (1966), using the formula $A' = \cos(45° - A) + 1$, where A' = transformed aspect and A = aspect in degrees. The Beers transformation is a commonly used formula for the conversion of the circular measure of slope aspect in degrees into linear values that can be used in correlation and regression analysis. Beers transformation yields values between 0 and 2 that are used to relate aspect to topographic moisture and solar exposure. Drier, solar exposed slopes (SW, 225°) have the lowest values and moist, sheltered slopes (NE, 45°) the highest transformed

Table 4. Ordinal values for topographic position and slope inclination used in data analysis.

Topographic Position	Slope Inclination
basin/depression = -1	0–3º = 1 (flat)
plain/level/bottom = 0	4–6º = 2 (gentle / undulating)
toe slopes = 1	7–13º = 3 (sloping / rolling)
lower slope = 2	14–20º = 4 (moderate / hilly)
middle slope = 3	21–40º = 5 (steep)
upper slope = 4	41º+ = 6 (very steep)
crest = 5	

values. Surface substrate values were converted to decimals and arcsine transformed to normalize their distributions.

A synthetic Topographic Relative Moisture Index (TRMI) was calculated for each plot using a procedure modified from Parker (1982). TRMI is a scalar index ranging from 0 (lowest moisture potential) to 50 (highest moisture potential) and is computed by combining three topographic variables that potentially influence water runoff, evapotranspiration, and soil moisture retention:

- Slope inclination (10-point scale; per Parker [1982])
- Aspect (20-point scale) = Beers-transformed aspect X 10
- Topographic position (20-point scale; per Parker [1982])

Normally slope shape would be included as an additional 10-point scale but, unfortunately, data on slope shape were not consistently collected from the plots in this study. Because of this omission, as well as assumptions of the formula that may not apply as well to Piedmont and Coastal Plain topography as to montane topography, TRMI as calculated for this study, should be regarded as strictly experimental.

Soil samples collected from plots were oven-dried, sieved (2 mm), and analyzed for pH, estimated nitrogen release (ENR), phosphorus (P), soluble sulfur (S), exchangeable cations (calcium [Ca], magnesium [Mg], potassium [K], and sodium [Na] in ppm), extractable micronutrients (boron [B], iron [Fe], manganese [Mn], copper [Cu], zinc [Zn], and aluminum [Al], in ppm), cation exchange capacity (CEC; m.e.q./100g), total base saturation (%TBS), and percent organic matter (%OM). Chemical analyses were conducted by Brookside Laboratories, Inc., New Knoxville, Ohio. Extractions were carried out using the Mehlich III method (Mehlich 1984) and percent organic matter was determined by loss on ignition. Values for all soil variables except pH were natural log-transformed to normalize their distributions and make the values more biologically interpretable (Palmer 1993). A calcium:magnesium ratio and a synthetic fertility index ([cation exchange capacity X total base saturation] / 100) were also calculated for each plot.

Cluster Analysis

In order to identify groups of compositionally similar plots samples, a hierarchical, agglomerative, polythetic, cluster analysis was implemented using the software program PC-ORD (version 5.0; McCune and Mefford 1999). In this type of numerical classification, sample

units (plots) are compared and joined into clusters based on their relative similarity. This type of cluster analysis results in a treelike diagram called a dendrogram that depicts the progressive joining of individual plots into larger and larger clusters. Ecologists can use the dendrogram to identify classes (subsets of plots) to subject to further analyses. In the context of this type of analysis, hierarchical means that large clusters are composed of smaller clusters. Agglomerative means that the analysis proceeds by joining clusters rather than by dividing clusters. Polythetic means that many attributes of the items are used to decide the optimum way to combine or divide clusters (McCune and Grace 2002).

Plot by species matrices for cluster analysis were constructed using raw species cover class scores. The Lance-Williams Flexible-Beta linkage method (Lance and Williams 1966, 1967) and either the Bray-Curtis (Sorensen) dissimilarity measure (Bray and Curtis 1957) or Relative Euclidian distance were used to identify compositionally similar groups of plots. The Flexible-Beta method is a generalized sorting strategy, the performance of which varies with user-specified emphasis (beta) on different measures of between-group distance. In general, beta settings ranging from the default of –0.25 to –0.5 produce optimal results with vegetation data, performing very similarly to minimum-variance clustering, i.e., Ward's method (Ward 1963). The Bray-Curtis coefficient (also known as the Sorensen coefficient) has been used with demonstrable success in a wide range of ecological studies (Beals 1984). Among available measures of ecological "distance," represented as a mathematical dissimilarity between samples, the Bray-Curtis coefficient is a balanced measure that places some emphasis on dominant (i.e., high-cover) species while still giving minor (i.e., low-cover) species considerable weight in the analysis (Gauch 1982). Relative Euclidian distance is conceptually similar, except that abundance values are relativized such that the total abundances for all plots are equal.

Using these procedures, the 2,250-plot dataset was progressively fragmented by identifying one or more homogeneous subsets at each iteration, removing those subsets, and re-clustering the remaining plots. These data subsets were then subjected to more comprehensive cluster, statistical, and ordination analyses.

Summary Statistics

Summary tables of compositional statistics were calculated to evaluate the adequacy of groups recognized in cluster analysis and ultimately to assist in naming and describing the community types. Total mean cover and total frequency across all plots were determined for every taxon. To compute mean cover, cover class scores were converted to the midpoints of their respective percent ranges, the midpoints were averaged, and resulting values were back-transformed to cover class scores. For each taxon in each group under consideration, the following summary statistics were then calculated:

- Frequency - the number of samples in a group in which a species occurs.

- Mean Cover - back-transformed cover class value corresponding to mean percent cover calculated from midpoint values of cover class ranges. All samples assigned to a group were considered when calculating mean cover, not just those in which a taxon was present; absences were assigned a cover value of 0.

- Relative Cover - the arithmetic difference between mean cover (for a given group of samples) and total mean cover (for the entire data set) (= Mean Cover - Total Mean Cover). Expressed by plus or minus symbols, this value provides a *relative* approximation of how much more, or less, abundant a particular species is in a community type compared to the overall data set.

- Constancy - the proportion of samples in a group in which a species occurs, expressed as a percentage (= [Frequency / Number of samples in group] × 100).

- Fidelity - the degree to which a species is restricted to a group, expressed as the proportion of total frequency that frequency in a given group constitutes (= [Frequency / Total Frequency] × 100). An accidental or nonnative species can have maximal (100) fidelity to a type if it occurs in only one sample in the entire data set. As a result, fidelity alone can perform poorly as a criterion for identifying characteristic species and distinguishing among types.

- Diagnostic Value (DV) (= [Constancy × Fidelity] / 100). A synthetic value indicating species that are both frequent within and relatively restricted to a group of plots.

- Diagnostic Value Adjusted by Cover, Scaled (Adj DV [scaled]) (= [Diagnostic Value × Mean Cover] / 9). By dividing DV × Mean Cover by 9, the maximum possible cover value, this statistic synthesizes information about frequency, diagnostic value, and mean abundance. A species entirely restricted to a particular community type, occurring in every sample of that type, and attaining maximum mean cover will have a Scaled Adjusted DV of 100 for that type. Empirically, taxa most characteristic of a type will have a much lower Adjusted DV, although the exact range of values in any given type or data set may vary considerably.

- Diagnostic Value Adjusted by Cover, Unscaled (Adj DV [unscaled]) (=Diagnostic Value × $2^{\text{relative cover}}$). An alternative, unscaled synthetic measure of adjusted DV, using relative cover as the modifier of DV. Since cover classes form a logarithmic, rather than linear scale of values, Unscaled Adjusted DV is a statistically more legitimate means of incorporating information on cover, and has the advantage of not favoring only dominant species and better identifying species that are considerably more abundant within a given type than in the data set as a whole. This statistic is sensitive, however, to vegetation types containing few samples and to species with low overall frequency. Additionally, the following statistics were generated for each group:

- Mean Species Richness - the average number of species present per plot; only species rooted inside plot boundaries were included in this calculation.

- Homoteneity - the average constancy of the S-most constant species, where S = mean species richness for the type. This value (*sensu* Curtis 1959) can be considered an index of the relative uniformity of a group of plots; higher values for homoteneity indicate greater uniformity in species composition among plots. Although homoteneity is not independent of group size, often increasing as the number of group members decreases, it

can be used to evaluate whether community types have been defined at an appropriate level.

Environmental Summary Statistics

Mean values for continuous and ordinal environmental variables were calculated for each group to aid in describing the units and identifying the differences between them. These calculations were performed with raw (untransformed) values, which were averaged across all plots representing a given group. Environmental variables were summarized only for groups with at least half the plots containing data. Mean aspect was calculated as the average position along an arc defined by the range of aspect values.

Ordination

The ordination method of non-metric multidimensional scaling (NMDS; Kruskal 1964) was used to examine classified units in a multidimensional space, detect compositional variation and trends that are obscured in cluster analysis, and aid in identifying the environmental gradients along which vegetation classes and community types are distributed. NMDS is a type of indirect gradient analysis that assigns samples to coordinates in ordination space in a way that maximizes, to the extent possible, the rank-order (i.e., non-parametric) correlation between inter-sample distance in ordination space and inter-sample dissimilarity (i.e., ecological distance; Minchin 1987). A detailed discussion of NMDS and other ordination techniques can be found in McCune and Grace (2002).

Ordination studies were conducted for each major compositional group identified in cluster analysis, as well as for selected smaller groups of closely related community types. The software program PC-ORD (version 5.0; McCune and Mefford 1999) was used to implement NMDS ordination analysis. The Bray-Curtis coefficient (Sorensen) or Relative Euclidean, the same measure used in cluster analysis, was used to calculate dissimilarity and VARIMAX rotation was employed to optimize axis placement in all ordination runs. Each ordination was computed using 100 random starting configurations, and configurations with the lowest stress levels were used for interpretation. Prior to running ordination analysis, outlier plots that would have undesirable effects on the ordination results were identified and removed using the outlier analysis function in PC-ORD.

Based on preliminary plots of stress vs. dimensionality, most ordinations were extracted in three dimensions (some were in two dimensions). Pearson's r^2 correlations between environmental variables and ordination axes were calculated, and significant correlations were displayed through joint plot overlays. A joint plot is a diagram that shows the relationship of a set of variables and ordination scores. Radiating lines (vectors) representing environmental variables are depicted within ordination space. The angles and lengths of the radiating lines indicate the direction and strength of the relationship between the variable and the ordination scores. The 19 soil variables and 10 topographic variables used in ordination analyses are listed in Table 5.

Crosswalking classification units to the USNVC

Vegetation classes developed through quantitative analysis were compared to existing units of the USNVC. All quantitatively-derived types were either assigned to a conceptually similar

Table 5. Environmental variables used in ordination joint plots. Only variables correlated with plot ordination scores are shown in the joint plot diagrams.

Topographic variables and percentage substrate	
Beers Aspect	transformed aspect (Beers et al. 1966)
Slope Value	ordinal value for slope
Topo position	ordinal value for topographic position
TRMI	Topographic Relative Moisture Index
Bedrock	percentage cover by bedrock in plot
Boulders and Stones	percentage cover by rocks > 10 cm in plot
Gravel and Cobbles	percentage cover by rocks 0.2–10 cm in plot
Decaying Wood	percentage cover by dead wood in plot
Water	percentage cover by water in plot
Mineral Soil_Sand	percentage cover by bare sand or mineral soil in plot

Soil chemistry variables	
Al	extractable aluminum (in parts-per-million)
B	extractable boron (in parts-per-million)
Base Saturation (%TBS)	percent total base saturation
Ca	exchangeable calcium (in parts-per-million)
CaMgRatio	calcium:magnesium ratio
CEC	cation exchange capacity (m.e.q. / 100 g)
Cu	extractable copper (in parts-per-million)
Fe	extractable iron (in parts-per-million)
Fertility	synthetic fertility index (= CEC × Base Saturation / 100)
K	exchangeable potassium (in parts-per-million)
Mg	exchangeable magnesium (in parts-per-million)
Mn	extractable manganese (in parts-per-million)
N	estimated nitrogen release (in lbs-per-acre)
Na	exchangeable sodium (in parts-per-million)
OM	% organic matter (by loss on ignition)
P	phosphorus (in parts-per-million)
pH	measure of acidity based on the activity of hydrogen
S	soluble sulpher (in parts-per-million)
Zn	extractable zinc (in parts-per-million)

USNVC association, or used as the basis for a new USNVC association. In selecting nominals for new USNVC associations, high-constancy species (especially those with relatively high mean cover and high diagnostic value, if available) were favored to facilitate identification of the type in the field. A constant species was generally considered to be a species occurring in > 67% of plot samples within a classified association. In a few cases, species that were less constant in a type but had high mean cover and diagnostic value were selected as parenthetical nominals. The global USNVC descriptions for existing associations were edited, and global descriptions for new associations were drafted. All classifications, crosswalks, and new USNVC associations were reviewed by Natural Heritage Ecologists from Virginia, Maryland, North Carolina, West Virginia, and NatureServe.

In addition to the vegetation classes derived from quantitative analysis, other vegetation classes used to describe the vegetation in the seven parks were developed from qualitative observations in the parks. Some of these qualitatively-derived units were crosswalked to the USNVC association level, while others (i.e. cultural or disturbed vegetation) were not appropriate for inclusion in the USNVC, and were described as nonstandard, park-specific vegetation classes.

Characterization of Vegetation

Once the regional vegetation classification was complete, vegetation classes across all seven parks were assigned a common name based on the Natural Communities of Virginia (Fleming et al. 2006) or, if no appropriate name existed in Fleming et al. (2006), the USNVC association common name was used, or a park-specific common name was assigned. Park-specific descriptions for all vegetation classes occurring at Richmond National Battlefield Park were drafted using data from field observation points and quantitative plots. A dichotomous key to the vegetation classes occurring in the park was created for use by park natural resource managers and others. A dichotomous key is a tool for identifying unknown entities, in this case, vegetation classes. It is structured by a series of couplets, two statements that describe different, mutually exclusive characteristics of the vegetation. Choosing the statement that best fits the vegetation in question leads the user to the correct vegetation class. The dichotomous key should be used in conjunction with the detailed vegetation class descriptions to confirm that the class selected with the key is appropriate.

Vegetation Map Preparation

Spatial data from field observation points and quantitative plots were used to edit the formation-level maps of Richmond National Battlefield Park to better reflect vegetation classes. Using ArcView 3.3, polygon boundaries were revised onscreen over leaf-off photography. Units used to label polygons on the map (i.e. map classes) are equivalent to one or more vegetation classes from the regional vegetation classification, or to a land-use class from the Anderson (Anderson et al. 1976) Level II classification system. Each polygon on the Richmond National Battlefield Park map was assigned to one of twenty-one map classes based on plot data, field observations, aerial photography signatures, and topographic maps. The mapping boundary was based on park boundary data obtained from Richmond National Battlefield Park in June 2004. Two of the ten park units (Chimborazo Park and Garthright House) consist of historic buildings and/or visitor centers and were not included in the vegetation mapping project. Spatial data depicting the locations of earthworks was obtained from the park and used to identify polygons of the cultural

map classes Open Earthworks and Forested Earthworks. The vegetation map was clipped at the park boundary because areas outside the park were not surveyed or included in the accuracy assessment.

Accuracy Assessment

Two sources of potential error in the vegetation map include: 1) horizontal positional accuracy, in which a location on the photomosaic 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. The USGS-NPS VMP protocols (TNC and ESRI 1994c) were followed to assess the horizontal positional accuracy of the digital photo mosaics (leaf-on and leaf-off) and the thematic accuracy of the vegetation map.

<u>Positional Accuracy Assessment</u>

The horizontal positional accuracy of the leaf-on and leaf-off mosaics was assessed using guidelines of the USGS-NPS VMP (TNC and ESRI 1994c). For purposes of accuracy assessment, each set of mosaics (leaf-on and leaf-off) was treated as a single entity because the photography for each was acquired with the same camera and with one set of airborne GPS and IMU data. Well-defined positional accuracy ground control points were placed throughout all quadrants of each set of mosaics in ArcMap. Ground control points and zoomed-in screenshots of each point were plotted on hard copy maps with the mosaic as a background. These maps and plots were used to locate the ground control points in the field. Field staff recorded the ground control point coordinates with a Trimble Pro XR/XRS or GeoXT. Mapped ground control points that were physically inaccessible were also noted. The field crew collected accuracy assessment data at 29 ground control points for the leaf-on mosaics and at 27 ground control points for the leaf-off mosaics. The coordinate data were collected with real time GPS and post processed with differential correction using Pathfinder Office software. Prior to calculating accuracy, four ground control points for the leaf-on mosaics and three ground control points for the leaf-off mosaics were identified as outliers with SAS's JMP program and removed. The field-collected GPS coordinates for the remaining 25 points for the leaf-on mosaics and 24 points for the leaf-off mosaics were compared to the coordinates obtained from each 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). Figures 4 and 5 show the distribution of the ground control points for the leaf-on and leaf-off mosaics, respectively.
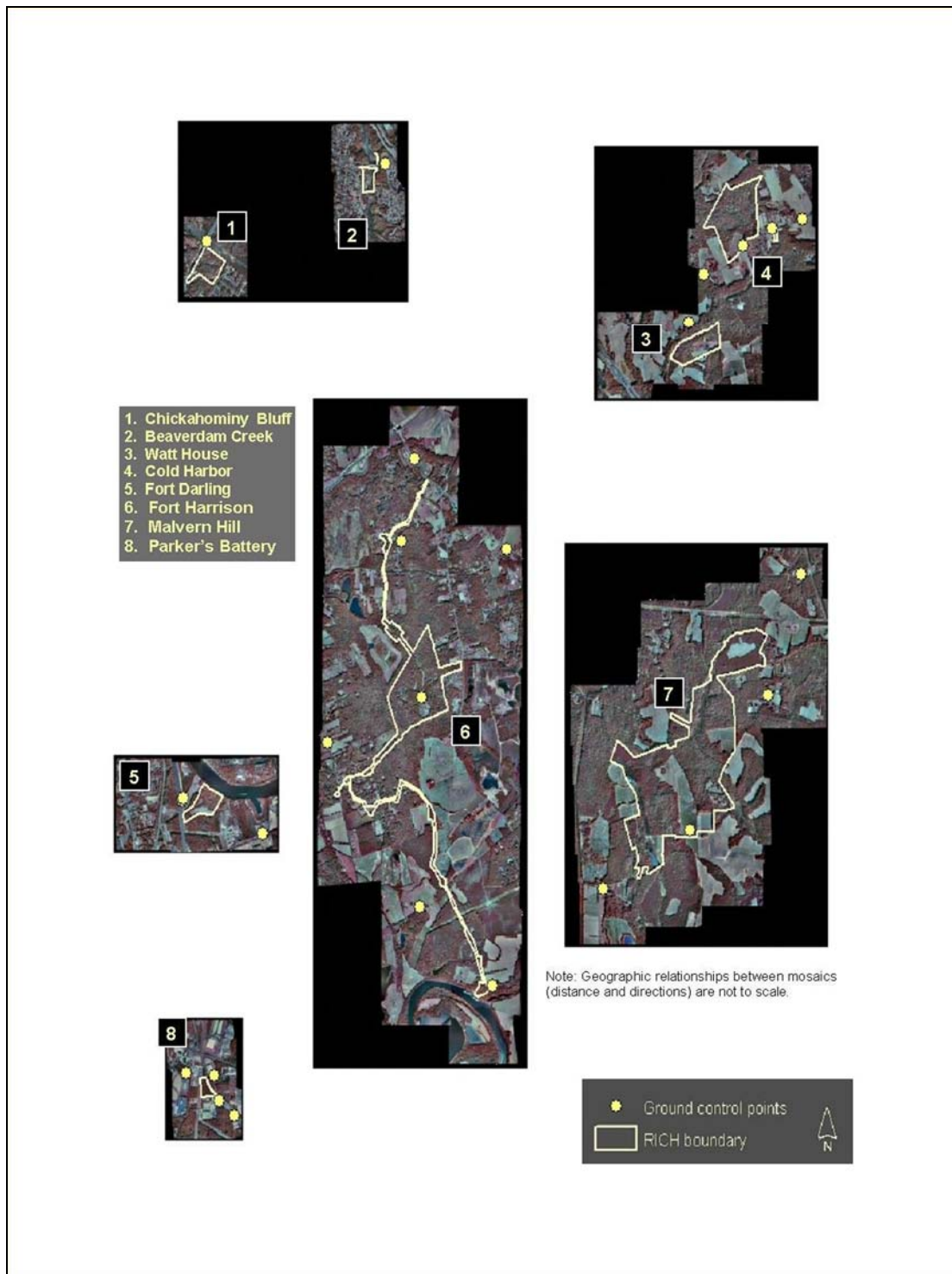
Figure 4. Ground control points used to calculate horizontal positional accuracy of the Richmond National Battlefield Park (RICH) leaf-on (fall) mosaics.
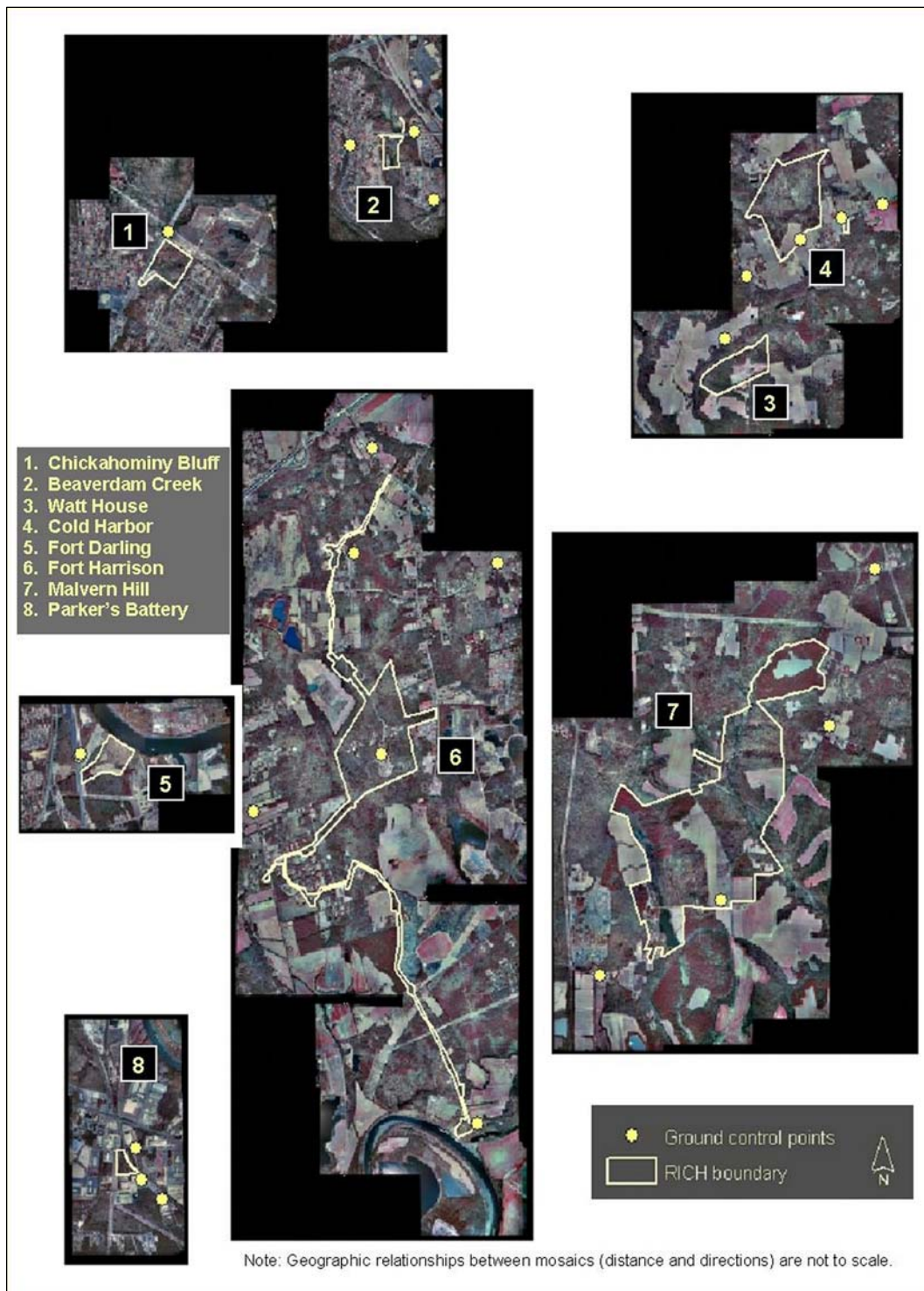
Figure 5. Ground control points used to calculate horizontal positional accuracy of the
Richmond National Battlefield Park (RICH) leaf-off (spring) mosaics.

Thematic Accuracy Assessment

The Virginia Natural Heritage Program assessed the thematic accuracy of the vegetation map. A stratified random sampling approach was used, proportionally stratifying the samples among map classes representing natural or semi-natural vegetation. Polygons representing the Anderson land-use classes Other Urban or Built-up Land, Transportation, Communications, and Utilities, and Residential, and three intensively managed, cultural map classes, Cultural Meadow, Forested Earthworks, and Open Earthworks were excluded from the accuracy assessment. Two other map classes, Successional Black Walnut Forest and Successional Shrub Swamp, were excluded from the accuracy assessment since each is represented by a single, very small polygon that was thoroughly surveyed during the mapping phase of the project. All polygons less then minimum mapping unit (0.5 ha, 1.2 ac) were excluded from the sampling design. Sample size for each class was determined by class abundance and frequency as recommended in section 4.4.2 of the USGS-NPS VMP standards, with one regional modification (Table 6). Due to the fragmented nature of cultural parks, most map classes are rare and a modification of Scenario B was needed to accommodate the vegetation pattern seen in the park. Table 7 summarizes the thematic accuracy assessment sampling strategy, showing the allocation of the 71 accuracy assessment points among the map classes.

Prior to selecting sampling locations, all points surveyed during the mapping phase of the project (qualitative observation points and quantitative plots) were buffered by 40 m (131 ft) and excluded from the sampling universe. The ArcView 3.3 extension, Random Point Generator v. 1.3 (Jenness 2005), was used to randomly select the location of the accuracy assessment points within polygons of each map class. This extension generates random points within a specified distance for a set of input theme features (e.g. polygons), producing a new ArcView shapefile and/or a results table. Where possible, accuracy assessment points were generated so that they were at least 40 m (131 ft) from polygon edges. The size and linearity of some polygons, however, made it impossible to meet these criteria for all polygons. Decreasing edge buffer distances 20 m or 10 m (66 ft, or 33 ft) were used as necessary based on polygon size and shape.

Field staff were provided with maps showing the boundaries of the target polygons and the location of accuracy assessment points, as well as a GPS unit preloaded with all the accuracy assessment point locations. In August and September 2006, and in May 2007, each accuracy assessment point was located in the field using a Garmin Map76 WAAS enabled GPS. Field staff determined the map class at the accuracy assessment point using the dichotomous key and the detailed vegetation descriptions. Dominant and characteristic vascular plant species were listed by strata with an indication of their prevalence in the stand (i.e. dominant, common, or rare). Qualitative observations were made that described any variation of vegetation or environment within the polygon, such as the inclusion of more than one class in a polygon. Field staff also estimated the percentage of the target polygon observed and any problems using the key or interpreting the vegetation type in the polygon. The minimum area of observation around the sampling point was 0.5 ha (1.2 ac) or a circle with a radius of approximately 40 m (131 ft). The accuracy assessment data form used in this study is shown in Appendix B. Figure 6 shows the locations of the 71 accuracy assessment points. Accuracy assessment data collected from these 71 points were entered into the PLOTS database version 2.0 (NatureServe 2004) and are provided as a supplement to this report.

Table 6. Recommended sample size for accuracy assessment points based on the stratified random sampling process (TNC and ESRI 1994c). Modification for Virginia cultural parks shown as scenario B2.

Scenario	Description	Polygons in class	Area occupied by class	Recommended number of samples in class
A	Abundant. Map class has many polygons that cover a large area.	≥30	≥50 ha	30
B	Relatively abundant. Map class has few polygons that cover a large area.	<30	≥50 ha	20
B2	Regional modification to Scenario B	≥5, ≤20	≥50 ha	10
C	Relatively rare. Map class has many polygons, but covers a small area.	>30	<50 ha	20
D	Rare. Map class has few polygons; most or all polygons are small.	≥5, ≤30	<50 ha	5
E	Very rare. Map class has too few polygons to permit statistical assessment.	<5	<50 ha	Visit all and confirm

Table 7. Thematic accuracy assessment (AA) strategy for Richmond National Battlefield Park, showing number of polygons, mapped hectares, and number of AA points sampled for each vegetation-map class.

Map class	Number of polygons	Number of polygons > 0.5 ha	Mapped hectares	Number of AA points sampled
Acidic Oak - Hickory Forest	14	9	45.2	9
Beaver Wetland Complex	6	5	48.9	5
Coastal Plain / Piedmont Acidic Seepage Swamp	7	7	9.1	6
Coastal Plain / Piedmont Small-Stream Floodplain Forest	5	2	4.1	2
Coastal Plain Mixed Oak / Heath Forest	10	10	70.9	9
Loblolly Pine - Hardwood Forest	12	8	38.3	5
Loblolly Pine Plantation	3	3	38.9	3
Mesic Mixed Hardwood Forest	20	17	81.0	11
Non-Riverine Saturated Forest	6	6	26.8	7
Non-Riverine Saturated Forest - pine subtype	4	3	5.8	3
Successional Mixed Scrub	3	2	3.2	2
Successional Red-cedar Forest	2	1	1.0	1
Successional Tuliptree Forest	13	8	48.3	8
Cultural Meadow	18	12	81.2	0
Forested Earthworks	11	10	25.0	0
Open Earthworks	4	2	4.7	0
Other Urban or Built-up Land	8	6	9.2	0
Residential	15	3	4.2	0
Successional Black Walnut Forest	1	1	0.6	0
Successional Shrub Swamp	1	1	0.5	0
Transportation, Communications, and Utilities	22	11	19.5	0
TOTAL	185	127	566.4	71
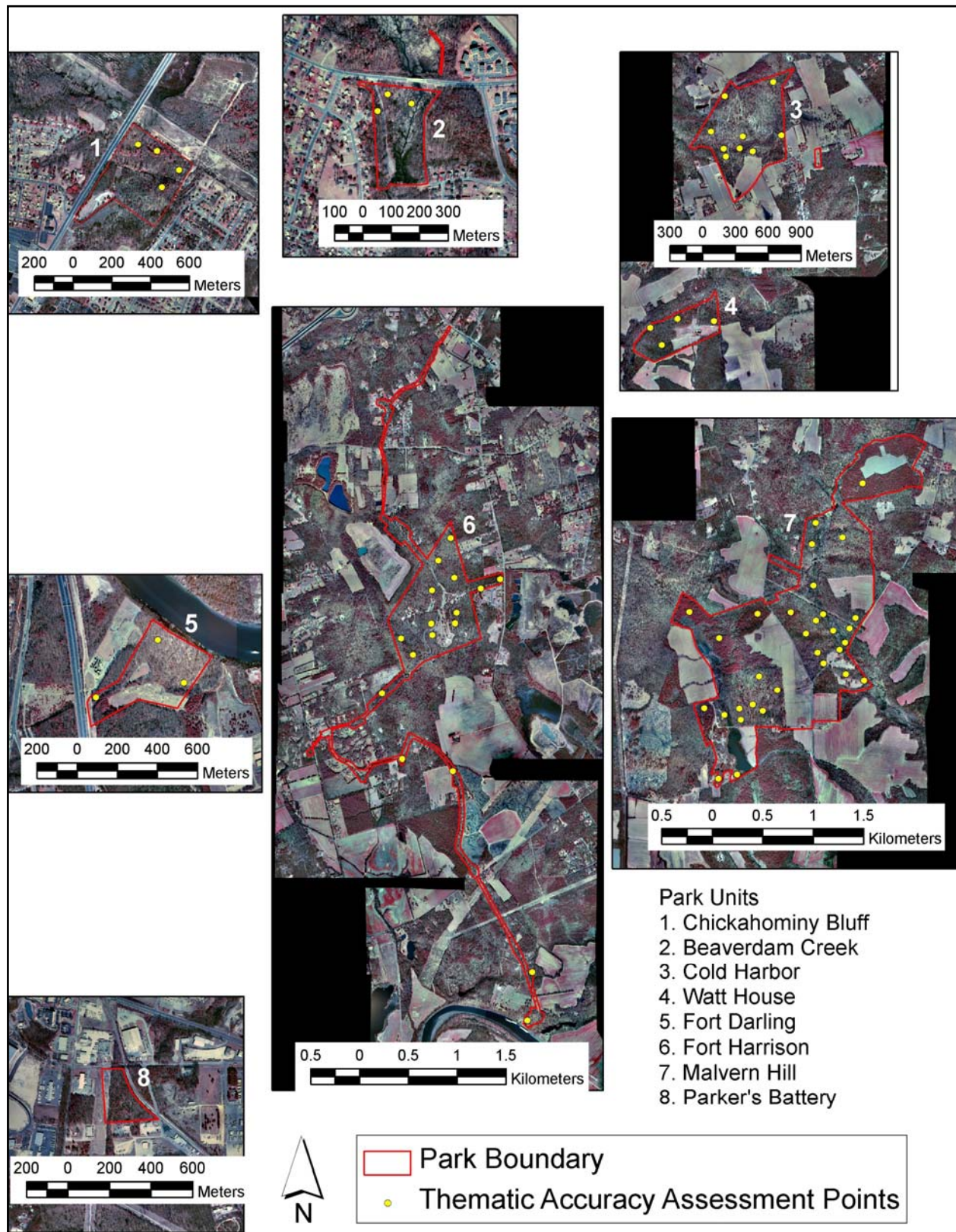
Figure 6. Locations of thematic accuracy assessment sampling points in Richmond National Battlefield Park.

Data from 71 accuracy assessment points were entered into an Excel spreadsheet listing accuracy assessment point ID, vegetation map polygon ID, vegetation map class, and first and second (if available) map class determination from accuracy assessment field observations. The thematic accuracy of the vegetation map was then tabulated using a contingency matrix that compares the map class observed on the ground (accuracy assessment observation) with the map class mapped at the same location on the final vegetation map (reference data). The contingency table lists reference data values in the columns and accuracy assessment observation values in the rows. The number of each reference data and accuracy assessment observation pair for all sampling locations is indicated at each row/column intersection in the matrix. Correct mappings are indicated on the table where the row and column values are the same and typically occur on the diagonal on the matrix. Overall percent accuracy and Kappa index were calculated for the map using equations from the USGS-NPS VMP accuracy assessment guidelines (TNC and ESRI 1994c). Overall percent accuracy was calculated by dividing the number of correctly classified accuracy assessment points by the total number of accuracy assessment points. The Kappa index is the preferred method of reporting overall thematic accuracy because it takes into account that a certain number of correct classifications will occur by chance (Foody 1992). The USGS-NPS VMP protocol requires that the Kappa index of vegetation maps exceed 80% (TNC and ESRI 1994c). To calculate the probability that a reference data observation has been correctly classified (producer's accuracy or omission error), the number of reference data points correctly classified is divided by the total number of reference data points in that map class. To calculate the probability that the mapped vegetation classes represent the vegetation actually found on the ground (user's accuracy or commission error), the number of correctly classified reference samples was divided by the total number of samples classified or mapped to that vegetation class. The errors of omission and errors of commission for mapped vegetation classes should exceed 80%, according to the USGS-NPS VMP protocol (TNC and ESRI 1994c).

Metadata Preparation

All map products are accompanied by detailed Federal Geographic Data Committee (FGDC) compliant metadata (FGDC 1998a). Metadata are data about data. They describe the content, quality, condition, and other characteristics of the data. Metadata are critical elements of each spatial dataset, allowing future users of the data to understand how the dataset was developed, its appropriate uses, and to locate specific information within the spatial dataset. Metadata records were prepared for each mosaic, for the vegetation map, and for the all georeferenced plot data and accuracy assessment point data.

A metadata record for each set of mosaics was 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 which are stored in the data archive. Key information for the leaf-on (fall) and leaf-off (spring) mosaics and for the formation-level vegetation dataset is summarized in Tables 8 and 9, respectively.

Table 8. Summary of key information for Richmond National Battlefield Park leaf-on (fall) mosaics.

Title of metadata record:	Richmond National Battlefield Park Color Infrared Orthorectified Photomosaic - Leaf-on (ERDAS IMAGINE .img and MrSID formats)
Publication date of mosaics (from metadata):	March 1, 2003
Date aerial photography was acquired:	October 23, 2001
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:	109
Archive location of air photos, airborne GPS and IMU files, and camera calibration certificate:	North Carolina State University, Center for Earth Observation
Scanning specifications:	600 dpi, 24-bit color depth
Horizontal positional accuracy of mosaics:	1.098 meters, meets Class 1 National MapAccuracy Standard
Number of ground control points upon which estimated accuracy is based:	25
Method of calculating positional accuracy:	Root mean square error
Archive location of mosaics and metadata:	North Carolina State University, Center for Earth Observation
Formats of archived mosaics:	.img (uncompressed) and
	MrSID (20:1 compression)

Table 9. Summary of key information for Richmond National Battlefield Park leaf-off (spring) mosaics.

Title of metadata record:	Richmond National Battlefield Park Color Infrared Orthorectified Photomosaic-Leaf-off (ERDAS IMAGINE .img and MrSID formats)
Publication date of mosaics (from metadata):	March 1, 2003
Date aerial photography was acquired:	February 28, 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:	85
Archive location of air photos, airborne GPS and IMU files, and camera calibration certificate:	North Carolina State University, Center for Earth Observation
Scanning specifications:	600 dpi, 24-bit color depth
Horizontal positional accuracy of mosaics:	1.327 meters, meets Class 1 National Map Accuracy Standard
Number of ground control points upon which estimated accuracy is based:	24
Method of calculating positional accuracy:	Root mean square error
Archive location of mosaics and metadata:	North Carolina State University, Center for Earth Observation
Formats of archived mosaics:	.img (uncompressed) and
	MrSID (20:1 compression)

Metadata records for the vegetation map and for all georeferenced plot and accuracy assessment point data were created using a combination of the NPS Metadata Tools and Editor Version 1.1 and NPS Database Metadata Extractor MS Access Add-in Version 1.0 (NPS 2006). Each file was parsed using the USGS metadata compiler Metaparser (MP) v. 2.8.25 (Schweitzer 1995) and the Federal Geographic Data Committee (FGDC) configuration file. This process ensures that all elements required by the FGDC standard are included in the metadata files. All errors and omissions identified by the parser were corrected.

Results

Field Surveys

Field work was completed in Richmond National Battlefield Park in 2007. Data were collected from 11 quantitative vegetation plots located throughout the park (Figure 7). Species observed during quantitative plot sampling and in accuracy assessment observation points are listed in Appendix C. This list should not be considered a comprehensive flora for the park, but could be used to add to existing vascular plant lists for the area. Of the 230 vascular plant taxa noted during fieldwork, 10 were nonnative species and, of those, nine are considered invasive by the Virginia Department of Conservation and Recreation (VADCR 2003). Two species noted in the park, Collin's sedge (*Carex collinsii*) and palegreen orchid (*Plantanthera flava* var. *flava*), are included on the Vascular Plant Watchlist of the Virginia Department of Conservation and Recreation, Division of Natural Heritage (Townsend 2007). Taxa on this list are decidedly uncommon in Virginia, but not scarce enough to merit inclusion on the Rare Vascular Plant List.; however, they are monitored to determine general population trends.

Vegetation Classification and Characterization

Initial cluster analysis of the 2,250-plot regional dataset divided the data into three major subsets, upland forests (899 plots), non-tidal wetlands (553 plots), and tidal wetlands (798 plots). Subsequent cluster analysis divided these groups further into 22 subsets, each representing major branches on analysis dendrograms. More comprehensive cluster, statistical, and ordination analyses were conducted on these 22 subsets, resulting in a classification of over 100 vegetation associations. Over the course of the project, 20 new associations were described for the USNVC and 40 existing associations were revised.

A reduced dataset representing 11 major groupings in the original 2,250-plot cluster analysis was extracted and used to illustrate results pertaining to the seven national parks in this study. A table showing the distribution of vegetation classes across all seven parks, including Richmond National Battlefield Park, is presented in Appendix D. Quantitative analysis classified 35 associations occurring in the seven national parks in Virginia. An additional 19 associations and 12 nonstandard, park-specific vegetation classes representing disturbed, cultural, or exotic vegetation were also recognized from the seven parks, but were not represented by quantitative plot data and thus not included in the quantitative analyses. Global and subnational (state) conservation ranks used in Appendix D are defined in Appendix E, and a summary of select environmental variables for associations derived from quantitative analysis of plot data is presented in Appendix F.

The major vegetation groups represented at Richmond National Battlefield Park are 1) oak / heath forests, 2) mesic acidic forests, 3) oak - hickory forests, 4) seepage wetlands, 5) alluvial forests, and 6) nonriverine forests. Cluster dendrograms, ordination scatterplots, and joint plots resulting from quantitative analysis of plot data from these groups are presented in Appendix G. Compositional summary statistics for each association present in Richmond National Battlefield Park which was derived from the quantitative analysis of the regional plot data are presented in Appendix H.
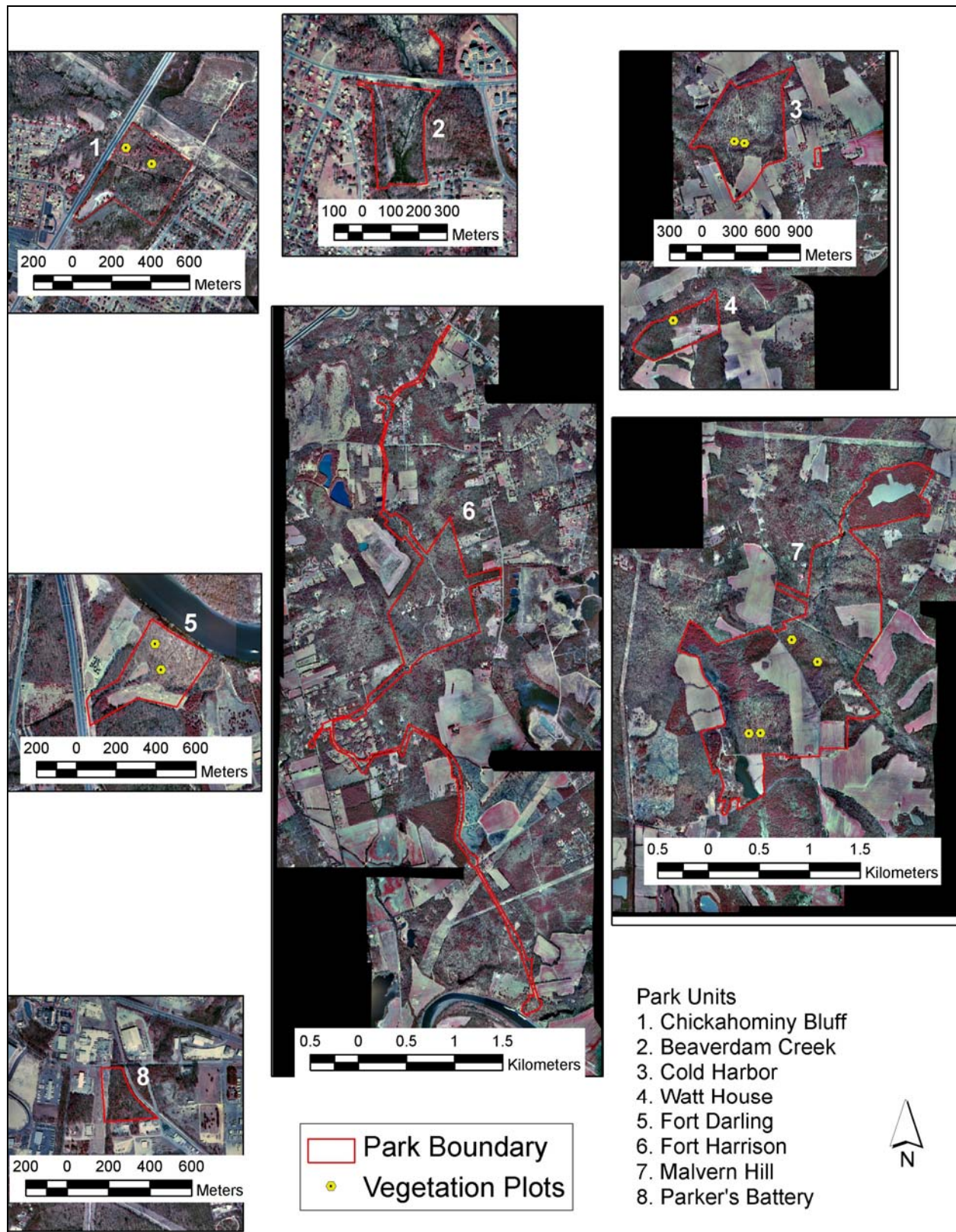
Figure 7. Location of quantitative vegetation plots in Richmond National Battlefield Park.

The analysis results presented in Appendix G support the classification of plot samples into the six major vegetation groups represented at Richmond National Battlefield Park. Classification dendrograms illustrate the compositional similarity among each group of plots in a vegetation association. The classifications are further supported by the ordination diagrams, which show the same groups of plots in ordination space.

The percentage variance represented by each ordination for the major vegetation groups in the park is presented in Table 10. Environmental variables significantly correlated with ordinations axes are illustrated with joint plot diagrams. All vegetation associations resulting from the regional analysis are shown in the dendrograms and ordination diagrams, even those not present in Richmond National Battlefield Park. In this way, species and environmental relationships among associations can be examined in a regional context.

The classification of 93 oak / heath forest sample plots is illustrated in Figures G1–G2 of Appendix G. Plot samples cluster into two compositionally distinct groups in both the dendrogram and the three-dimensional ordination (Appendix G, Figures G1 and G2). The two associations, Coastal Plain Mixed Oak / Heath Forest (CEGL006269) and Piedmont / Low Elevation Mixed Oak / Heath Forest (CEGL008521) separate along axis three of the ordination diagram. There were no environmental variables that were significantly correlated with the ordination axes. The two oak / heath sample plots for Richmond National Battlefield Park are classified as Coastal Plain Mixed Oak / Heath Forest (CEGL006269). Environmental variables from plot samples classified as Coastal Plain Mixed Oak / Heath Forest are summarized in Appendix F. A compositional summary based on 18 sample plots of this association is presented in Appendix H, Table H3. The two plot samples from Richmond National Battlefield Park are very typical of the association, both compositionally and environmentally. The Richmond National Battlefield Park plot samples contained all of the most constant species, but did lack the parenthetical nominal, sand hickory (*Carya pallida*). Coastal Plain Mixed Oak / Heath Forest is found in three of the seven national parks included in this study (Appendix D). It is a

Table 10. Proportion of variance represented by each axis, based on coefficients of determination (r^2) between ordination distances and distances in the original n-dimensional space for the major vegetation groups at Richmond National Battlefield Park. Two-dimensional ordinations have "n/a" listed in Axis 3 column.

Vegetation Group	Increment			Cumulative
	Axis 1	Axis 2	Axis 3	
oak / heath forests	0.356	0.223	0.238	0.817
mesic acidic forests	0.124	0.426	0.233	0.783
oak - hickory forests	0.083	0.155	0.543	0.781
seepage wetlands	0.329	0.531	n/a	0.860
alluvial forests	0.094	0.767	n/a	0.861
nonriverine forests	0.064	0.539	0.225	0.818

widespread, large patch to matrix-forming forest community known from rolling to level Coastal Plain landscapes from New Jersey south to Virginia. In central and southeastern Virginia, it extends slightly into the eastern portion of the Piedmont.

Classification results for the mesic acidic forest group are presented in Appendix G, Figures G3–G5. Plot samples cluster into two compositionally distinct groups in both the dendrogram and the three-dimensional ordination (Appendix G, Figures G3 and G4). Axis three of the joint plot (Appendix G, Figure G5) is highly correlated with joint plot vectors representing pH and the soil cations calcium, magnesium, manganese, and iron. The two associations classified within the mesic acidic forests group are Mesic Mixed Hardwood Forest (CEGL006075) and Piedmont / Coastal Plain Oak - Beech Heath Forest (CEGL006919). Although both associations can occur in the same landscape, Piedmont / Coastal Plain Oak - Beech Heath Forest is found on steeper, more exposed slopes with less fertile soils than Mesic Mixed Hardwood Forest. A summary of environmental variables for the two associations is presented in Appendix F. Only one of the two associations, Mesic Mixed Hardwood Forest (CEGL006075), occurs at Richmond National Battlefield Park, and two plot samples from the park represent this association. A compositional summary for the 170 sample plots of Mesic Mixed Hardwood Forest is presented in Appendix H, Table H2. Plot samples of Mesic Mixed Hardwood Forest from Richmond National Battlefield Park are compositionally representative of the association, however, the plot sample from the slopes of Boatswain Creek in the Watts House unit had only 20 species, about half the typical species richness for the association. Mesic Mixed Hardwood Forest was documented in five of the seven national parks included in this study (Appendix D). It is a common and wide-ranging community known from the Piedmont and Coastal Plain of Virginia and Maryland northward to southern New England.

The results of the regional analysis of the oak - hickory forest group are illustrated in Figures G6–G8 of Appendix G. Plot samples cluster into two compositionally distinct groups in both the dendrogram (Appendix G, Figure G6) and the three-dimensional ordination (Appendix G, Figure G7). Strong correlations of soil fertility variables with axis three of the ordination suggest that soil nutrients have an important influence on vegetation patterns within this group (Appendix G, Figure G8). Two associations, Acidic Oak-Hickory Forest (CEGL008475) and Basic Oak - Hickory Forest (CEGL007232), were recognized in analysis and there is much variation within each group of plot samples along a gradual cline of site conditions, soil chemistry, and floristic composition. Only Acidic Oak-Hickory Forest was classified from Richmond National Battlefield Park. The two plot samples from the park have typical species composition for the association (Appendix H, Table H1). The Acidic Oak-Hickory Forest sample from Malvern Hill had 62 species per 400 m^2 quadrat, which was greater than the mean of 53 species for the association. The sample from Fort Darling had only 32 species per 400 m^2 quadrat. Acidic Oak-Hickory Forest is found on acidic soils that are common throughout the Piedmont and the association is a common matrix forest type in the Carolinas, Virginia, and south-central Maryland. However, since most of the rolling upland landscape of the Piedmont has been logged more than once since European settlement, stands older than 80 years are uncommon. Acidic Oak-Hickory Forest occurs in six of the seven national parks included in this study (Appendix D). The other association classified within the Oak - Hickory Forest group, Basic Oak - Hickory Forest (CEGL007232), is not present at Richmond National Battlefield Park. Compared to Acidic Oak - Hickory Forest, Basic Oak - Hickory Forest is associated with soils that are more alkaline and characterized by high cation levels (Appendix F). Although Basic

Oak-Hickory Forest is widely distributed in the Piedmont from southern Virginia to Alabama, it is an uncommon community type that is strongly restricted to mafic substrates and subject to ongoing threats from cutting and conversion of hardwood stands to pine silvicultures.

Classification results for the seepage wetland group are presented in Figures G9–G11 of Appendix G. Plot samples from 72 seepage wetlands cluster into three compositionally distinct groupings in both the dendrogram and the two-dimensional ordination (Appendix G, Figures G9 and G10). Axis one of the joint plot (Appendix G, Figure G11) is highly correlated with the joint plot vectors representing pH, calcium / magnesium ratio, base saturation, and fertility index, while axis two is significantly correlated with high percentage cover of boulders. Together, these axes represent 86% of the variance in the data (Table 10). The only seepage wetland present in Richmond National Battlefield Park is Coastal Plain / Piedmont Acidic Seepage Swamp (CEGL006238). Plots classified as this association have the lowest average soil pH value in the group and low levels of base cations (Appendix F). A compositional summary of the association is presented in Table H4 of Appendix H. The two plots from the park are very typical of the association, with all the nominal and constant species. This association is found in four of the seven national parks included in this study (Appendix D). The remaining two seepage wetland associations represent basic seepage swamps and occur on high base status soils with high cation levels (Appendix F and Appendix G, Figure G11). All three seepage wetland associations are considered either globally rare or uncommon in the State of Virginia (Appendix D).

The regional analysis of alluvial forest sample plots is illustrated in Figures G12–G14 of Appendix G. Plot samples cluster into three compositionally distinct groups in both the dendrogram and the two-dimensional ordination. Plot samples segregate along axis two, which represents 77% of the variance in the data (Table 10). The joint plot (Appendix G, Figure G14) shows the correlation of soil fertility variables with axis two of the ordination, suggesting that soil nutrients have an important influence on vegetation patterns within this group. The 48 regional plot samples representing the only alluvial forest association found at Richmond National Battlefield Park, Coastal Plain / Piedmont Small-Stream Floodplain Forest (CEGL004418), are at the lowest end of the soil fertility gradient (Appendix G, Figure G14) and have the lowest averages in the group for soil variables indicative of fertility (Appendix F, Table F2). Coastal Plain / Piedmont Small-Stream Floodplain Forest develops over acidic soils along small streams in the Coastal Plain of Maryland and Virginia and west across the Virginia and North Carolina Piedmont to the Cumberland Plateau and Ridge and Valley. Piedmont / Mountain Alluvial Forest (CEGL006492) is found on small to medium sized streams over more fertile alluvium, while Piedmont / Mountain Floodplain Forest (CEGL006217) is found on the large floodplains of major mid-Atlantic rivers over the most fertile alluvium (Appendix F). No examples of Coastal Plain / Piedmont Small-Stream Floodplain Forest were quantitatively sampled in Richmond National Battlefield Park because all examples were too disturbed. A compositional summary of the association is presented in Appendix H, Table H5. This association is found in four of the seven national parks in this study (Appendix D).

The nonriverine forest group is presented in Appendix G, Figures G15–G17. Plot samples from 62 nonriverine forest plots cluster into four compositionally distinct groupings in the dendrogram, the two-dimensional ordination, and the three-dimensional ordination (Appendix F, Figures F7–F9). The associations show the most separation in terms of species composition

along axis two of the ordinations (Table 10; Appendix G, Figure F17). Ordination scores were not significantly correlated with available environmental data; however, as a group, these forests have low values for soil chemistry variables, indicating acid soils with low fertility (Appendix F). Only one association of this forest group, Non-Riverine Saturated Forest (CEGL004644), is found in Richmond National Battlefield Park. A compositional summary for this association is presented in Appendix H, Table H6. The three sample plots from Richmond National Battlefield Park are compositionally typical for the association, having most of the nominal species and many of the constant species. All three plot samples lack swamp chestnut oak (*Quercus michauxii*), a parenthetical nominal, one plot lacks the nominal American holly, and another plot lacks coastal sweetpepperbush (*Clethra alnifolia*). Non-Riverine Saturated Forest occurs in four of the seven national parks included in this study. All four of the nonriverine forest associations recognized in this analysis are uncommon to rare in the mid-Atlantic region and three are globally rare (Appendix D).

In addition to the vegetation classes derived from quantitative analysis, other vegetation classes used to describe the vegetation in the seven parks were developed from qualitative observations in the parks. Many of these qualitatively-derived units were crosswalked to the USNVC association level, while others were not appropriate for inclusion in the USNVC and were described as nonstandard, park-specific vegetation classes. A total of 19 associations and 12 nonstandard park-specific vegetation classes representing disturbed or cultural vegetation were recognized from the seven parks. Richmond National Battlefield Park has 12 of these cultural or disturbed vegetation classes. Seven of these vegetation classes were crosswalked to the association level of the USNVC and five represented vegetation that had no defined classification in the USNVC. These five vegetation classes were given nonstandard, park-specific names to describe the vegetation in Richmond National Battlefield Park. All vegetation classes from the regional classification, their relationship to the USNVC, and their distribution across all seven parks in this study are shown in Appendix D.

Vegetation Community Descriptions and Map Classes

Twenty-one map classes were used in the vegetation map for Richmond National Battlefield Park. Map classes are equivalent to one or more vegetation classes from the regional vegetation classification, or to a land-use class from the Anderson (Anderson et al. 1976) Level II classification system. Table 11 lists the 21 map classes used to map the park and shows the relationships to standard classifications and to the regional vegetation classes developed for the seven parks in this study. Thirteen of the 21 map classes were crosswalked to the finest level of the USNVC (association). Five of the 21 map classes were described as nonstandard, park-specific vegetation classes and three were crosswalked to the Anderson (Anderson et al. 1976) Level II classification. Detailed local descriptions for each USNVC association or other map class present at Richmond National Battlefield Park were written based on information collected within the park boundary. All map classes crosswalked to the association level of the USNVC include range-wide descriptions (i.e. global descriptions). Global descriptions of the USNVC associations were extracted from the September 27, 2007 version of the USNVC (NatureServe 2007).

Table 11. Vegetation-map classes and corresponding USNVC associations (NatureServe 2007) or other classification for Richmond National Battlefield Park.

Map Class	USNVC Association (association code)	Regional Vegetation or Land-use Class * (name source)
Acidic Oak - Hickory Forest	*Quercus alba - Quercus rubra - Carya alba / Cornus florida / Vaccinium stamineum / Desmodium nudiflorum Piedmont* Forest (CEGL008475)	Acidic Oak - Hickory Forest (Fleming et al. 2006)
Beaver Wetland Complex	*Alnus serrulata* Swamp Shrubland (CEGL005082)	Beaver Wetland Complex (park-specific name)
Coastal Plain Mixed Oak / Heath Forest	*Quercus alba - Quercus falcata - (Carya pallida) / Gaylussacia frondosa* Forest (CEGL006269)	Coastal Plain Mixed Oak / Heath Forest (Fleming et al. 2006)
Coastal Plain / Piedmont Acidic Seepage Swamp	*Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum* var. *nudum / Osmunda cinnamomea - Woodwardia areolata* Forest (CEGL006238)	Coastal Plain / Piedmont Acidic Seepage Swamp (Fleming et al 2006)
Coastal Plain / Piedmont Small-Stream Floodplain Forest	*Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* Forest (CEGL004418)	Coastal Plain / Piedmont Small-Stream Floodplain Forest (park-specific name)
Cultural Meadow	*Dactylis glomerata - Phleum pratense - Festuca* spp. *- Solidago* spp. Herbaceous Vegetation (CEGL006107)	Cultural Meadow (park-specific name)
Forested Earthworks	Not defined - nonstandard, park-specific vegetation class	Forested Earthworks (park-specific name)
Loblolly Pine - Hardwood Forest	*Pinus taeda - Liquidambar styraciflua* Semi-natural Forest (CEGL008462)	Loblolly Pine - Hardwood Forest (park-specific name)
Loblolly Pine Plantation	*Pinus taeda* Planted Forest (CEGL007179)	Loblolly Pine Plantation (NatureServe 2007)
Mesic Mixed Hardwood Forest	*Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / (Ilex opaca* var. *opaca) / Polystichum acrostichoides* Forest (CEGL006075)	Mesic Mixed Hardwood Forest (Fleming et al. 2006)
Non-Riverine Saturated Forest	*Quercus (phellos, pagoda, michauxii) / Ilex opaca* var. *opaca / Clethra alnifolia / Woodwardia areolata* Forest (CEGL004644)	Non-Riverine Saturated Forest (Fleming et al. 2006)
Non-Riverine Saturated Forest - pine subtype	Not defined - nonstandard, park-specific vegetation class	Non-Riverine Saturated Forest - pine subtype (park-specific name)
Open Earthworks	Not defined - nonstandard, park-specific vegetation class	Open Earthworks (park-specific name)
Other Urban or Built-up Land	Not defined - Anderson land-use class	Other Urban or Built-up Land (17) (Anderson et al. 1976)
Residential	Not defined - Anderson land-use class	Residential (11) (Anderson et al. 1976)

Map Class	USNVC Association (association code)	Regional Vegetation or Land-use Class * (name source)
Successional Black Walnut Forest	*Juglans nigra / Verbesina alternifolia* Forest (CEGL007879)	Successional Black Walnut (NatureServe 2007)
Successional Mixed Scrub	Not defined - nonstandard, park-specific vegetation class	Successional Mixed Scrub (park-specific name)
Successional Red-cedar Forest	*Juniperus virginiana* Forest (CEGL006024)	Successional Red-cedar Forest (park-specific name)
Successional Shrub Swamp	Not defined - nonstandard, park-specific vegetation class	Successional Shrub Swamp (park-specific name)
Successional Tuliptree Forest	*Liriodendron tulipifera - Quercus* spp. Forest (CEGL007221)	Successional Tuliptree Forest (park-specific name)
Transportation, Communications, and Utilities	Not defined - Anderson land-use class	Transportation, Communications, and Utilities (14) (Anderson et al. 1976)

*Equivalent to the Common name (Park-specific) as used in detailed descriptions in Appendix I.

Detailed local and global descriptions of the USNVC associations are contained in Appendix I. Local descriptions for other map classes (nonstandard, park-specific vegetation classes and land-use classes) are also provided. The descriptions are indexed by the regional vegetation class or land-use class name. Representative photographs of the vegetation classes are provided after the descriptions. Photographs were taken by VADNH staff unless otherwise indicated. A bibliography for the sources cited in the global vegetation descriptions from the USNVC is also provided in Appendix I.

Fields used in the local and global descriptions are defined in Appendix J. Each USNVC association is also crosswalked to the state classification for Virginia (Fleming et. al 2006). The state conservation rank (S Rank), global conservation rank (G Rank), and classification confidence for state and global classifications are included in the descriptions. Definitions of the conservation ranks are listed in Appendix E.

The dichotomous key to the vegetation-map classes of Richmond National Battlefield Park is presented in Appendix K. The dichotomous key should be used in conjunction with the detailed vegetation descriptions.

Vegetation Map Production

The final vegetation map for Richmond National Battledfield Park is shown in Figures 8 and 9 and a summary of the map class distribution and abundance is provided in Table 12. The mapping boundary was based on park boundary data obtained from Richmond National Battlefield Park in June 2004. The vegetation map was clipped at the park boundary because areas outside the park were not surveyed or included in the accuracy assessment.

Polygons that are attributed with Anderson Level II class 14 (Transportation, Communication, and Utilities) are further attributed in the comment field of the vegetation map attribute table to identify what finer feature they represent (transportation, utility corridor, maintained roadside). Other Urban or Built-up Land polygons are further distinguished in the comment field of the map attribute table if they represent a forested developed area. Particularly disturbed examples of Acidic Oak - Hickory Forest that do not have the typical species composition and diversity are labeled as disturbed in the comment field of the vegetation map attribute table.

A field was included in the map attribute table to indicate which United States Fish and Wildlife Service (USFWS) wetland system (*sensu* Cowardin et al. 1979) a map class represents. Polygons representing wetland formations (i.e. those with hydrologic modifiers of temporarily flooded, seasonally flooded, and saturated in the formation name) are tagged to the appropriate system in the USFWS wetland classification. Polygons representing vegetation that is not classed as a wetland have the value of "upland" in this field. Maps of polygons representing the wetland map classes are shown in Figures 10 and 11. These maps do not show jurisdiction wetlands, but rather the distributions of wetland map classes with USNVC formations containing wetland modifiers. The hydrology of the map class may not represent the hydrology on the ground and small areas of wetlands may be included within polygons classed as upland. All wetland map classes in Richmond National Battlefield Park fall into the Palustrine System of the USFWS wetland classification.
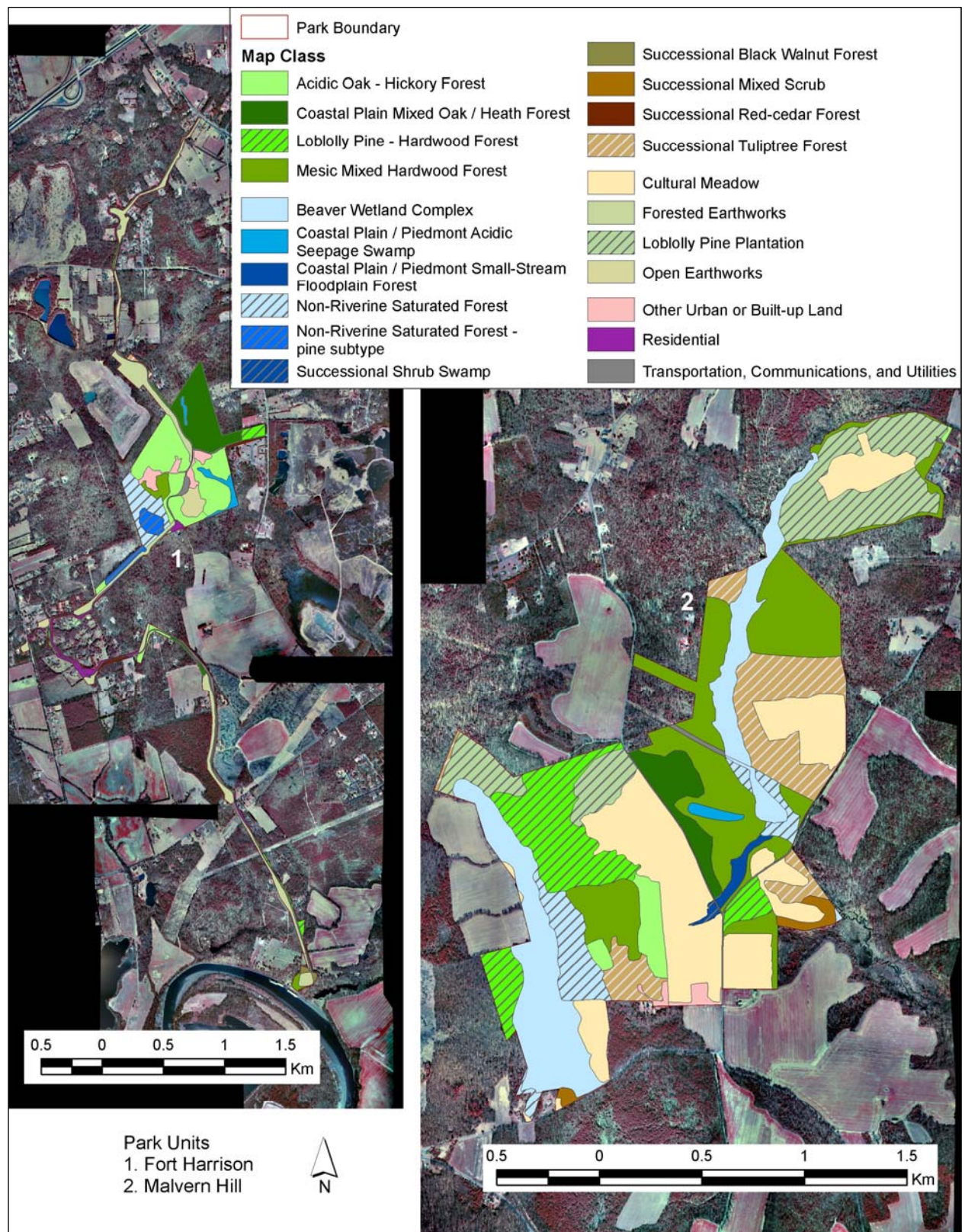
Figure 8. Vegetation and Anderson Level II map classes for Richmond National Battlefield Park, Fort Harrison and Malvern Hill.
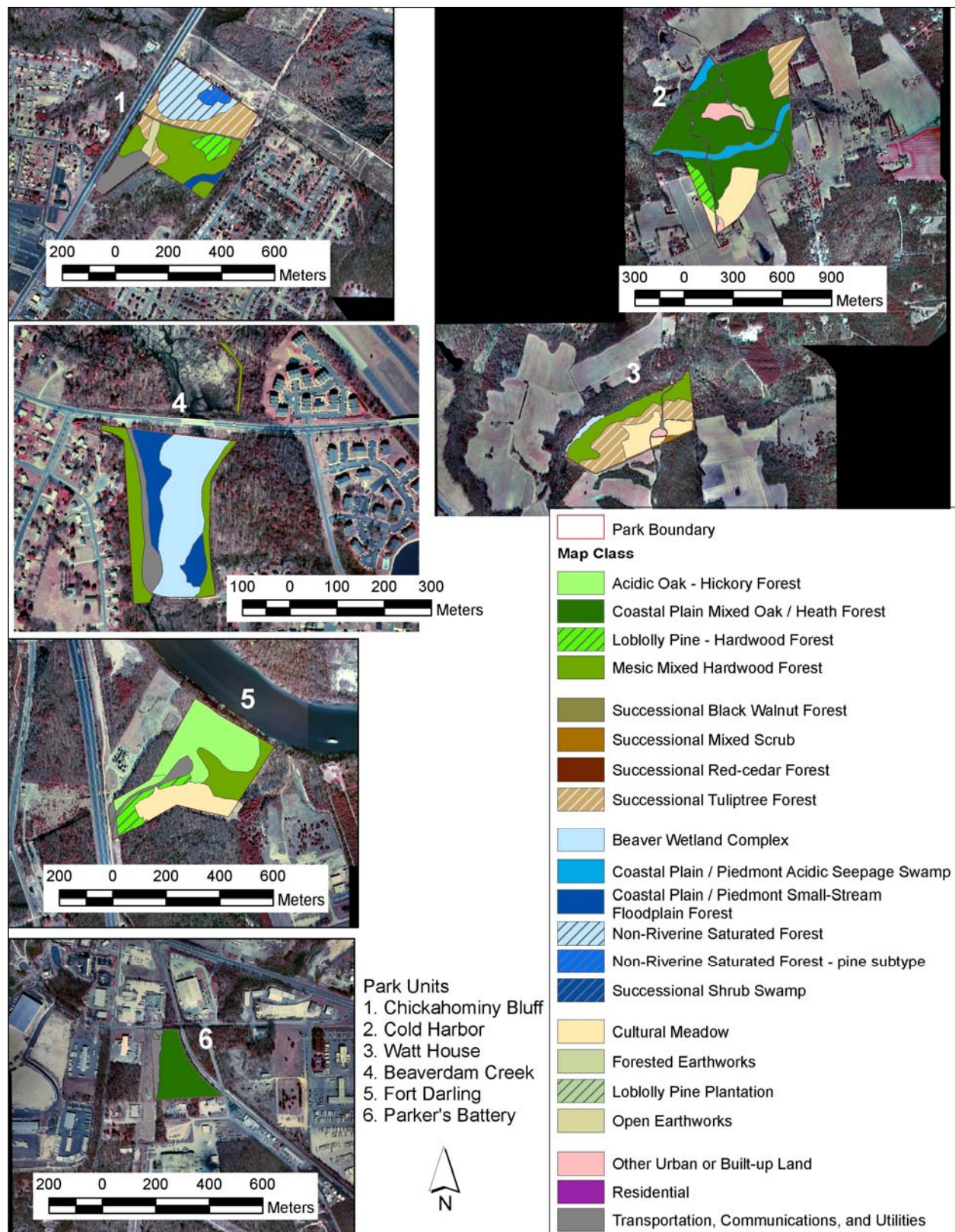
Figure 9. Vegetation and Anderson Level II map classes for six units of Richmond National Battlefield Park.

Table 12. Number of polygons, total mapped hectares (acres), and number of quantitative plots sampled for 21 vegetation-map classes at Richmond National Battlefield Park.

Map class	Number of polygons	Total mapped hectares	Total mapped acres	Number of plots sampled
Acidic Oak - Hickory Forest	14	45.2	111.6	2
Beaver Wetland Complex	6	48.9	120.8	0
Coastal Plain / Piedmont Acidic Seepage Swamp	7	9.1	22.4	2
Coastal Plain / Piedmont Small-Stream Floodplain Forest	5	4.1	10.1	0
Coastal Plain Mixed Oak / Heath Forest	10	70.9	175.1	2
Cultural Meadow	18	81.2	200.7	0
Forested Earthworks	11	25.0	61.7	0
Loblolly Pine - Hardwood Forest	12	38.3	94.7	0
Loblolly Pine Plantation	3	38.9	96.2	0
Mesic Mixed Hardwood Forest	20	81.0	200.1	2
Non-Riverine Saturated Forest	6	26.8	66.1	3
Non-Riverine Saturated Forest - pine subtype	4	5.8	14.3	0
Open Earthworks	4	4.7	11.6	0
Other Urban or Built-up Land	8	9.2	22.7	0
Residential	15	4.2	10.3	0
Successional Black Walnut Forest	1	0.6	1.6	0
Successional Mixed Scrub	3	3.2	7.8	0
Successional Red-cedar Forest	2	1.0	2.4	0
Successional Shrub Swamp	1	0.5	1.4	0
Successional Tuliptree Forest	13	48.3	119.4	0
Transportation, Communications, and Utilities	22	19.5	48.2	0
TOTAL	185	566.3	1,399.2	11
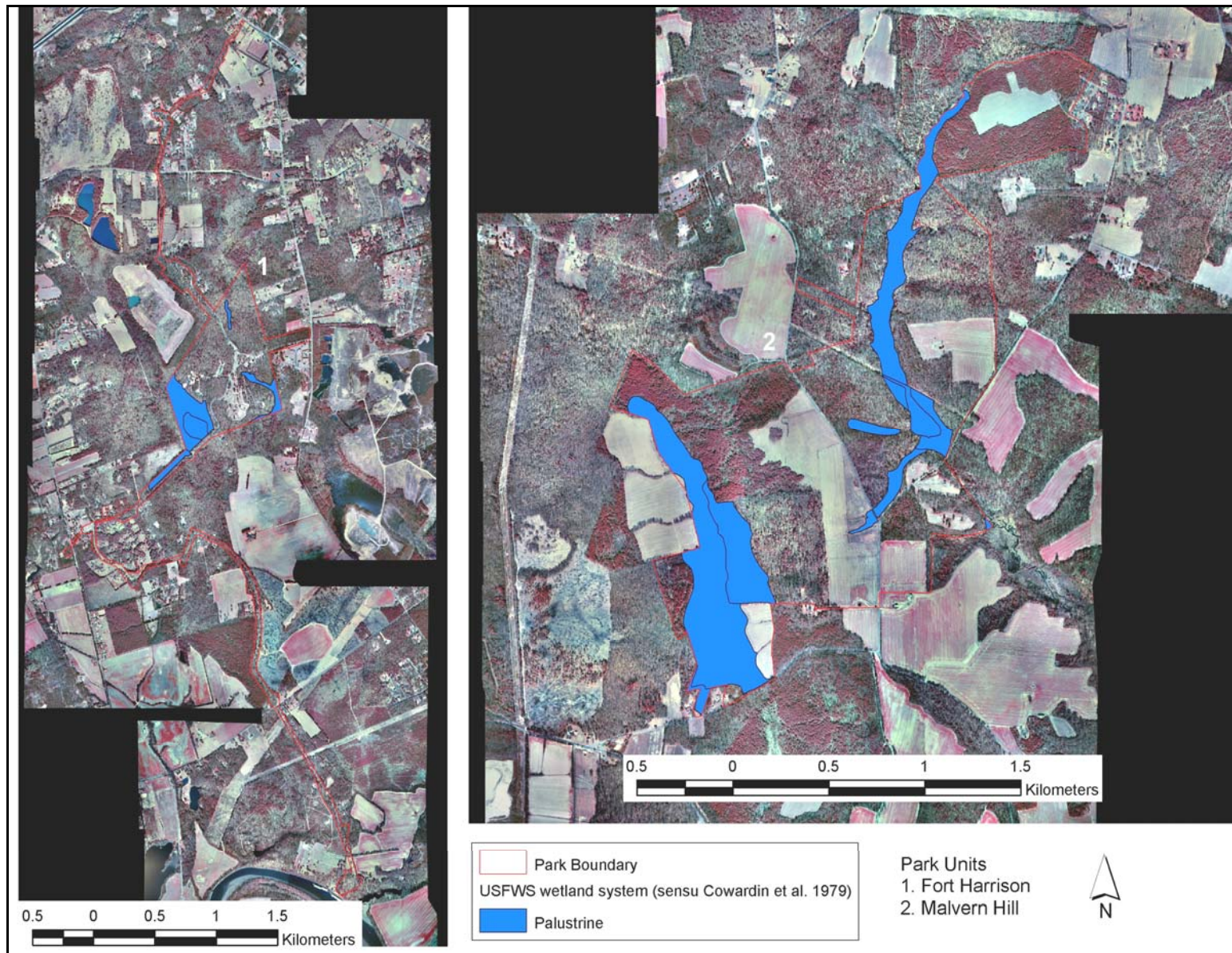
Figure 10. Distribution of wetland vegetation-map classes in Richmond National Battlefield Park, Fort Harrison and Malvern Hill.
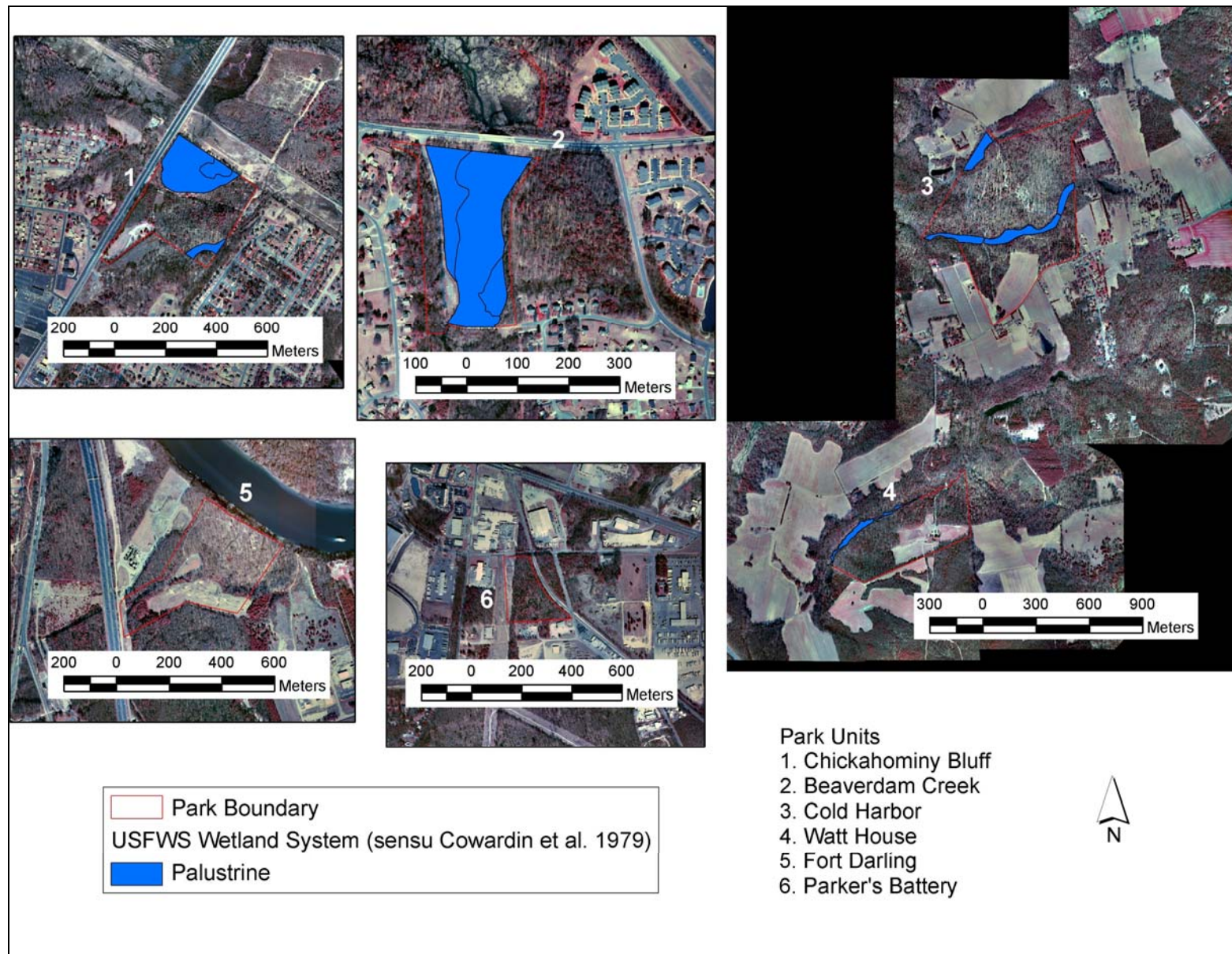
Figure 11. Distribution of wetland vegetation-map classes in six units of Richmond National Battlefield Park.

Accuracy Assessment

Positional Accuracy

The final horizontal positional accuracies of the leaf-on and leaf-off mosaics are 1.098 meters and 1.327 meters, 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 NCSU-CEO data archive.

Thematic Accuracy

The results of thematic accuracy assessment for the vegetation map were calculated with a contingency matrix (Table 13). The Kappa Index for the vegetation map was 84.4%±10.2%, with an overall accuracy of 85.9%. This meets the USGS-NPS VMP requirement of 80%. Four classes have errors of omission that fall below 80%; Coastal Plain Small-Stream Floodplain Forest (50%), Mesic Mixed Hardwood Forest (72.7%), Successional Mixed Scrub (50%), and Successional Tuliptree Forest (75%). Errors of omission are errors in classifying the accuracy assessment observation and represent the probability that the ground samples have been classed correctly. Examination of the errors associated with each observation shows that they can be attributed to below minimum mapping unit inclusions of other vegetation types within the target polygons or to the difficulty of assigning a vegetation classification to very disturbed, transitional vegetation. Where errors were due to difficulty in distinguishing compositionally similar vegetation types, field keys and vegetation descriptions were modified to better make these distinctions. The overall rarity of most classes lead to small sample sizes, which also contributed to the high errors of omission.

Errors of commission are map errors and denote the probability that the mapped vegetation associations represent the associations actually found on the ground. The error of commission for 10 of the 13 map classes that were assessed exceeds the USGS/NPS Vegetation Mapping Protocol requirement of 80% (Table 13). Three map classes have errors of commission that fall below 80%; Coastal Plain Small-Stream Floodplain Forest (50%), Successional Mixed Scrub (50%), and Successional Tuliptree Forest (66.7%). One area mapped as Coastal Plain Mixed Oak / Heath Forest had an accuracy assessment observation classed as Acidic Oak - Hickory Forest. A polygon mapped as Mesic Mixed Hardwood had an accuracy assessment observation classed as Successional Tuliptree Forest. One area mapped as Successional Tuliptree Forest had an accuracy assessment observation classed as Coastal Plain / Piedmont Small-Stream Floodplain Forest, and another was classed as Coastal Plain Mixed Oak / Heath Forest. Some of these errors may be due to the difficulty of distinguishing deciduous types on aerial photography, since the deciduous signatures are virtually identical. Other errors may be due to the compositional similarity of some types (i.e. Acidic Oak - Hickory Forest vs. Coastal Plain Mixed Oak / Heath Forest, or Successional Tuliptree Forest vs. disturbed Coastal Plain / Piedmont Small-Stream Floodplain Forest) and the difficulty of classifying some stands in the field.

Table 13. Contingency matrix and calculated errors for the thematic accuracy assessment of the vegetation map for Richmond National Battlefield Park. Gray cells show the number of sampling points that were correct.

Accuracy Assessment Observation	Mapped Vegetation Class (Reference Data)													Grand Total	Error of Commission (Percent Correct)
	Acidic Oak - Hickory Forest	Beaver Wetland Complex	Coastal Plain / Piedmont Acidic Seepage Swamp	Coastal Plain / Piedmont Small-Stream Floodplain Forest	Coastal Plain Mixed Oak / Heath Forest	Loblolly Pine - Hardwood Forest	Loblolly Pine Plantation	Mesic Mixed Hardwood Forest	Non-Riverine Saturated Forest	Non-Riverine Saturated Forest - pine subtype	Successional Mixed Scrub	Successional Red-cedar Forest	Successional Tuliptree Forest		
Acidic Oak - Hickory Forest	9				1			1						11	81.8%
Beaver Wetland Complex		5							1					6	83.3%
Coastal Plain / Piedmont Acidic Seepage Swamp			6											6	100.0%
Coastal Plain / Piedmont Small-Stream Floodplain Forest				1									1	2	50.0%
Coastal Plain Mixed Oak / Heath Forest					8			1					1	10	80.0%
Loblolly Pine - Hardwood Forest						4								4	100.0%
Loblolly Pine Plantation							3							3	100.0%
Mesic Mixed Hardwood Forest								8						8	100.0%
Non-Riverine Saturated Forest									6					6	100.0%
Non-Riverine Saturated Forest - pine subtype										3				3	100.0%
Successional Mixed Scrub						1					1			2	50.0%
Successional Red-cedar Forest												1		1	100.0%
Successional Tuliptree Forest				1				1			1		6	9	66.7%
Grand Total	9	5	6	2	9	5	3	11	7	3	2	1	8	71	
Error of Omission (Percent Correct)	100.0%	100.0%	100.0%	50.0%	88.9%	80.0%	100.0%	72.7%	85.7%	100.0%	50.0%	100.0%	75.0%		

Total points correct   **61**
Overall Accuracy   **85.9%**
Kappa Index   **84.4%**
90% Confidence Interval   **10.2%**

Project deliverables

Final products of the vegetation mapping project are shown in Table 14. All products have been delivered to the National Park Service by the Virginia Department of Conservation and Recreation, Division of Natural Heritage, with this report, or at an earlier date by NCSU-CEO.

Table 14. Summary of products resulting from the classification and mapping of vegetation at Richmond National Battlefield Park.

Product	FGCD-complaint spatial metadata
Park orthophoto mosaics (leaf-on and leaf-off)	Yes
Vegetation plot sampling data in the PLOTS 2.0 database	Not applicable
Vegetation plot point data (ArcView shapefile)	Yes
Thematic accuracy assessment sampling points (ArcView shapefile)	Yes
Digital photos representative of vegetation types	Not applicable
Association-level vegetation polygon map	Yes
Final report with vegetation keys and descriptions in digital and hardcopy format	Not applicable

Discussion

Vegetation Classification and Characterization

A comprehensive regional analysis resulted in the classification of over 100 USNVC associations, spanning nearly all major physiographic provinces in the region. Thirty-five of the associations are represented in the seven national parks included in this study. An additional 19 associations and 12 nonstandard, park-specific classes representing disturbed, cultural, or exotic vegetation were also recognized from the seven parks. This study at Richmond National Battlefield Park identified and characterized 21 map classes, representing 13 USNVC associations, three Anderson Level II land-use classes (Anderson et al. 1976), and five nonstandard, park-specific vegetation classes (Table 11).

At the end of the United States Civil War, much of the land that today is Richmond National Battlefield Park was deforested for agricultural or military reasons. In the intervening years, these same areas have undergone natural reforestation and now support forests in various states of succession. In addition, recent land-use history and ongoing management to maintain the historical and cultural landscape of the United States Civil War has significantly influenced the vegetation in the park today. Early successional or transitional vegetation and cultural map classes cover over 57% of the land in Richmond National Battlefield Park.

Early successional or transitional vegetation alone covers 32% of the land in the park (180 ha [444 ac]). This vegetation is the result of relatively recent (20–80 years) abandonment of pine plantations and fields, or tree canopy removal by disturbances such as pine bark beetle infestation, wind, beaver activity, timber harvests, or other silvicultural practices. The upland stands are dominated by early successional, weedy tree species in the canopy and subcanopy, and can have high cover of nonnative plants in the shrub and herbaceous layers. Beaver-disturbed areas typically occur as semipermanently flooded habitat variously dominated by trees, shrubs, herbs, or open water. All these map classes are rapidly changing in species composition and vegetation structure. In the absence of beaver and nonnative plant species invasions, these stands would eventually succeed into one of the later successional forest types mapped in the park. Map classes representing early successional or transitional vegetation are Beaver Wetland Complex, Loblolly Pine - Hardwood Forest, Loblolly Pine Plantation, Successional Black Walnut Forest, Successional Mixed Scrub, Successional Red-cedar Forest, Successional Shrub Swamp, and Successional Tuliptree Forest. These map classes are described in Appendix I.

Cultural map classes cover almost 25% of the park's acreage (144 ha; 355 ac). Cultural Meadow is the most common cultural map class in the park, covering 25 ha (62 ac). Cultural Meadow includes all mowed or maintained fields and agricultural leases in the park. Most of the cultural meadows are managed to maintain the open fields characteristic of Civil War battlefields. Other cultural map classes include Forested Earthworks, Open Earthworks, Other Urban or Built-up Land, Residential, and Transportation, Communications, and Utilities. These map classes are described in Appendix I.

Late successional deciduous forests and forested wetlands are found on the remaining 43% of park land. In the context of this study, late successional forests are relatively mature forests

found in the least disturbed areas in the park. These native vegetation associations or "natural communities" have the most stable species composition with a greater diversity of native flora than other map classes representing transitional, disturbed, or cultural vegetation. Seven map classes represent late successional vegetation and together they cover 243 ha (600 ac). The seven map classes can be broadly characterized based on different environmental settings as upland forests (3 map classes) and forested wetlands (4 map classes).

Three upland forest map classes that represent later successional vegetation cover 197 ha (487 ac) or just over 35% of park land in areas that have not been converted to pine forests or other transitional vegetation. The most common upland forest map class is Mesic Mixed Hardwood Forest which covers 14% (81 ha [200 ac]) of the park land and is found on mesic lower slopes and ravines throughout Richmond National Battlefield Park. Some of the forested areas in Richmond National Battlefield Park mapped as Successional Tuliptree Forest may have been Mesic Mixed Hardwood Forest prior to canopy removal. Mesic Mixed Hardwood Forest is a common and widespread community in the Mid-Atlantic Piedmont and Coastal Plain and was documented in five of the seven parks in this study.

Coastal Plain Mixed Oak / Heath Forest covers 12.5% (71 ha [175 ac]) of the park land and is found on xeric upland flats and gentle slopes over sandy, well-drained, infertile soils. The majority of Coastal Plain Mixed Oak / Heath Forest is mapped at Cold Harbor, where the forest is managed with prescribed fires. Smaller stands of Coastal Plain Mixed Oak / Heath Forest are found at Fort Harrision, Malvern Hill, and Parker's Battery. Coastal Plain Mixed Oak / Heath Forest is a common and widespread community in the Coastal Plain and eastern Piedmont of Virginia, where it often forms the matrix forest. It was documented in three of the seven parks in this study.

Acidic Oak - Hickory Forest is mapped at Fort Darling, Fort Harrison, and Malvern Hill. Typical expressions of this association are dominated by oaks and hickories (*Carya* spp.) with flowering dogwood (*Cornus florida*) and a large number of low-cover, dry-mesophytic herbs. Species-richness can exceed 80 taxa per 400 m^2 on undisturbed sites where deer or invasive nonnative plants are not problematic. Of the 45.1 ha (111.6 ac) mapped as Acidic Oak - Hickory Forest in Richmond National Battlefield Park, only about 15 ha (37 ac) have typical species composition. The remaining 30 ha (74 ac) are atypical, either from past land use, deer browse, or recent wind disturbance. In sample plots from typical, undisturbed stands of Acidic Oak - Hickory Forest in the park, species richness ranged from 32–62 species per 400 m^2 plot. Throughout the mid-Atlantic region, American beech, American holly, and red maple (*Acer rubrum*) are heavily invading the understories of some stands of this type, likely due to the exclusion in recent decades of fires, logging, and other disturbances that favor oak regeneration (Orwig and Abrams 1994; Abrams and Copenheaver 1999). As a result, these stands appear to be succeeding to a more mesic forest composition, as is the case in some portions of Richmond National Battlefield Park. Acidic Oak - Hickory Forest ranges through the Piedmont of the Carolinas and Virginia, north into south-central Maryland. It is not a rare community type (G4G5), but extensive stands and stands older than about 80 years old are uncommon, since most of the rolling upland landscapes of the Piedmont have been logged more than once since European settlement or converted to pine plantations. The association is one of the most common later-successional forest types in the Piedmont, occurring as a matrix forest in the

southern portion of its range, and a matrix or large-patch forest northward into Virginia. Acidic Oak - Hickory Forest was mapped in six of the seven parks included in this study.

Forested wetlands cover 8% (45.7 ha [112.9 ac]) of the park area and include four map classes. The majority of the forested wetlands in the park (32.5 ha [80.4 ac]) is mapped as Non-Riverine Saturated Forest or Non-Riverine Saturated Forest - pine subtype at Chickahominy Bluff, Fort Harrison, and Malvern Hill. The examples of Non-Riverine Saturated Forest at Richmond National Battlefield Park are on ancient river terraces of the James and Chickahominy rivers, and most of the acreage has been impacted by historic anthropogenic activities, such as logging and ditching, and current hydrological changes from beaver activities. The stands in the park are surrounded by cultural and semi-natural vegetation and are isolated from a functioning natural landscape. Most areas mapped as Non-Riverine Saturated Forest are largely young tree regeneration with extensive areas of nonnative species. However, there are small, isolated areas with large individuals of hydric oak species and highly representative species composition for the association. Willow oaks (*Quercus phellos*) greater than 1.0 m (3.3 ft) in diameter were recorded from Chickahominy Bluff, and many cherrybark oaks (*Quercus pagoda*) at Malvern Hill measured over 80 cm (31.5 in) diameter. Non-Riverine Saturated Forest is restricted to extensive, flat terraces and very wide, ancient floodplains that are no longer subject to alluvial processes, but are seasonally flooded due to a high water table. These specialized wetland habitats were probably never common on the landscape. Non-Riverine Saturated Forest is only known from about 25 sites in 13 counties in Virginia and it may range into Maryland. Much of the suitable habitat for the association has been lost to agriculture, hydrologic alterations, and conversion of hardwood forests to silvicultural pine plantations.

Non-Riverine Saturated Forest - pine subtype includes forested wetlands that are dominated by *Pinus taeda* (loblolly pine) and larger than 0.5 ha (1.23 ac) in size. This map class is considered a physiognomic/early succesional variant of Non-Riverine Saturated Forest and occurs on sites that have been clearcut or otherwise heavily disturbed in the past. Non-Riverine Saturated Forest - pine subtype typically occurs as large evergreen patches within the mostly deciduous Non-Riverine Saturated Forest. They tend to be much less diverse than the deciduous phase of this forest.

Several isolated headwater wetlands totaling 9 ha (22.4 ac) in Cold Harbor, Malvern Hill, and Forest Harrison support a forested wetland mapped as Coastal Plain / Piedmont Acidic Seepage Swamp. Small areas of this community below minimum mapping unit may occur elsewhere throughout the park, where otherwise upland forest polygons cross small drainages. Coastal Plain / Piedmont Acidic Seepage Swamp is an uncommon (G3?) wetland habitat, scattered in the Coastal Plain from southeastern New York and New Jersey to southeastern Virginia. Habitats supporting this community type are characterized by the abundant discharge of groundwater into small, braided stream bottoms, keeping the ground saturated throughout the growing season. Several uncommon odonates (dragonflies and damselflies) depend on forested seeps for breeding habitat. Throughout its range, Coastal Plain / Piedmont Acidic Seepage Swamp is threatened by beaver activities, agricultural pollutants, hydrologic disturbances, and logging. Because of their isolated hydrology and small size, these forested wetlands are often exempt from protective wetland regulations and much of the habitat throughout its range is vulnerable to destruction by indirect development impacts such as siltation, canopy removal, and subsequent nonnative species invasions.

Small areas totaling 4 ha (10 ac) at Beaverdam Creek, Chickahominy Bluff, Malvern Hill, and Watt House are mapped as Coastal Plain / Piedmont Small-Stream Floodplain Forest. Forests of this map class occur over deep, sandy alluvial soils that are subject to occasional, brief flooding, typically once or twice a year. The deep, moist, well-drained soils are highly susceptible to nonnative species invasion, thus, it is important not to site trails and roads in the active floodplain and to mitigate impacts from surrounding development. The examples of this forest in the park are highly disturbed and have herb strata dominated by nonnative invasive plants. Much of the area that formerly supported this community has been altered by beaver activity and is now mapped as Beaver Wetland Complex. Coastal Plain / Piedmont Small-Stream Floodplain Forest is a relatively common association (G4), but high quality, undisturbed examples are rare. It is widespread from the Coastal Plain of Maryland and Virginia through the Piedmont of Virginia and North Carolina to the Cumberland Plateau. Coastal Plain / Piedmont Small-Stream Floodplain Forest was mapped in four of the seven parks included in this study.

Of the 21 map classes used to map the vegetation at Richmond National Battlefield Park, six are natural communities as defined in the Natural Communities of Virginia (http://www.dcr.virginia.gov/natural_heritage/nctoc.shtml): Acidic Oak - Hickory Forest, Coastal Plain / Piedmont Acidic Seepage Swamp, Coastal Plain / Piedmont Small-Stream Floodplain Forest, Coastal Plain Mixed Oak / Heath Forest, Mesic Mixed Hardwood Forest, and Non-Riverine Saturated Forest. Exemplary occurrences of these communities are tracked by Virginia's Department of Conservation and Recreation, Division of Natural Heritage. In order to be considered an exemplary occurrence, stands have to meet strict type-specific criteria of size, condition, and landscape context. All globally rare (G1 or G2) or state rare (S1 or S2) communities are tracked, regardless of their size, condition, and landscape context. A portion of the area mapped as Coastal Plain / Piedmont Acidic Seepage Swamp in Cold Harbor met the criteria and is considered a Natural Heritage exemplary natural community occurrence. The other five natural communities in the park do not meet the criteria, but these native plant associations are an important part of the park's natural resources and should be targets for conservation and management. Even though Non-Riverine Saturated Forest has a conservation rank of G2?, the areas mapped as this community in Richmond National Battlefield Park were not considered exemplary natural community occurrences because the global conservation rank of this association is currently under review for a rank change to G3. As a G3 community, the examples in the park would not meet the criteria to be considered exemplary.

Invasive nonnative plant species are one of the main threats to the native vegetation associations at Richmond National Battlefield Park. Ten nonnative plant species were noted in the quantitative plots and accuracy assessment observations. Cultural and early successional map classes had the most diversity of nonnative plant species. Of the other map classes, forested wetlands had the highest cover by invasive, nonnative species. The most common and problematic species include Japanese honeysuckle (*Lonicera japonica*) and Nepalese browntop (*Microstegium vimineum*). These species are particularly troublesome because of their shade tolerance and aggressive growth habits. These species can be opportunistic invaders of the older, more intact forest communities, getting a foothold where roads, trails, tip-up mounds, downfalls, and other gap-disturbances have disturbed mineral soil. Once established, colonies are able to more easily expand or spread into nearby microhabitats.

Japanese honeysuckle is especially destructive to native vegetation because of its rapid, twining growth and dense, semi-evergreen foliage that shades out competitors. Its vines frequently strangle shrubs and tree saplings, and over-grow more delicate herbs in a variety of settings. Nepalese browntop is the fastest spreading, most problematic exotic everywhere in Virginia today. Within the past two decades, it has abundantly invaded moist, openly shaded habitats throughout the mid-Atlantic region, forming monospecific carpets of tangled culms that tend to crowd out competing herbaceous species (Tu 2000). A recent study strongly suggests that Nepalese browntop responds to forest canopy disturbances with a sudden increase in biomass that impedes woody regeneration and lowers overall species diversity and stem densities (Oswalt et al. 2007). Other studies have demonstrated that once established, Nepalese browntop over-runs native herbaceous competitors and leads to dramatic declines of herb richness within a few years (Barden 1987; Hunt and Zaremba 1992).

Other highly invasive nonnative species noted in the park include tree of heaven (*Ailanthus altissima*), Chinese privet (*Ligustrum sinense*), and wartremoving herb (*Murdannia keisak*). Also noted were English ivy (*Hedera helix*), Princesstree (*Paulownia tomentosa*), and oriental ladysthumb (*Polygonum caespitosum* var. *longisetum)*, which are considered moderately invasive by the Virginia Department of Conservation and Recreation (VADCR 2003).

Vegetation Map Production

The final map for Richmond National Battlefield Park depicts 21 map classes. Thirteen map classes are crosswalked to USNVC vegetation associations, five are nonstandard, park-specific vegetation classes, and three are Anderson land-use classes. Each polygon representing a USNVC association was attributed with the appropriate USNVC formation and alliance based on the hierarchy of the USNVC. The final map table includes eight formations and 13 alliances.

The Kappa index for the final vegetation map meets the USGS-NPS VMP protocol requirement of 80%. Errors of commission and omission reported for four map classes fall below the USGS-NPS VMP protocol requirement of 80%. Examination of the errors associated with each observation shows that they can be attributed to below minimum mapping unit inclusions of other vegetation types within the target polygons or to the difficulty of assigning a vegetation classification to very disturbed, transitional vegetation. Additionally, some of the mapping errors may have been due to the difficulty of distinguishing deciduous types on aerial photography, since many deciduous signatures are virtually identical.

The final vegetation map is based on aerial photography that was flown in February 2002. Since that time, the vegetation in the park has continued to change. In September 2003, Hurricane Isabel altered the mapped vegetation in many areas of the park. Since 2001, forested areas at Watt House and Malvern Hill were cleared to create open fields. The temporal progression of early successional forest types will continue to alter the mapped vegetation, as will the park's ongoing management of invasive species. Despite these changes, the vegetation map produced by this project provides crucial baseline data for the park resource managers.

Recommendations for Future Projects

Invasive nonnative plant species are the main threat to the native vegetation associations at Richmond National Battlefield Park and, in most cases, represent species that were not present in the historical landscapes of the Civil War. Continued monitoring and management of invasive species in and around all the natural communities in the park should be a priority for the park's resource managers. Control of invasive nonnative species on forest edges and along trails and roads can help prevent new invasions. The most common and problematic species include Japanese honeysuckle and Nepalese browntop. Dormant season herbicide application can be effective in treating Japanese honeysuckle infestations, but timing is critical. As a rule, foliar application of 1.5% glyphosate (*e.g.*, Roundup) after the first killing frost and before the first hard frost is most effective (Nuzzo 1997). The annual Nepalese browntop is a prolific seed-producer, and seed banks can persist for at least five years (Tu 2000). Control of the species can be very labor intensive (*i.e*., hand-pulling) or destructive to non-target plants (*i.e*., herbicide application). Since the species can germinate following early season removal, removal two or more times a season to more quickly deplete the seed bank has shown promise as a technique for discrete, high-priority sites (TNC, Maryland Field Office, Mary Travaglini, Invasive Species Biologist, pers. comm., 2007). Twelve species of fungi and eight arthropod species are reported as natural enemies of Nepalese browntop in Asia, but no biological controls are currently available (Zheng et al. 2006) for use in the United States. Eradication of the species from large sites where it is well established is not a realistic goal with the tools now available. However, reducing populations to manageable or non-invasive levels, especially in rare habitats and vegetation types, should be a high priority for the National Park Service. While not a long-term solution, keeping Nepalese browntop in check while effective biological controls are developed is the best strategy available at present and is critical to avoiding drastic declines in biodiversity and forest health in the near future.

The protection of the significant wetland community at Cold Harbor should be a priority for park managers. Coastal Plain / Piedmont Acidic Seepage Swamp communities are fed by generous quantities of nutrient-poor groundwater seepage. Clearcutting, site clearing, road construction, and other development actions are potential sources of groundwater perturbation, erosion, run-off, and siltation which could threaten this community. Outright destruction of these wetlands by beaver impoundments and related flooding is also a possible threat. Maintenance of requisite habitat conditions requires protection of upslope hydrologic recharge zones and sufficient buffer to ensure the quality and quantity of both groundwater seepage and surface water. Road construction, timber harvest, and other ground-disturbing activities should be avoided within the watershed containing these wetlands. While beaver-related flooding is not a current threat to the Cold Harbor wetlands, beaver activities should be closely monitored within the site and, when necessary, actions to deter and prevent additional expansion of the beaver population should be taken. Options to control impacts from beaver populations include the use of drain pipe modifications and/or electrified barriers at critical dam and culvert areas, as well as regulated harvest trapping and nuisance trapping as permitted in and around the park.

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Appendix A. Quantitative vegetation plot sampling form.
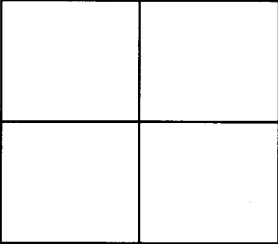
GENERAL INFORMATION
PLOT: _____
Project: Mid atlantic Veg mapping
Date: _____
Surveyors: _____

Plot dimensions: _____ by _____ m
Sample area _____ sq. m

PLOT DOCUMENTATION
Source Code: _____
Film Roll: _____
Frames: _____
Description of pic(s):

Relative Stand Size
A - extensive (> 100x plot size)
B - large (10-100x plot size)
C - small (3-10x plot size)
D - very small (1-3x plot size)
U - Unknown

PLOT LOCATION
Managed Area (Park):
Survey Site: _____ Quad: _____
County:
GPS unit: Garmin GPSMAP76
UTM zone: Datum: WGS 84
GPS pointname or file:
est accuracy: _____   m/ft   # of sats fixed:
Reciever status: 2D / 3D / 2D WAAS / 3D WAAS

Field UTM X _ _ _ _,_ _ _ E   Y _,_ _ _ _,_ _ _ N

LAT _____

Long _____

Marked est. location on toposheet _____ yes

SITE CHARACTERISTICS   compass: magnetic   corrected _____

Elevation _____   m/ft
via GPS __   map ____   altimeter __

Slope (o) ____	**Slope Shape (V w/ slope)**		**Aspect** (N = 0o): _____
single measure. __ avg of __	VERTICALLY HORIZONTALLY		single measure. _____
or:	C - concave	C - concave	avg of _____
A - 0-3% (level or nearly so)	X - convex	X - convex	
B - 3-8% (gentle/undulating)	S - straight	S - straight	F (flat) N 338-22 ° NE 23-67 °
C - 8-16% (sloping/rolling)			V (variable) E 68-112 ° SE 113-157 °
D - 16-30% (moderate/hilly)	H - hummock (___%) and		S 158-202 ° SW 203-247 °
E - 30-65% (steep)	hollow (___%) microtopography		W 248-292 ° NW 293-337 °
F - 65-75% (very steep)	I - irregular craggy/		
G - 75+% (extremely steep)	bouldery microtopography		

Topographic **Position**	**Landform**		**Surface Substrate** _____	**% Cover**
A - crest	IF - interfluve	P - flat plain	bedrock	
B - upper slope	G - gap/saddle	D - dune	boulders and stones	
C - middle slope	SS - side slope	OF - overwash flat	gravel and cobbles	
D - lower slope	SB - slope bench	I - interdune	litter / organic matter	
E - toe slope	FP - fan piedmont	TF - tidal flat	decaying wood	
F - plain/level/bottom	C - cove	R - ravine	water	
G - basin/depression	E - escarpment/face	S - seep/swale	mineral soil / sand	
	O - bedrock outcrop	A - alluvial plain	other	
	DS - debris slope	L - levee	(bryophytes and lichens)	
	H - hill/monadnock	CS - channel shelf	TOTAL	100%
	U - rolling upland	BS - backswamp		
	OTHER:	B - basin/sag pond		

Soil Drainage Class	**Soil Moisture Regime**	**Hydrologic Regime**
A - very poorly drained	A - very xeric (moist for neglig. time after ppt)	__ Terrestrial(i.e. not a wetland)
B - poorly drained	B - xeric (moist for brief time)	
C - somewhat poorly drained	C - somewhat xeric (moist for short time)	Tidal
D - moderately well drained	D - submesic (moist for moderately short time)	A - Irregularly exposed
E - well drained	E - mesic (moist for significant time)	B - Regularly flooded
F - rapidly drained	F - subhygric (wet for signicant part of	C - Irregularly flooded
	growing season; mottles <20cm)	D - Wind tidally flooded
Inundation	G - hygric (wet for most of growing season;	Non-Tidal
A - never	permanent seepage/mottling)	A - Permanently flooded
B - infrequently	H - subhydric (water table at or near surface	B - Semipermanently flooded
C - regularly; for <6 mos.	for most of the year)	C - Seasonally flooded
D - regularly; for >6 mos.	I - hydric (water table at or above surface	D - Intermittently flooded
E - always submerged by	year round)	E - Temporarily flooded
shallow water (<30cm)	- ephemeral seepage/subsurface water	F - Saturated
F - always submerged by	present locally in plot	Salinity/Halinity
deep water (>30cm)		A - Saltwater Refractometer
		B - Brackish Measurement:
		C - Oligohaline __
		D - Freshwater

Cowardin System
Upland _____ Riverine _____ Lacustrine _____ Estuarine _____ Palustrine _____

Soil Sample   Single Sample   ____   Composite Sample   ____   Mean of   ____

Soil Profile Description
Horizon/
Depth(cm)   Description (texture, structure, consistency) _____

0- | _____

II. VEGETATION STRUCTURE AND PHYSIOGNOMY

PLOT _____, P.3

NOTE: Record height (m), cover class (10 pt scale), and phenology / lifeform for each stratum.

Stratum	T35+	T20-35	T10-20	T6-10	S1	S2	H		N	
COVER CLASS										
Max Height m										
Phenology/	D	ME	D	ME	D	ME	D	ME	D	ME	D	ME	Pt	F	B		LIC
Growth form	MD	E	MD	E	MD	E	MD	E	MD	E	MD	E	G	W	MIXED	

maximum CANOPY HEIGHT _____ m

COLUMN VALUES:

T>35 = tree canopy > 35m (T1)	H = field layer (0 -0.5 m)
T20 = tree canopy 20-35m (T2)	N = nonvascular
T10 = tree canopy 10-20m (T2)	V = vines
T6 = tree canopy 6-10m (T3)	E = epiphytes
S1 = tree or shrub 1-6m	TC = total cover
S2 = woody sp. 0.5 - 1 m	C = collection

WOODY STEMS >= 2.5 CM DBH IN PLOT; record in 5cm classes; record to the nearest cm if DBH>40cm

SPECIES	2.5	5	10	15	20	25	30	35	40+

*In TNC Plots database: T1 = T>35; T2 = greatest of T20 or T10; T3 = T6

* Put total cover for vines (V) and epiphytes (E) but indicate height strata by a check

III. SPECIES COMPOSITION AND COVER CLASS BY STRATUM.

Record species cover in the following cover classes:

1=trace, 2=a few (<1%), 3=1-2%, 4=2-5%, 5=5-10%, 6=10-25%, 7=25-50%, 8=50-75%, 9=75-100%.

record cover values for each stratum AND for total cover in entire sample. Check "C" for collection, "D" for discard, ID flag 1-5

T>35	T20	T10	T6	S1	S2	H	N	V	E		TC	TAXON	C	#	D	ID

Appendix B. Accuracy assessment data form for the vegetation map of Richmond National Battlefield Park.

I. IDENTIFIERS AND LOCATION DATA

1. AA Point Code _AA_____ 2. Park Code: RICH 3. Date (*y/m/d*): 2006 / /

4. Observer(s) _____

5. GPS unit (*circle*): Garmin GPSMap76 / Garmin GPSMap76s

6. DATUM (*circle*): WGS84 / other (*specify _____*) 7. GPS file name _____

8. Estimated accuracy _____ m 9. Number of points averaged _____

10. Receiver status (*circle*): 2D / 3D / 2D WAAS / 3D WAAS / no signal (*estimated location marked on DRG*)

11. Field UTM X ___ ___ ___ ___ ___ ___ m E Y ___ ___ ___ ___ ___ ___ ___ m N

OR Lat _____ Long _____

II. ENVIRONMENTAL / SITE DESCRIPTION

1. Environmental Comments (*if site is a wetland, indicate type of hydrology, e.g., seepage wetland, temporarily flooded stream bottom, seasonally flooded pond, etc.*)

III. VEGETATION DESCRIPTION (observation is within a 0.5 ha area - approx. a 40 m radius circle)

1. Prevalent vegetation association within 0.5 ha of observation area, based on field key:

2. Other vegetation associations present within 0.5 ha observation area:

3. Representativeness: is the vegetation within the 0.5 ha observation area representative of vegetation in the surrounding mapped polygon? If vegetation of the AA point is an anomalous inclusion in the polygon, please note

4. Approximately what percentage of the mapped polygon did you observe? OR approximate size of area observed? (This may be also be drawn on a map. Include with form)

RICH AA DATA FORM, p.2   AA POINT CODE _____

IV. VEGETATION STRUCTURE (*check maximum cover class in each stratum*):

Stratum / max. ht.	1–25% cover	26–50% cover	51–75% cover	76–100% cover
35 m				
20 m				
10 m				
6 m				
2 m				
0.5 m + herbs				

V. VEGETATION COMPOSITION (*list characteristic species and indicate dominant by a "D," present by a "P," and rare by "R" in the appropriate strata*).

SPECIES	Canopy layer	Sub-canopy layer	Shrub layer	Herb layer

VI. ADDITIONAL COMMENTS (*use this space to provide additional comments about vegetation structure or composition*)

VII. CLASSIFICATION COMMENTS (*use this space to provide additional comments about problems or ease in applying the vegetation key at this site, rationale for choice of association if there was doubt, etc. **Comments for modifying the key are welcome***)

INSTRUCTIONS FOR RICHMOND NATIONAL BATTLEFIELD PARK
VEGETATION MAP ACCURACY ASSESSEMENT

This observation point field form was developed for the Mid-Atlantic Vegetation mapping project. Its purpose is to generate record observations at vegetation polygons and compare them to the mapped data. The general procedure you will follow is to navigate to the pre-selected point using a Garmin GPSMap76 or GPSMap76s GPS unit. Try to navigate as close as possible to the pre-selected point. The species list is collected at that point and the 0.5 ha surrounding the point. Comments re: the vegetation within the entire polygon are also recorded on this form. Once at the pre-selected observation point, you will record your location by collecting a waypoint with the GPS unit and record the required data in the order that it appears on the field form.

The materials you should have before you begin are 1) plots of the 7.5' DRG (and photos if helpful) showing the polygon boundaries, but no information about polygon attributes; 2) pre-selected AA point coordinates loaded into your GPS unit; 3) the field key to vegetation types, and 4) vegetation type descriptions. You should also carry a compass. A measure tape may help for distances and heights. Once you have navigated to an observation point, you should closely observe the vegetation within the prescribed data collection area, which in most cases will be a approximated circular 0.5 ha area (radius = ca. 40 m). You can simply pace one or more radii of 40 meters from the point to assist in gauging the extent of the observation area. Keep the observations within the defined polygon and adjust the area surveyed accordingly (i.e. if the polygon is linear or less than 0.5 ha, keep the observation within the polygon)

In cases where an observation point falls in an ecotone, or contains two distinctly different vegetation types, describe the type that covers the larger area and provide notes (see section III3) on the second type. In the rare instance where an observation area is equally divided between two vegetation types, you will have to complete observation point field forms for each type. During navigation to and from a point, generally observe the vegetation in the mapped polygon so that you can answer section III2 (see below).

Specific Instructions for completing the AA field form:
I.1-4. Self explanatory

I.5-11. Indicate GPS unit used and record the file name for the location data that you collect. Record the number of points averaged, accuracy, and either UTM or Lat/Long coordinates displayed by the GPS unit. In the event that GPS locational data cannot be obtained, mark your estimated location on a 7.5' USGS quad or DRG.

II.1. Make note of any other environmental characteristics that might assist in interpreting the site. Also use this space to record general information on hydrology, if the site is a wetland.

III.1. Use the field key to determine the vegetation type prevalent at the site.

III.2. If one or more additional vegetation types occur within the sample site, record them.

III.3. To the extent possible, and based on general observations made navigating to and from the point, note whether the prevalent vegetation of the sample site is representative of the larger polygon in which it is located. It is especially important to note instances where the vegetation of the site is an anomaly or local inclusion within the polygon.

III.4. Provide a rough estimate of the percentage of the larger polygon that you observed (*e.g.*, 10%, 20%, etc.). or draw the area on your map and include with this form.

IV. Check the maximum cover class for each vertical vegetation stratum indicated on the table. The heights in the left column indicate the maximum height of each stratum. The lowest stratum contains all woody plants < 0.5 m tall and all herbaceous plants, regardless of height.

V. List species you would consider to be characteristic of the vegetation at the site. These generally include dominant species and less abundant species that are indicative of specific site conditions such as soil chemistry or

hydrologic regime. Write the species in the left column and note its status in the appropriate layer(s) using the symbols "D" for dominant, "P" for present, and "R" for rare (1-3 individuals).

VI. Use this space to record any additional information or comments about vegetation structure or composition that would assist in interpreting this site.

VII. Use this space to record any additional information about vegetation classification. It is especially important to note if problems were encountered applying the field key or interpreting the vegetation.

Appendix C. Vascular plants observed in quantitative vegetation plots and accuracy assessment observation points in Richmond National Battlefield Park in 2002–2006.

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).

Family	Scientific Name	Common Name
Aceraceae	*Acer rubrum*	red maple
Alismataceae	*Sagittaria latifolia*	broadleaf arrowhead
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
	Toxicodendron vernix	poison sumac
Annonaceae	*Asimina triloba*	pawpaw
Apiaceae	*Cicuta maculata* var. *maculata*	spotted water hemlock
	Oxypolis rigidior	stiff cowbane
	Sanicula canadensis	Canadian blacksnakeroot
Apocynaceae	*Trachelospermum difforme*	climbing dogbane
Aquifoliaceae	*Ilex opaca* var. *opaca*	American holly
	Ilex verticillata	common winterberry
Araceae	*Arisaema triphyllum*	Jack in the pulpit
	Orontium aquaticum	goldenclub
	Peltandra virginica	green arrow arum
	Symplocarpus foetidus	skunk cabbage
Araliaceae	*Aralia spinosa*	devil's walkingstick
	Hedera helix	English ivy[e#]
Aristolochiaceae	*Aristolochia serpentaria*	Virginia snakeroot
	Hexastylis virginica	Virginia heartleaf
Asclepiadaceae	*Asclepias verticillata*	whorled milkweed
Aspleniaceae	*Asplenium platyneuron*	ebony spleenwort
Asteraceae	*Antennaria plantaginifolia*	woman's tobacco
	Bidens frondosa	devil's beggartick
	Elephantopus nudatus	smooth elephantsfoot
	Elephantopus tomentosus	devil's grandmother
	Erechtites hieraciifolia var. *hieraciifolia*	American burnweed
	Eupatorium fistulosum	trumpetweed
	Eupatorium purpureum var. *purpureum*	sweetscented joepyeweed
	Hieracium gronovii	queendevil
	Prenanthes altissima	tall rattlesnakeroot
	Prenanthes serpentaria	cankerweed
	Verbesina alternifolia	wingstem
	Vernonia noveboracensis	New York ironweed
Balsaminaceae	*Impatiens capensis*	jewelweed
Betulaceae	*Alnus serrulata*	hazel alder
	Betula nigra	river birch
	Carpinus caroliniana	American hornbeam
	Corylus americana	American hazelnut
	Ostrya virginiana	hophornbeam

Family	Scientific Name	Common Name
Bignoniaceae	*Campsis radicans*	trumpet creeper
Blechnaceae	*Woodwardia areolata*	netted chainfern
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle[e#]
	Sambucus nigra ssp. *canadensis*	common elderberry
	Viburnum acerifolium	mapleleaf viburnum
	Viburnum dentatum	southern arrowwood
	Viburnum nudum	possumhaw
	Viburnum prunifolium	blackhaw
Caryophyllaceae	*Silene caroliniana* ssp. *pensylvanica*	Pennsylvania catchfly
	Stellaria media	common chickweed
	Euonymus americana	strawberry bush
Clethraceae	*Clethra alnifolia*	coastal sweetpepperbush
Clusiaceae	*Hypericum hypericoides* ssp. *hypericoides*	St. Andrew's cross
Commelinaceae	*Commelina communis*	Asiatic dayflower
	Murdannia keisak	wartremoving herb[e#]
Convolvulaceae	*Ipomoea pandurata*	man of the earth
Cornaceae	*Cornus florida*	flowering dogwood
	Cornus foemina	stiff dogwood
Cupressaceae	*Juniperus virginiana* var. *virginiana*	eastern redcedar
Cyperaceae	*Carex abscondita*	thicket sedge
	Carex albicans	whitetinge sedge
	Carex albolutescens	greenwhite sedge
	Carex atlantica ssp. *atlantica*	prickly bog sedge
	Carex atlantica ssp. *capillacea*	prickly bog sedge
	Carex cephalophora	oval-leaf sedge
	Carex collinsii	Collins' sedge
	Carex complanata	hirsute sedge
	Carex crinita	fringed sedge
	Carex debilis	white edge sedge
	Carex digitalis	slender woodland sedge
	Carex hirsutella	fuzzy wuzzy sedge
	Carex intumescens	greater bladder sedge
	Carex laevivaginata	smoothsheath sedge
	Carex laxiculmis var. *laxiculmis*	spreading sedge
	Carex lonchocarpa	southern long sedge
	Carex pensylvanica	Pennsylvania sedge
	Carex radiata	eastern star sedge
	Carex seorsa	weak stellate sedge
	Carex swanii	Swan's sedge
	Carex willdenowii	Willdenow's sedge
	Rhynchospora inexpansa	nodding beaksedge
	Rhynchospora microcephala	smallhead beaksedge
	Scirpus cyperinus	woolgrass
Dioscoreaceae	*Dioscorea quaternata*	fourleaf yam
	Dioscorea villosa	wild yam

Family	Scientific Name	Common Name
Dryopteridaceae	*Athyrium filix-femina*	common ladyfern
	Onoclea sensibilis	sensitive fern
	Polystichum acrostichoides	Christmas fern
Ebenaceae	*Diospyros virginiana*	common persimmon
Ericaceae	*Gaylussacia baccata*	black huckleberry
	Gaylussacia frondosa	blue huckleberry
	Kalmia latifolia	mountain laurel
	Leucothoe racemosa	swamp doghobble
	Lyonia ligustrina	maleberry
	Rhododendron periclymenoides	pink azalea
	Rhododendron viscosum	swamp azalea
	Vaccinium corymbosum	highbush blueberry
	Vaccinium formosum	southern blueberry
	Vaccinium fuscatum	black highbush blueberry
	Vaccinium pallidum	Blue Ridge blueberry
	Vaccinium stamineum	deerberry
Fabaceae	*Amphicarpaea bracteata*	American hogpeanut
	Cercis canadensis var. *canadensis*	eastern redbud
	Desmodium nudiflorum	nakedflower ticktrefoil
	Lespedeza violacea	violet lespedeza
Fagaceae	*Castanea pumila* var. *pumila*	chinkapin
	Fagus grandifolia	American beech
	Quercus ×subintegra	hybrid oak
	Quercus alba	white oak
	Quercus coccinea	scarlet oak
	Quercus falcata	southern red oak
	Quercus michauxii	swamp chestnut oak
	Quercus muehlenbergii	chinkapin oak
	Quercus pagoda	cherrybark oak
	Quercus palustris	pin oak
	Quercus phellos	willow oak
	Quercus prinus	chestnut oak
	Quercus rubra	northern red oak
	Quercus stellata	post oak
	Quercus velutina	black oak
Hamamelidaceae	*Liquidambar styraciflua*	sweetgum
Juglandaceae	*Carya alba*	mockernut hickory
	Carya glabra	pignut hickory
	Carya ovalis	red hickory
	Carya pallida	sand hickory
	Juglans nigra	black walnut
Juncaceae	*Juncus effusus*	common rush
Lamiaceae	*Lycopus virginicus*	Virginia water horehound
Lauraceae	*Lindera benzoin*	northern spicebush
	Sassafras albidum	sassafras

Family	Scientific Name	Common Name
Liliaceae	*Lilium superbum*	turk's-cap lily
	Liriope sp.	lilyturf [e]
	Maianthemum racemosum ssp. *racemosum*	feathery false lily of the valley
	Medeola virginiana	Indian cucumber
	Polygonatum biflorum	smooth Solomon's seal
	Uvularia sessilifolia	sessileleaf bellwort
Lycopodiaceae	*Lycopodium obscurum*	rare clubmoss
Magnoliaceae	*Liriodendron tulipifera*	tuliptree
	Magnolia virginiana	sweetbay
Monotropaceae	*Monotropa uniflora*	Indianpipe
Moraceae	*Morus rubra*	red mulberry
Nyssaceae	*Nyssa biflora*	swamp tupelo
	Nyssa sylvatica	blackgum
Oleaceae	*Chionanthus virginicus*	white fringetree
	Fraxinus americana	white ash
	Fraxinus pennsylvanica	green ash
	Ligustrum sinense	Chinese privet[e#]
Ophioglossaceae	*Botrychium virginianum*	rattlesnake fern
Orchidaceae	*Cypripedium acaule*	moccasin flower
	Goodyera pubescens	downy rattlesnake plantain
	Platanthera ciliaris	yellow fringed orchid
	Platanthera clavellata	small green wood orchid
	Platanthera flava var. *flava*	palegreen orchid
	Platanthera lacera	green fringed orchid
Osmundaceae	*Osmunda cinnamomea* var. *cinnamomea*	cinnamon fern
	Osmunda regalis var. *spectabilis*	royal fern
Phytolaccaceae	*Phytolacca americana*	American pokeweed
Pinaceae	*Pinus taeda*	loblolly pine
	Pinus virginiana	Virginia pine
Platanaceae	*Platanus occidentalis*	American sycamore
Poaceae	*Andropogon virginicus*	broomsedge bluestem*
	Chasmanthium laxum	slender woodoats
	Cinna arundinacea	sweet woodreed
	Cynodon dactylon	Bermudagrass[e]*
	Dactylis glomerata	Orchardgrass[e#]*
	Danthonia spicata	poverty oatgrass
	Dichanthelium boscii	Bosc's panicgrass
	Dichanthelium clandestinum	deertongue*
	Dichanthelium commutatum	variable panicgrass
	Dichanthelium dichotomum	cypress panicgrass
	Echinochloa crus-galli	barnyardgrass[e]*
	Elymus hystrix	eastern bottlebrush grass*
	Elymus virginicus	Virginia wildrye*
	Glyceria striata	fowl mannagrass*
	Leersia oryzoides	rice cutgrass
	Leersia virginica	whitegrass
	Lolium pratense	meadow ryegrass[e#]*

Family	Scientific Name	Common Name
Poaceae (cont'd)	*Microstegium vimineum*	Nepalese browntop[e#]
	Saccharum alopecuroidum	silver plumegrass*
	Schizachyrium scoparium	little bluestem
	Zizaniopsis miliacea	giant cutgrass
Polygonaceae	*Polygonum arifolium*	halberdleaf tearthumb
	Polygonum caespitosum var. *longisetum*	oriental ladysthumb[e#]
	Polygonum sagittatum	arrowleaf tearthumb*
	Polygonum virginianum	jumpseed
Pyrolaceae	*Chimaphila maculata*	striped prince's pine
Ranunculaceae	*Clematis ochroleuca*	curlyheads
Rosaceae	*Amelanchier arborea*	common serviceberry
	Geum canadense	white avens
	Photinia pyrifolia	red chokeberry
	Prunus serotina var. *serotina*	black cherry
	Rosa palustris	swamp rose*
	Rubus argutus	sawtooth blackberry
	Rubus flagellaris	northern dewberry
	Rubus hispidus	bristly dewberry
Rubiaceae	*Cephalanthus occidentalis*	common buttonbush
	Galium aparine	stickywilly*
	Galium circaezans	licorice bedstraw
	Houstonia purpurea var. *purpurea*	Venus' pride
	Mitchella repens	partridgeberry
Salicaceae	*Salix nigra*	black willow
Saururaceae	*Saururus cernuus*	lizard's tail
Saxifragaceae	*Heuchera americana*	American alumroot
Scrophulariaceae	*Chelone glabra*	white turtlehead
	Gratiola virginiana	roundfruit hedgehyssop
	Paulownia tomentosa	princesstree[e#]
Simaroubaceae	*Ailanthus altissima*	tree of heaven[e#]
Smilacaceae	*Smilax bona-nox*	saw greenbrier
	Smilax glauca	cat greenbrier
	Smilax herbacea	smooth carrionflower
	Smilax laurifolia	laurel greenbrier
	Smilax rotundifolia	roundleaf greenbrier
	Smilax walteri	coral greenbrier
Sparganiaceae	*Sparganium americanum*	American bur-reed
Sphagnaceae	*Sphagnum* sp.	a sphagnum
Taxodiaceae	*Taxodium distichum*	bald cypress*
Thelypteridaceae	*Thelypteris noveboracensis*	New York fern
	Thelypteris palustris var. *pubescens*	eastern marsh fern
Typhaceae	*Typha latifolia*	broadleaf cattail*
Ulmaceae	*Celtis occidentalis*	common hackberry
	Ulmus alata	winged elm
	Ulmus americana	American elm
	Ulmus rubra	slippery elm
Urticaceae	*Boehmeria cylindrica*	smallspike false nettle

Family	Scientific Name	Common Name
Violaceae	*Viola ×primulifolia*	primrose-leaved violet
	Viola cucullata	marsh blue violet
Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper
	Vitis rotundifolia	muscadine
	Vitis vulpina	frost grape

[e] Species not native to Virginia.

[#] Species considered to be invasive nonnative species by the VADCR (VADCR 2003).

[*] Species not measured in quantitative plots or accuracy assessment observations, but noted during fieldwork and used to characterize a vegetation class in Appendix I.

Appendix D. Distribution of vegetation classes, derived from the analysis of regional quantitative plot data, across seven national parks in Virginia.

Vegetation was classified and mapped in seven national park units in Virginia: Appomattox Court House National Historical Park (APCO), Booker T. Washington National Monument (BOWA), Colonial National Historical Park (COLO), Fredericksburg and Spotsylvania National Military Park (FRSP), George Washington Birthplace National Monument (GEWA), Petersburg National Battlefield (PETE), and Richmond National Battlefield Park (RICH). The classification used to map these parks was developed regionally, using quantitative data that were collected from all seven parks and combined with existing data from throughout the Mid-Atlantic Piedmont and Coastal Plain. Quantitative analysis classified 35 associations occurring in the seven parks. An additional 19 associations and 12 nonstandard park-specific vegetation classes representing disturbed, cultural, or exotic vegetation were also recognized from the seven parks, but were not represented by quantitative data. The relationship of all vegetation classes to the map classes used to map Richmond National Battlefield Park can be found in Table 11 of the main report. Vegetation classes listed with USNVC codes are equivalent to associations in the United States National Vegetation Classification (NatureServe 2007). Global and State conservation ranks are defined in Appendix E.

Appendix D. Distribution of vegetation classes across seven national parks in Virginia.

	USNVC code	Global/State Conservation Ranks	BOWA	APCO	FRSP	RICH	PETE	COLO	GEWA	Plots in regional analysis
UPLAND FORESTS										
Oak / Heath Forests										**93**
Coastal Plain Mixed Oak / Heath Forest	CEGL006269	G4G5/S4			x	x	x			18
Piedmont / Low Elevation Mixed Oak / Heath Forest	CEGL008521	G5/S5		x	x			x		75
Pine - Oak Forests										**25**
Coastal Plain Loblolly Pine - Oak Forest	CEGL004766	GNR/SNR						x		8
Eastern White Pine - Hardwood Forest	CEGL008539	G4/S4?			x					17
Mesic Acidic Forests										**196**
Mesic Mixed Hardwood Forest	CEGL006075	G5/S5		x	x	x	x	x		170
Piedmont / Coastal Plain Oak - Beech / Heath Forest	CEGL006919	GNR/SNR						x		26
Oak - Hickory Forests										**137**
Acidic Oak - Hickory Forest	CEGL008475	G4G5/S4	x	x	x	x	x	x		121
Basic Oak - Hickory Forest	CEGL007232	G3G4/S3		x						16
Basic Mesic and Calcareous Forests										**77**
Inner Piedmont / Lower Blue Ridge Basic Mesic Forest	CEGL006186	G4?/S4	x	x						31
Coastal Plain Mesic Calcareous Ravine Forest	CEGL007181	G2?/S2						x		22
Coastal Plain Dry Calcareous Forest	CEGL007748	G1/S1						x	x	24
NON-TIDAL WETLANDS										
Seepage Wetlands										**72**
Coastal Plain / Piedmont Acidic Seepage Swamp	CEGL006238	G3?/S3?			x	x	x		x	39
Northern Piedmont / Lower New England Basic Seepage Swamp	CEGL006406	G4G5/S2?		x						18
Coastal Plain Calcareous Seepage Swamp	CEGL006413	G2/S1S2						x		15
Alluvial Forests										**100**
Coastal Plain / Piedmont Small-Stream Floodplain Forest	CEGL004418	G4/S4			x	x	x	x		48
Piedmont / Mountain Alluvial Forest	CEGL006492	G4/S4	x	x						14
Piedmont / Mountain Floodplain Forest	CEGL006217	G4/S4			x					38
Swamp Forests										**70**
Coastal Plain / Piedmont Floodplain Swamp Forest (Mixed Oak - Red Maple Type)	CEGL006605	G3G4/S3			x		x			47
Coastal Plain / Piedmont Floodplain Swamp Forest (Green Ash - Red Maple Type)	CEGL006606	GNR/SNR						x		23
Nonriverine Forests										**62**
Upland Depression Swamp	CEGL007403	G2G3/S2		x						9
Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type)	CEGL006110	G4G5/S3			x			x		14
Coastal Plain Depression Wetland (Swamp Tupelo Type)	CEGL006223	G2S2						x		18
Non-Riverine Saturated Forest	CEGL004644	G2?/S2				x	x		x	21
TIDAL WETLANDS										
Tidal Herbaceous Marshes										**133**
Tidal Freshwater Marsh	CEGL004706	G3G4/SNR						x		18
Tidal Mesohaline and Polyhaline Marsh (Low Salt Marsh)	CEGL006586	GNR/SNR						x	x	13
Tidal Mesohaline and Polyhaline Marsh (Transitional Marsh)	CEGL006418	GNR/SNR						x		18
Tidal Oligohaline Marsh (Common Reed Tidal Marsh)	CEGL004187	GNA/SNA						x	x	7
Tidal Oligohaline Marsh (Interior Depression Marsh)	CEGL006578	GNR/SNR						x		13
Tidal Oligohaline Marsh (Big Cordgrass Type)	CEGL004195	G4/SNR						x	x	18
Tidal Oligohaline Marsh (Mixed Forbs Type)	CEGL006181	GNR/SNR						x	x	32
Tidal Oligohaline Marsh (Saltmeadow Cordgrass - Olney Three-Square Low Interior Marsh Type)	CEGL006612	GNR/SNR						x		14
Tidal Forests and Shrublands										**97**
Salt Scrub	CEGL003921	G5/SNR						x		13
Tidal Shrub Swamp (Iva Type)	CEGL006848	G5/SNR							x	30
Tidal Shrub Swamp (Wax Myrtle Type)	CEGL004656	G4/SNR						x		49
Tidal Bald Cypress Forest / Woodland	CEGL004654	G2S2						x		5

	USNVC code	Global/State Conservation Ranks	BOWA	APCO	FRSP	RICH	PETE	COLO	GEWA	Plots in regional analysis
DISTURBED, CULTURAL, EXOTIC VEGETATION										
Dense Hardwood Regeneration	nonstandard		x	x				x		0
Disturbed Acidic Slope Forest	CEGL007726	GNA/SNA							x	0
Disturbed Calcareous Forest	nonstandard					x	x	x		0
Early-Successional Loblolly Pine Forest	CEGL006011	GNA/SNA					x		x	0
Golden Bamboo Shrubland	CEGL008560	GNA/SNA						x		0
Loblolly Pine - Hardwood Forest	CEGL008462	GNA/SNA				x	x		x	0
Loblolly Pine Plantation	CEGL007179	GNA/SNA		x	x	x	x	x	x	0
Successional Black Locust Forest	CEGL007279	GNA/SNA							x	0
Successional Black Walnut Forest	CEGL007879	GNA/SNA		x		x		x		0
Successional Mixed Scrub	nonstandard			x	x	x	x			0
Successional Red-cedar Forest	CEGL006024	GNA/SNA		x	x	x			x	0
Successional Sweetgum Forest	CEGL007216	GNA/SNA				x	x	x		0
Successional Tree-of-Heaven Forest	CEGL007191	GNA/SNA		x				x		0
Successional Tuliptree - Loblolly Pine Forest	CEGL007521	GNA/SNA						x		0
Successional Tuliptree Forest	CEGL007221	GNA/SNA	x	x	x	x	x			0
Successional Virginia Pine Forest	CEGL002591	GNA/SNA	x	x	x					0
Virginia Pine Plantation	CEGL004730	GNA/SNA		x						0
White Pine Plantation	CEGL007178	GNA/SNA	x							0
Beaver Wetland Complex	CEGL005082	G4G5/SNR		x	x	x	x			0
Successional River Birch - Red Maple Floodplain Forest	CEGL006976	GNR/SNR			x					0
Successional Tuliptree Floodplain Forest	CEGL007330	GNA/SNA			x					0
Disturbed Depressional Wetland	nonstandard							x		0
Disturbed Seepage Swamp	nonstandard							x		0
Disturbed Tidal Hardwood Swamp	nonstandard							x		0
Non-Riverine Saturated Forest - pine subtype	nonstandard					x				0
Successional Shrub Swamp	nonstandard					x				0
Cultural Meadow	CEGL006107	GNA/SNA	x	x	x	x	x	x	x	0
Forested Earthworks	nonstandard					x	x			0
Grazed Woodlot	nonstandard			x						0
Open Earthworks	nonstandard					x	x			0
Semipermanent Impoundment	nonstandard				x		x	x	x	0

Appendix E. Definitions of global and subnational (state) conservation ranks.

NatureServe and the Network of Natural Heritage Programs and Conservation Data Centers work together to assign conservation status ranks to elements of biodiversity (plants, animals, and ecological communities). These ranks have been developed using range-wide data collected by the Natural Heritage Network for nearly three decades and are critical in setting conservation priorities. Community types are ranked on a global (G), national (N), and subnational (S) scale of 1 to 5, with 1 indicating critical imperilment due to rarity, endemism, and/or threats, and 5 indicating little or no risk of extirpation or elimination.

The primary ranking factors used in assessing the appropriate conservation status rank for an ecological community element are: (1) the total number of occurrences, and (2) the total area (acreage) of the element. Secondary ranking factors, such as the geographic range over which the element occurs, the threats to the occurrences, and the viability of the occurrences, also affect the rank.

Additional factors that have been used in arriving at an assessment of a community's range-wide (global) rank include the geographic range over which the type occurs, the long term decline of the type across this range, the degree of site specificity exhibited by the type, and the rarity across the range based on state ranks assigned by state Natural Heritage Programs.

To learn more about Natural Heritage Methodology, go to
http://www.natureserve.org/prodServices/heritagemethodology.jsp.

Global Rank Codes and Definitions

Global ranks (i.e. range-wide conservation status ranks) are assigned at NatureServe's Headquarters or by a designated lead office in the Heritage/Conservation Data Center Network.

GX - Extirpated - Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

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).

G1 - Critically Imperiled - Critically imperiled globally. Generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G2 - Imperiled - Imperiled globally. Generally 6–20 occurrences and/or few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G3 - Vulnerable - 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 - Apparently Secure - Uncommon but not rare. Apparently secure, but with cause for long-term concern. May be quite rare in parts of its range, especially at the periphery; apparently not vulnerable in most of its range

G5 - Secure - 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.

GNA - Rank not applicable - Common cultural, ruderal, planted, modified, managed, invasive, and/or non-natural type that is not a suitable target for conservation activities.

GNR - Not Yet Ranked - Status has not yet been assessed.

GU - Unrankable - Status cannot be determined at this time.

G#G# - Rank Range - The actual rank of the element is within the range specified by the numbers; however, the exact status of the rarity of the element is uncertain. For example, G2G3 indicates that the rank may be either G2 or G3.

State Rank Codes and Definitions

State ranks are assigned by the Virginia Division of Natural Heritage and apply to an element only as it exists in each state, regardless of its range-wide status.

SX - Extirpated - Presumed extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

SH - Historical - Possibly extirpated (Historical). Historically known from the state, but not verified for an extended period, usually >15 years; this rank is used primarily when inventory has been attempted recently.

S1 - Critically Imperiled - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state; generally with 5 or fewer occurrences state-wide, and/or covering less than 50 ha (124 ac) in aggregate; or covering a larger area but highly threatened with destruction or modification.

S2 - Imperiled - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Generally with 6–20 occurrences state-wide, and/or covering less than 250 ha (618 ac) in aggregate; or covering a larger area but threatened with destruction or modification.

S3 - Vulnerable - Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Generally with 21–100 occurrences state-wide; or with a larger number of occurrences subject to relatively high levels of threat; may be of relatively frequent occurrence in specific localities or geographic parts of the state.

S4 - Apparently Secure - Uncommon but not rare, and usually widespread in the state. Some cause for long-term concern due to declines or other factors.

S5 - Secure - Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.

SNA - Rank not applicable - Common cultural, ruderal, planted, modified, managed, invasive, and/or non-natural type that is not a suitable target for conservation activities.

SNR - Not Ranked - Status has not yet been assessed. As the state vegetation classifications are further revised by additional information, the SNR will be changed to a numeric rank based on available data.

SU - Unrankable - Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

S#S# - Rank Range - The actual rank of the element is within the range specified by the numbers; however, the exact status of the rarity of the element is uncertain. For example, S1S3 indicates that the rank may be either S1, S2, or S3.

Global and State Rank Qualifier Codes and Definitions

? - Inexact or Uncertain - 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.

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.

Appendix F. Environmental variable averages for associations derived from the analysis of regional quantitative plot data.

Mean values for selected continuous and ordinal environmental variables were calculated for the 35 associations occurring in seven national parks in Virginia that were derived from the analysis of quantitative plot data. Calculations were performed with raw (untransformed) values by taking the average across all plots representing a given association. Environmental variables were only summarized if at least half the plots in a given association contained data; otherwise the table cells are shaded. Mean aspect was calculated as the average position along an arc defined by the range of aspect values. Topographic variables and percentage substrate are presented in a separate table from soil chemistry variables.

Column headings are as follows:

Topographic variables
    Aspect
    Slope Inclination (see Table 4)
    Topographic Position (see Table 4)
    TRMI = Topographic Relative Moisture Index

Percentage substrate
    %Bedrock = percentage cover by bedrock in plot
    %Large Rocks = percentage cover by boulders and stones (rocks > 10 cm) in plot
    %Small Rocks = percentage cover by gravel and cobble (rocks 0.2–10 cm) in plot
    %Min. Soil = percentage cover by bare sand or mineral soil in plot
    %Litter&Duff = percentage cover by leaf litter and duff in plot
    %Wood = percentage cover by dead wood in plot
    %Water = percentage cover by water in plot
    %NonVasc = percentage cover by nonvascular plants in plot

Soil chemistry variables are as defined in Table 5.

Associations present in Richmond National Battlefield Park are listed in bold font.

Table F1. Environmental variable averages by association - topographic variables and percentage substrate.

	USNVC code	Aspect	Slope Inclination	Topographic Position	TRMI	% Bedrock	% Large Rocks	% Small Rocks	% Min. Soil	% Litter& Duff	% Wood	% Water	% NonVasc
Coastal Plain Mixed Oak / Heath Forest	**CEGL006269**	**flat to SW**	**gentle to moderate**	**lower to middle slope**	**26.7**	**0**	**0**	**0**	**6**	**91**	**3**	**0**	**1**
Piedmont / Low Elevation Mixed Oak / Heath Forest	CEGL008521	S	gentle	upper slope	24.6	0	0	1	1	94	4	0	0
Coastal Plain Loblolly Pine - Oak Forest	CEGL004766	flat	level to gentle	plain/level/bottom - lower slope	31.5	0	0	0	1	96	4	0	1
Eastern White Pine - Hardwood Forest	CEGL008539	NNW	moderate to steep	middle slope	25.9	<1	2	<1	1	95	2	0	3
Mesic Mixed Hardwood Forest	**CEGL006075**	**NNE**	**moderate**	**lower to middle slope**	**29.7**	**0**	**1**	**0**	**2**	**94**	**3**	**0**	**1**
Piedmont / Coastal Plain Oak - Beech / Heath Forest	CEGL006919	N	steep	middle slope	26.4	0	0	0	2	95	3	0	4
Acidic Oak - Hickory Forest	**CEGL008475**	**WSW**	**moderate**	**middle slope**	**25.5**	**0**	**2**	**1**	**3**	**91**	**3**	**0**	**3**
Basic Oak - Hickory Forest	CEGL007232	S	gentle to moderate	lower to middle slope	26.5	0	3	0	7	87	3	0	1
Inner Piedmont / Lower Blue Ridge Basic Mesic Forest	CEGL006186	ESE	steep	middle slope	32.6	1	10	0	2	82	5	0	7
Coastal Plain Mesic Calcareous Ravine Forest	CEGL007181	NE	moderate to steep	lower to middle slope	27.2	0	0	0	9	89	2	0	4
Coastal Plain Dry Calcareous Forest	CEGL007748	S	moderate to steep	middle to upper slope	19.4	0	0	0	15	79	5	1	0
Coastal Plain / Piedmont Acidic Seepage Swamp	**CEGL006238**	**flat**	**level to gentle**	**plain/level/bottom**	**38.2**	**0**	**0**	**0**	**3**	**85**	**3**	**9**	**13**
Northern Piedmont / Lower New England Basic Seepage Swamp	CEGL006406	flat	level to gentle	plain/level/bottom - toe slope	37.6	0	2	0	15	68	3	6	1
Coastal Plain Calcareous Seepage Swamp	CEGL006413	flat	level	plain/level/bottom	40.8	1	0	0	5	89	2	4	2
Coastal Plain / Piedmont Small-Stream Floodplain Forest	**CEGL004418**	**flat**	**level**	**plain/level/bottom**	**40.5**	**0**	**0**	**0**	**2**	**93**	**3**	**2**	**1**
Piedmont / Mountain Alluvial Forest	CEGL006492	flat	level	plain/level/bottom	41.2	0	0	0	14	82	4	0	0
Piedmont / Mountain Floodplain Forest	CEGL006217	flat	level to gentle	plain/level/bottom	41.6	0	<1	0	39	58	3	0	<1

	USNVC code	Aspect	Slope Inclination	Topographic Position	TRMI	% Bedrock	% Large Rocks	% Small Rocks	% Min. Soil	% Litter& Duff	% Wood	% Water	% NonVasc
Swamp Forests													
Coastal Plain / Piedmont Floodplain Swamp Forest (Mixed Oak - Red Maple Type)	CEGL006605	flat	level to basin / depression	plain/level/bottom	40.0	0	0	0	7	88	4	1	2
Coastal Plain / Piedmont Floodplain Swamp Forest (Green Ash - Red Maple Type)	CEGL006606	flat	level to basin / depression	plain/level/bottom	40.4	0	0	0	15	72	2	11	1
Nonriverine Forests													
Upland Depression Swamp	CEGL007403	flat	level to basin / depression	various	35.1	1	0	0	1	92	5	2	3
Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type)	CEGL006110	flat	level to basin / depression	various	37.1	0	0	0	4	86	4	6	16
Coastal Plain Depression Wetland (Swamp Tupelo Type)	CEGL006223	flat	level to basin / depression	basin/depression	40.0	0	0	0	1	98	2	0	0
Non-Riverine Saturated Forest	**CEGL004644**	**flat**	**level**	**plain/level/bottom**	**40.0**	**0**	**0**	**0**	**1**	**89**	**7**	**3**	**4**
Tidal Marshes													
Tidal Freshwater Marsh	CEGL004706	flat	level to gentle	plain/level/bottom	40.0	0	0	0	62	19	0	19	0
Tidal Mesohaline and Polyhaline Marsh (Low Salt Marsh)	CEGL006586	flat	level	plain/level/bottom	40.0	0	0	0	14	17	0	69	0
Tidal Mesohaline and Polyhaline Marsh (Transitional Marsh)	CEGL006418	flat	level to gentle	plain/level/bottom	40.0	0	0	0	43	28	0	28	0
Tidal Oligohaline Marsh (Common Reed Tidal Marsh)	CEGL004187	flat	level	plain/level/bottom	40.0								
Tidal Oligohaline Marsh (Interior Depression Marsh)	CEGL006578	flat	level	plain/level/bottom	40.0	0	0	0	25	67	0	8	0
Tidal Oligohaline Marsh (Big Cordgrass Type)	CEGL004195	flat	level	plain/level/bottom	40.0								
Tidal Oligohaline Marsh (Mixed Forbs Type)	CEGL006181	flat	level	plain/level/bottom	40.0	0	0	0	20	53	0	27	0
Tidal Marshes (cont)													
Tidal Oligohaline Marsh (Saltmeadow Cordgrass - Olney Three-Square Low Interior Marsh Type)	CEGL006612	Flat	level to gentle	plain/level/bottom	40.0	0	0	0	5	71	0	24	0
Tidal Forests and Shrublands													
Salt Scrub	CEGL003921	flat	level	plain/level/bottom	40.0								
Tidal Shrub Swamp (Iva Type)	CEGL006848	flat	level	plain/level/bottom	40.0								
Tidal Shrub Swamp (Wax Myrtle Type)	CEGL004656	flat	level	plain/level/bottom	40.0								
Tidal Bald Cypress Forest/Woodland	CEGL004654	flat	level	plain/level/bottom	40.0	0	0	0	0	9	1	90	0

Table F2. Environmental variable averages by association - soil chemistry variables.

	USNVC code	pH	N	P	S	Ca	Mg	K	Na	B	Fe	Mn	Cu	Zn	Al	CEC	TBS	OM	CaMg Ratio	Fertility
Oak / Heath Forests																				
Coastal Plain Mixed Oak / Heath Forest	**CEGL006269**	**4.2**	**79**	**31**	**31**	**132**	**31**	**28**	**12**	**0.60**	**282**	**10**	**0.41**	**1.1**	**634**	**8.1**	**19.2**	**3.3**	**4.3**	**1.0**
Piedmont / Low Elevation Mixed Oak / Heath Forest	CEGL008521	4.2	90	14	31	135	28	35	12	0.41	295	14	0.57	1.4	764	10.3	12.1	4.6	4.7	1.1
Pine - Oak Forests																				
Coastal Plain Loblolly Pine - Oak Forest	CEGL004766	4.1	90	25	40	165	52	34	11	0.80	324	64	0.59	1.5	697	12.1	13.5	4.1	3.3	1.4
Eastern White Pine - Hardwood Forest	CEGL008539	4.2	95	13	35	205	44	47	12	0.5	297	43	0.6	1.6	852	14.4	10.2	6.1	5.0	1.5
Mesic Acidic Forests																				
Mesic Mixed Hardwood Forest	**CEGL006075**	**4.4**	**92**	**28**	**34**	**303**	**68**	**55**	**14**	**0.46**	**186**	**66**	**0.90**	**2.3**	**776**	**11.4**	**23.3**	**4.6**	**4.9**	**2.3**
Piedmont / Coastal Plain Oak - Beech / Heath Forest	CEGL006919	4.2	88	19	29	155	39	39	12	0.40	279	9	0.53	1.3	746	11.2	15.2	4.2	5.6	1.2
Oak - Hickory Forests																				
Acidic Oak - Hickory Forest	**CEGL008475**	**4.6**	**99**	**18**	**33**	**320**	**80**	**60**	**13**	**0.39**	**204**	**80**	**1.69**	**2.4**	**908**	**10.1**	**27.1**	**5.6**	**4.3**	**2.5**
Basic Oak - Hickory Forest	CEGL007232	5.3	106	32	29	1508	241	108	12	0.62	175	215	2.03	3.0	740	14.3	63.5	6.4	7.3	9.9
Basic Mesic and Calcareous Forests																				
Inner Piedmont / Lower Blue Ridge Basic Mesic Forest	CEGL006186	5.5	110	29	30	1712	281	139	11	0.72	149	172	2.24	4.0	774	15.2	69.9	8.9	6.0	11.2
Coastal Plain Mesic Calcareous Ravine Forest	CEGL007181	5.7	93	34	34	2246	96	75	18	0.76	131	78	0.86	2.9	538	14.7	81.5	4.5	24.1	12.3
Coastal Plain Dry Calcareous Forest	CEGL007748	6.5	100	40	39	4707	116	113	31	1.10	158	67	1.10	3.7	403	27.4	86.3	5.9	40.7	24.9
Seepage Wetlands																				
Coastal Plain / Piedmont Acidic Seepage Swamp	**CEGL006238**	**4.6**	**96**	**19**	**45**	**318**	**90**	**38**	**30**	**0.52**	**343**	**13**	**0.95**	**3.6**	**470**	**34.1**	**34.0**	**8.0**	**4.0**	**2.5**
Northern Piedmont / Lower New England Basic Seepage Swamp	CEGL006406	5.2	110	24	88	1071	195	58	33	0.74	417	64	2.50	7.1	425	13.0	56.5	7.3	6.4	7.3
Coastal Plain Calcareous Seepage Swamp	CEGL006413	6.1	114	29	104	3327	93	56	52	1.23	554	31	1.29	9.82	222	21.4	83.5	15	46.6	17.8
Alluvial Forests																				
Coastal Plain / Piedmont Small-Stream Floodplain Forest	**CEGL004418**	**4.5**	**88**	**20**	**35**	**603**	**119**	**62**	**25**	**0.54**	**264**	**82**	**1.51**	**3.7**	**585**	**10.9**	**42.4**	**4.4**	**5.5**	**4.1**
Piedmont / Mountain Alluvial Forest	CEGL006492	5.3	94	32	23	1127	180	62	25	0.67	204	119	3.02	5.8	520	11.1	69.0	4.8	6.3	7.4
Piedmont / Mountain Floodplain Forest	CEGL006217	6.7	79	44	42	2570	169	63	19	0.8	242	106	3.0	14.4	309	14.9	97.8	3.8	16.8	14.2
Swamp Forests																				
Coastal Plain / Piedmont Floodplain Swamp Forest (Mixed Oak - Red Maple Type)	CEGL006605	4.5	91	27	47	388	82	53	18	0.57	381	67	1.57	4.5	668	11.6	27.3	4.7	5.5	2.8
Coastal Plain / Piedmont Floodplain Swamp Forest (Green Ash - Red Maple Type)	CEGL006606	5.2	101	28	99	1471	155	55	44	0.58	343	70	1.87	7.2	447	14.1	62.8	6.6	11.9	9.0

	USNVC code	pH	N	P	S	Ca	Mg	K	Na	B	Fe	Mn	Cu	Zn	Al	CEC	TBS	OM	CaMg Ratio	Fertility
Nonriverine Forests																				
Upland Depression Swamp	CEGL007403	4.3	110	47	61	501	130	55	39	0.52	395	23	1.29	4.3	1052	16.0	29.2	7.3	3.8	3.0
Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type)	CEGL006110	4.1	109	48	56	193	68	53	17	0.53	297	30	0.90	2.4	890	17.3	10.9	7.0	3.1	1.7
Coastal Plain Depression Wetland (Swamp Tupelo Type)	CEGL006223																			
Non-Riverine Saturated Forest	**CEGL004644**	**4.3**	**99**	**32**	**53**	**288**	**62**	**43**	**26**	**0.72**	**333**	**6**	**0.60**	**2.0**	**614**	**14.3**	**17.8**	**4.3**	**6.1**	**2.3**
Tidal Freshwater Marsh	CEGL004706																			
Tidal Mesohaline and Polyhaline Marsh (Low Salt Marsh)	CEGL006586																			
Tidal Mesohaline and Polyhaline Marsh (Transitional Marsh)	CEGL006418																			
Tidal Oligohaline Marsh (Common Reed Tidal Marsh)	CEGL004187																			
Tidal Oligohaline Marsh (Interior Depression Marsh)	CEGL006578	4.5	126	33	1189	986	990	249	1504	1.25	507	100	2.41	29.6	523	31.2	63.3	15.9	1.4	20.4
Tidal Oligohaline Marsh (Big Cordgrass Type)	CEGL004195																			
Tidal Oligohaline Marsh (Mixed Forbs Type)	CEGL006181	4.6	128	27	906	937	930	206	1845	1.3	560	162	1.29	14.9	487	32.5	65.3	20.7	1.1	21.0
Tidal Oligohaline Marsh (Saltmeadow Cordgrass - Olney Three-Square Low Interior Marsh Type)	CEGL006612																			
Salt Scrub	CEGL003921																			
Tidal Shrub Swamp (Iva Type)	CEGL006848																			
Tidal Shrub Swamp (Wax Myrtle Type)	CEGL004656																			
Tidal Bald Cypress Forest/Woodland	CEGL004654																			

Appendix G. Cluster dendrograms, ordination scatterplots, and joint plots resulting from quantitative analysis of regional plot data for six major vegetation groups present at Richmond National Battlefield Park.

Major vegetation groups are presented as follows:

Oak / Heath Forests (Figures G1–G2)
Mesic Acidic Forests (Figures G3–G5)
Oak - Hickory Forests (Figures G6–G8)
Seepage Wetlands (Figures G9–G11)
Alluvial Forests (Figures G12–G14)
Nonriverine Forests (Figures G15–G17)
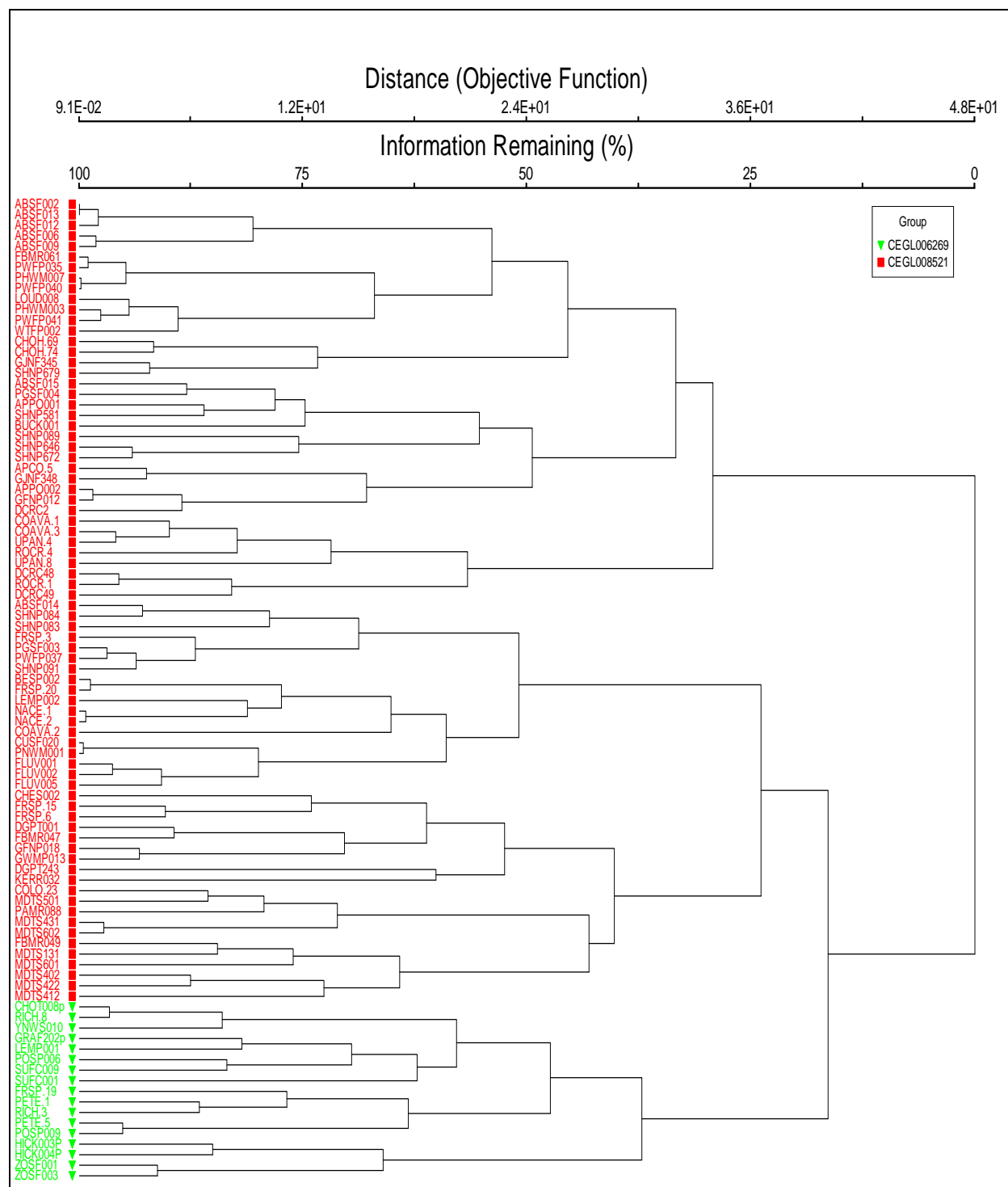
Figure G1. Dendrogram resulting from cluster analysis of species coverage data from 93 oak / heath forest plots. Plot membership in two oak / heath forest associations is shown. CEGL006269 = Coastal Plain Mixed Oak / Heath Forest; CEGL008521 = Piedmont Low Elevation Mixed Oak / Heath Forest. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979).
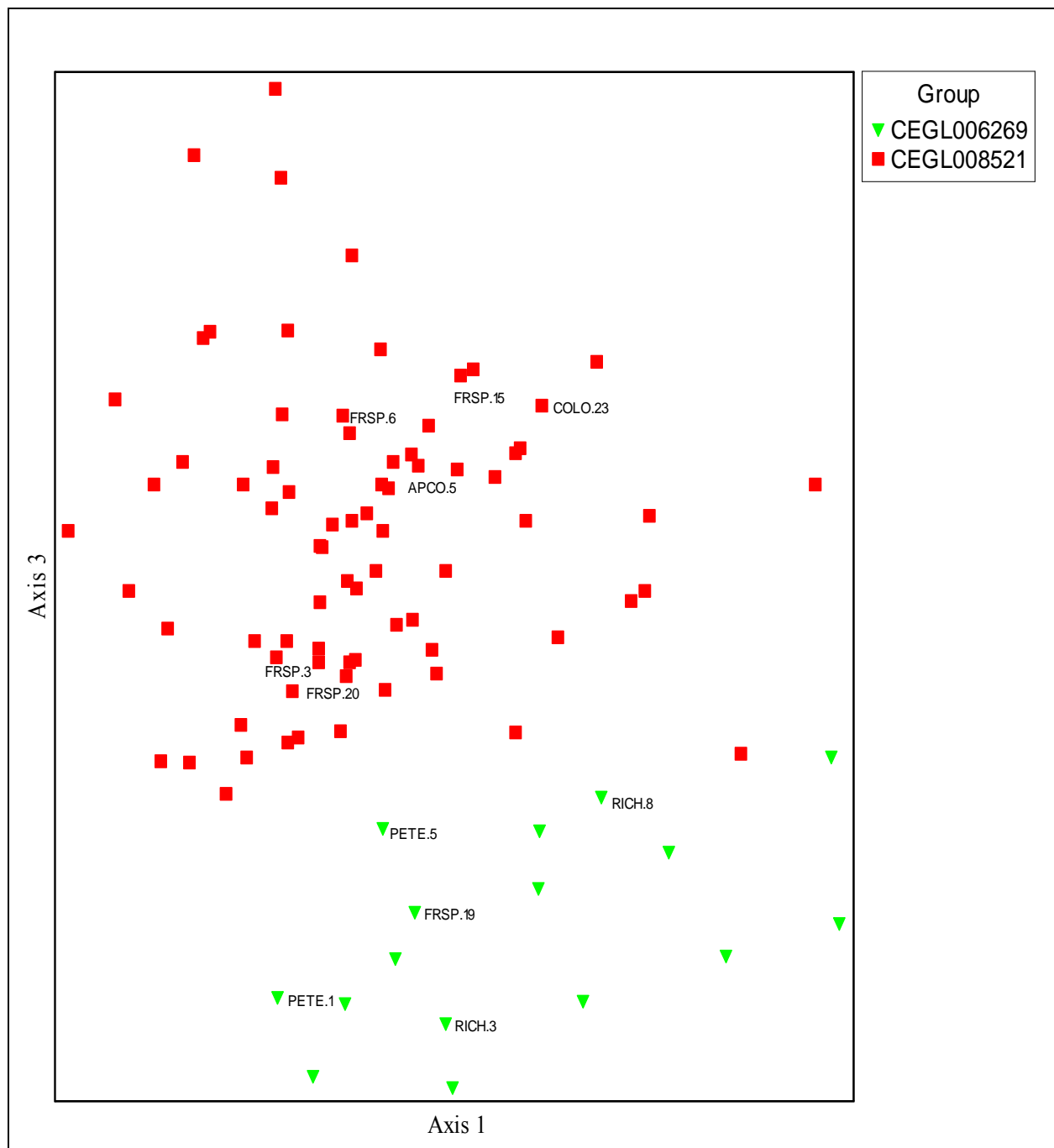
Figure G2. Scatterplot diagram for three-dimensional NMDS ordination of 92 oak/heath forest plots, showing Axis 1 and 3. Plot membership in two oak/heath forest associations is based on cluster analysis. CEGL006269 = Coastal Plain Mixed Oak / Heath Forest; CEGL008521 = Piedmont Low Elevation Mixed Oak / Heath Forest. Plots from the seven Virginia national parks are labeled to the right of or below the symbol. One plot was determined to be an outlier and eliminated from the dataset prior to ordination.
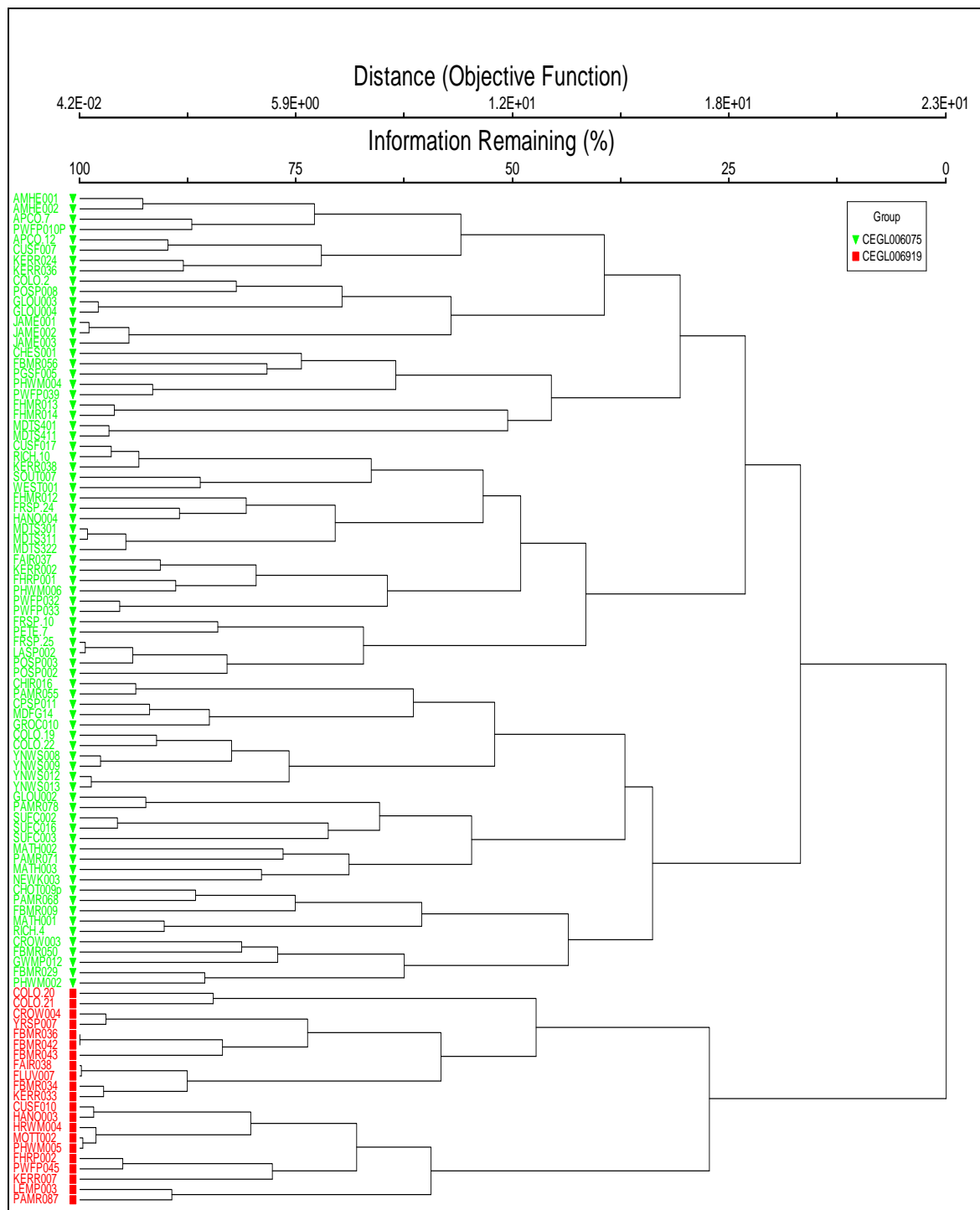
Figure G3. Dendrogram resulting from cluster analysis of species coverage data from 98 mesic acidic forest plots. Plot membership in two mesic acidic forest associations is shown. CEGL006075 = Mesic Mixed Hardwood Forest; CEGL006919 = Piedmont / Coastal Plain Oak - Beech / Heath Forest. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979). 196 plots of this type were originally identified in the regional analysis. A reduced dataset is used here for graphical depiction.
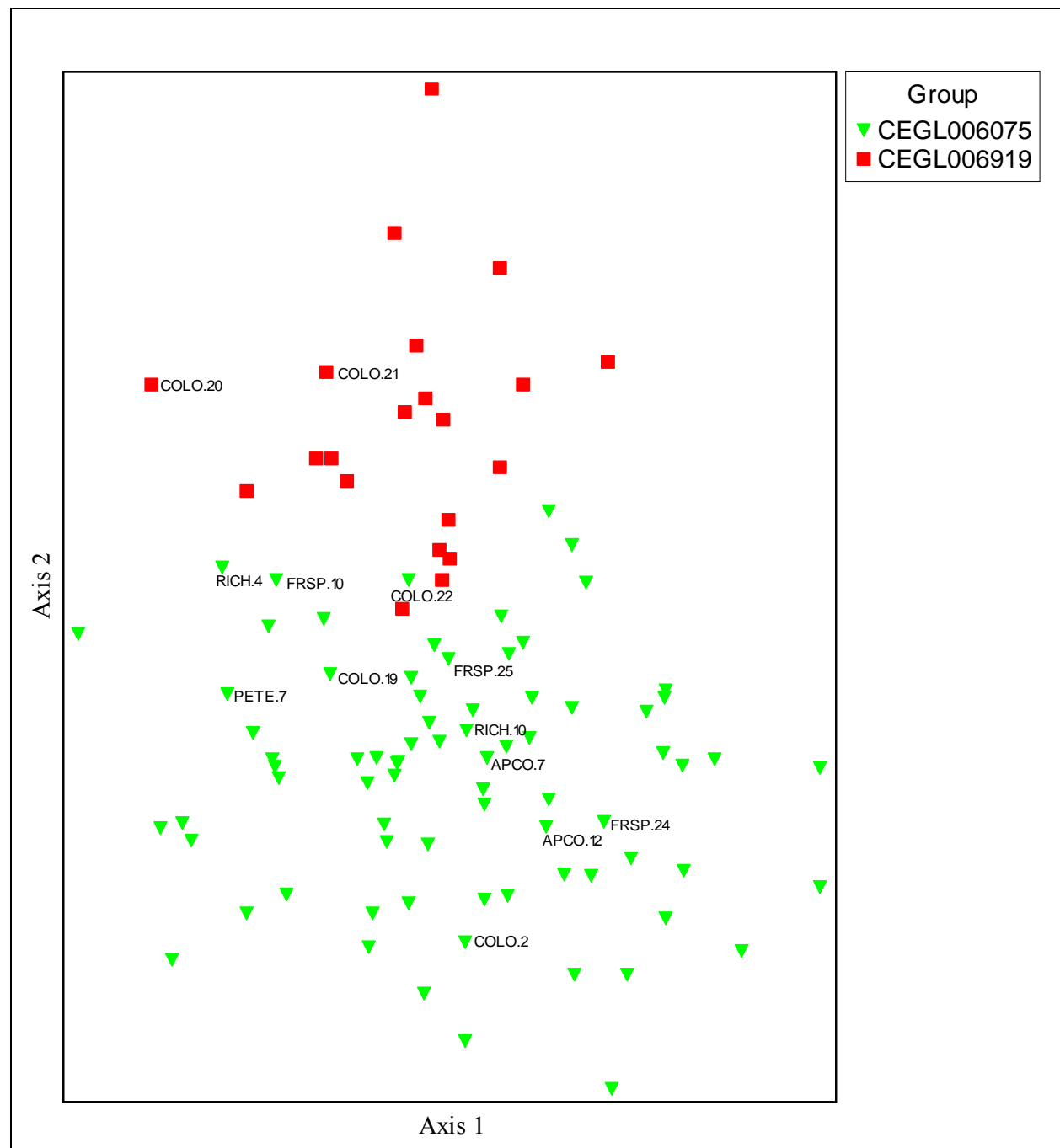
Figure G4. Scatterplot diagram for three-dimensional NMDS ordination of 98 mesic acidic forest plots, showing Axis 1 and 2. Plot membership in two acidic mesic forest associations is based on cluster analysis CEGL006075 = Mesic Mixed Hardwood Forest; CEGL006919 = Piedmont / Coastal Plain Oak - Beech / Heath Forest. Plots from the seven Virginia national parks are labeled to the right of or below the symbol.
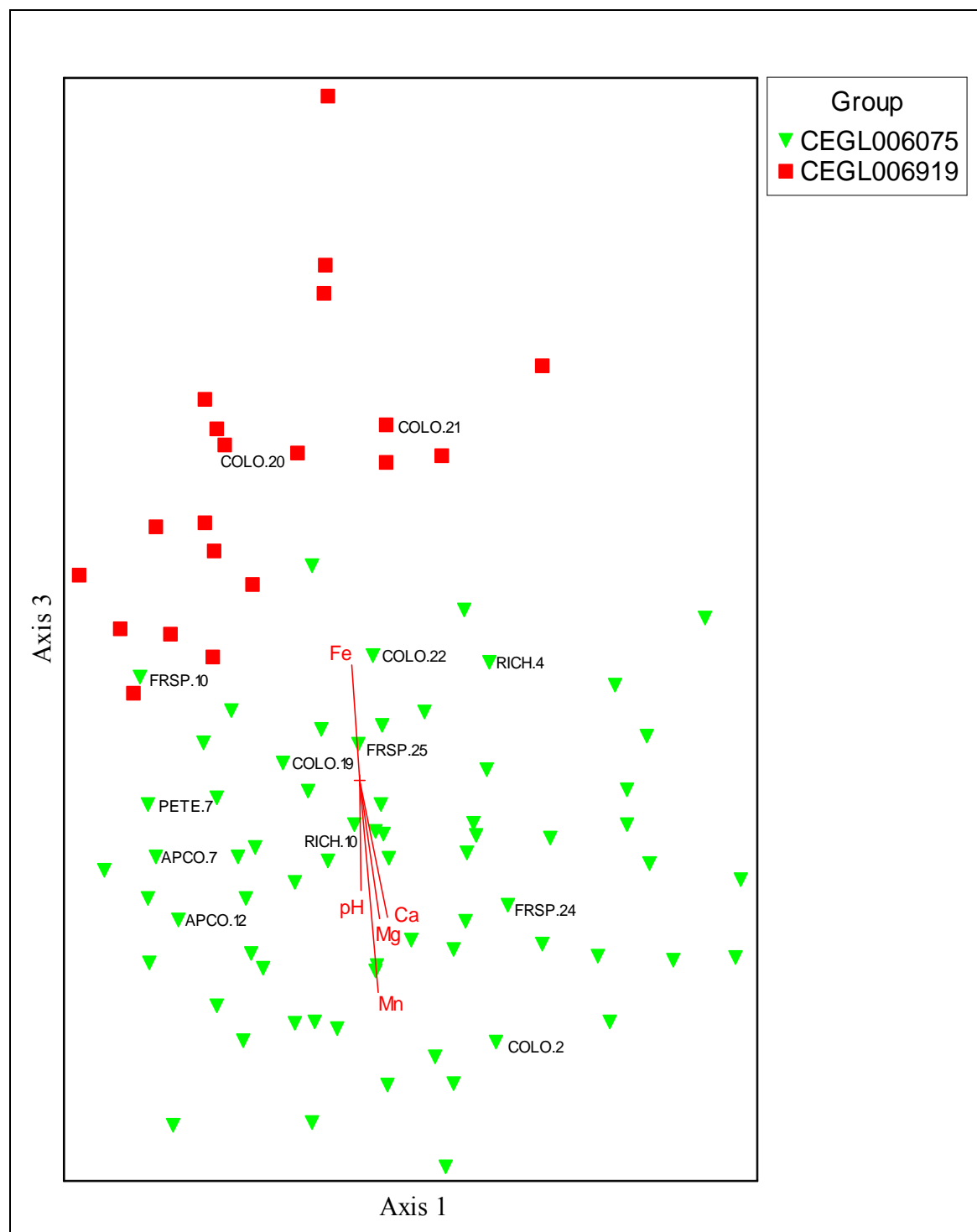
Figure G5. Joint plot showing significant correlations (r^2 = 0.20) of 19 soil variables with ordination scores for 87 mesic acidic forest plots on Axis 1 and Axis 3 of the NMDS ordination. The angles and lengths of the radiating lines indicate the direction and strength of the relationship. Environmental variables used in joint plots are listed in Table 5. Only the 87 plots in this group with complete soil chemistry data were included in the ordination. Plots from the seven Virginia national parks are labeled to the right of or below the symbol.
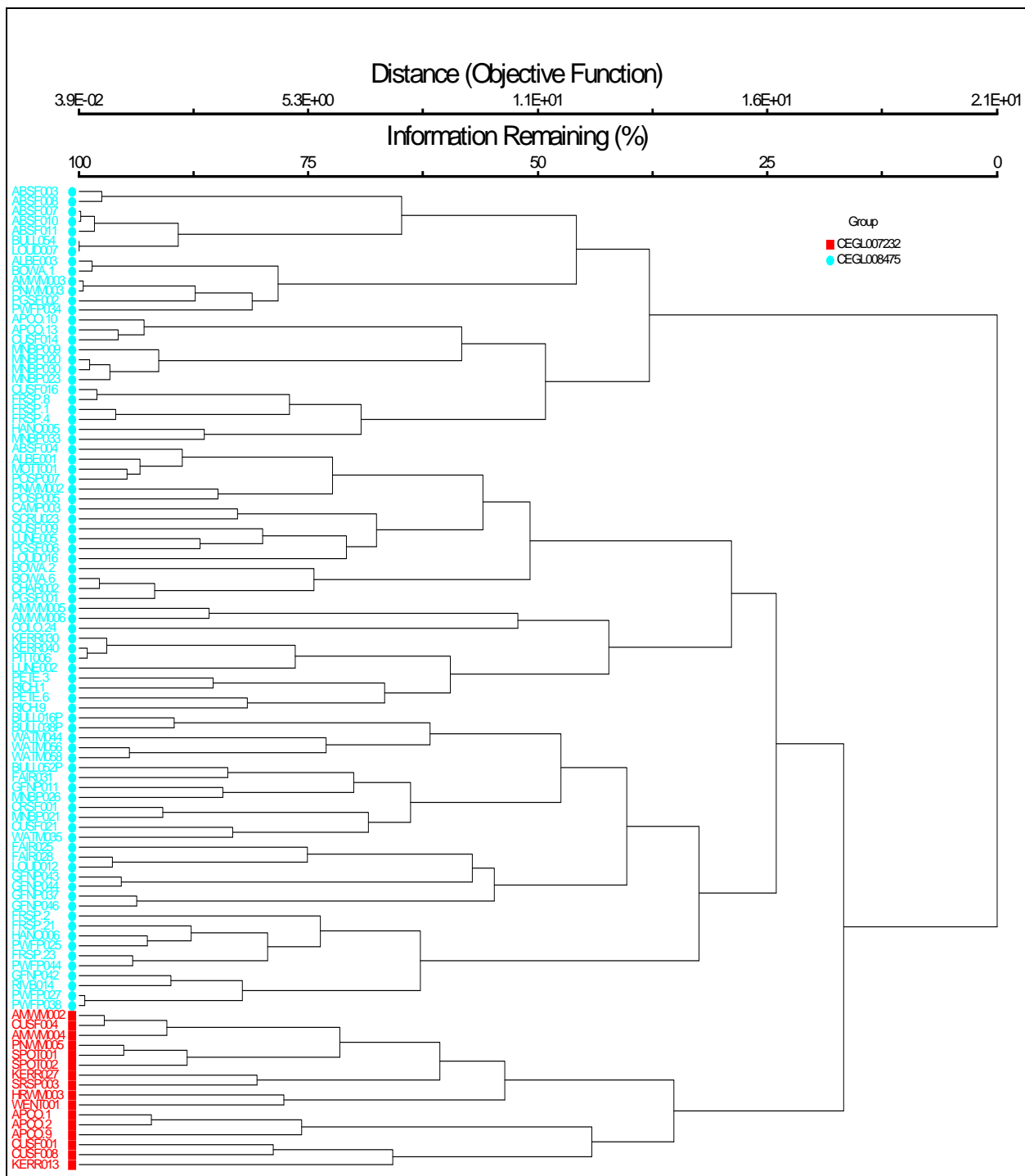
Figure G6. Dendrogram resulting from cluster analysis of species coverage data from 99 oak-hickory forest plots. Plot membership in two oak-hickory forest associations is shown. CEGL007232 = Basic Oak - Hickory Forest; CEGL008475 = Acidic Oak - Hickory Forest. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979). 137 plots of this type were originally identified in the regional analysis. A reduced dataset is used here for graphical depiction.
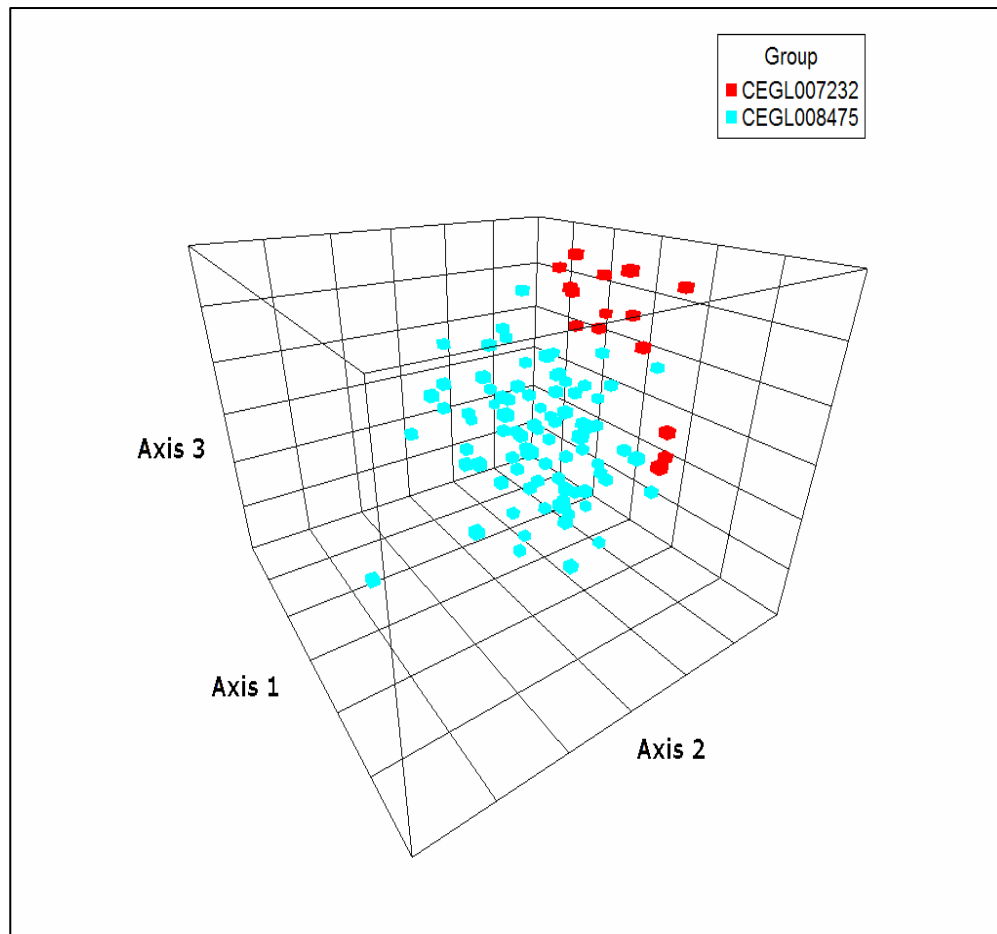
Figure G7. Scatterplot diagram for three-dimensional NMDS ordination of 98 oak-hickory forest plots. Plot membership in two oak-hickory forest associations is based on cluster analysis. CEGL007232 = Basic Oak - Hickory Forest; CEGL008475= Acidic Oak - Hickory Forest. One plot was determined to be an outlier and eliminated from the dataset prior to ordination.
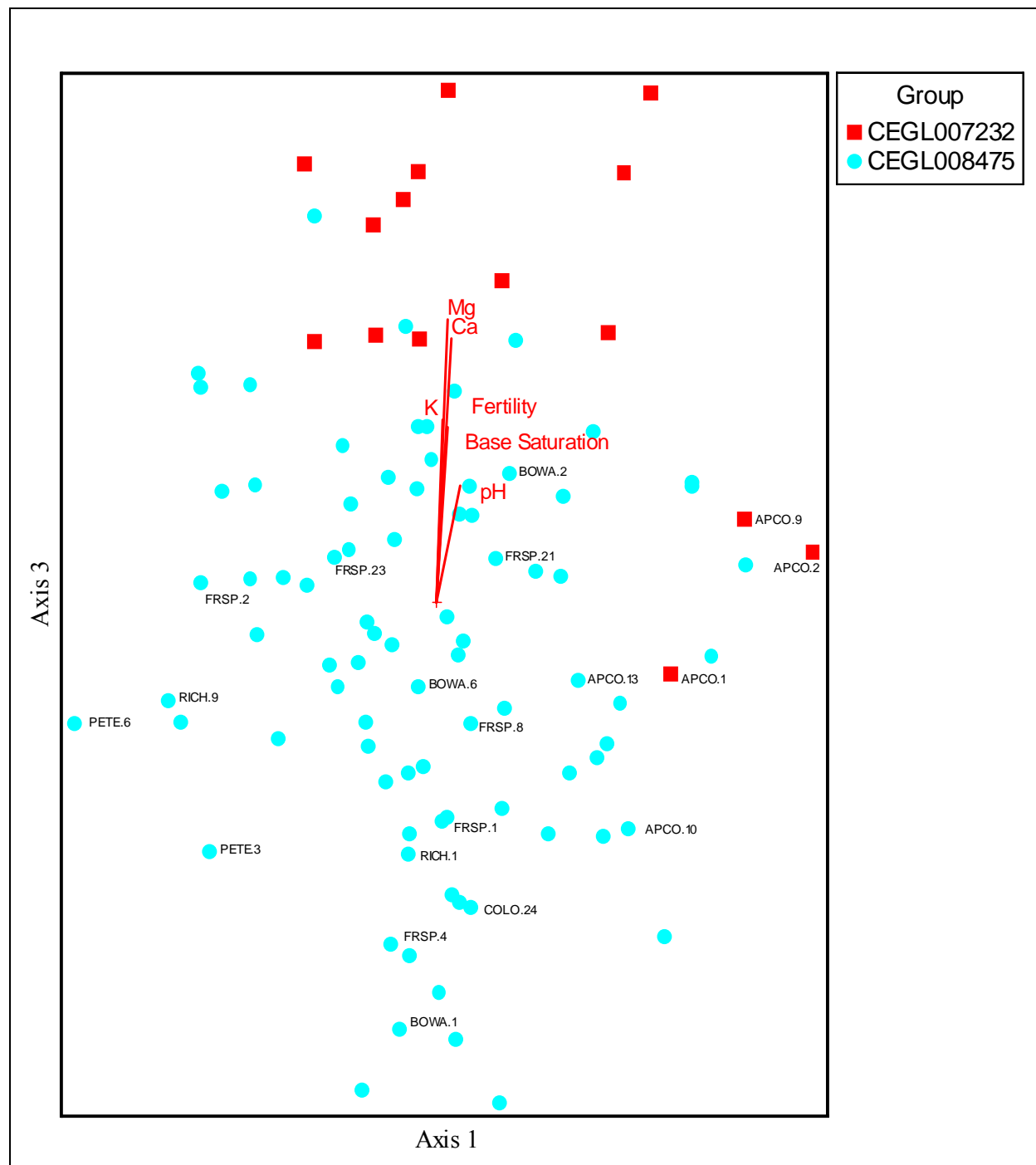
Figure G8. Joint plot showing significant correlations ($r^2 = 0.20$) of environmental variables with ordination scores for 98 oak-hickory forest plots on Axis 1 and Axis 3 of the NMDS ordination. The angles and lengths of the radiating lines indicate the direction and strength of the relationship. Environmental variables used in joint plots are listed in Table 5. Plots from the seven Virginia national parks are labeled to the right of or below the symbol.
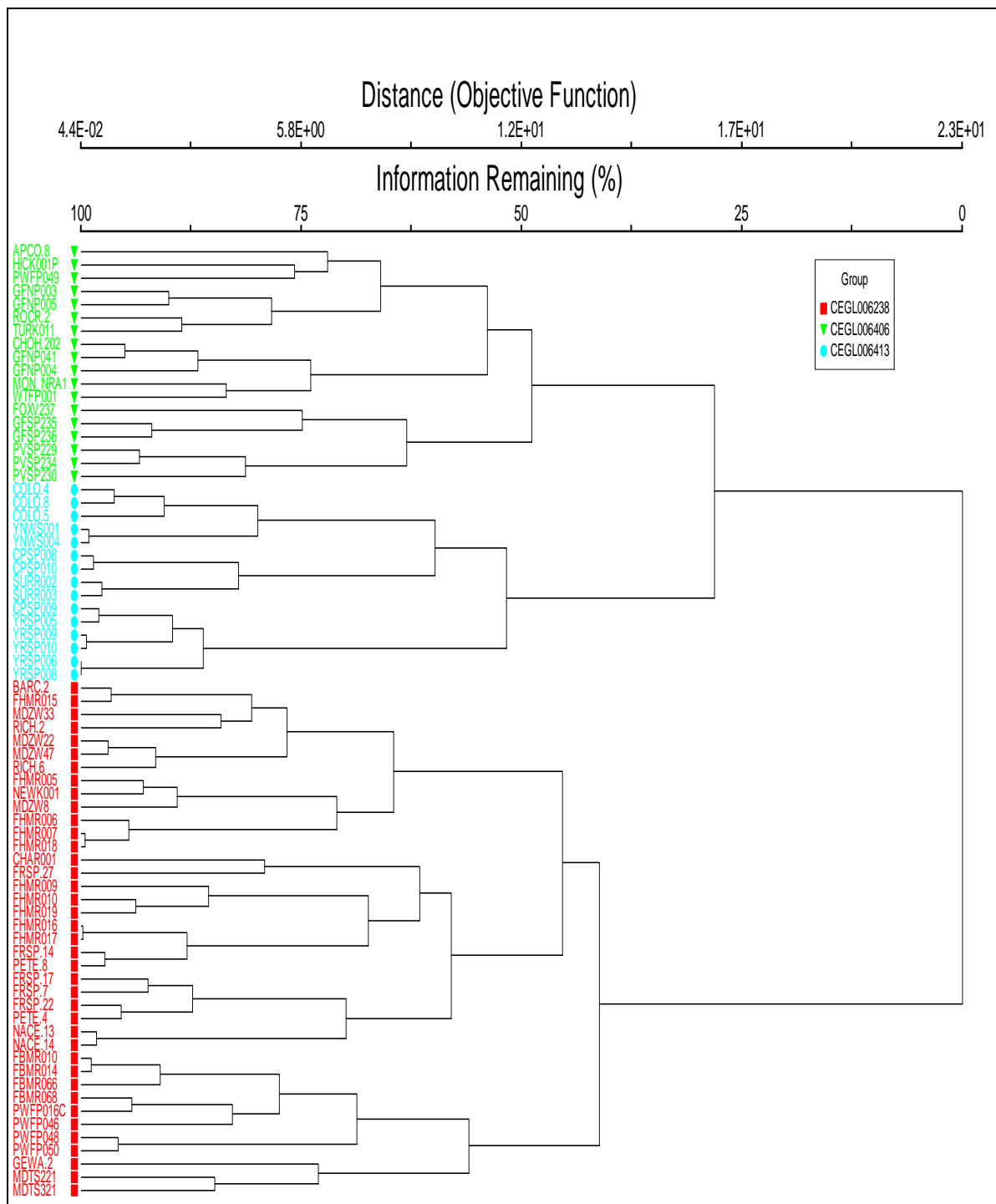
Figure G9. Dendrogram resulting from cluster analysis of species coverage data from 72 seepage wetland plots. Plot membership in three seepage wetland associations is shown. CEGL006238 = Coastal Plain / Piedmont Acidic Seepage Swamp; CEGL006406 = Northern Piedmont / Lower New England Basic Seepage Swamp; CEGL006413 = Coastal Plain Calcareous Seepage Swamp. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979).
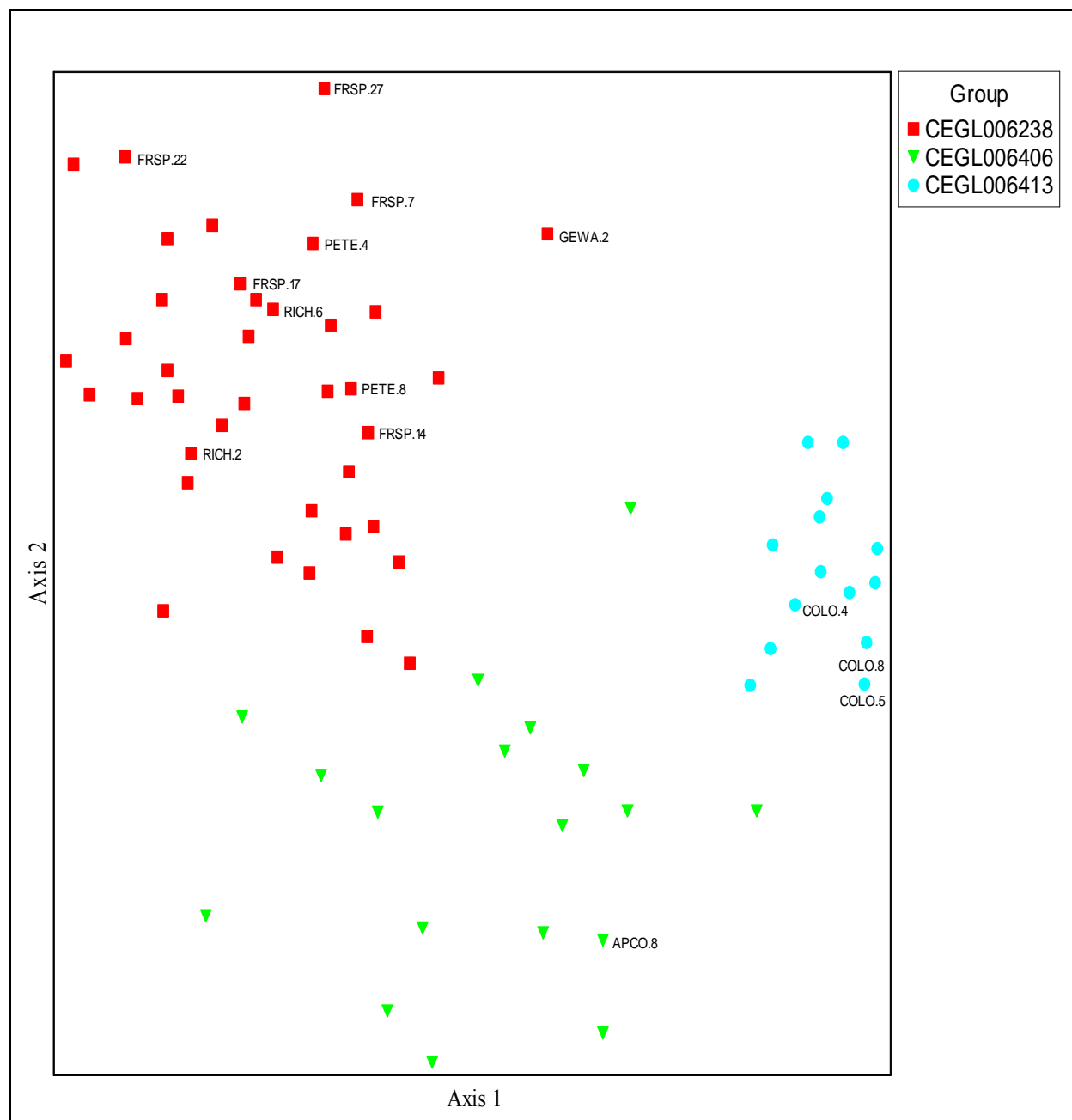
Figure G10. Scatterplot diagram for two-dimensional NMDS ordination of 71 seepage wetland plots. Plot membership in three seepage wetland associations is based on cluster analysis. CEGL006238 = Coastal Plain / Piedmont Acidic Seepage Swamp; CEGL006406 = Northern Piedmont / Lower New England Basic Seepage Swamp; CEGL006413 = Coastal Plain Calcareous Seepage Swamp. Plots from the seven Virginia national parks are labeled to the right of or below the symbol. One plot was determined to be an outlier and was eliminated from the dataset prior to ordination.
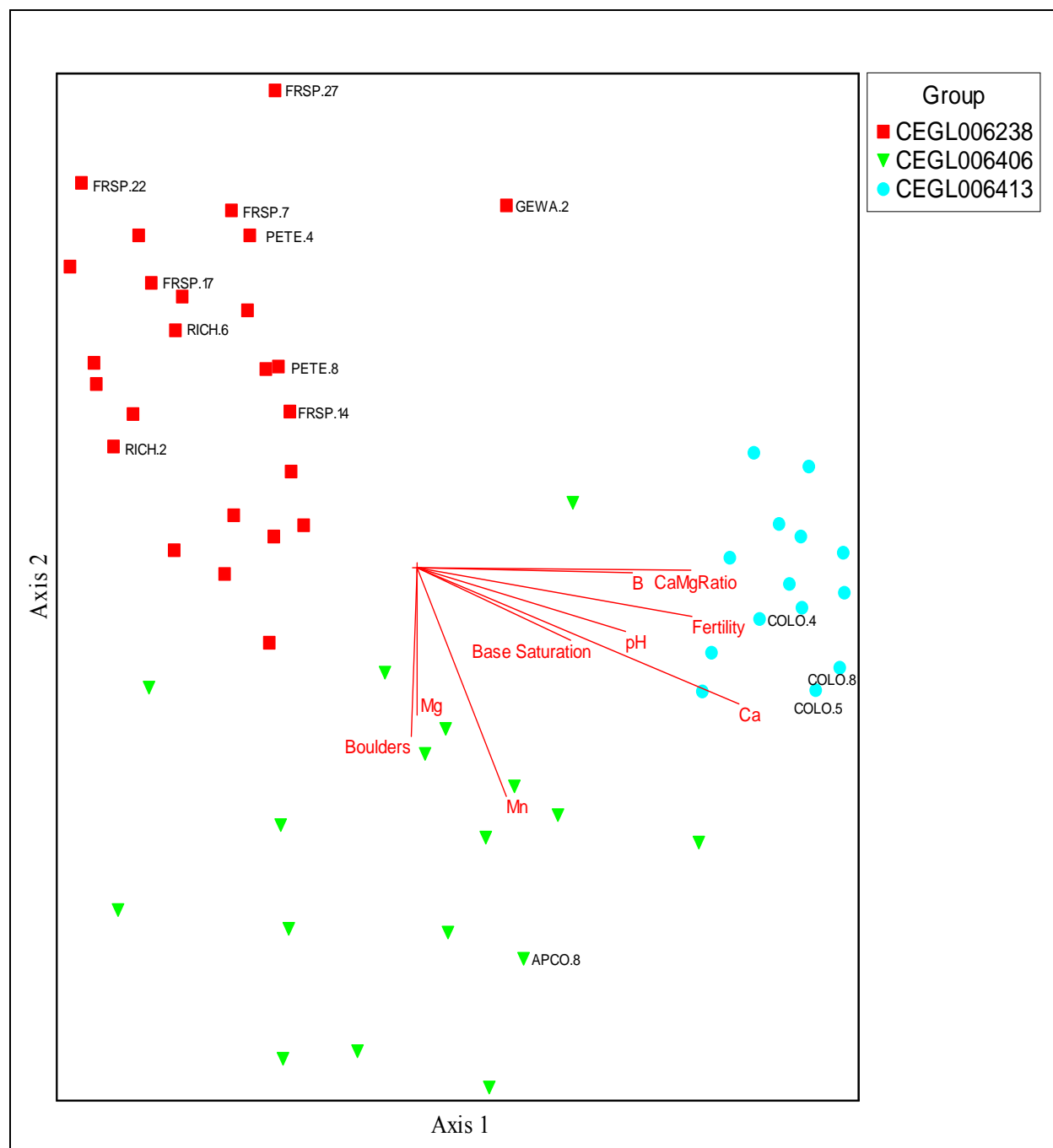
Figure G11. Joint plot showing significant correlations (r2 = 0.290) of environmental variables with ordination scores for 56 seepage wetland plots on Axis 1 and Axis 2 of the NMDS ordination. The angles and lengths of the radiating lines indicate the direction and strength of the relationship. Environmental variables used in joint plots are listed in Table 5. Plots from the seven Virginia national parks are labeled to the right of or below the symbol. Only the 56 plots in this group with complete environmental data were included in the ordination.
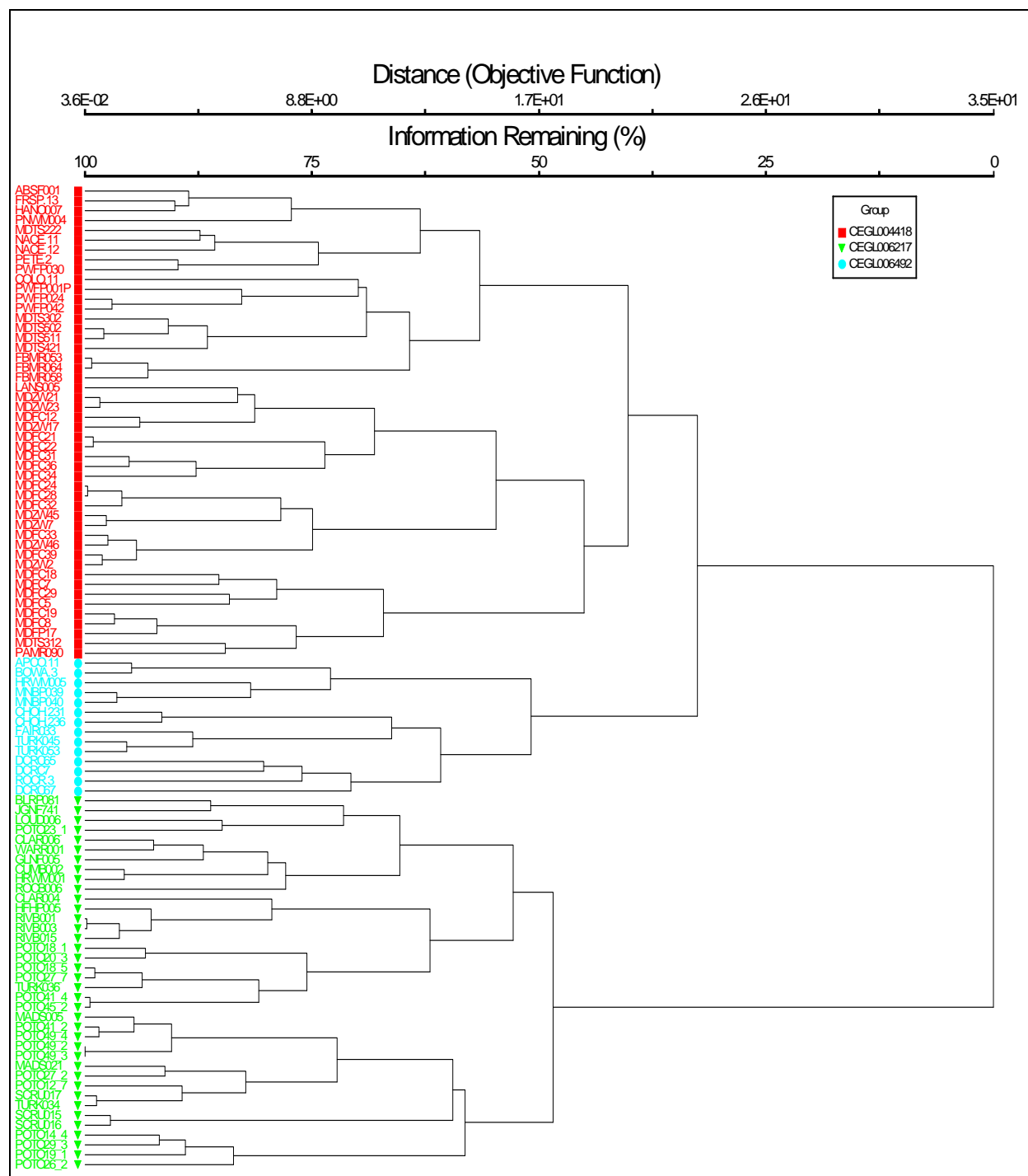
Figure G12. Dendrogram resulting from cluster analysis of species coverage data from 100 alluvial forest plots. Plot membership in three alluvial forest associations is shown. CEGL004418 = Coastal Plain / Piedmont Small-Stream Floodplain Forest; CEGL006217= Piedmont / Mountain Floodplain Forest; CEGL006492= Piedmont / Mountain Alluvial Forest. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979).
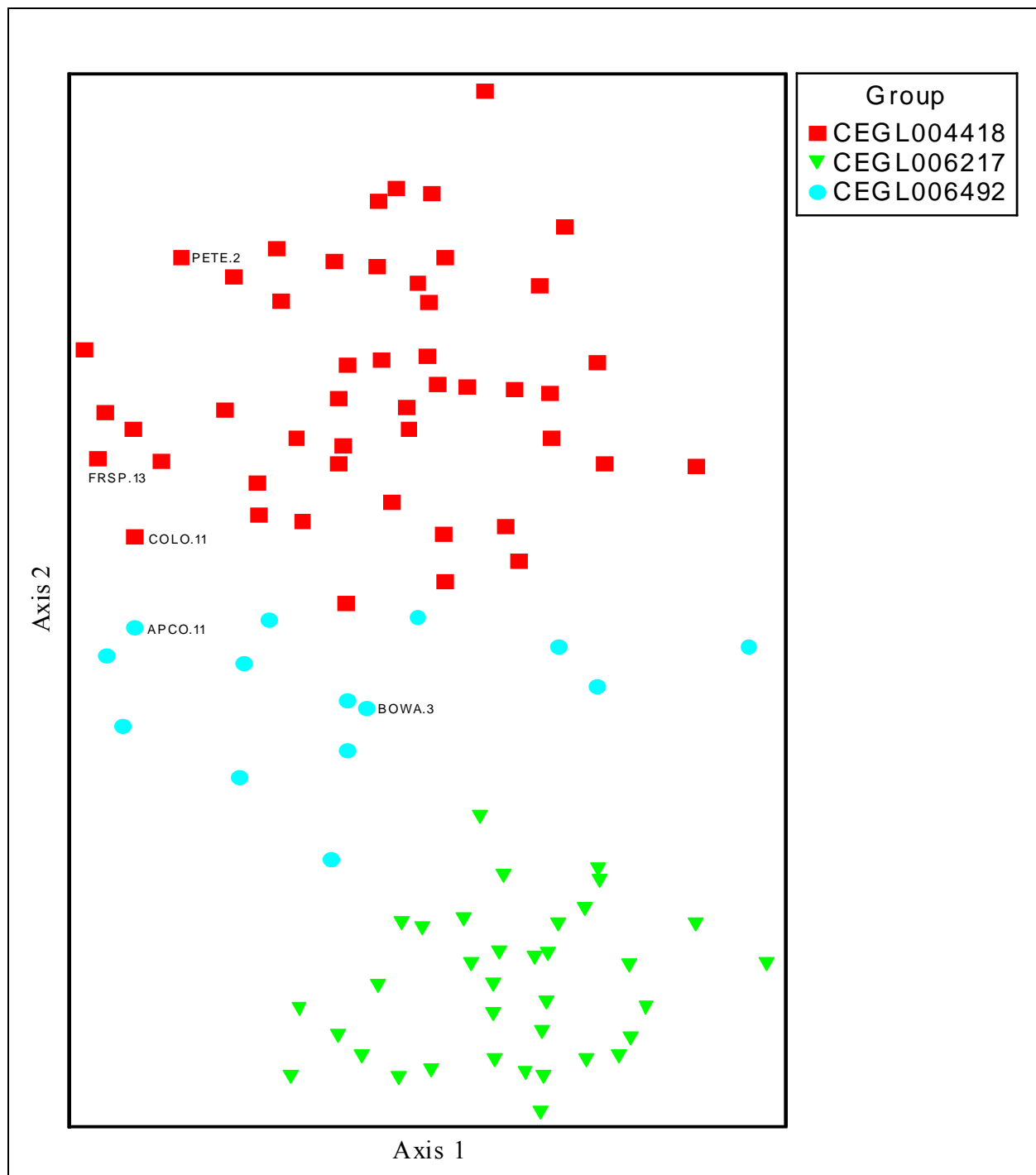
Figure G13. Scatterplot diagram for two-dimensional NMDS ordination of 97 alluvial forest plots. Plot membership in three alluvial forest associations is based on cluster analysis. CEGL004418 = Coastal Plain / Piedmont Small-Stream Floodplain Forest; CEGL006217= Piedmont / Mountain Floodplain Forest; CEGL006492 = Piedmont / Mountain Alluvial Forest. Three plots were determined to be outliers and eliminated from the dataset prior to ordination. Plots from the seven Virginia national parks are labeled to the right of or below the symbol.
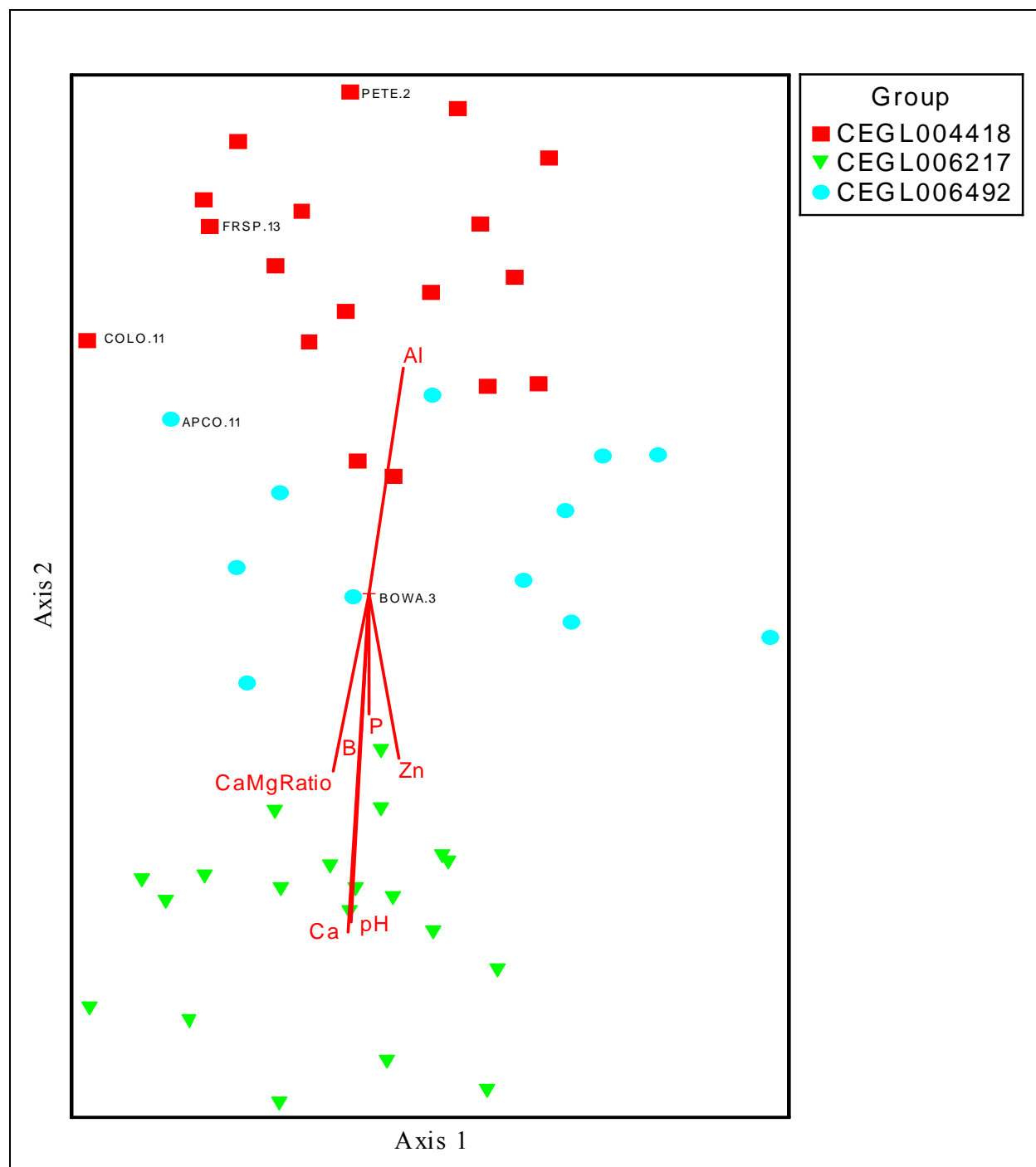
Figure G14. Joint plot showing significant correlations (r2 = 0.20) of environmental variables with ordination scores for 50 alluvial forest plots on Axis 1 and Axis 2 of the NMDS ordination. The angles and lengths of the radiating lines indicate the direction and strength of the relationship. Environmental variables used in joint plots are listed in Table 5. Plots from the seven Virginia national parks are labeled to the right of the symbol. Only the 50 plots with complete environmental data were included in the ordination.
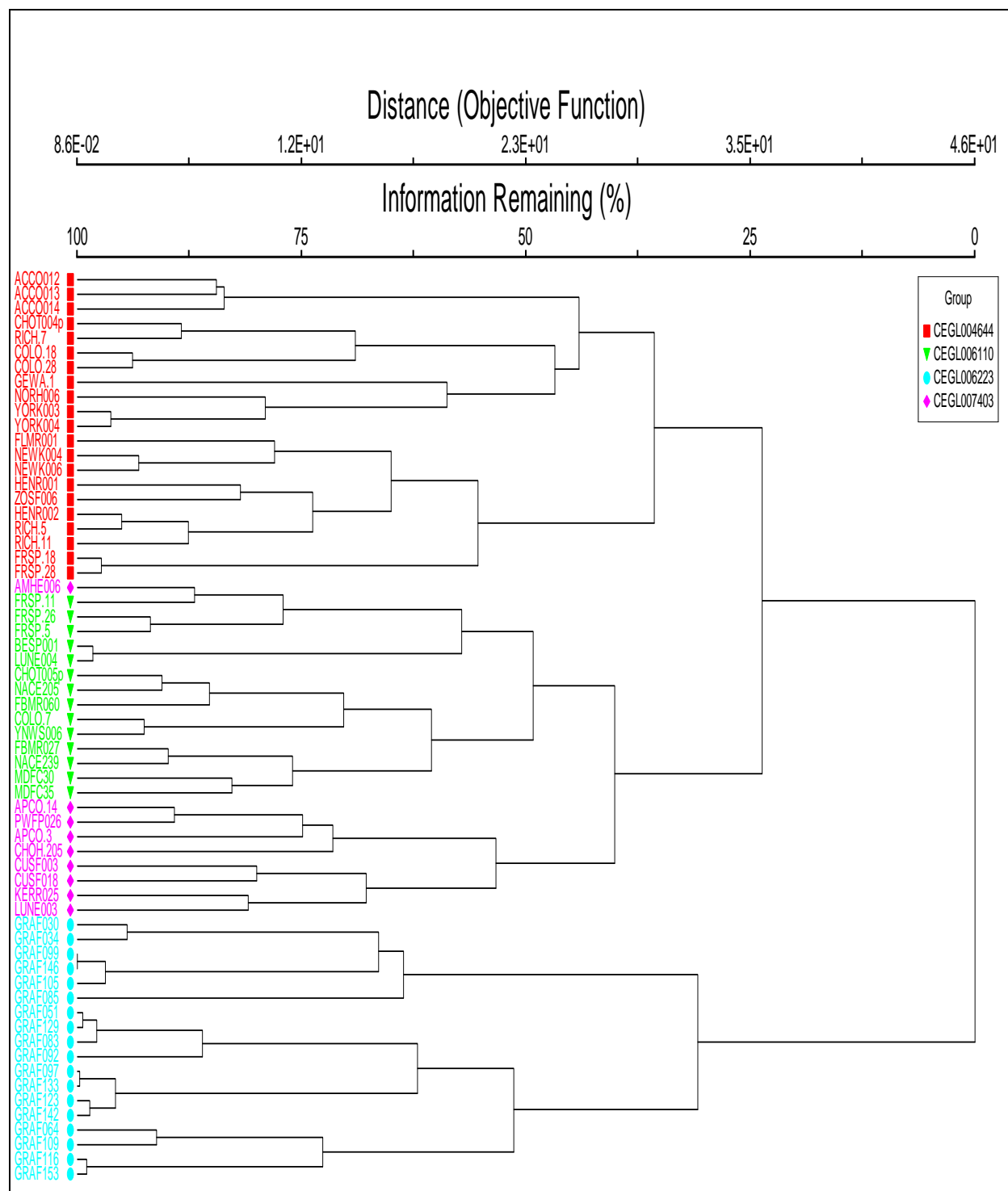
Figure G15. Dendrogram resulting from cluster analysis of species coverage data from 62 nonriverine forest plots. Plot membership in four nonriverine forest associations is shown. CEGL004644 = Non-Riverine Saturated Forest; CEGL006110 = Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type); CEGL006223 = Coastal Plain Depression Wetland (Swamp Tupelo Type); CEGL007403 = Upland Depression Swamp. Distance on the dendrogram scale is Wishart's objective function (Wishart 1979).
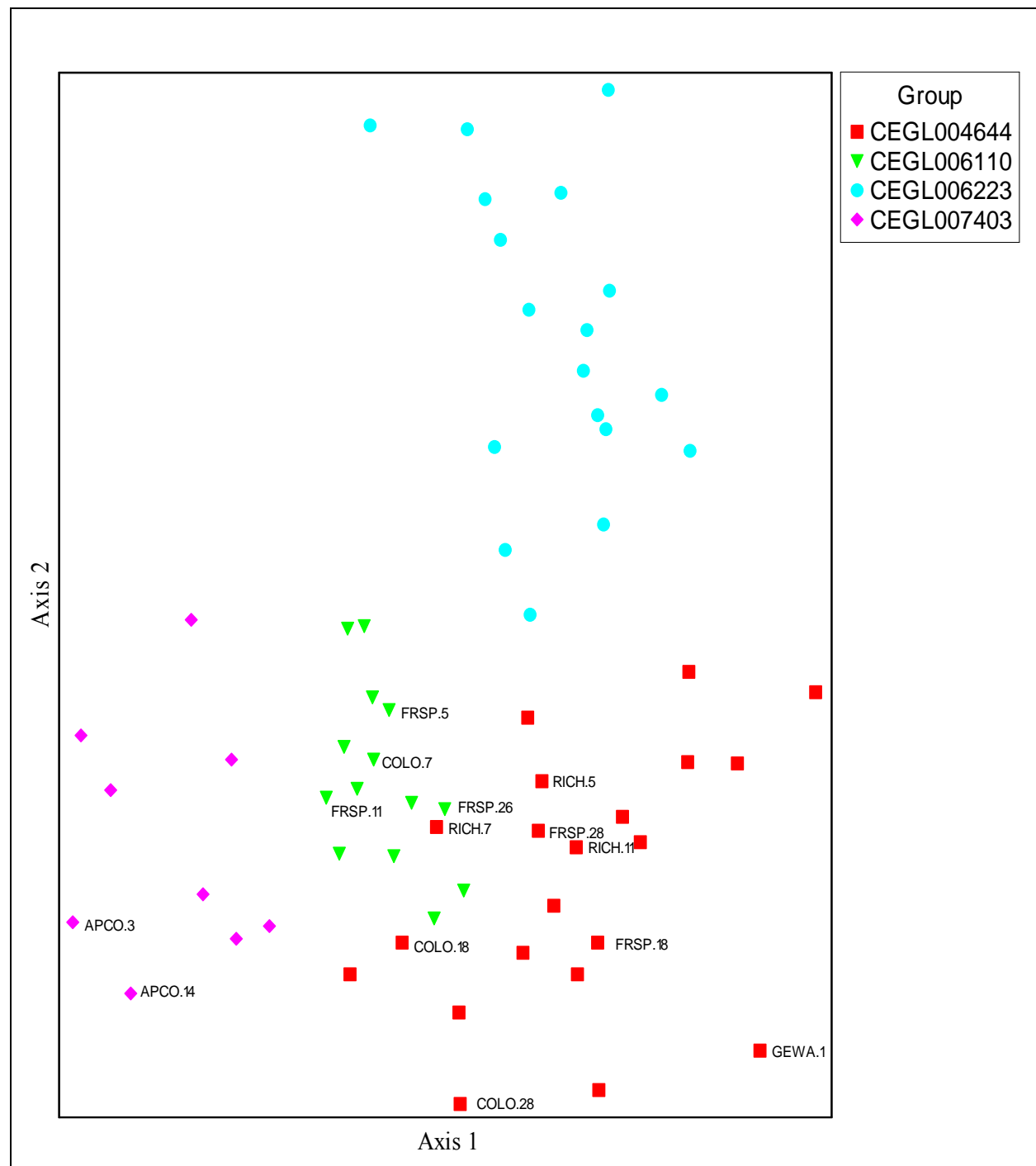
Figure G16. Scatterplot diagram for two-dimensional NMDS ordination of 62 nonriverine forest plots. Plot membership in four nonriverine forest associations is based on cluster analysis. CEGL004644 = Non-Riverine Saturated Forest; CEGL006110 = Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type); CEGL006223 = Coastal Plain Depression Wetland (Swamp Tupelo Type); CEGL007403 = Upland Depression Swamp. Plots from the seven Virginia national parks are labeled to the right of or below the symbol.
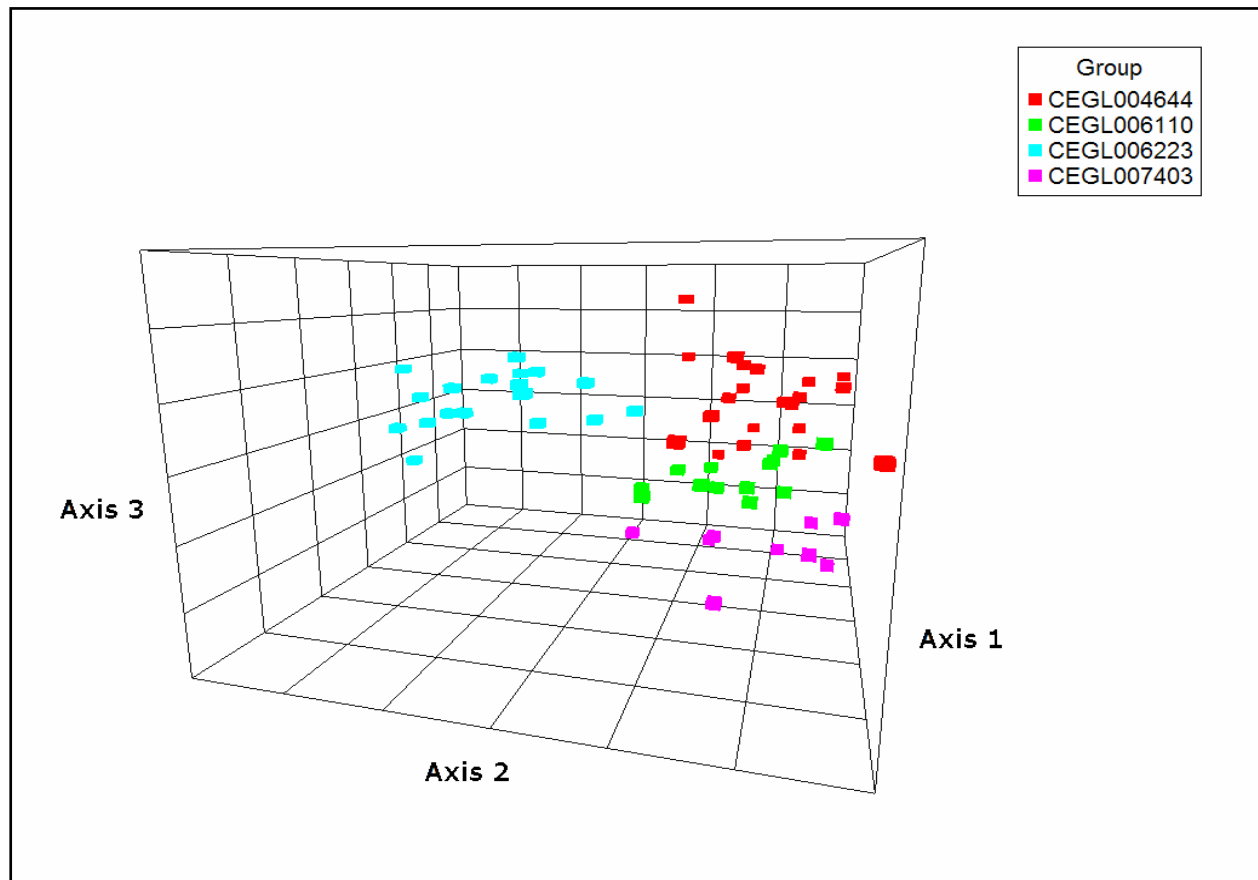
Figure G17. Scatterplot diagram for three-dimensional NMDS ordination of 62 nonriverine forest plots. Plot membership in four nonriverine forest associations is based on cluster analysis. CEGL004644 = Non-Riverine Saturated Forest; CEGL006110 = Coastal Plain Depression Wetland (Red Maple - Sweetgum - Willow Oak Type); CEGL006223 = Coastal Plain Depression Wetland (Swamp Tupelo Type); CEGL007403 = Upland Depression Swamp.

Appendix H. Compositional summary statistics for vegetation associations within Richmond National Battlefield Park derived from the analysis of regional quantitative plot data.

Compositional statistics were calculated to evaluate the adequacy of groups recognized in cluster analysis and ultimately to assist in naming and describing vegetation associations. Only associations derived from quantitative analysis of the regional plot data are shown. Total mean cover and total frequency were determined for every taxon across the entire dataset. Compositional statistics are shown only for prevalent species in each vegetation association, except for those associations where mean species richness is less than or equal to 10 species. Prevalence is an attribute assigned to a portion of the species within a vegetation type (Curtis 1959). Prevalence is determined by ranking the species of a vegetation type in order of descending constancy then, beginning with the most constant species, selecting as prevalent, a number of species equal to the mean species richness for the vegetation type. Species shaded in green were chosen as primary nominals in the association name, while those in blue are parenthetical nominals.

See Methods - Vegetation Classification and Characterization - Summary Statistics section for an explanation of variables shown in each table.

Vegetation associations are presented as follows:

Table H1. Compositional summary statistics from the regional analysis of Acidic Oak - Hickory Forest (CEGL008475).

Mean Species Richness	53
Homoteneity	0.598
Number of Plots	121

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Acer rubrum	1090	6	6	0	96	11	10	7	10
Parthenocissus quinquefolia	899	2	2	0	90	12	11	2	11
Nyssa sylvatica	810	5	5	0	88	13	11	6	11
Polygonatum biflorum	462	2	2	0	85	22	19	4	19
Vaccinium stamineum	373	2	4	++	83	27	22	10	88
Maianthemum racemosum ssp. *racemosum*	481	2	2	0	81	20	16	4	16
Prunus serotina var. *serotina*	619	2	2	0	80	16	12	3	12
Liriodendron tulipifera	753	5	5	0	79	13	10	6	10
Chimaphila maculata	412	2	2	0	79	23	18	4	18
Fraxinus americana	509	4	4	0	77	18	14	6	14
Quercus velutina	428	4	5	+	76	21	16	9	32
Sassafras albidum	520	3	3	0	76	18	13	4	13
Galium circaezans	384	2	2	0	71	22	16	3	16
Carya glabra	437	4	5	+	66	18	12	7	24
Juniperus virginiana var. *virginiana*	353	2	2	0	65	22	14	3	14
Carex albicans	290	2	2	0	61	25	15	3	15
Vitis vulpina	384	2	2	0	61	19	12	3	12
Smilax glauca	528	2	2	0	61	14	8	2	8
Amelanchier arborea	387	2	3	+	59	18	11	4	22
Rubus flagellaris	329	2	2	0	56	20	11	3	11
Fagus grandifolia	630	6	5	-	53	10	5	3	3
Danthonia spicata	255	2	2	0	53	25	13	3	13
Viburnum prunifolium	361	2	2	0	52	17	9	2	9
Toxicodendron radicans	747	3	2	-	52	8	4	1	2
Viburnum acerifolium	319	2	4	++	51	19	10	4	39
Dioscorea quaternata	339	2	2	0	51	18	9	2	9
Smilax rotundifolia	797	3	2	-	48	7	3	1	2
Solidago caesia	232	2	2	0	47	24	11	3	11
Euonymus americanus	433	2	2	0	47	13	6	1	6
Carya ovalis	160	4	5	+	43	33	14	8	28
Dichanthelium boscii	248	2	3	+	43	21	9	3	18
Uvularia perfoliata	219	2	2	0	43	24	10	2	10
Carex digitalis	268	2	2	0	43	19	8	2	8
Dichanthelium dichotomum	270	2	2	0	43	19	8	2	8
Rhododendron periclymenoides	275	2	2	0	43	19	8	2	8

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Diospyros virginiana	292	2	2	0	43	18	8	2	8
Carpinus caroliniana	497	4	4	0	42	10	4	2	4
Quercus prinus	396	5	5	0	41	12	5	3	5
Rosa carolina var. *carolina*	138	1	2	+	39	34	13	3	27
Quercus coccinea	212	4	4	0	38	21	8	4	8
Polystichum acrostichoides	414	3	2	-	38	11	4	1	2
Cercis canadensis var. *canadensis*	248	3	3	0	36	17	6	2	6
Houstonia purpurea var. *purpurea*	125	1	2	+	36	34	12	3	25
Scutellaria elliptica	135	1	2	+	36	32	11	3	23
Ilex opaca var. *opaca*	575	4	2	- -	36	7	3	1	1
Gaylussacia baccata	224	4	3	-	34	18	6	2	3
Aristolochia serpentaria	153	1	2	+	33	26	9	2	17
Vitis aestivalis	151	2	2	0	33	26	9	2	9

Table H2. Compositional summary statistics from the regional analysis of Mesic Mixed Hardwood Forest (CEGL006075).

Mean Species Richness	42
Homoteneity	0.573
Number of Plots	170

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Fagus grandifolia	630	6	7	+	97	26	25	20	51
Acer rubrum	1090	6	6	0	92	14	13	9	13
Liriodendron tulipifera	753	5	6	+	92	21	19	13	38
Parthenocissus quinquefolia	899	2	2	0	89	17	15	3	15
Quercus alba	720	6	6	0	84	20	16	11	16
Cornus florida	626	4	5	+	82	22	18	10	37
Quercus rubra	668	5	6	+	77	20	15	10	30
Nyssa sylvatica	810	5	5	0	77	16	12	7	12
Prunus serotina var. *serotina*	619	2	2	0	75	21	15	3	15
Toxicodendron radicans	747	3	2	-	75	17	13	3	6
Ilex opaca var. *opaca*	575	4	5	+	73	22	16	9	31
Polystichum acrostichoides	414	3	4	+	71	29	20	9	41
Maianthemum racemosum ssp. *racemosum*	481	2	2	0	64	23	15	3	15
Polygonatum biflorum	462	2	2	0	63	23	15	3	15
Smilax rotundifolia	797	3	2	-	62	13	8	2	4
Asimina triloba	519	5	4	-	61	20	12	5	6
Euonymus americanus	433	2	2	0	61	24	15	3	15
Smilax glauca	528	2	2	0	60	19	12	3	12
Carya alba	410	4	4	0	58	24	14	6	14
Carpinus caroliniana	497	4	4	0	58	20	12	5	12
Mitchella repens	395	2	2	0	55	24	13	3	13
Vaccinium pallidum	527	4	2	- -	52	17	9	2	2
Carya glabra	437	4	4	0	51	20	10	5	10
Carex digitalis	268	2	2	0	51	32	16	4	16
Chimaphila maculata	412	2	2	0	49	20	10	2	10
Sassafras albidum	520	3	2	-	49	16	8	2	4
Desmodium nudiflorum	307	2	2	0	48	27	13	3	13
Viburnum acerifolium	319	2	3	+	46	24	11	4	22
Galium circaezans	384	2	2	0	45	20	9	2	9
Dioscorea quaternata	339	2	2	0	45	22	10	2	10
Fraxinus americana	509	4	2	- -	45	15	7	1	2
Lonicera japonica	516	2	2	0	44	14	6	1	6
Liquidambar styraciflua	472	4	4	0	42	15	6	3	6
Quercus velutina	428	4	4	0	42	17	7	3	7
Vitis vulpina	384	2	2	0	40	18	7	2	7
Lindera benzoin	456	4	3	-	39	14	6	2	3
Amelanchier arborea	387	2	2	0	36	16	6	1	6
Quercus prinus	396	5	5	0	34	15	5	3	5
Epifagus virginiana	107	1	2	+	34	54	18	4	37
Carex albicans	290	2	2	0	33	19	6	1	6
Medeola virginiana	175	1	2	+	29	28	8	2	16
Eurybia divaricata	236	2	2	0	28	20	6	1	6

Table H3. Compositional summary statistics from the regional analysis of Coastal Plain Mixed Oak / Heath Forest (CEGL006269).

Mean Species Richness	27
Homoteneity	0.673
Number of Plots	18

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Gaylussacia frondosa	63	2	7	+++++	100	29	29	22	914
Quercus alba	720	6	7	+	100	3	3	2	5
Vaccinium pallidum	527	4	5	+	100	3	3	2	7
Acer rubrum	1090	6	5	-	94	2	1	1	1
Ilex opaca var. opaca	575	4	6	++	89	3	2	2	10
Vaccinium stamineum	373	2	4	++	89	4	4	2	15
Quercus falcata	178	3	6	+++	83	8	7	5	56
Quercus velutina	428	4	6	++	83	4	3	2	12
Nyssa sylvatica	810	5	5	0	83	2	2	1	2
Diospyros virginiana	292	2	2	0	83	5	4	1	4
Sassafras albidum	520	3	2	-	78	3	2	0	1
Vitis rotundifolia	169	2	4	++	72	8	6	2	22
Smilax glauca	528	2	2	0	72	2	2	0	2
Liquidambar styraciflua	472	4	3	-	67	3	2	1	1
Quercus coccinea	212	4	5	+	61	5	3	2	6
Cornus florida	626	4	4	0	61	2	1	0	1
Pinus taeda	112	2	3	+	61	10	6	2	12
Gaylussacia baccata	224	4	4	0	56	4	2	1	2
Amelanchier arborea	387	2	2	0	56	3	1	0	1
Carya pallida	22	2	5	+++	44	36	16	9	129
Fagus grandifolia	630	6	5	-	44	1	1	0	0
Carya alba	410	4	3	-	44	2	1	0	0
Juniperus virginiana var. virginiana	353	2	3	+	39	2	1	0	2
Castanea pumila var. pumila	73	1	2	+	39	10	4	1	7
Mitchella repens	395	2	2	0	39	2	1	0	1
Chimaphila maculata	412	2	1	-	39	2	1	0	0
Quercus phellos	238	4	1	- - -	39	3	1	0	0

Table H4. Compositional summary statistics from the regional analysis of Coastal Plain / Piedmont Acidic Seepage Swamp (CEGL006238).

Mean Species Richness	43
Homoteneity	0.589
Number of Plots	39

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Acer rubrum	1090	6	7	+	97	3	3	3	7
Nyssa sylvatica	810	5	6	+	97	5	4	3	9
Smilax rotundifolia	797	3	3	0	95	5	4	1	4
Mitchella repens	395	2	2	0	95	9	9	2	9
Osmunda cinnamomea	129	2	5	+++	92	27	25	14	200
Ilex opaca var. opaca	575	4	5	+	92	6	6	3	11
Viburnum nudum	73	2	5	+++	89	47	42	23	333
Magnolia virginiana	87	2	6	++++	84	37	31	21	496
Liriodendron tulipifera	753	5	5	0	82	4	3	2	3
Ilex verticillata	194	2	4	++	74	14	11	5	43
Lycopus virginicus	179	1	2	+	68	15	10	2	20
Woodwardia areolata	73	2	4	++	66	34	23	10	90
Leersia virginica	201	2	3	+	66	12	8	3	16
Lindera benzoin	456	4	4	0	63	5	3	1	3
Medeola virginiana	175	1	2	+	63	14	9	2	17
Vaccinium corymbosum	136	2	5	+++	61	17	10	6	82
Arisaema triphyllum	405	2	2	0	61	6	3	1	3
Liquidambar styraciflua	472	4	5	+	58	5	3	1	5
Symplocarpus foetidus	80	3	6	+++	55	26	15	10	116
Rhododendron viscosum	49	2	4	++	53	41	21	10	86
Quercus alba	720	6	4	- -	53	3	1	1	0
Osmunda regalis var. spectabilis	78	2	3	+	53	26	13	4	27
Carex debilis	130	2	3	+	53	15	8	3	16
Parthenocissus quinquefolia	899	2	2	0	53	2	1	0	1
Viola primulifolia	37	1	2	+	50	51	26	6	51
Carex intumescens var. intumescens	111	2	2	0	50	17	9	2	9
Cinna arundinacea	229	3	2	-	50	8	4	1	2
Clethra alnifolia	52	2	6	++++	47	35	16	11	262
Leucothoe racemosa	88	2	3	+	47	20	10	3	19
Platanthera clavellata	40	1	2	+	47	45	21	5	43
Rubus hispidus	88	2	2	0	47	20	10	2	10
Chionanthus virginicus	176	2	3	+	45	10	4	1	9
Viburnum dentatum	236	2	2	0	45	7	3	1	3
Vaccinium fuscatum	134	2	4	++	42	12	5	2	20
Viola cucullata	89	2	2	0	42	18	8	2	8
Dioscorea villosa	58	1	2	+	39	26	10	2	20
Glyceria striata	152	2	2	0	39	10	4	1	4
Carex atlantica ssp. atlantica	41	2	4	++	37	34	13	6	50
Thelypteris noveboracensis	157	3	4	+	37	9	3	1	7
Chasmanthium laxum	76	2	3	+	37	18	7	2	14
Carex seorsa	38	2	2	0	37	37	14	3	14
Chelone glabra	81	1	2	+	37	17	6	1	13

Table H5. Compositional summary statistics from the regional analysis of Coastal Plain / Piedmont Small-Stream Floodplain Forest (CEGL004418).

Mean Species Richness	45
Homoteneity	0.527
Number of Plots	48

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Liriodendron tulipifera	753	5	7	++	96	6	6	5	23
Lindera benzoin	456	4	6	++	94	10	9	6	37
Toxicodendron radicans	747	3	4	+	94	6	6	3	11
Liquidambar styraciflua	472	4	6	++	92	9	9	6	34
Parthenocissus quinquefolia	899	2	4	++	92	5	4	2	18
Ilex opaca var. *opaca*	575	4	5	+	90	7	7	4	13
Smilax rotundifolia	797	3	3	0	88	5	5	2	5
Acer rubrum	1090	6	6	0	85	4	3	2	3
Arisaema triphyllum	405	2	4	++	81	10	8	3	31
Asimina triloba	519	5	5	0	73	7	5	3	5
Thelypteris noveboracensis	157	3	6	+++	71	22	15	10	123
Carpinus caroliniana	497	4	5	+	71	7	5	3	10
Euonymus americanus	433	2	2	0	69	8	5	1	5
Polystichum acrostichoides	414	3	3	0	65	7	5	2	5
Mitchella repens	395	2	2	0	56	7	4	1	4
Fagus grandifolia	630	6	5	-	54	4	2	1	1
Lonicera japonica	516	2	3	+	54	5	3	1	5
Boehmeria cylindrica	226	2	3	+	52	11	6	2	12
Carex debilis	130	2	2	0	48	18	8	2	8
Nyssa sylvatica	810	5	5	0	46	3	1	1	1
Athyrium filix-femina var. *asplenioides*	157	2	4	++	46	14	6	3	26
Cinna arundinacea	229	3	3	0	46	10	4	1	4
Platanus occidentalis	85	2	4	++	44	25	11	5	43
Cornus florida	626	4	4	0	42	3	1	1	1
Onoclea sensibilis	95	1	2	+	42	21	9	2	18
Polygonum virginianum	203	2	2	0	42	10	4	1	4
Circaea lutetiana ssp. *canadensis*	247	2	2	0	42	8	3	1	3
Carex intumescens var. *intumescens*	111	2	2	0	40	17	7	2	7
Carex radiata	146	2	2	0	40	13	5	1	5
Festuca subverticillata	268	2	2	0	40	7	3	1	3
Impatiens capensis	203	2	2	0	38	9	3	1	3
Viburnum dentatum	236	2	2	0	38	8	3	1	3
Smilax glauca	528	2	2	0	38	3	1	0	1
Carya cordiformis	289	3	3	0	33	6	2	1	2
Medeola virginiana	175	1	2	+	33	9	3	1	6
Amphicarpaea bracteata	261	2	2	0	33	6	2	0	2
Betula nigra	60	2	5	+++	31	25	8	4	63
Lycopus virginicus	179	1	2	+	31	8	3	1	5
Sanicula canadensis	307	2	2	0	31	5	2	0	2
Ulmus americana	238	3	3	0	29	6	2	1	2

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Sambucus canadensis = Sambucus nigra ssp. *canadensis*	94	1	2	+	29	15	4	1	9
Carex swanii	124	1	2	+	29	11	3	1	7
Woodwardia areolata	73	2	2	0	29	19	6	1	6
Campsis radicans	208	2	2	0	29	7	2	0	2
Galium triflorum	258	2	2	0	29	5	2	0	2

Table H6. Compositional summary statistics from the regional analysis of Non-Riverine Saturated Forest (CEGL004644).

Mean Species Richness	35
Homoteneity	0.574
Number of Plots	21

SPECIES	TOTAL FREQ	TOTAL MEAN COVER	Mean Cover	Relative Cover	Constancy	Fidelity	Diagnostic Value	Adj DV (scaled)	Adj DV (unscaled)
Liquidambar styraciflua	472	4	6	++	100	4	4	3	18
Acer rubrum	1090	6	6	0	100	2	2	1	2
Nyssa sylvatica	810	5	5	0	90	2	2	1	2
Smilax rotundifolia	797	3	4	+	90	2	2	1	4
Quercus phellos	238	4	6	++	86	8	6	4	26
Ilex opaca var. *opaca*	575	4	6	++	81	3	2	2	10
Mitchella repens	395	2	2	0	76	4	3	1	3
Toxicodendron radicans	747	3	2	-	76	2	2	0	1
Woodwardia areolata	73	2	5	+++	71	21	15	8	117
Quercus michauxii	91	2	6	++++	67	15	10	7	164
Pinus taeda	112	2	4	++	67	13	8	4	33
Clethra alnifolia	52	2	6	++++	62	25	15	10	248
Quercus pagoda	39	2	6	++++	57	31	18	12	281
Carex debilis	130	2	4	++	57	9	5	2	21
Magnolia virginiana	87	2	3	+	57	14	8	3	16
Vitis rotundifolia	169	2	2	0	57	7	4	1	4
Viburnum nudum	73	2	4	++	52	15	8	4	32
Parthenocissus quinquefolia	899	2	2	0	52	1	1	0	1
Chasmanthium laxum	76	2	4	++	48	13	6	3	25
Leucothoe racemosa	88	2	3	+	48	11	5	2	11
Euonymus americanus	433	2	2	0	48	2	1	0	1
Quercus alba	720	6	5	-	43	1	1	0	0
Osmunda regalis var. *spectabilis*	78	2	4	++	43	12	5	2	20
Osmunda cinnamomea	129	2	4	++	43	7	3	1	12
Vaccinium corymbosum	136	2	4	++	43	7	3	1	11
Carex intumescens var. *intumescens*	111	2	3	+	43	8	3	1	7
Ilex verticillata	194	2	2	0	43	5	2	0	2
Liriodendron tulipifera	753	5	2	- - -	43	1	1	0	0
Carex seorsa	38	2	5	+++	38	21	8	4	64
Carpinus caroliniana	497	4	5	+	38	2	1	0	1
Fraxinus pennsylvanica	238	4	4	0	38	3	1	1	1
Vaccinium fuscatum	134	2	3	+	38	6	2	1	5
Campsis radicans	208	2	2	0	38	4	1	0	1
Viburnum dentatum	236	2	2	0	38	3	1	0	1
Fagus grandifolia	630	6	2	- - - -	38	1	0	0	0

Appendix I. Local and global descriptions of vegetation associations and other vegetation-map classes for Richmond National Battlefield Park.

This appendix contains detailed local descriptions for vegetation associations and other map classes present at Richmond National Battlefield Park based on information collected within the park boundary. Of the 21 map classes used to map Richmond National Battlefield Park, thirteen were crosswalked to the finest level of the USNVC (association), five were described as nonstandard, park-specific classes, and three were crosswalked to Anderson (Anderson et al. 1976) level II classification.

All map classes crosswalked to the association level of the USNVC also include range-wide descriptions (i.e. global descriptions). Information in the global descriptions of the associations was extracted from the September 27, 2007 version of the NatureServe central databases (NatureServe 2007). A copywrite notice precedes the report.

Fields used in the local and global descriptions are defined in Appendix J. Vascular plant species nomenclature within the local and global descriptions follows the nationally standardized list of Kartesz (1999), with very few exceptions. This nomenclature differs from PLANTS 3.5 in only a very few cases, and when this difference occurs, synonymy is indicated parenthetically in the local description information. 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. English names for associations and alliances use NatureServe Central Ecology-accepted names and may differ slightly from PLANTS 3.5 common names that are used within the local description information and throughout the rest of the report. Sources cited in the local and global vegetation descriptions are included in the literature section at the end of this appendix. Representative photographs of the vegetation types are provided after the descriptions. Photographs were taken by VADNH staff unless otherwise indicated.

Each association is crosswalked to the Ecological Group level of the state classification for Virginia (Fleming et. al 2006), which is the level that is currently tracked in the NatureServe databases from which this appendix was created. Ecological Groups contain multiple associations, some rare and some common, so a state rank is not appropriate for this level of classification. The state name (Sname) field within "Subnational Distribution with Crosswalk Data" crosswalks the USNVC association to the Ecological Group level of the Virginia Classification of Ecological Communities and the subnational ranking information is qualified with a * , indicating that the ranking information is not at the association level. State ranks for USNVC associations are managed within the Virginia Division of Natural Heritage and the state/subnational conservation rank (SRank) and global conservation rank (GRank) for all associations are provided in Appendix D. Definitions of the conservation ranks are in Appendix E. Values for the relationship (Rel) and crosswalk confidence (Conf) are defined in Appendix J.

The dichotomous key to the Richmond National Battlefield Park map classes is presented in Appendix K. The key should be used in conjunction with the detailed descriptions.

COMMON NAME (PARK-SPECIFIC):   LOBLOLLY PINE PLANTATION

SYNONYMS
USNVC English Name: **Loblolly Pine Planted Forest**
USNVC Scientific Name: *Pinus taeda* **Planted Forest**
USNVC Identifier: **CEGL007179**

LOCAL INFORMATION

Environmental Description: Loblolly Pine Plantation occurs on areas where *Pinus taeda* (loblolly pine) has been planted. In Richmond National Battlefield Park, these forests occur on gently sloping uplands over various soil types.

Vegetation Description: Loblolly Pine Plantation includes planted evergreen forests with canopies dominated by *Pinus taeda* (loblolly pine). Polygons of this map class can be dominated by *Pinus taeda* (loblolly pine) planted in discernable rows with little or no other tree or shrub species. This map class also includes recently abandoned plantations which, after a time with no active management, begin to development a shrub layer of hardwood species. Hardwood species occurring in the understory can include early-successional species such as *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), and *Acer rubrum* (red maple). Other shrubs and small trees found in this association include *Ilex opaca* var. *opaca* (American holly), *Nyssa sylvatica* (blackgum), *Quercus* spp. (oaks), and *Carya* spp. (hickories). Litter typically dominates the ground layer with no or very sparse herbaceous/woody seedling cover. The vines *Toxicodendron radicans* (eastern poison ivy) and *Vitis rotundifolia* (muscadine) can be common.

Within Richmond National Battlefield Park, Loblolly Pine Plantation can range from obvious plantations with trees in straight rows to dense, shrubby stands of *Pinus taeda* (loblolly pine). Polygons may be somewhat heterogeneous and have small areas (less than 0.5 ha) dominated by dense hardwood regeneration or other successional hardwood patches, but the overall polygon has an evergreen forest canopy dominated by young *Pinus taeda* (loblolly pine).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus taeda* (loblolly pine)

Characteristic Species: *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus taeda* (loblolly pine).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: Loblolly Pine Plantation is found in the Malvern Hill unit of Richmond National Battlefield Park where it covers 38.9 hectares (96.2 acres) in three polygons.

Classification Comments: Loblolly Pine Plantation is distinguished from other vegetation in Richmond National Battlefield Park by having a canopy dominated by *Pinus taeda* (loblolly pine), either planted in discernable rows or as an early-successional forest. These forests are distinguished from Loblolly Pine - Hardwood Forest by being younger overall and without significant hardwood succession. The signature of Loblolly Pine Plantation has a finer texture, with smaller tree crowns than those of Loblolly Pine - Hardwood Forest, and the overall polygon composition is of evergreen trees, without large areas of deciduous overstory.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park 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	Planted/Cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.)
Formation	Planted/cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.x.)
Alliance	*Pinus taeda* Planted Forest Alliance (A.99)
Alliance (English name)	Loblolly Pine Planted Forest Alliance
Association	*Pinus taeda* Planted Forest
Association (English name)	Loblolly Pine Planted Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association represents young, monospecific planted stands of *Pinus taeda* (loblolly pine). Due to the commercial value of this species, this type is widely distributed across much of the southeastern United States from the Interior Highlands to the Coastal Plain, including areas outside the natural range of the species. The core concept of stands attributable to this type are those which support dense, often perfect rows of planted *Pinus taeda* (loblolly pine) or otherwise dense, young stands which are established, managed, and/or maintained for the extraction of forest products (usually pulpwood). In most cases these stands support almost no other tree species in the overstory. Understory composition and density can vary widely depending upon location, management history, and stand age. Stands are typically established with mechanical planting, but may also be established through other means. This association rarely exceeds 20–40 years of age on most timberlands. Excluded from this association are plantation stands which have "broken up" with age or thinning to approximate a more natural structure. Dense planting in rows, if successful, tends to result in nearly complete canopy closure which persists until the stand has either been regenerated or transitions into a different association. Herbaceous ground cover of any kind tends to be sparse due to reduction during site preparation, the typically dense canopy cover, and to the fact that many young plantations are infrequently burned at best.

Environmental Description: Environmental setting varies widely by site. Stands often occur on level to gently sloping areas, on soils that range from dry to poorly drained.

Vegetation Description: There is considerable local variation among stands of this planted vegetation type across its broad range (from the Interior Highlands to the Coastal Plain, including areas outside the natural range of the species). In the Ouachita Mountains planted loblolly is found with a variable amount of *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Quercus marilandica* (blackjack oak), *Quercus stellata* (post oak), and *Quercus velutina* (black oak); on drier sites *Pinus echinata* (shortleaf pine), *Carya alba* (mockernut hickory), and *Carya texana* (black hickory); and *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and *Quercus nigra* (water oak) on wetter sites. The understory can be thick especially after thinning and/or burning. Common understory species are *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium arboreum* (farkleberry), *Vaccinium stamineum* (deerberry), *Cornus florida* (flowering dogwood), *Ulmus alata* (winged elm), and others. Vines

are an important component, including *Berchemia scandens* (Alabama supplejack), *Lonicera japonica* (Japanese honeysuckle), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis* spp. (grapes), *Smilax* spp. (greenbriers), and *Toxicodendron radicans* (eastern poison ivy). In dense stands the herbaceous layer is suppressed by dense needle litter. In thinned and burned stands the plantations are often grazed. Herbaceous species can include *Solidago ulmifolia* (elmleaf goldenrod), *Chasmanthium sessiliflorum* (longleaf woodoats), *Schizachyrium scoparium* (little bluestem), *Danthonia spicata* (poverty oatgrass), *Tephrosia virginiana* (Virginia tephrosia), *Lespedeza* spp. (lespedezas), *Symphyotrichum patens* (late purple aster), *Eupatorium* spp. (thoroughworts), and others. In Oklahoma, associates include *Rhus copallinum* (flameleaf sumac), *Hypericum densiflorum* (bushy St. Johnswort), *Liquidambar styraciflua* (sweetgum) and *Toxicodendron radicans* (eastern poison ivy) (Hoagland 2000). Additional data on several stands on the Croatan National Forest can be found in Doyle and Allard (1990).

Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: This association is found throughout the southeastern United States.
States/Provinces: AL, AR, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA
Federal Lands: DOD (Arnold, Fort Benning, Fort Bragg, Fort Gordon, Fort Stewart); DOE (Savannah River Site); NPS (Appomattox Court House, Chickamauga-Chattanooga?, Colonial, Fredericksburg-Spotsylvania, George Washington Birthplace, Natchez Trace, Obed, Petersburg, Richmond, Vicksburg); USFS (Angelina, Bankhead?, Bienville, Cherokee, Conecuh, Croatan, Davy Crockett, De Soto, Delta, Francis Marion, Holly Springs, Kisatchie, Land Between the Lakes, Oconee, Ouachita, Ouachita (Coastal Plain), Ouachita (Mountains), Ozark, Sabine, Sam Houston, St. Francis?, Sumter, Sumter (Mountains), Sumter (Piedmont), Talladega, Talladega (Oakmulgee), Talladega (Talladega), Tombigbee, Tuskegee); USFWS (Blackwater, Chesapeake Marshlands, Eufaula, Prime Hook).

CONSERVATION STATUS
Rank: GNA (cultural) (8-Aug-2000).
Reasons: This community represents vegetation which 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. It is not a conservation priority and does not receive a conservation rank.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: At Arnold Air Force Base, Coffee and Franklin counties, Tennessee, *Pinus taeda* (loblolly pine) is near the edge of its putative natural range and was apparently absent prior to being planted there between 1945 and 1950 on abandoned agricultural land and along roadsides. Older plantings have not been intensively managed, and many have become "modified" vegetation (e.g., CEGL007109) and are no longer regarded as plantations. More recently (1998–2001) some of these older pine stands have been harvested and replaced with true *Pinus taeda* (loblolly pine) plantations. *Pinus taeda* (loblolly pine) also invades seasonally wet hardwood depressions, but these stands remain recognizable as to their natural identity (e.g.,

CEGL007364). Associations occur as plantations and on old fields on Kisatchie and Sumter national forests and after blowdowns on the Kisatchie. South Carolina information after Jones et al. (1981). In the Coastal Plain of South Carolina, there are mature loblolly plantations, often with *Prunus serotina* var. *serotina* (black cherry) in the understory, that have been prescribed burned (based on seven plots at Savannah River Site) - such stands are presumably better covered under *Pinus taeda* (loblolly pine) Forest Alliance (A.130). Plantations occur in obvious rows in the aerial photos of the Delmarva Peninsula in Maryland.

Similar Associations:

- *Pinus taeda - Liriodendron tulipifera / Acer saccharum* Successional Forest (CEGL007105).
- *Pinus taeda - Quercus (falcata, hemisphaerica, nigra) - Liquidambar styraciflua / Rhus copallinum - Vaccinium stamineum* Forest (CEGL008450).
- *Pinus taeda / Liquidambar styraciflua - Acer rubrum* var. *rubrum / Vaccinium stamineum* Forest (CEGL006011)--develops when stands develop typical two-layered structure with well-developed subcanopy.
- *Pinus taeda / Rhus copallinum* Managed Forest (CEGL007108)--may replace this association as stands mature.
- *Pinus taeda / Saccharum alopecuroidum - (Andropogon* spp.) Forest (CEGL007109).

Related Concepts:

- Loblolly Pine: 81 (Eyre 1980) B

SOURCES

Description Authors: A. S. Weakley, mod. L. A. Sneddon.

References: ALNHP 2002, Doyle and Allard 1990, Eyre 1980, Hoagland 1998, Hoagland 2000, Jones et al. 1981, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC 1998.

Figure I1. Loblolly Pine Plantation at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 300449, northing 4142903.

COMMON NAME (PARK-SPECIFIC):   LOBLOLLY PINE - HARDWOOD FOREST

SYNONYMS
USNVC English Name: **Loblolly Pine - Sweetgum Semi-natural Forest**
USNVC Scientific Name: *Pinus taeda - Liquidambar styraciflua* **Semi-natural Forest**
USNVC Identifier: **CEGL008462**

LOCAL INFORMATION

Environmental Description: These second- or third-growth forests develop after agricultural abandonment or other anthropogenic disturbances on upland flat areas and slopes that formerly supported Coastal Plain Mixed Oak / Heath Forest, Acidic Oak - Hickory Forest or Mesic Mixed Hardwood Forest. In Richmond National Battlefield Park, Loblolly Pine - Hardwood Forest occurs on disturbed uplands or as narrow strips along roadways and Cultural Meadows in an otherwise residential or agricultural landscape.

Vegetation Description: Loblolly Pine - Hardwood Forests are mostly evergreen to mixed evergreen-deciduous forests with canopies dominated by *Pinus taeda* (loblolly pine) occurring with various hardwood species. *Liquidambar styraciflua* (sweetgum) and/or *Liriodendron tulipifera* (tuliptree) are the most common canopy associates, but oaks such as *Quercus falcata* (southern red oak) or *Quercus phellos* (willow oak) may also occur in the canopy. Subcanopy and shrub layers can have species from the canopy as well as *Acer rubrum* (red maple), *Cornus florida* (flowering dogwood), *Carpinus caroliniana* (American hornbeam), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Nyssa sylvatica* (blackgum), *Ilex opaca* var. *opaca* (American holly), and occasional individuals of *Quercus* spp. (oaks) like *Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), and *Quercus phellos* (willow oak). The exotic species *Ailanthus altissima* (tree of heaven) and *Paulownia tomentosa* (princesstree) are typical in this successional forest. The vines *Campsis radicans* (trumpet creeper), *Lonicera japonica* (Japanese honeysuckle), *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), and *Vitis rotundifolia* (muscadine) can cover large areas in these forests. The ground layer is usually covered by pine litter with few herbs. *Erechtites hieraciifolia* var. *hieraciifolia* (American burnweed), *Phytolacca americana* (American pokeweed), and the exotic grass *Microstegium vimineum* (Nepalese browntop) are typical herbs. Other forest herbs are possible but occur inconsistently and at low cover.

In Richmond National Battlefield Park, Loblolly Pine - Hardwood Forests can vary in structure, occurring as forests with distinct canopy, subcanopy, and shrub strata or as a more-or-less single stratum of scrubby trees greater than 6 m tall. Polygons of Loblolly Pine - Hardwood Forest may have small areas with younger pine or hardwood regeneration, but overall polygon canopy composition will be a mixture of *Pinus taeda* (loblolly pine) and hardwood species or an older, emergent evergreen canopy of *Pinus taeda* (loblolly pine) with a subcanopy of deciduous (hardwood) species.

Loblolly Pine - Hardwood Forest that has become established on wet soils may have hydric oaks such as *Quercus pagoda* (cherrybark oak) and *Quercus michauxii* (swamp chestnut oak) occurring in combination with successional species.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus taeda* (loblolly pine)
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree)

Characteristic Species: *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Lonicera japonica* (Japanese honeysuckle), *Pinus taeda* (loblolly pine), *Toxicodendron radicans* (eastern poison ivy).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: Loblolly Pine - Hardwood Forest is found at the following park units in Richmond National Battlefield Park: Fort Darling, Malvern Hill, Fort Harrison, Cold Harbor, and Chickahominy Bluff. It is mapped as 12 polygons, 38.3 hectares (94.7 acres).

Classification Comments: Loblolly Pine - Hardwood Forest can be distinguished from Loblolly Pine Plantation by having significant canopy mixtures of hardwood species or a subcanopy of hardwood trees. Mainly deciduous areas within Loblolly Pine - Hardwood Forest could be confused with Mesic Mixed Hardwood Forest, but are distinguished by having more even-aged, low diversity tree composition and associates of successional and weedy species. Loblolly Pine - Hardwood Forest can be distinguished from Successional Tuliptree Forest by having greater than 25% canopy cover of *Pinus taeda* (loblolly pine) within a polygon. Stands mapped as Loblolly Pine - Hardwood Forest with a sparse pine canopy and a high cover of exotic species in a dense subcanopy / shrub layer may be transitional to and confused with the map class Successional Mixed Scrub, but is distinguished by its overall forest structure (i.e., tall stature and tree lifeform).

Older stands mapped as this association may be transitional to Coastal Plain Mixed Oak / Heath Forest, Acidic Oak - Hickory Forest or Mesic Mixed Hardwood Forest and be difficult to distinguish.

Some polygons of this map class may contain human-created earthworks, but since the ground vegetation is not maintained through mowing or other manipulation, these stands are classified as Loblolly Pine - Hardwood Forest.

Other Comments: Depiction of this map class is based on photography acquired in February 2002. Acreage of this map class in the Malvern Hill unit has been cleared since acquisition of aerial photography used for this project.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park 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 taeda* Forest Alliance (A.130)
Alliance (English name)	Loblolly Pine Forest Alliance
Association	*Pinus taeda - Liquidambar styraciflua* Semi-natural Forest
Association (English name)	Loblolly Pine - Sweetgum Semi-natural Forest
Ecological System(s):	East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest (CES203.506).

GLOBAL DESCRIPTION

Concept Summary: This community type is broadly defined to accommodate mid- to late-successional upland forests strongly codominated by *Pinus taeda* (loblolly pine) and *Liquidambar styraciflua* (sweetgum), resulting from past disturbance (such as agricultural or other land clearing). Understory composition differs based on edaphic site and on age and history. This broadly defined type occupies a variety of edaphic sites, ranging from mesic through dry-mesic sites on a wide variety of (generally acidic) soils. If left unmanaged or undisturbed, this can be a short-lived forest type, which is likely to succeed with greater age into various oak- and oak-pine-dominated forests.

Environmental Description: Stands of this community type are strongly codominated by *Pinus taeda* (loblolly pine) and *Liquidambar styraciflua* (sweetgum), resulting from past disturbance followed by forest succession. This community type is more influenced by past land-use history than by specific soil differences. However, this community type tends to occur on poorly drained and low-nutrient soils, especially in areas that were farmed heavily in the past. Stands on poorly drained sites have often been subjected to ditching activities.

Vegetation Description: Stands of this community type are strongly codominated by *Pinus taeda* (loblolly pine) and *Liquidambar styraciflua* (sweetgum). Some other species which may be present in stands of this association include *Quercus phellos* (willow oak), *Quercus nigra* (water oak), *Ulmus alata* (winged elm), *Acer rubrum* (red maple), *Quercus michauxii* (swamp chestnut oak), *Nyssa sylvatica* (blackgum), and *Prunus serotina* var. *serotina* (black cherry), along with *Vitis rotundifolia* (muscadine), *Toxicodendron radicans* (eastern poison ivy), *Rubus argutus* (sawtooth blackberry), *Smilax rotundifolia* (roundleaf greenbrier), *Eupatorium capillifolium* (dogfennel), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), *Erigeron strigosus* (prairie fleabane), *Solidago gigantea* (giant goldenrod), *Ambrosia artemisiifolia* (annual ragweed), *Juncus effusus* (common rush), *Juncus subcaudatus* (woodland rush), and the exotics *Lespedeza cuneata* (Chinese lespedeza) and *Ligustrum sinense* (Chinese privet). Examples of this association in low-lying areas may also have a dense herbaceous layer of *Microstegium vimineum* (Nepalese browntop).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus taeda* (loblolly pine)
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree)

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

DISTRIBUTION

Range: This altered forest type is widespread in the lowland portions of the southeastern to mid-Atlantic United States, particularly on the Coastal Plain, but also on adjacent inland provinces.
States/Provinces: AL, AR, DE, GA, LA, MD, MS, NC, OK, SC, TN, TX, VA
Federal Lands: DOD (Fort Benning?); NPS (Chickamauga-Chattanooga, George Washington Birthplace, Guilford Courthouse, Kings Mountain, Little River Canyon?, Natchez Trace, Ninety Six, Petersburg, Richmond, Shiloh); USFS (Angelina, Bienville, Conecuh?, Croatan, Davy Crockett, Kisatchie, Oconee, Ouachita, Ouachita (Coastal Plain), Ouachita (Mountains), Sabine, Sam Houston, Talladega, Talladega (Oakmulgee), Talladega (Talladega), Tuskegee?, Uwharrie); USFWS (Blackwater, Chesapeake Marshlands, Prime Hook).

CONSERVATION STATUS

Rank: GNA (modified/managed) (20-Oct-2000).
Reasons: This forest represents early successional or silviculturally managed vegetation and is thus not of conservation concern and does not receive a conservation status rank.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 1 - Strong.
Comments: This community likely occurs along the northern periphery of the Gulf Coast Prairies and Marshes Ecoregion of eastern Texas. The similarity of this association with *Pinus taeda / Liquidambar styraciflua - Acer rubrum* var. *rubrum / Vaccinium stamineum* Forest (CEGL006011) suggests that a merge with that type should be considered.

Similar Associations:
- *Liriodendron tulipifera - Pinus taeda* Forest (CEGL007521)--with greater dominance by *Liriodendron*.
- *Pinus echinata* Early-Successional Forest (CEGL006327).
- *Pinus taeda - (Pinus echinata) - Quercus falcata - Carya texana / Vaccinium arboreum* Forest (CEGL007528)--overlaps only in the western part of the range of this type.
- *Pinus taeda / Liquidambar styraciflua - Acer rubrum* var. *rubrum / Vaccinium stamineum* Forest (CEGL006011)--is an earlier successional stage of this association and is distinguished by a lack of *Liquidambar styraciflua* in the canopy and a well-developed hardwood understory.
- *Pinus taeda / Saccharum alopecuroidum - (Andropogon* spp.) Forest (CEGL007109)--a related *Pinus taeda*-dominated type placed in evergreen.
- *Pinus virginiana* Successional Forest (CEGL002591).

Related Concepts:
- IF3a. Recently Harvested Timber Land (Allard 1990) B
- IF3b. Plantation (Hardwood or Conifer) (Allard 1990) B
- Loblolly Pine - Hardwood (13) (USFS 1988) ?
- Loblolly Pine - Hardwood: 82 (Eyre 1980) B
- T1B3aIII6a. *Pinus taeda - Liquidambar styraciflua* (Foti et al. 1994) ?

SOURCES
Description Authors: A. S. Weakley, mod. R. White and E. Largay.
References: Allard 1990, Eyre 1980, Foti 1994, Foti et al. 1994, Harcombe and Neaville 1977, Hoagland 2000, NatureServe Ecology - Southeastern U.S. unpubl. data, Peet et al. unpubl. data 2002, Schotz pers. comm., Southeastern Ecology Working Group n.d., USFS 1988, Zanoni et al. 1979.

Figure I2. Loblolly Pine - Hardwood Forest at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 290613, northing 4145418.

COMMON NAME (PARK-SPECIFIC):   SUCCESSIONAL RED-CEDAR FOREST

SYNONYMS
USNVC English Name: **Eastern Red-cedar Forest**
USNVC Scientific Name: *Juniperus virginiana* **Forest**
USNVC Identifier: **CEGL006024**

LOCAL INFORMATION

Environmental Description: Successional Red-cedar Forest includes stands dominated by *Juniperus virginiana* var. *virginiana* (eastern redcedar), typically on former fields and around former homesites. In Richmond National Battlefield Park, these forests occur as very small stands bordering roads and residential areas.

Vegetation Description: In Richmond National Battlefield Park, Successional Red-cedar Forest is an open forest where the trees are typically widely spaced and may have stems of other successional species, such as *Liriodendron tulipifera* (tuliptree), *Sassafras albidum* (sassafras), or *Prunus serotina* var. *serotina* (black cherry), but is always dominated by *Juniperus virginiana* var. *virginiana* (eastern redcedar). The herb layer is often dominated by grasses such as *Andropogon virginicus* (broomsedge bluestem) and *Lolium pratense* (meadow ryegrass) with mixtures of exotic species and other species typical of open disturbed areas.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus virginiana* var. *virginiana* (eastern redcedar)

Characteristic Species: *Juniperus virginiana* var. *virginiana* (eastern redcedar).
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: This association is mapped as two small polygons at Forest Harrison, covering a total of one hectare (2.4 acres).

Classification Comments: Successional Red-cedar Forest is distinguished from other evergreen forests in Richmond National Battlefield Park by being dominated by *Juniperus virginiana* var. *virginiana* (eastern redcedar).

Other Comments: Information not available.
Local Description Authors: K.D. Patterson.
Plots: None.
Richmond National Battlefield Park 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	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c.)
Alliance	*Juniperus virginiana* Semi-natural Forest Alliance (A.137)
Alliance (English name)	Eastern Red-cedar Forest Alliance
Association	*Juniperus virginiana* Forest
Association (English name)	Eastern Red-cedar Forest

Ecological System(s):   Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association is a broadly defined old-field early-successional community occurring in a variety of environmental settings in the northeastern states. Canopy closure and height are variable, as are shrub and herbaceous associates. *Juniperus virginiana* var. *virginiana* (eastern redcedar) dominates the canopy layer. Common associates, typically occurring as scattered individuals, may include *Pinus strobus* (eastern white pine), *Acer rubrum* (red maple), *Quercus* spp. (oaks), and *Prunus serotina* var. *serotina* (black cherry). Shrub cover varies, with the most forested stands having little or no shrub cover. Exotic shrubs such as *Elaeagnus umbellata* (autumn olive), *Lonicera morrowii* (Morrow's honeysuckle), and *Rosa multiflora* (multiflora rose) are characteristic, along with *Rubus* spp. (blackberries). Herbaceous cover likewise varies. Common species in the more open-canopy stands include old-field denizens such as *Schizachyrium scoparium* (little bluestem), *Festuca rubra* (red fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Agrostis gigantea* (redtop), *Andropogon virginicus* (broomsedge bluestem), *Elymus repens* (quackgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Monarda fistulosa* (wild bergamot), *Toxicodendron radicans* (eastern poison ivy), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In dense forest stands, herbs may be absent or limited to scattered shade-tolerant species such as *Alliaria petiolata* (garlic mustard) and *Allium vineale* (wild garlic), and *Dennstaedtia punctilobula* (eastern hayscented fern). These forests are often young and result from the colonization of old agricultural fields by *Juniperus virginiana* var. *virginiana* (eastern redcedar) over native and exotic forbs and grasses. These stands may eventually succeed to other forest types as mid- and late-successional canopy species colonize and subsequently overtop the *Juniperus* (juniper).

Environmental Description: This is a broadly defined old-field early-successional community occurring in a variety of environmental settings, typically on former agricultural land and other disturbed or degraded environmental settings. Soils are mesic to dry-mesic and moderately well-drained to well-drained.

Vegetation Description: *Juniperus virginiana* var. *virginiana* (eastern redcedar) dominates the canopy layer in stands of this type, which ranges from broadly spaced woodlands to dense and nearly impenetrable thickets. Common associates, typically occurring as scattered individuals, may include *Pinus strobus* (eastern white pine), *Acer rubrum* (red maple), *Quercus* spp. (oaks), and *Prunus serotina* var. *serotina* (black cherry). Shrub cover varies according to canopy closure, with the most forested stands having little or no shrub cover. Exotic shrubs such as *Elaeagnus umbellata* (autumn olive), *Lonicera morrowii* (Morrow's honeysuckle), and *Rosa multiflora* (multiflora rose) are most characteristic, along with *Rubus* spp. (blackberries). Herbaceous cover likewise varies. Common species in the more open-canopy stands include old-field denizens such as *Schizachyrium scoparium* (little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Festuca rubra* (red fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Agrostis gigantea* (redtop), *Elymus repens* (quackgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Monarda fistulosa* (wild bergamot), *Toxicodendron radicans* (eastern poison ivy), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In dense forest stands, herbs may be absent or limited to scattered shade-tolerant species such as *Alliaria petiolata* (garlic mustard), *Allium vineale* (wild garlic), and *Dennstaedtia punctilobula* (eastern hayscented fern).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus virginiana* var. *virginiana* (eastern redcedar)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lonicera morrowii* (Morrow's honeysuckle)
Tall shrub/sapling	Needle-leaved tree	*Juniperus virginiana* var. *virginiana* (eastern redcedar)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Elaeagnus umbellata* (autumn olive)
Short shrub/sapling	Broad-leaved deciduous shrub	*Rosa multiflora* (multiflora rose), *Toxicodendron radicans* (eastern poison ivy)
Herb (field)	Forb	*Solidago rugosa* (wrinkleleaf goldenrod)
Herb (field)	Graminoid	*Schizachyrium scoparium* (little bluestem)

Characteristic Species: *Elaeagnus umbellata* (autumn olive), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Lonicera morrowii* (Morrow's honeysuckle), *Rosa multiflora* (multiflora rose), *Schizachyrium scoparium* (little bluestem), *Solidago rugosa* (wrinkleleaf goldenrod), *Toxicodendron radicans* (eastern poison ivy).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is of broad distribution, occurring widely throughout the northeastern U.S. It has been documented from only a limited range but is undoubtedly more widely distributed.

States/Provinces: MA, NJ, NY, PA, VA.

Federal Lands: NPS (Appomattox Court House, Boston Harbor Islands, Cape Cod, Delaware Water Gap, Fire Island, Fredericksburg-Spotsylvania, George Washington Birthplace, Richmond).

CONSERVATION STATUS

Rank: GNA (ruderal) (10-Oct-2001).

Reasons: This forest represents early-successional, modified, or silviculturally managed vegetation and is thus not of conservation concern and does not receive a conservation status rank. This vegetation may be easily restorable by either management, time, or restoration of ecological processes.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: This association is currently very generally defined.

Similar Associations: Information not available.

Related Concepts: Information not available.

SOURCES

Description Authors: L. A. Sneddon, mod. R. E. Zaremba, M. Pyne, S. C. Gawler.

References: Clark 1986, Eastern Ecology Working Group n.d., Sneddon and Lundgren 2001.

Figure I3. Successional Red-cedar Forest at Richmond National Battlefield Park. May 2007.
NAD 1983 / UTM easting 290431, northing 4145355.

COMMON NAME (PARK-SPECIFIC):   **MESIC MIXED HARDWOOD 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: Mesic Mixed Hardwood Forest occurs on mesic lower slopes and ravines throughout Richmond National Battlefield Park.

Vegetation Description: Mesic Mixed Hardwood Forest is a deciduous forest with a canopy composed of variable combinations of *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Liquidambar styraciflua* (sweetgum), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Quercus falcata* (southern red oak). Other species that are associates in the canopy can include *Acer rubrum* (red maple), *Pinus taeda* (loblolly pine), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus michauxii* (swamp chestnut oak), *Quercus muehlenbergii* (chinkapin oak), and *Quercus velutina* (black oak), The subcanopy has species from the canopy and sometimes *Ilex opaca* var. *opaca* (American holly), *Nyssa sylvatica* (blackgum), and *Quercus phellos* (willow oak). Common shrub species include *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Euonymus americanus* (strawberry bush), *Ilex opaca* var. *opaca* (American holly), *Kalmia latifolia* (mountain laurel), and *Lindera benzoin* (northern spicebush). The ground is often dominated by leaf litter with little to no vegetation cover, although the exotic grass *Microstegium vimineum* (Nepalese browntop) may be locally dominant in some stands. The woody vines *Smilax rotundifolia* (roundleaf greenbrier), *Vitis rotundifolia* (muscadine) and the non-native *Lonicera japonica* (Japanese honeysuckle) can also be common on the ground and climbing into the canopy. The most constant herbaceous species are *Athyrium filix-femina* (common ladyfern), *Dichanthelium boscii* (Bosc's panicgrass), *Polystichum acrostichoides* (Christmas fern), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Mitchella repens* (partridgeberry), and *Polygonatum biflorum* var. *biflorum* (smooth Solomon's-seal). Other characteristic species include *Carex laxiculmis* var. *laxiculmis*, *Carex albicans* (whitetinge sedge), *Chimaphila maculata* (striped prince's pine), *Galium circaezans* (licorice bedstraw), *Goodyera pubescens* (downy rattlesnake plantain), *Hexastylis virginica* (Virginia heartleaf), *Medeola virginiana* (Indian cucumber), *Sanicula canadensis* (Canadian blacksnakeroot), and *Thelypteris noveboracensis* (New York fern).

The dominant canopy species may vary from stand to stand and include *Liriodendron tulipifera* (tuliptree), *Quercus alba* (white oak), *Fagus grandifolia* (American beech), *Quercus rubra* (northern red oak), or *Liquidambar styraciflua* (sweetgum), or variable combinations of these species. Disturbed examples or those grading into Loblolly Pine - Hardwood Forest may have some *Pinus taeda* (loblolly pine) in the canopy and more cover of exotic species such as *Microstegium vimineum* (Nepalese browntop) or *Lonicera japonica* (Japanese honeysuckle). Polygons mapped as this type may contain small (less than 0.5 hectare) inclusions of Coastal

Plain Acidic Seepage Swamp where the polygons cross ravine bottoms. Streamside examples may include small floodplain terraces with small amounts of *Platanus occidentalis* (American sycamore) or *Acer rubrum* (red maple) in the canopy.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Quercus alba* (white oak)
Tree subcanopy	Broad-leaved evergreen tree	*Ilex opaca* var. *opaca* (American holly)

Characteristic Species: *Carex laxiculmis* var. *laxiculmis*, *Fagus grandifolia* (American beech), *Ilex opaca* var. *opaca* (American holly), *Liriodendron tulipifera* (tuliptree), *Polystichum acrostichoides* (Christmas fern), *Quercus alba* (white oak).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR*	B	1	Mesic Mixed Hardwood Forest	Fleming et al. 2001

Local Range: Mesic Mixed Hardwood Forest is mapped as 20 polygons throughout Richmond National Battlefield Park, covering 80.9 hectares (200 acres).

Classification Comments: Mesic Mixed Hardwood Forest is distinguished from Successional Tuliptree Forest and Loblolly Pine - Hardwood Forest by having a more diverse canopy and a less "weedy," more diverse herbaceous stratum, often with *Fagus grandifolia* (American beech) and/or *Quercus* spp. (oaks) dominant in the canopy. Stands of Mesic Mixed Hardwood Forest that are dominated by *Liriodendron tulipifera* (tuliptree) have multiple age classes in the canopy, rather than being even-aged like Successional Tuliptree Forest, and have canopy / subcanopy associates of other mesic hardwood species. Some stands mapped at Mesic Mixed Hardwood may be difficult to distinguish from Acidic Oak - Hickory Forest and may be transitional to this association.

Other Comments: Much of the evergreen photo-signature in polygons of Mesic Mixed Hardwood Forest is from *Ilex opaca* var. *opaca* (American holly) in the understory.

Local Description Authors: K. D. Patterson.

Plots: RICH.4, RICH.10.

Richmond National Battlefield Park 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 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* (American beech), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera* (tuliptree) in various proportions. Overstory associates over the range include *Quercus velutina* (black oak), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), and *Fraxinus americana* (white ash). The subcanopy is characterized by young *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), and *Sassafras albidum* (sassafras). *Ilex opaca* var. *opaca* (American holly) is particularly characteristic and abundant on the Coastal Plain. The shrub layer varies from very sparse to well-developed and can include *Asimina triloba* (pawpaw), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum dentatum* (southern arrowwood), and *Euonymus americanus* (strawberry bush). Heath shrubs, such as *Vaccinium corymbosum* (highbush blueberry) and *Vaccinium pallidum* (Blue Ridge blueberry), may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia* (Virginia creeper), *Smilax glauca* (cat greenbrier), and *Toxicodendron radicans* (eastern poison ivy). In the southern part of the range, *Oxydendrum arboreum* (sourwood) and *Vitis rotundifolia* (muscadine) may be conspicuous members of the understory. The herb layer is comprised of *Polystichum acrostichoides* (Christmas fern), *Thelypteris noveboracensis* (New York fern), *Uvularia perfoliata* (perfoliate bellwort), *Cypripedium acaule* (moccasin flower), *Mitchella repens* (partridgeberry), *Tipularia discolor* (crippled cranefly), *Goodyera pubescens* (downy rattlesnake plantain), *Eurybia divaricata* (white wood aster), *Chimaphila maculata* (striped prince's pine), *Carex swanii* (Swan's sedge), *Medeola virginiana* (Indian cucumber), *Athyrium filix-femina* (common ladyfern), *Carex digitalis* (slender woodland sedge), *Carex willldenowii* (Willdenow's sedge), *Epifagus virginiana* (beechdrops), *Maianthemum canadense* (Canada mayflower), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Polygonatum biflorum* (smooth Solomon's seal), *Podophyllum peltatum* (mayapple), *Arisaema triphyllum* (Jack in the pulpit), and *Maianthemum racemosum* (feathery false lily of the valley).

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 southeastern Virginia northward.

Vegetation Description: Rangewide, this vegetation type is characteristically a mixed mesophytic forest dominated by *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera* (tuliptree) in various proportions. Overstory associates over the range include *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus velutina* (black oak), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and *Fraxinus americana* (white ash). The subcanopy is characterized by

young *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Ilex opaca* var. *opaca* (American holly), and *Sassafras albidum* (sassafras). The shrub layer varies from very sparse to well-developed and can include *Asimina triloba* (pawpaw), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum dentatum* (southern arrowwood), and *Euonymus americanus* (strawberry bush). Heath shrubs, such as *Vaccinium corymbosum* (highbush blueberry) and *Vaccinium pallidum* (Blue Ridge blueberry), may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia* (Virginia creeper), *Smilax glauca* (cat greenbrier), and *Toxicodendron radicans* (eastern poison ivy). The herb layer is comprised of *Polystichum acrostichoides* (Christmas fern), *Uvularia perfoliata* (perfoliate bellwort), *Cypripedium acaule* (moccasin flower), *Mitchella repens* (partridgeberry), *Tipularia discolor* (crippled cranefly), *Goodyera pubescens* (downy rattlesnake plantain), *Eurybia divaricata* (white wood aster), *Chimaphila maculata* (striped prince's pine), *Carex swanii* (Swan's sedge), *Medeola virginiana* (Indian cucumber), *Athyrium filix-femina* (common ladyfern), *Carex digitalis* (slender woodland sedge), *Carex willldenowii* (Willldenow's sedge), *Epifagus virginiana* (beechdrops), *Maianthemum canadense* (Canada mayflower), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Polygonatum biflorum* (smooth Solomon's seal). *Podophyllum peltatum* (mayapple), *Arisaema triphyllum* (Jack in the pulpit), and *Maianthemum racemosum* (feathery false lily of the valley).

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

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Quercus alba* (white oak)
Tree subcanopy	Broad-leaved deciduous tree	*Cornus florida* (flowering dogwood)
Tree subcanopy	Broad-leaved evergreen tree	*Ilex opaca* var. *opaca* (American holly)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Viburnum acerifolium* (mapleleaf viburnum)
Shrub/sapling (tall & short)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
Herb (field)	Forb	*Podophyllum peltatum* (mayapple), *Polygonatum biflorum* (smooth Solomon's seal)
Herb (field)	Fern or fern ally	*Polystichum acrostichoides* (Christmas fern)

Characteristic Species: *Carex laxiculmis* var. *laxiculmis*, *Fagus grandifolia* (American beech), *Ilex opaca* var. *opaca* (American holly), *Quercus alba* (white oak), *Viburnum acerifolium* (mapleleaf viburnum).

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: DC, DE:S5, MD, NJ:S3, NY, PA:S1, VA:S5.

Federal Lands: DOD (Fort A.P. Hill, Fort Belvoir, Kerr Reservoir, Yorktown); NPS (Appomattox Court House, C&O Canal, Colonial, Fredericksburg-Spotsylvania, George Washington Parkway, National Capital-East, Petersburg, Prince William, Richmond, Rock Creek, Sagamore Hill, Shenandoah, Thomas Stone); USFWS (James River, Prime Hook).

CONSERVATION STATUS

Rank: G5 (31-Jan-2007).

Reasons: This association is common and widespread on the northeastern Coastal Plain and the Piedmont in Virginia and Maryland.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: The regional circumscription of this type is very robust and supported by 170 plots from Virginia, Maryland, and the District of Columbia. These were analyzed by VDNH with a 1300-plot regional dataset compiled for the NCR and mid-Atlantic national parks vegetation mapping projects.

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 acrostichoides - 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.) ?
- *Fagus grandifolia - Quercus alba - Liriodendron tulipifera - Liquidambar styraciflua* Forest (Bartgis 1986) ?
- *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 1993, 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, Soil Conservation Service 1987.

Figure I4. Mesic Mixed Hardwood Forest (plot RICH.10) at Richmond National Battlefield Park. June 2005. NAD 1983 / UTM easting 285568, northing 4144332.

COMMON NAME (PARK-SPECIFIC):   SUCCESSIONAL BLACK WALNUT FOREST

SYNONYMS
USNVC English Name: **Black Walnut / Wingstem Forest**
USNVC Scientific Name: *Juglans nigra / Verbesina alternifolia* **Forest**
USNVC Identifier: **CEGL007879**

LOCAL INFORMATION

Environmental Description: Successional Black Walnut occurs on disturbed flat areas over soils that appear to have a calcareous influence. High soil fertility on these sites may be the result of past enrichment by livestock or cultivation.

Vegetation Description: Successional Black Walnut Forest is a disturbed forest dominated by *Juglans nigra* (black walnut), *Celtis occidentalis* (common hackberry), and *Liquidambar styraciflua* (sweetgum). Other species in the canopy include *Liriodendron tulipifera* (tuliptree), *Pinus taeda* (loblolly pine), and *Ulmus alata* (winged elm). Tall shrubs are *Cercis canadensis* (eastern redbud), *Prunus serotina* var. *serotina* (black cherry), *Morus rubra* (red mulberry), and *Juniperus virginiana* var. *virginiana* (eastern redcedar). The herb layer is a carpet of *Microstegium vimineum* (Nepalese browntop) with scattered clumps of *Elymus hystrix* (eastern bottlebrush grass).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	Juglans nigra (black walnut)

Characteristic Species: *Celtis occidentalis* (common hackberry), *Cercis canadensis* (eastern redbud), *Juglans nigra* (black walnut).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: Successional Black Walnut is mapped as a single polygon at the southern end of the Fort Harrison unit (Fort Brady).

Classification Comments: Information not available.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park 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	*Juglans nigra* Forest Alliance (A.1932)
Alliance (English name)	Black Walnut Forest Alliance
Association	*Juglans nigra / Verbesina alternifolia* Forest
Association (English name)	Black Walnut / Wingstem Forest

Ecological System(s):   South-Central Interior Large Floodplain (CES202.705).
                                  Southern Interior Low Plateau Dry-Mesic Oak Forest (CES202.898).

GLOBAL DESCRIPTION

Concept Summary: This successional black walnut forest of the Southeast, ranging from Virginia to Georgia, occurs largely on former homesites, usually on disturbed soils having a neutral to basic pH. The community was originally defined from former homesites in Great Smoky Mountains National Park, where this association is an open, successional forest. It has since been found on some old pasture sites, associated with former settlement, and is potentially a wide-ranging type. The canopy can be closed to somewhat open. *Juglans nigra* (black walnut) is often the sole canopy tree, though *Liriodendron tulipifera* (tuliptree), *Juglans cinerea* (butternut), *Robinia pseudoacacia* (black locust), *Morus rubra* (red mulberry), and *Aesculus flava* (yellow buckeye) are codominants in some examples. Associates can also include *Platanus occidentalis* (American sycamore), *Fraxinus americana* (white ash), and *Ulmus rubra* (slippery elm); *Sassafras albidum* (sassafras) may be present as a small tree. The herb stratum is dominated by *Verbesina alternifolia* (wingstem) and/or *Ageratina altissima* (white snakeroot). Other herbs include *Amphicarpaea bracteata* (American hogpeanut), *Agrimonia pubescens* (soft agrimony), *Galium triflorum* (fragrant bedstraw), *Osmorhiza longistylis* (longstyle sweetroot), *Viola striata* (striped cream violet), and *Ambrosia trifida* (great ragweed). The exotics *Rosa multiflora* (multiflora rose) and *Microstegium vimineum* (Nepalese browntop) can be common in this community.

Environmental Description: This community often occurs on former homesites along streams or on slopes, possibly in association with circumneutral soils. It was originally defined from former homesites in Great Smoky Mountains National Park, where this association is an open, successional forest. This community was sampled on former homesites along streams, possibly in association with circumneutral soils, at 460–610 m (1500–2000 feet) elevation in the Smokies, as well as on ridgetops, slopes, and stream areas in the Cumberlands and Alleghenies at 460–1070 m (1500–3500 feet). In addition, the association was sampled from the Piedmont of South Carolina in low-lying, poor-drainage areas from approximately 170–200 m (550–650 feet) in elevation.

Vegetation Description: *Juglans nigra* (black walnut) is often the sole canopy tree, though *Liriodendron tulipifera* (tuliptree), *Juglans cinerea* (butternut), *Celtis laevigata* (sugarberry), and *Aesculus flava* (yellow buckeye) are dominant or codominant in some examples. Associates can also include *Platanus occidentalis* (American sycamore), *Fraxinus americana* (white ash), and *Ulmus rubra* (slippery elm); *Sassafras albidum* (sassafras) or *Cercis canadensis* (eastern redbud) may be present as small trees. The herb stratum is highly variable, often dominated by *Verbesina alternifolia* (wingstem) and/or *Verbesina alternifolia* (wingstem). Other herbs include *Amphicarpaea bracteata* (American hogpeanut), *Agrimonia pubescens* (soft agrimony), *Galium triflorum* (fragrant bedstraw), *Osmorhiza longistylis* (longstyle sweetroot), *Viola striata* (striped cream violet), and *Ambrosia trifida* (great ragweed). The exotic *Rosa multiflora* (multiflora rose) can be common in this community.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Juglans nigra* (black walnut)
Herb (field)	Forb	*Verbesina alternifolia* (wingstem)

Characteristic Species: *Cercis canadensis* (eastern redbud), *Juglans nigra* (black walnut), *Rosa multiflora* (multiflora rose), *Verbesina alternifolia* (wingstem).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

Range: This potentially widespread association is currently known from Tennessee and Kentucky east to the Carolinas and north to Virginia and West Virginia. It may range into adjacent states.
States/Provinces: GA, KY, NC, SC, TN, VA, WV.
Federal Lands: DOD (Camp Dawson); NPS (Appomattox Court House, Big South Fork, Blue Ridge Parkway, Chickamauga-Chattanooga, Colonial, Cumberland Gap, Great Smoky Mountains, Kings Mountain, Mammoth Cave, Ninety Six, Richmond).

CONSERVATION STATUS
Rank: GNA (ruderal) (2-Apr-2001).
Reasons: This vegetation represents vegetation created by anthropogenic disturbance and is thus not a conservation priority. Grank changed from GW to GD 2001-04-02 MP.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 - Weak.
Comments: This association was originally described from Great Smoky Mountains National Park where this association can be distinguished with aerial photography.
Similar Associations:
- *Prunus serotina - Liriodendron tulipifera - Acer rubrum - Fraxinus americana* Forest (CEGL006599)--is a modified successional forest that may also have a large component of *Juglans nigra* and occurs on disturbed sites, but it is largely dominated by early-successional trees in the canopy.
Related Concepts:
- Successional black walnut forest (Vanderhorst 2001) =

SOURCES
Description Authors: K. D. Patterson, mod. R. White and S. C. Gawler.
References: NatureServe Ecology - Southeastern U.S. unpubl. data, Peet et al. unpubl. data 2002, Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001.

Figure I5. Successional Black Walnut Forest at Richmond National Battlefield Park. May 2007.
NAD 1983 / UTM easting 291030, northing 4140981.

COMMON NAME (PARK-SPECIFIC):   SUCCESSIONAL TULIPTREE FOREST

SYNONYMS
USNVC English Name: **Tuliptree - Oak species Forest**
USNVC Scientific Name: *Liriodendron tulipifera - Quercus* **spp. Forest**
USNVC Identifier: **CEGL007221**

LOCAL INFORMATION

Environmental Description: Successional Tuliptree Forest is an upland deciduous forest that develops on clearcuts and old fields, or on areas cleared by fire or other natural disturbances.
Vegetation Description: The canopy is deciduous, typically even-aged and predominately comprised of early-successional species. This forest is typically dominated by *Liriodendron tulipifera* (tuliptree) and/or *Liquidambar styraciflua* (sweetgum). *Pinus taeda* (loblolly pine) and *Acer rubrum* (red maple) may also be common in the canopy. Other canopy associates can vary with environmental setting. Species from the canopy are common in the subcanopy as are *Nyssa sylvatica* (blackgum) and *Prunus serotina* var. *serotina* (black cherry), although other species can occur. The shrub layers are variable. *Acer rubrum* (red maple), *Ilex opaca* var. *opaca* (American holly), and the exotic *Ailanthus altissima* (tree of heaven) are common. Vines can cover large areas, draping over trees and shrubs and dominating canopy openings. Common vines are the exotic species *Lonicera japonica* (Japanese honeysuckle), as well as *Toxicodendron radicans* (eastern poison ivy) and *Vitis rotundifolia* (muscadine). The ground layer is variable but is commonly dominated by either *Lonicera japonica* (Japanese honeysuckle) or a carpet of the exotic grass *Microstegium vimineum* (Nepalese browntop). Typical herbaceous species can by weedy or exotic species such as *Lycopodium obscurum* (rare clubmoss), *Galium aparine* (stickywilly), *Phytolacca americana* (American pokeweed), *Polygonum caespitosum* var. *longisetum* (oriental ladysthumb), and *Verbesina alternifolia* (wingstem). On other sites, herbs typical of mesic hardwood forests can be found, including *Desmodium nudiflorum* (nakedflower ticktrefoil), *Polystichum acrostichoides* (Christmas fern), and *Thelypteris noveboracensis* (New York fern).

In Richmond National Battlefield Park, canopy dominance varies from pure *Liriodendron tulipifera* (tuliptree) to pure *Liquidambar styraciflua* (sweetgum). The relative dominance of *Liquidambar styraciflua* (sweetgum) increases with soil moisture, and it tends to dominate in ravine bottoms and near wetlands. Near disturbed field edges, the canopy may be very open, with vines dominating the vegetation cover.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree)
Herb (field)	Vine/Liana	*Lonicera japonica* (Japanese honeysuckle)
Herb (field)	Graminoid	*Microstegium vimineum* (Nepalese browntop)

Characteristic Species: *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Lonicera japonica* (Japanese honeysuckle), *Microstegium vimineum* (Nepalese browntop).
Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: Successional Tuliptree Forest is mapped as 13 polygons throughout Richmond National Battlefield Park. It covers a total of 48 hectares (119 acres).

Classification Comments: Successional Tuliptree Forest is distinguished from other upland deciduous forest types in Richmond National Battlefield Park by having a canopy dominated by *Liriodendron tulipifera* (tuliptree) or *Liquidambar styraciflua* (sweetgum) and species-poor shrub and herb strata composed primarily of weedy and exotic species. This forest tends to be even-aged and often has coppice regeneration, unlike Mesic Mixed Hardwood Forest. Additionally, Successional Tuliptree Forest lacks the canopy / subcanopy diversity typical in Mesic Mixed Hardwood Forest stands. Even though this forest may contain *Pinus taeda* (loblolly pine), it is distinguished from Loblolly Pine - Hardwood Forest by having less than 25% canopy cover of *Pinus taeda* (loblolly pine) in a polygon.

Other Comments: Areas around Gaines Mill (Watt House) have been cleared since February 2002, when the photos used for this mapping project were acquired. Vegetation is mapped based on the 2002 photography; thus some areas that were forested on the base map may now be open field (Cultural Meadow). At Malvern Hill, a small stand (2.8 hectares [7 acres]) of this association has been influenced by beaver activity and has a small inclusion of disturbed seasonally flooded forest within the area mapped as Successional Tuliptree Forest. Older stands mapped as Successional Tuliptree Forest may be transitional to and confused with Mesic Mixed Hardwood Forest.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park 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 - Quercus* spp. Forest
Association (English name)	Tuliptree - Oak species Forest
Ecological System(s):	Southern Coastal Plain Mesic Slope Forest (CES203.476).
	Southern Interior Low Plateau Dry-Mesic Oak Forest (CES202.898).
	East Gulf Coastal Plain Northern Dry Upland Hardwood Forest (CES203.483).
	Allegheny-Cumberland Dry Oak Forest and Woodland (CES202.359).

GLOBAL DESCRIPTION

Concept Summary: This broadly defined semi-natural or successional community is one of several described upland associations dominated by *Liriodendron tulipifera* (tuliptree). It ranges from the southern Cumberland Plateau, Piedmont, and Interior Low Plateau of the southeastern U.S. north to the northern Piedmont of New Jersey. These successional forests often follow cropping, clearcut logging, or other severe disturbance, and are successional to mixed oak-hickory forests. Examples are common across large areas of the upland landscape which have

previously been disturbed. Soils usually exhibit evidence of disturbance and may have little to no organic horizon development. Environmental setting is variable, ranging from level to gently sloping uplands to well-drained floodplains and stream terraces. Species found in stands attributable to this type may include a fairly diverse and varied composition. *Acer rubrum* (red maple), *Quercus* spp. (oaks), and occasionally *Liquidambar styraciflua* (sweetgum) or *Robinia pseudoacacia* (black locust) may be common in stands of this type; *Betula lenta* (sweet birch) often occurs at the northern end of the range. The oaks in these stands are frequently multi-stemmed, resulting from coppicing. Shrub composition is variable but may include *Sambucus canadensis* (= *Sambucus nigra* ssp. *canadensis*, common elderberry) and *Vaccinium pallidum* (Blue Ridge blueberry). Herbs are likewise variable; West Virginia samples feature *Dioscorea quaternata* (fourleaf yam), *Lysimachia quadrifolia* (whorled yellow loosestrife), *Maianthemum racemosum* (feathery false lily of the valley), *Solidago curtisii* (mountain decumbent goldenrod), *Symphyotrichum prenanthoides* (crookedstem aster), and *Geranium maculatum* (spotted geranium). This association differs from other described types in the alliance based on the lack of a significant pine component [see *Liriodendron tulipifera - Pinus taeda* Forest (CEGL007521)] and the absence of species affiliated with circumneutral conditions [see *Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest (CEGL007220)]; it is later successional and more diverse than *Liriodendron tulipifera* Forest (CEGL007218) or *Liriodendron tulipifera - Robinia pseudoacacia* Forest (CEGL007219).

Environmental Description: These semi-natural upland deciduous forests are found primarily in areas which were once clearcuts, old fields, or were cleared by fire or other natural disturbances. These successional forests often follow cropping, clearcut logging, or other severe disturbance, and are successional to mixed oak-hickory forests. Examples are common across large areas of the upland landscape which have previously been disturbed. Soils usually exhibit evidence of disturbance and may have little to no organic horizon development. Environmental setting is variable, ranging from level to gently sloping uplands to well-drained floodplains and stream terraces.

Vegetation Description: The canopy of this semi-natural upland association is dominated by *Liriodendron tulipifera* (tuliptree). *Quercus* (oak) species (*Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Quercus falcata* (southern red oak), *Quercus nigra* (water oak), *Quercus velutina* (black oak)) are often present; additional associates may include *Acer rubrum* (red maple), *Carya* spp. (hickories), *Fagus grandifolia* (American beech), *Nyssa sylvatica* (blackgum), *Cornus florida* (flowering dogwood), and *Robinia pseudoacacia* (black locust). *Betula lenta* (sweet birch) is a common associate at the northern range limit. Shrub layers may include saplings of the canopy species and *Acer pensylvanicum* (striped maple), *Amelanchier arborea* (common serviceberry), *Hamamelis virginiana* (American witchhazel), *Lindera benzoin* (northern spicebush) (in small amounts), and *Vaccinium pallidum* (Blue Ridge blueberry). Herbs vary across the range but may include *Actaea racemosa* (= Cimicifuga racemosa, Black bugbane), *Dichanthelium clandestinum* (deertongue), *Dioscorea quaternata* (fourleaf yam), *Galium circaezans* (licorice bedstraw), *Geranium maculatum* (spotted geranium), *Goodyera pubescens* (downy rattlesnake plantain), *Medeola virginiana* (Indian cucumber), *Potentilla simplex* (common cinquefoil), *Scutellaria serrata* (showy skullcap), *Thelypteris noveboracensis* (New York fern), and *Uvularia perfoliata* (perfoliate bellwort). *Lycopodium obscurum* (rare clubmoss) may be abundant in some stands.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Liriodendron tulipifera* (tuliptree)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Cornus florida* (flowering dogwood)
Herb (field)	Fern or fern ally	*Lycopodium obscurum* (rare clubmoss)

Characteristic Species: *Acer pensylvanicum* (striped maple), *Acer rubrum* (red maple), *Actaea racemosa* (= Cimicifuga racemosa. Black bugbane), *Amelanchier arborea* (common serviceberry), *Carya glabra* (pignut hickory), *Dichanthelium clandestinum* (deertongue), *Fagus grandifolia* (American beech), *Galium circaezans* (licorice bedstraw), *Geranium maculatum* (spotted geranium), *Goodyera pubescens* (downy rattlesnake plantain), *Hamamelis virginiana* (American witchhazel), *Lycopodium obscurum* (rare clubmoss), *Medeola virginiana* (Indian cucumber), *Nyssa sylvatica* (blackgum), *Quercus falcata* (southern red oak), *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), *Robinia pseudoacacia* (black locust), *Thelypteris noveboracensis* (New York fern), *Uvularia perfoliata* (perfoliate bellwort), *Vaccinium pallidum* (Blue Ridge blueberry).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is known from the southern Cumberland Plateau, Piedmont, and Interior Low Plateau of the southeastern U.S. and may also occur in the Upper East Gulf Coastal Plain. It ranges north to the northern Piedmont of New Jersey and adjacent Pennsylvania. It is also known from Alabama, Georgia, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, West Virginia, and possibly Virginia and Delaware.

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

Federal Lands: DOD (Camp Dawson, Fort Benning); NPS (Appomattox Court House, Big South Fork, Blue Ridge Parkway, Booker T. Washington, Chickamauga-Chattanooga?, Cowpens, Cumberland Gap, Fredericksburg-Spotsylvania, Guilford Courthouse, Kennesaw Mountain, Kings Mountain, Mammoth Cave, Morristown, Natchez Trace, New River Gorge, Ninety Six, Obed, Petersburg, Richmond, Shiloh, Valley Forge); USFS (Bankhead, Daniel Boone, Oconee?, Talladega, Talladega (Oakmulgee)?, Talladega (Talladega)).

CONSERVATION STATUS

Rank: GNA (ruderal) (19-Aug-2002).

Reasons: This forest represents early-successional vegetation and is thus not of conservation concern. This is a successional vegetation type composed of native species. Its conservation value is limited, but mature examples could provide buffer for communities of greater conservation value.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Within its range, it differs from other described types based on the lack of a significant pine component [see *Liriodendron tulipifera - Pinus taeda* Forest (CEGL007521)] and the absence of species affiliated with circumneutral conditions [see *Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest (CEGL007220)]; it is later successional and more diverse than *Liriodendron tulipifera* Forest (CEGL007218) and tends to be found on more stable soil substrates and less steep slopes than *Liriodendron tulipifera - Robinia pseudoacacia* Forest (CEGL007219).

Similar Associations:

- *Liriodendron tulipifera - Acer negundo* Forest (CEGL007184)--a bottomland type.
- *Liriodendron tulipifera - Robinia pseudoacacia* Forest (CEGL007219)--is generally found on steeper slopes and/or shallow soils and with a more intense history of disturbance.
- *Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest (CEGL007220)--is generally found on calcareous or at least pH neutral soils.
- *Prunus serotina - Liriodendron tulipifera - Acer rubrum - Fraxinus americana* Forest (CEGL006599).
- *Prunus serotina - Sassafras albidum - (Fraxinus americana) / Juniperus virginiana* Forest (CEGL004133).

Related Concepts:

- Successional forest of low-elevation plateaus (Vanderhorst 2001) B
- Tulip Poplar Type (Schmalzer and DeSelm 1982) B
- Yellow poplar community (Ehrenfeld 1977) =

SOURCES

Description Authors: R.E. Evans and M. Pyne, mod. L.A. Sneddon, R. White, S.C. Gawler.

References: Ehrenfeld 1977, Gallyoun et al. 1996, Keever 1973, NatureServe Ecology - Southeastern U.S. unpubl. data, Overlease 1987, Russell and Schuyler 1988, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001, Vanderhorst and Streets 2006.

Figure I6. Successional Tuliptree Forest at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 300536, northing 4143132.

COMMON NAME (PARK-SPECIFIC):   ACIDIC OAK - HICKORY FOREST

SYNONYMS

USNVC English Name:	**White Oak - Northern Red Oak - Mockernut Hickory / Flowering Dogwood / Deerberry / Naked-stem Tick-trefoil Piedmont Forest**
USNVC Scientific Name:	***Quercus alba - Quercus rubra - Carya alba / Cornus florida / Vaccinium stamineum / Desmodium nudiflorum* Piedmont Forest**
USNVC Identifier:	**CEGL008475**

LOCAL INFORMATION

Environmental Description: Acidic Oak - Hickory Forest is found on lower slopes and rolling upland areas of Richmond National Battlefield Park.

Vegetation Description: Acidic Oak - Hickory Forest is a deciduous forest with overstory composition that varies somewhat from stand to stand but is dominated by mixtures of oaks and hickories, typically *Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Quercus falcata* (southern red oak), *Quercus velutina* (black oak), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), and *Carya ovalis* (red hickory). *Quercus alba* (white oak) and/or *Quercus rubra* (northern red oak) are usually the leading oak dominants in these forests. Other trees that can occur in the canopy and subcanopy, usually with less cover, include *Acer rubrum* (red maple), *Fagus grandifolia* (American beech), *Fraxinus americana* (white ash), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Nyssa sylvatica* (blackgum), *Pinus taeda* (loblolly pine), *Quercus coccinea* (scarlet oak), and *Quercus stellata* (post oak). The shrub layer is usually open and composed of species from the canopy layers, as well as *Amelanchier arborea* (common serviceberry), *Cornus florida* (flowering dogwood), *Diospyros virginiana* (common persimmon), *Ilex opaca* var. *opaca* (American holly), and *Sassafras albidum* (sassafras). The low-shrub / herb layer is often very sparse in cover but diverse in species, characteristically with mixtures of woody seedlings, vines, ericaceous shrubs, sedges, grasses, and forbs. The heath species *Gaylussacia frondosa* (blue huckleberry), *Vaccinium pallidum* (Blue Ridge blueberry), and *Vaccinium stamineum* (deerberry) can have patchy cover in this forest, and the vine *Vitis rotundifolia* (muscadine) often covers large areas. Typical grasses and sedges in this forest are *Carex albicans* (whitetinge sedge), *Carex cephalophora* (oval-leaf sedge), *Carex hirsutella* (fuzzy wuzzy sedge), *Carex pensylvanica* (Pennsylvania sedge), *Carex swanii* (Swan's sedge), *Carex willldenowii* (Willdenow's sedge), *Danthonia spicata* (poverty oatgrass), *Dichanthelium boscii* (Bosc's panicgrass), *Dichanthelium commutatum* (variable panicgrass), and *Dichanthelium dichotomum* (cypress panicgrass). Common forbs are *Antennaria plantaginifolia* (woman's tobacco), *Aristolochia serpentaria* (Virginia snakeroot), *Asplenium platyneuron* (ebony spleenwort), *Chimaphila maculata* (striped prince's pine), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Erechtites hieraciifolia* var. *hieraciifolia* (American burnweed), *Galium circaezans* (licorice bedstraw), *Hieracium gronovii* (queendevil), *Houstonia purpurea* var. *purpurea* (Venus' pride), *Ipomoea pandurata* (man of the earth), *Lespedeza violacea* (violet lespedeza), *Mitchella repens* (partridgeberry), *Polygonatum biflorum* (smooth Solomon's seal), *Polystichum acrostichoides* (Christmas fern), *Prenanthes serpentaria* (cankerweed), *Sanicula canadensis* (Canadian blacksnakeroot), *Silene caroliniana* ssp. *pensylvanica* (Pennsylvania catchfly), and *Trachelospermum difforme* (climbing dogbane).

Examples affected by deer browsing may have little herb cover and be difficult to distinguish from Coastal Plain Mixed Oak / Heath Forest with low to moderate heath cover. Forests with wind damage from recent hurricanes may have canopy openings with weedy or ruderal species. Most examples of Acidic Oak - Hickory Forest in Richmond National Battlefield Park are mature with large trees, however, younger stands with small trees are possible.

Disturbed examples may have large, open grown *Quercus falcata* (southern red oak) occurring with multi-stemmed (coppice) trees, indicating that the areas may have once been more open (pasture) and that some trees have resprouted after the above-ground portions were removed by disturbance (logging, wind, clearing). Disturbed examples tend to have lower species diversity, higher cover of *Liquidambar styraciflua* (sweetgum), and higher ground cover of bare leaf litter with weedy herbs and woody vines. Typical vines in disturbed examples are *Campsis radicans* (trumpet creeper), *Lonicera japonica* (Japanese honeysuckle), *Smilax rotundifolia* (roundleaf greenbrier), and *Vitis rotundifolia* (muscadine). Areas where wind or other disturbance has opened the canopy may have more cover by herbaceous species; *Andropogon virginicus* (broomsedge bluestem), *Chasmanthium laxum* (slender woodoats), *Danthonia spicata* (poverty oatgrass), and *Hypericum hypericoides* (St. Andrew's cross) are typical.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Quercus alba* (white oak), *Quercus rubra* (northern red oak)

Characteristic Species: *Carex albicans* (whitetinge sedge), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Carya ovalis* (red hickory), *Desmodium nudiflorum* (nakedflower ticktrefoil).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR*	B	1	Acidic Oak - Hickory Forest	Fleming et al. 2001

Local Range: Acidic Oak - Hickory Forest is mapped as 14 polygons in the Fort Darling, Malvern Hill, and Fort Harrison units of Richmond National Battlefield Park. It covers a total of 45 hectares (111.6 acres), 30 hectares (74 acres) of which are considered to be atypical, disturbed examples.

Classification Comments: Although Acidic Oak - Hickory Forest may have low to moderate cover of heath species in the shrub layer, it is distinguished from Oak / Heath by having greater species diversity in all layers. Typically, this forest has twice the species richness of Coastal Plain Mixed Oak / Heath Forest. It is distinguished by a greater herb diversity and by the relative importance of *Carya* spp. (hickories) in the canopy and subcanopy layers. Disturbed stands do not have the typical species composition and diversity (see above) and polygons considered disturbed examples of this association are labeled as "disturbed" in the comment field of the vegetation map attribute table.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.

Plots: RICH.1, RICH.9.

Richmond National Battlefield Park 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 alba - (Quercus rubra, Carya* spp.) Forest Alliance (A.239)
Alliance (English name)	White Oak - (Northern Red Oak, Hickory species) Forest Alliance
Association	*Quercus alba - Quercus rubra - Carya alba / Cornus florida / Vaccinium stamineum / Desmodium nudiflorum* Piedmont Forest
Association (English name)	White Oak - Northern Red Oak - Mockernut Hickory / Flowering Dogwood / Deerberry / Naked-stem Tick-trefoil Piedmont Forest
Ecological System(s):	Northern Atlantic Coastal Plain Hardwood Forest (CES203.475).
	Northeastern Interior Dry-Mesic Oak Forest (CES202.592).
	Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).
	Piedmont Hardpan Woodland and Forest (CES202.268).

GLOBAL DESCRIPTION

Concept Summary: This forest is found on submesic to subxeric upland sites throughout the Piedmont of the Carolinas, Virginia, south-central Maryland, and possibly Georgia. It favors mid- to upper-slope positions with northerly or easterly aspects, or mid- to lower slopes with more southerly aspects. In drier landscapes, this type occupies habitats considered relatively mesic (e.g., concave slopes, lower slopes, shallow ravines). These sites are described as dry to intermediate in soil moisture. The soils are moderately to strongly acidic and nutrient-poor, being weathered primarily from felsic metamorphic, metasedimentary, and sedimentary rocks, or composed of unconsolidated sediments. At some sites, soils are weathered from interbedded metasedimentary and mafic rocks, resulting in soil chemistry that is intermediate or slightly basic. Stands of this forest are closed to somewhat open and are dominated by mixtures of oaks and hickories, with *Quercus alba* (white oak) being most prevalent, along with *Quercus rubra* (northern red oak), *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus falcata* (southern red oak), *Carya alba* (mockernut hickory), *Carya ovalis* (red hickory), and *Carya glabra* (pignut hickory). *Carya* spp. (hickories) are common in this type but often most abundant in the understory. In forests with a history of disturbance, such as selective logging or windstorms, early-successional species such as *Liriodendron tulipifera* (tuliptree) or *Pinus* sp. (a pine) may codominate. In Virginia examples, *Quercus prinus* (chestnut oak) is inconstant but sometimes important. In addition, *Pinus* spp. (pines), *Liriodendron tulipifera* (tuliptree), *Liquidambar styraciflua* (sweetgum), and *Acer rubrum* (red maple) may be common. Understory species include *Acer rubrum* (red maple), *Cornus florida* (flowering dogwood), *Oxydendrum arboreum* (sourwood), *Ilex opaca* var. *opaca* (American holly), and *Nyssa sylvatica* (blackgum). Shrubs include *Vaccinium stamineum* (deerberry), *Vaccinium pallidum* (Blue Ridge blueberry), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum rafinesquianum* (downy arrowwood), and *Euonymus americanus* (strawberry bush). The woody vines *Vitis rotundifolia* (muscadine) and *Toxicodendron radicans* (eastern poison ivy) often are present. Herbs vary from sparse to moderately dense, with dry-mesophytic, acid-tolerant species such as *Hexastylis* spp. (heartleafs), *Goodyera pubescens* (downy rattlesnake plantain), *Chimaphila maculata* (striped prince's pine), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Maianthemum racemosum* (feathery false lily of the valley), *Polygonatum biflorum* (smooth Solomon's seal), *Viola hastata* (halberdleaf yellow violet), *Tipularia discolor* (crippled cranefly), and *Hieracium venosum*

(rattlesnakeweed) prevalent. This association occupies less nutrient-rich habitats than *Quercus rubra - Quercus alba - Carya glabra / Geranium maculatum* Forest (CEGL007237).

Environmental Description: The sites on which this vegetation is found are described as "intermediate" in soil moisture (Jones 1988a, 1988b). Soils are less nutrient-rich than *Quercus alba - Quercus rubra - Carya (ovata, carolinae-septentrionalis) / Cercis canadensis* Forest (CEGL007232). Virginia stands occur on submesic to subxeric uplands with acidic, moderately nutrient-poor soils weathered from felsic metamorphic, metasedimentary, and sedimentary rocks (especially Triassic siltstones), and unconsolidated sediments. However, Virginia soils supporting this type are demonstrably more fertile than those supporting very species-poor mixed oak forests with dense ericaceous shrub layers. At some sites, soils are weathered from interbedded metasedimentary and mafic rocks, resulting in soil chemistry that is intermediate or slightly basic. This type frequently occupies somewhat mesic habitats (e.g., concave slopes, lower slopes, shallow ravines) in dry landscapes where mixed oak/heath types are prevalent. It is a large-patch or matrix type in some parts of Virginia but is not as abundant in the Piedmont as mixed oak/heath forests (G. Fleming pers. comm. 2001). In North Carolina, this is a matrix type, probably the most common forest type remaining in the Piedmont.

Vegetation Description: Stands of this forest are closed to somewhat open, and are dominated by mixtures of oaks and hickories, with *Quercus alba* (white oak) being most prevalent, along with *Quercus rubra* (northern red oak), *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Carya alba* (mockernut hickory), *Carya ovalis* (red hickory), and *Carya glabra* (pignut hickory). *Carya* spp. (hickories) are common in this type but often most abundant in the understory. In Virginia examples, *Quercus prinus* (chestnut oak) and *Quercus falcata* (southern red oak) are inconstant but sometimes important. In addition, *Pinus* spp. (pines), *Liriodendron tulipifera* (tuliptree), *Liquidambar styraciflua* (sweetgum), and *Acer rubrum* (red maple) may be common, especially in disturbed stands. Understory species include *Acer rubrum* (red maple), *Cornus florida* (flowering dogwood), *Oxydendrum arboreum* (sourwood), *Ilex opaca* var. *opaca* (American holly), and *Nyssa sylvatica* (blackgum). Shrubs include *Vaccinium stamineum* (deerberry), *Vaccinium pallidum* (Blue Ridge blueberry), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum rafinesquianum* (downy arrowwood), and *Euonymus americanus* (strawberry bush). In Virginia, *Vaccinium pallidum* (Blue Ridge blueberry) and *Vaccinium stamineum* (deerberry) are the principal ericads of patchy low-shrub layers (G. Fleming pers. comm. 2004). The woody vines *Vitis rotundifolia* (muscadine) and *Toxicodendron radicans* (eastern poison ivy) often are present. Herbs vary from sparse to moderately dense, with dry-mesophytic species such as *Hexastylis* spp. (heartleafs), *Goodyera pubescens* (downy rattlesnake plantain), *Chimaphila maculata* (striped prince's pine), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Maianthemum racemosum* (feathery false lily of the valley), *Polygonatum biflorum* (smooth Solomon's seal), *Viola hastata* (halberdleaf yellow violet), *Tipularia discolor* (crippled cranefly), *Carex albicans* (whitetinge sedge), and *Hieracium venosum* (rattlesnakeweed) prevalent (Schafale and Weakley 1990). Although not lush, these forests can be impressively species-rich, with high woody diversity and many low-cover herbaceous species occurring. Species richness of 116 Virginia plots averages 53 taxa per 400 square meters, varying from a low of 17 to a high of 114. Low species richness in this type is most often the result of long-term overgrazing by large deer populations. At least some of the stands with high species richness are located on sites where deer populations are effectively controlled.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Carya ovalis* (red hickory), *Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus rubra* (northern red oak), *Quercus velutina* (black oak)
Tree subcanopy	Broad-leaved deciduous tree	*Cornus florida* (flowering dogwood), *Nyssa sylvatica* (blackgum), *Oxydendrum arboreum* (sourwood)
Tree subcanopy	Broad-leaved evergreen tree	*Ilex opaca* var. *opaca* (American holly)

Characteristic Species: *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Carya ovalis* (red hickory), *Chimaphila maculata* (striped prince's pine), *Cornus florida* (flowering dogwood), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Euonymus americanus* (strawberry bush), *Goodyera pubescens* (downy rattlesnake plantain), *Hieracium venosum* (rattlesnakeweed), *Ilex opaca* var. *opaca* (American holly), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Maianthemum racemosum* (feathery false lily of the valley), *Nyssa sylvatica* (blackgum), *Oxydendrum arboreum* (sourwood), *Polygonatum biflorum* (smooth Solomon's seal), *Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), *Tipularia discolor* (crippled cranefly), *Toxicodendron radicans* (eastern poison ivy), *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium stamineum* (deerberry), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum rafinesquianum* (downy arrowwood), *Viola hastata* (halberdleaf yellow violet), *Vitis rotundifolia* (muscadine).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association occurs throughout the Piedmont of the Carolinas, Virginia, south-central Maryland, and possibly Georgia. In northern Virginia and Maryland, it also occurs occasionally in the Coastal Plain.

States/Provinces: GA?, MD, NC, SC, VA.

Federal Lands: DOD (Fort Pickett, Kerr Reservoir); NPS (Appomattox Court House, Booker T. Washington, C&O Canal, Colonial, Fredericksburg-Spotsylvania, George Washington Parkway, Guilford Courthouse, Kings Mountain, Manassas, Ninety Six, Petersburg, Prince William, Richmond, Rock Creek); USFS (Oconee?, Uwharrie).

CONSERVATION STATUS

Rank: G4G5 (15-Feb-2007).

Reasons: This is not a rare community type, although stands older than about 80 years old are probably rare. Most of the rolling upland landscape of the Piedmont and other regions where this occurs have been logged more than once since European settlement. This is a large-patch or matrix type in some regions of Virginia (G. Fleming pers. comm. 2001). In North Carolina, this is a matrix type, probably the most common forest type remaining in the Piedmont.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 1 - Strong.

Comments: At the northern end of the range, the classification is supported by analysis of a 1250-plot regional dataset assembled for the NCR and mid-Atlantic national parks vegetation mapping project. In that analysis, this association was represented by 116 Virginia plots and several from Montgomery County, Maryland.

Similar Associations:

- *Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium* Forest (CEGL006336)--northern analogue from Maryland to New England.
- *Quercus alba - Carya alba / Euonymus americanus / Hexastylis arifolia* Forest (CEGL006227)--similar with a more southerly range.
- *Quercus alba - Carya alba / Vaccinium elliottii* Forest [Provisional] (CEGL007224)--of the Coastal Plain.
- *Quercus alba - Carya glabra* / Mixed Herbs Coastal Plain Forest (CEGL007226)--of the Coastal Plain.
- *Quercus alba - Quercus nigra - Quercus falcata / Ilex opaca / Clethra alnifolia - Arundinaria gigantea* ssp. *tecta* Forest (CEGL007862)--of the Coastal Plain.
- *Quercus alba - Quercus rubra - Carya (ovata, carolinae-septentrionalis) / Cercis canadensis* Forest (CEGL007232)--occurs in the same region but on basic soils weathered from mafic rocks.
- *Quercus falcata - Quercus alba - Carya alba / Oxydendrum arboreum / Vaccinium stamineum* Forest (CEGL007244)--is a drier community of similar substrates, with more *Quercus falcata* or *Quercus stellata* than *Quercus rubra* codominating with *Quercus alba*.
- *Quercus rubra - Quercus alba - Carya glabra / Geranium maculatum* Forest (CEGL007237).
- *Quercus rubra / Magnolia tripetala - Cercis canadensis / Actaea racemosa - Tiarella cordifolia* Forest (CEGL003949).

Related Concepts:

- *Quercus alba - Quercus rubra - Carya (alba, glabra) / Cornus florida / Vaccinium stamineum* Forest (VDNH 2003) =
- *Quercus alba - Quercus rubra - Carya (alba, glabra) / Cornus florida / Vaccinium stamineum* Forest (Fleming pers. comm.) ?
- IA6i. Interior Upland Dry-Mesic Oak - Hickory Forest (Allard 1990) B
- Oak - Chestnut - Hickory Forest (Ambrose 1990) B
- Piedmont Acidic Oak-Hickory Forest (Fleming et al. 2004) ?
- White oak - northern red oak - false Solomon's seal (*Quercus alba - Quercus rubra - Smilacina racemosa*) community type (Jones 1988a) ?
- White oak - northern red oak - false Solomon's seal (*Quercus alba - Quercus rubra - Smilacina racemosa*) community type (Jones 1988b) ?

SOURCES

Description Authors: M. P. Schafale and G. P. Fleming.

References: Allard 1990, Ambrose 1990, Fleming et al. 2001, Fleming et al. 2004, Fleming pers. comm., Harrison 2004, Jones 1988a, Jones 1988b, NRCS 2006, Nelson 1986, Patterson pers. comm., Schafale and Weakley 1990, Skeen et al. 1980, Southeastern Ecology Working Group n.d., VDNH 2003.

Figure I7. Acidic Oak-Hickory Forest (plot RICH.1) at Richmond National Battlefield Park. April 2002. NAD 1983 / UTM easting 285537, northing 4144461.

Figure I8. Acidic Oak - Hickory Forest (disturbed) at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 290210, northing 4144909.

COMMON NAME (PARK-SPECIFIC):   **COASTAL PLAIN MIXED OAK / HEATH FOREST**

SYNONYMS

USNVC English Name: **White Oak - Southern Red Oak - (Sand Hickory) / Dangleberry Forest**

USNVC Scientific Name: *Quercus alba - Quercus falcata - (Carya pallida) / Gaylussacia frondosa* **Forest**

USNVC Identifier: **CEGL006269**

LOCAL INFORMATION

Environmental Description: Coastal Plain Mixed Oak / Heath Forest occurs on upland flats and gentle slopes in Richmond National Battlefield Park. Soils tend to be somewhat sandy and infertile.

Vegetation Description: Coastal Plain Mixed Oak / Heath Forest is a xeric deciduous to mixed evergreen-deciduous forest dominated by oaks or oak and pine. The canopy is typically dominated by varying mixtures of *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Quercus velutina* (black oak), and *Pinus taeda* (loblolly pine). Other canopy and subcanopy associates can include *Quercus prinus* (chestnut oak), *Quercus coccinea* (scarlet oak), *Quercus stellata* (post oak), *Acer rubrum* (red maple), and *Nyssa sylvatica* (blackgum). Typical tall shrubs in this forest can include *Ilex opaca* var. *opaca* (American holly), *Carya pallida* (sand hickory), *Diospyros virginiana* (common persimmon), *Sassafras albidum* (sassafras), *Vaccinium stamineum* (deerberry), and *Cornus florida* (flowering dogwood). Herbs are absent to very sparse with short ericaceous shrubs, leaf litter, or vines dominating the ground layer; most common is *Gaylussacia frondosa* (blue huckleberry), but other common shrub species include *Gaylussacia baccata* (black huckleberry), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax bona-nox* (saw greenbrier), *Vaccinium pallidum* (Blue Ridge blueberry), and *Vitis rotundifolia* (muscadine).

Disturbed or fire-suppressed examples may have high cover of *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), and/or *Ilex opaca* var. *opaca* (American holly) in the subcanopy. Young stands of this forest are dense and shrubby with small-diameter trees. Some stands have a high proportion of *Pinus taeda* (loblolly pine) in the canopy, which is indicative of past logging or another canopy-opening disturbance. These stands may appear on photography with a mixed evergreen-deciduous signature.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Quercus alba* (white oak)
Short shrub/sapling	Broad-leaved deciduous shrub	*Gaylussacia frondosa* (blue huckleberry)

Characteristic Species: *Gaylussacia frondosa* (blue huckleberry), *Pinus taeda* (loblolly pine), *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Sassafras albidum* (sassafras), *Vaccinium pallidum* (Blue Ridge blueberry).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR*	B	1	Oak / Heath Forest	Fleming et al. 2006

Local Range: Coastal Plain Mixed Oak / Heath Forest is found at Cold Harbor, Fort Harrison, Malvern Hill, and at Parker's Battery. It is mapped as 10 polygons, covering a total of 70.8 hectares (175 acres).

Classification Comments: Coastal Plain Mixed Oak / Heath Forest is distinguished from Acidic Oak - Hickory Forest by the presence of a dense, often continuous, ericaceous shrub layer, the absence or lower frequency of *Carya* spp. (hickories), and the absence or very low cover of herbaceous species. Coastal Plain Mixed Oak / Heath Forest, on average, has about half the number of species as found in typical examples of Acidic Oak - Hickory Forest.

Other Comments: Some of the evergreen signature in polygons of this mapping unit results from *Ilex opaca* var. *opaca* (American holly), an evergreen shrub that can become dense in fire-suppressed examples. Some stands in Richmond National Battlefield Park are managed with prescribed fire and may have dead trees and numerous woody saplings.

Local Description Authors: K. D. Patterson.

Plots: RICH.3, RICH.8.

Richmond National Battlefield Park 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 alba - Quercus (falcata, stellata)* Forest Alliance (A.241)
Alliance (English name)	White Oak - (Southern Red Oak, Post Oak) Forest Alliance
Association	*Quercus alba - Quercus falcata - (Carya pallida) / Gaylussacia frondosa* Forest
Association (English name)	White Oak - Southern Red Oak - (Sand Hickory) / Dangleberry Forest
Ecological System(s):	Northern Atlantic Coastal Plain Hardwood Forest (CES203.475).

GLOBAL DESCRIPTION

Concept Summary: This oak forest of the unglaciated northeastern Coastal Plain generally occurs on well-drained acidic soils, primarily loamy sands, sandy loams and silty/clay loams. Occasional stands occur on imperfectly drained, alternately wet and dry upland flats with hardpan subsoils. The canopy is dominated by a mixture of oaks, especially *Quercus alba* (white oak), *Quercus falcata* (southern red oak), and *Quercus velutina* (black oak). Associates include *Sassafras albidum* (sassafras), *Quercus coccinea* (scarlet oak), *Quercus stellata* (post oak), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), and *Pinus taeda* (loblolly pine), with *Acer rubrum* (red maple), *Ilex opaca* var. *opaca* (American holly), and *Cornus florida* (flowering dogwood) often forming a subcanopy. *Liriodendron tulipifera* (tuliptree) may be a canopy component in mature, fire-suppressed stands. *Carya pallida* (sand hickory) may also be present in the canopy. The shrub layer is well-developed and dominated by the deciduous ericads *Gaylussacia frondosa* (blue huckleberry), *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium stamineum* (deerberry), and occasionally *Lyonia mariana* (piedmont staggerbush). The vines *Smilax rotundifolia* (roundleaf greenbrier) and *Vitis rotundifolia* (muscadine) may be important in some stands. The herbaceous layer is generally sparse and characterized by dry-site species such as *Pteridium aquilinum* (western brackenfern), *Cypripedium acaule* (moccasin flower), *Chimaphila maculata* (striped prince's pine), and *Gaultheria procumbens* (eastern teaberry).

Environmental Description: This community generally occurs on well-drained acidic soils, primarily loamy sands, sandy loams and silty/clay loams. Occasional stands occur on imperfectly drained, alternately wet and dry, upland flats with hardpan subsoils. Even on the latter, moisture potential of most sites supporting this vegetation can be characterized as subxeric to xeric. Soil samples collected from plots of this vegetation type in Virginia are extremely acidic, with very low base cation levels and total base saturation.

Vegetation Description: Physiognomy is generally a closed to somewhat open forest. The overstory of mid- to late-successional stands is dominated by a mixture of oaks, especially *Quercus alba* (white oak), *Quercus falcata* (southern red oak), and *Quercus velutina* (black oak). Early-successional stands recovering from recent logging or agricultural conversion usually have a strong admixture of *Pinus taeda* (loblolly pine). Other canopy associates include *Sassafras albidum* (sassafras), *Quercus coccinea* (scarlet oak) (occasionally codominant), *Quercus stellata* (post oak), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), *Carya alba* (mockernut hickory), and *Carya pallida* (sand hickory) (occasionally codominant). *Acer rubrum* (red maple), *Ilex opaca* var. *opaca* (American holly), and *Cornus florida* (flowering dogwood) are the principal subcanopy trees. In the southern part of the range, *Oxydendrum arboreum* (sourwood) and scrambling vines of *Vitis rotundifolia* (muscadine) can be important in the understory. The shrub layer is well-developed and dominated by the deciduous ericads *Gaylussacia frondosa* (blue huckleberry), *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium stamineum* (deerberry), and occasionally *Lyonia mariana* (piedmont staggerbush). The herbaceous layer is generally sparse and characterized by dry-site species such as *Pteridium aquilinum* (western brackenfern), *Cypripedium acaule* (moccasin flower), *Chimaphila maculata* (striped prince's pine), and *Gaultheria procumbens* (eastern teaberry).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus falcata* (southern red oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium stamineum* (deerberry)
Shrub/sapling (tall & short)	Vine/Liana	*Smilax rotundifolia* (roundleaf greenbrier), *Vitis rotundifolia* (muscadine)

Characteristic Species: *Acer rubrum* (red maple), *Carya pallida* (sand hickory), *Chimaphila maculata* (striped prince's pine), *Cornus florida* (flowering dogwood), *Cypripedium acaule* (moccasin flower), *Gaultheria procumbens* (eastern teaberry), *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (blue huckleberry), *Ilex opaca* var. *opaca* (American holly), *Nyssa sylvatica* (blackgum), *Pinus taeda* (loblolly pine), *Pteridium aquilinum* (western brackenfern), *Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus falcata* (southern red oak), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Vaccinium pallidum* (Blue Ridge blueberry), *Vaccinium stamineum* (deerberry).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association occurs on the Coastal Plain from New Jersey to Virginia and possibly northeastern North Carolina. In central and southeastern Virginia, it extends slightly into the eastern portion of the Piedmont.

States/Provinces: DE, MD, NC?, NJ:S3S4, VA:S4S5.
Federal Lands: DOD (Fort A.P. Hill, Yorktown); NPS (Fredericksburg-Spotsylvania, National Capital-East?, Petersburg, Richmond); USFWS (Blackwater, Chesapeake Marshlands, Prime Hook).

CONSERVATION STATUS
Rank: G4G5 (1-Dec-1997).
Reasons: The type is common and widespread on the Coastal Plain from New Jersey to Virginia. Mature examples are uncommon, and all stands are vulnerable to logging disturbances and fire suppression.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: Classification is supported by analysis of a 1250-plot regional dataset assembled for the NCR and mid-Atlantic national parks vegetation mapping projects. In that classification, this association was represented by 18 plots. *(Pinus taeda) - Quercus falcata / Gaylussacia frondosa* Forest (CEGL006169) has been archived and incorporated into this type by Gary Fleming.
Similar Associations:
- *Pinus rigida - Quercus coccinea - Quercus falcata / (Quercus marilandica) / Gaylussacia frondosa* Woodland (CEGL006329).
- *Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata* Forest (CEGL008521)--Piedmont analogue of CEGL006269; has more *Quercus prinus*, less *Quercus falcata*, and lacks *Gaylussacia frondosa* and other species more characteristic of the Coastal Plain.

Related Concepts:
- *Quercus alba - Quercus falcata - (Pinus taeda) / Gaylussacia frondosa* Forest (Fleming pers. comm.) =
- *Quercus alba - Quercus velutina - Quercus coccinea / Gaylussacia baccata - Vaccinium stamineum* Forest (VDNH 2003) =
- Dry Oak-Pine Forest, mixed oak-pine forest subtype (Breden 1989) ?
- Pine - oak association (Shreve et al. 1910) B

SOURCES
Description Authors: G. P. Fleming, mod. L. A. Sneddon.
References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Shreve et al. 1910, Sneddon et al. 1996, VDNH 2003.

Figure I9. Coastal Plain Mixed Oak / Heath Forest (plot RICH.3) at Richmond National Battlefield Park. April 2002. NAD 1983 / UTM easting 298060, northing 4162751.

COMMON NAME (PARK-SPECIFIC):   **COASTAL PLAIN / PIEDMONT SMALL-STREAM 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* **Forest**

USNVC Identifier: **CEGL004418**

LOCAL INFORMATION

Environmental Description: Coastal Plain / Piedmont Small-Stream Floodplain Forest is a deciduous forest found on small stream floodplains and sandy floodplain terraces. In Richmond National Battlefield Park, this forest is of limited extent and occurs as small, disturbed stands.

Vegetation Description: The canopy can have varying combinations of *Acer rubrum* (red maple), *Liriodendron tulipifera* (tuliptree), and *Liquidambar styraciflua* (sweetgum), occurring with other typical floodplain associates such as *Betula nigra* (river birch), *Platanus occidentalis* (American sycamore), *Salix nigra* (black willow), *Quercus phellos* (willow oak), *Quercus michauxii* (swamp chestnut oak), and occasionally *Fagus grandifolia* (American beech). Vines such as *Campsis radicans* (trumpet creeper), *Toxicodendron radicans* (eastern poison ivy), *Vitis vulpina* (frost grape), and the exotic *Lonicera japonica* (Japanese honeysuckle) are commonly found climbing into the canopy trees. Typical species of the shrub layer are *Carpinus caroliniana* (American hornbeam), *Clethra alnifolia* (coastal sweetpepperbush), *Ilex opaca* var. *opaca* (American holly), *Liquidambar styraciflua* (sweetgum), and *Ulmus rubra* (slippery elm). The herb layer in the disturbed floodplain forests of Richmond National Battlefield Park is often dominated by the exotic grass *Microstegium vimineum* (Nepalese browntop) with a scattering of other herbs. Forbs such as *Phytolacca americana* (American pokeweed) and *Polygonum caespitosum* var. *longisetum* (oriental ladysthumb), the grasses *Cinna arundinacea* (sweet woodreed), *Dichanthelium clandestinum* (deertongue) and *Elymus virginicus* (Virginia wildrye), and ferns such as *Athyrium filix-femina* (common ladyfern), *Thelypteris noveboracensis* (New York fern), and *Woodwardia areolata* (netted chainfern) can be found in these floodplain forests.

Canopy dominants can vary from stand to stand but always include at least some of the typical floodplain species mentioned above.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple), *Liriodendron tulipifera* (tuliptree)

Characteristic Species: *Acer rubrum* (red maple), *Athyrium filix-femina* (common ladyfern), *Cinna arundinacea* (sweet woodreed), *Liriodendron tulipifera* (tuliptree), *Platanus occidentalis* (American sycamore), *Salix nigra* (black willow).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR*	B	1	Coastal Plain / Piedmont Floodplain Forest	.

Local Range: Small, disturbed stands of this forest are found at Beaver Dam Creek, Chickahominy Bluff, Gaines Mill (Watt House), and at Malvern Hill. In total, it is mapped as

five polygons, ranging in size from 0.3 to 2 hectares (0.7 to 5 acres) and covering a total of 4 hectares (10 acres).

Classification Comments: This community is distinguished by its temporarily flooded hydrology and by occurring on floodplains of small creeks and streams. It has better drained soil than Non-Riverine Saturated Forest, which has a seasonally flooded hydrology and occurs on broad flat topographic features that are not part of the active floodplain. Very disturbed examples may be confused with Successional Tuliptree Forest.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park 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* Forest
Association (English name)	Sweetgum - Tuliptree / Northern Spicebush / Jack-in-the-Pulpit Forest
Ecological System(s):	Northern Atlantic Coastal Plain Stream and River (CES203.070).
	Southern Piedmont Small Floodplain and Riparian Forest (CES202.323).

GLOBAL DESCRIPTION

Concept Summary: These low-elevation forests develop along relatively acidic soils on 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. The canopy, subcanopy, shrub, and herbaceous layers often are well-developed. Dominant canopy species always include *Liquidambar styraciflua* (sweetgum) and *Liriodendron tulipifera* (tuliptree), while *Acer barbatum* (southern sugar maple) and *Acer rubrum* var. *rubrum* (red maple) 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* (American holly), *Aesculus sylvatica* (painted buckeye), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Fagus grandifolia* (American beech), *Juglans nigra* (black walnut), *Morus rubra* var. *rubra* (red mulberry), *Ostrya virginiana* var. *virginiana* (hophornbeam), *Oxydendrum arboreum* (sourwood), *Pinus echinata* (shortleaf pine), *Prunus serotina* var. *serotina* (black cherry), *Quercus alba* (white oak), *Quercus rubra* var. *rubra* (northern red oak), *Ulmus rubra* (slippery elm), *Ulmus americana* (American elm), *Ulmus alata* (winged elm), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Nyssa sylvatica* (blackgum), *Fraxinus americana* (white ash), *Halesia tetraptera* var. *tetraptera*

(mountain silverbell), *Arundinaria gigantea* ssp. *gigantea* (giant cane), *Cornus florida* (flowering dogwood), *Platanus occidentalis* (American sycamore), *Betula nigra* (river birch), and *Fraxinus pennsylvanica* (green ash). *Euonymus americanus* (strawberry bush), *Lindera benzoin* var. *benzoin* (northern spicebush), and *Corylus americana* (American hazelnut) are common and dominant in the shrub layer. The herbaceous layer is species-rich and often has good sedge development. The exotics *Microstegium vimineum* (Nepalese browntop), *Ligustrum sinense* (Chinese privet), and *Lonicera japonica* (Japanese honeysuckle) 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* (sweetgum) and *Liriodendron tulipifera* (tuliptree), while *Acer barbatum* (southern sugar maple) (in the southern part of the range) and *Acer rubrum* var. *rubrum* (red maple) 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* (American holly), *Aesculus sylvatica* (painted buckeye), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Fagus grandifolia* (American beech), *Juglans nigra* (black walnut), *Morus rubra* var. *rubra* (red mulberry), *Ostrya virginiana* var. *virginiana* (hophornbeam), *Oxydendrum arboreum* (sourwood), *Pinus echinata* (shortleaf pine), *Prunus serotina* var. *serotina* (black cherry), *Quercus alba* (white oak), *Quercus rubra* var. *rubra* (northern red oak), *Ulmus rubra* (slippery elm), *Ulmus americana* (American elm), *Ulmus alata* (winged elm), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Nyssa sylvatica* (blackgum), *Fraxinus americana* (white ash), *Halesia tetraptera* var. *tetraptera* (mountain silverbell), *Arundinaria gigantea* ssp. *gigantea* (giant cane), and *Fraxinus pennsylvanica* (green ash). Scattered individuals of *Platanus occidentalis* (American sycamore) and *Betula nigra* (river birch) may also occur in some stands. *Euonymus americanus* (strawberry bush), *Lindera benzoin* var. *benzoin* (northern spicebush), and *Corylus americana* (American hazelnut) are common and dominant in the shrub layer. Other shrub species that may be present include *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum nudum* var. *nudum* (possumhaw), *Viburnum prunifolium* (blackhaw), *Viburnum rufidulum* (rusty blackhaw), *Hamamelis virginiana* (American witchhazel), *Asimina triloba* (pawpaw), and *Ilex decidua* (possumhaw), among others. On the most acidic sites of the Maryland Coastal Plain, *Clethra alnifolia* (coastal sweetpepperbush), *Vaccinium corymbosum* (highbush blueberry), and *Magnolia virginiana* (sweetbay) may be present. Vines are prominent and include *Vitis rotundifolia* (muscadine), *Apios americana* (groundnut), *Campsis radicans* (trumpet creeper), *Aristolochia macrophylla* (pipevine), *Bignonia capreolata* (crossvine), *Dioscorea quaternata* (fourleaf yam), *Gelsemium sempervirens* (evening trumpetflower), *Parthenocissus quinquefolia* (Virginia creeper), *Campsis radicans* (trumpet creeper), *Passiflora lutea* (yellow passionflower), *Smilax bona-nox* (saw greenbrier), *Smilax glauca* (cat greenbrier), *Smilax hugeri* (Huger's

carrionflower), *Smilax rotundifolia* (roundleaf greenbrier), and *Toxicodendron radicans* ssp. *radicans* (eastern poison ivy). The herbaceous layer is species-rich and often has good sedge development. Common species in this layer include *Thalictrum thalictroides* (rue anemone), *Trillium cuneatum* (little sweet Betsy), *Arisaema triphyllum* (Jack in the pulpit), *Asplenium platyneuron* var. *platyneuron* (ebony spleenwort), *Botrychium virginianum* (rattlesnake fern), *Carex* spp. (sedges), *Carex impressinervia* (ravine sedge), *Carex striatula* (lined sedge), *Cinna arundinacea* (sweet woodreed), *Elymus virginicus* (Virginia wildrye), *Galium circaezans* (licorice bedstraw), *Geum canadense* (white avens), *Medeola virginiana* (Indian cucumber), *Polystichum acrostichoides* (Christmas fern), and *Scutellaria integrifolia* (helmet flower), among many others. *Thelypteris noveboracensis* (New York fern) is a common patch-dominant in the northern part of the range and the Uwharrie Mountains of North Carolina. The exotics *Microstegium vimineum* (Nepalese browntop), *Ligustrum sinense* (Chinese privet), and *Lonicera japonica* (Japanese honeysuckle) are common in this community. Other exotics that colonize quickly in disturbed and fragmented versions of this association include *Wisteria sinensis* (Chinese wisteria), *Rosa multiflora* (multiflora rose), *Clematis terniflora* (sweet autumn virginsbower), *Hedera helix* (English ivy), and *Elaeagnus* sp. (an elaeagnus).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree)

Characteristic Species: *Arisaema triphyllum* (Jack in the pulpit), *Asplenium platyneuron* (ebony spleenwort), *Botrychium virginianum* (rattlesnake fern), *Campsis radicans* (trumpet creeper), *Carex striatula* (lined sedge), *Cinna arundinacea* (sweet woodreed), *Corylus americana* (American hazelnut), *Elymus virginicus* (Virginia wildrye), *Euonymus americanus* (strawberry bush), *Galium circaezans* (licorice bedstraw), *Geum canadense* (white avens), *Lindera benzoin* (northern spicebush), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Medeola virginiana* (Indian cucumber), *Polystichum acrostichoides* (Christmas fern), *Scutellaria integrifolia* (helmet flower), *Smilax rotundifolia* (roundleaf greenbrier), *Thalictrum thalictroides* (rue anemone), *Toxicodendron radicans* (eastern poison ivy), *Trillium cuneatum* (little sweet Betsy).

Other Noteworthy Species:

Species	GRank	Type	Note
Carex impressinervia (ravine sedge)	G1G2	plant	

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: At Chickamauga-Chattanooga National Military Park, this association was observed on Lookout Creek, but no plot data were taken. Low-quality occurrences of this type may look very similar to some occurrences of *Liquidambar styraciflua - (Liriodendron tulipifera)* Temporarily Flooded Forest (CEGL007330). The presence of higher quality patches of native herbs and stands of native shrubs such as *Lindera benzoin* (northern spicebush) is the best way to distinguish these two types. In addition, stands of CEGL007330 will generally be more even-aged and single species-dominated than this association (CEGL004418).

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, negundo) - (Platanus occidentalis) / Carpinus caroliniana / Polygonum virginianum* Forest (CEGL006492).

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 I10. Coastal Plain / Piedmont Small-Stream Floodplain Forest at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 301043, northing 4143686.

COMMON NAME (PARK-SPECIFIC):   **NON-RIVERINE SATURATED FOREST -PINE
SUBTYPE**

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Nonstandard**

LOCAL INFORMATION

Environmental Description: This map class occurs in association with Non-Riverine Saturated Forest on broad, seasonally flooded to saturated flats. It occurs on sites that have been clearcut or otherwise heavily disturbed in the past.

Vegetation Description: This map class is considered a physiognomic/early-succesional variant of Non-Riverine Saturated Forest. It is a wetland evergreen forest with a canopy dominated by *Pinus taeda* (loblolly pine). The canopy may also contain *Quercus phellos* (willow oak). The subcanopy is deciduous with *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), *Quercus palustris* (pin oak), and *Quercus phellos* (willow oak). Shrub species include *Acer rubrum* (red maple), *Clethra alnifolia* (coastal sweetpepperbush), *Liquidambar styraciflua* (sweetgum), and *Magnolia virginiana* (sweetbay). Litter often dominates the ground with scattered herbs, including *Carex lonchocarpa* (southern long sedge), *Chasmanthium laxum* (slender woodoats), *Rhynchospora inexpansa* (nodding beaksedge), *Saccharum alopecuroidum* (silver plumegrass), and *Scirpus cyperinus* (woolgrass).

Some stands of this map class have significant wind disturbance.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus taeda* (loblolly pine)

Characteristic Species: *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus taeda* (loblolly pine), *Quercus phellos* (willow oak).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	Sname	Reference
VA	NA	.	.	[not crosswalked, not ranked]	.

Local Range: This map class is found in small stands at Chickahominy Bluff and at Fort Harrison. It covers a total of 5.7 hectares (14.2 acres).

Classification Comments: Stands tagged to this mapping unit are greater than 0.5 hectare and dominated by *Pinus taeda* (loblolly pine). They typically occur as large evergreen patches within mostly deciduous Non-Riverine Saturated Forest. They tend to be much less diverse than the deciduous phase of this forest.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park Inventory Notes: Information not available.

GLOBAL INFORMATION

Non-Riverine Saturated Forest - pine subtype is a park-specific, nonstandard type and has no global information.

Figure I11. Non-Riverine Saturated Forest - pine subtype at Richmond National Battlefield Park. October 2003. NAD 1983 / UTM easting 289278, northing 4162630. Photo credit - NCSU-CEO.

COMMON NAME (PARK-SPECIFIC): **NON-RIVERINE SATURATED FOREST**

SYNONYMS
USNVC English Name: **(Willow Oak, Cherrybark Oak, Swamp Chestnut Oak) / American Holly / Coastal Sweet-pepperbush / Netted Chainfern Forest**
USNVC Scientific Name: *Quercus (phellos, pagoda, michauxii) / Ilex opaca* **var.** *opaca / Clethra alnifolia / Woodwardia areolata* **Forest**
USNVC Identifier: **CEGL004644**

LOCAL INFORMATION

Environmental Description: Non-Riverine Saturated Forest is a mainly deciduous forest occurring on broad, saturated to seasonally flooded flats. These flats may have areas of hummock-and-hollow topography with water at or near the surface for most of the growing season. In Richmond National Battlefield Park, these areas may have formerly been portions of the active floodplain, but due to hydrologic alternations (beaver activity, urban development) are now never inundated by alluvial floodwaters. Some areas have evidence of historic ditching with remnants of human-made berms.

Vegetation Description: Non-Riverine Saturated Forest is typically dominated by *Acer rubrum* (red maple) and/or *Liquidambar styraciflua* (sweetgum) and can have codominance by *Quercus pagoda* (cherrybark oak), *Quercus phellos* (willow oak), and *Pinus taeda* (loblolly pine). Other trees that may be in the canopy and subcanopy are *Magnolia virginiana* (sweetbay), *Nyssa sylvatica* (blackgum), *Quercus alba* (white oak), *Quercus michauxii* (swamp chestnut oak), *Ulmus alata* (winged elm), *Ulmus americana* (American elm), and *Ulmus rubra* (slippery elm). Absent or of very low cover are *Betula nigra* (river birch), *Liriodendron tulipifera* (tuliptree), and *Platanus occidentalis* (American sycamore). Shrub density and composition can vary from stand to stand. *Clethra alnifolia* (coastal sweetpepperbush) is often dense locally as a low shrub. Other common species include *Ilex opaca* var. *opaca* (American holly), *Lindera benzoin* (northern spicebush), *Magnolia virginiana* (sweetbay), *Vaccinium corymbosum* (highbush blueberry), and *Viburnum nudum* (possumhaw). Common vines found as dense thickets or climbing into the canopy are *Campsis radicans* (trumpet creeper), *Lonicera japonica* (Japanese honeysuckle), *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), and *Vitis rotundifolia* (muscadine). The ground may be mostly bare, covered with matted leaf litter and mud, with scattered patches of wetland grasses, sedges, and ferns. Common species are *Carex albolutescens* (greenwhite sedge), *Carex crinita* (fringed sedge), *Carex debilis* (white edge sedge), *Carex seorsa* (weak stellate sedge), *Chasmanthium laxum* (slender woodoats), *Cinna arundinacea* (sweet woodreed), *Osmunda cinnamomea* var. *cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Sphagnum* spp. (sphagnum mosses), and *Woodwardia areolata* (netted chainfern).

Canopy dominants are typically *Acer rubrum* (red maple) and *Liquidambar styraciflua* (sweetgum) with mixtures of hydric oaks in the canopy, subcanopy and shrub layers, but remnant, very large *Quercus phellos* (willow oak) and *Quercus pagoda* (cherrybark oak) can be found in the canopy and can even dominate some areas. Herbaceous composition varies greatly in this forest. The exotic grass *Microstegium vimineum* (Nepalese browntop) can dominate in some stands. Wet depressions can have a predominance of hydrophytic herbs such as *Peltandra*

virginica (green arrow arum) and *Saururus cernuus* (lizard's tail) and wetland ferns *Osmunda cinnamomea* (cinnamon fern) and *Osmunda regalis* var. *spectabilis* (royal fern), while elevated hummocks tend to have more *Chasmanthium laxum* (slender woodoats) and *Cinna arundinacea* (sweet woodreed). Areas with heavy windthrow and canopy openings may have more "weedy" or ruderal species.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum)

Characteristic Species: *Acer rubrum* (red maple), *Carex debilis* (white edge sedge), *Liquidambar styraciflua* (sweetgum), *Quercus pagoda* (cherrybark oak), *Quercus phellos* (willow oak), *Woodwardia areolata* (netted chainfern).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR*	B	1	Non-Riverine Saturated Forest	Fleming et al. 2006

Local Range: Non-Riverine Saturated Forest is mapped as six polygons at Chickahominy Bluff, Forest Harrison, and at Malvern Hill. Polygons range in size from 0.8 to 9.7 hectares (2.0 to 24 acres) and cover a total of 26.7 hectares (66 acres).

Classification Comments: This forest is distinguished by its its occurrence on broad flats with saturated to seasonally flooded soils. Unlike Coastal Plain / Piedmont Small-Stream Floodplain Forest, this forest is not associated with active floodplains, is located well away from the main stream channel, and is never inundated by alluvial floodwaters. Additionally, species more common in Coastal Plain / Piedmont Small-Stream Floodplain Forest (i.e., *Betula nigra* (river birch), *Liriodendron tulipifera* (tuliptree), and *Platanus occidentalis* (American sycamore)) are absent or have low cover in this forest. Some stands of Non-Riverine Saturated Forest share many species in common with Coastal Plain / Piedmont Acidic Seepage Swamp. It is distinguished by having more overall hydric oaks (although not always in the canopy) and by occurring on broad, wet flats, rather than in small isolated ravine bottoms. Forests similar to Non-Riverine Saturated Forest, but with evergreen canopies dominated by *Pinus taeda* (loblolly pine), are mapped as a physiognomic variant or "Pine phase."

Other Comments: Mature, undisturbed examples of this association are rare throughout its geographic range. The stands of this forest at Richmond National Battlefield Park are disturbed and do not meet the criteria to be considered Natural Heritage exemplary natural community occurrences. Nonetheless, these native plant associations are an important part of the park's natural resources and should be targets for conservation and management. Areas of this forest larger than 0.5 hectare and dominated by *Pinus taeda* (loblolly pine) are mapped separately as Non-Riverine Saturated Forest - pine subtype. In Richmond National Battlefield Park, expansion of beaver wetlands is altering the hydrology of these forests, resulting in tree death and conversion of these forests to Beaver Wetland Complex.

Local Description Authors: K. D. Patterson.

Plots: RICH.5, RICH.7, RICH.11.

Richmond National Battlefield Park 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   *Quercus phellos* Seasonally Flooded Forest Alliance (A.330)
Alliance (English name)   Willow Oak Seasonally Flooded Forest Alliance
Association   *Quercus (phellos, pagoda, michauxii) / Ilex opaca* var. *opaca / Clethra alnifolia / Woodwardia areolata* Forest
Association (English name) (Willow Oak, Cherrybark Oak, Swamp Chestnut Oak) / American Holly / Coastal Sweet-pepperbush / Netted Chainfern Forest
Ecological System(s):   Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest (CES203.520).

GLOBAL DESCRIPTION

Concept Summary: This association occurs in the central and northern Virginia Coastal Plain on extensive, flat terraces and very wide, ancient floodplains that are no longer subject to alluvial processes. Its hydrology is seasonally to nearly permanently saturated, with occasional ponding or groundwater sheetflows, and is maintained by a high water table rather than riverine or estuarine flooding. The overstory of relatively undisturbed examples contain variable mixtures of hydrophytic oaks, most commonly *Quercus phellos* (willow oak), *Quercus pagoda* (cherrybark oak), and *Quercus michauxii* (swamp chestnut oak). Associated canopy species varying from site to site can include *Quercus alba* (white oak), *Quercus palustris* (pin oak), *Quercus lyrata* (overcup oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Pinus taeda* (loblolly pine), *Nyssa sylvatica* (blackgum), and *Fraxinus pennsylvanica* (green ash). The subcanopy layers are usually dominated by *Ilex opaca* var. *opaca* (American holly) and also contain *Magnolia virginiana* (sweetbay) and recruitment of the overstory trees. The shrub layer varies from open to dense. and most characteristically contains *Clethra alnifolia* (coastal sweetpepperbush), *Leucothoe racemosa* (swamp doghobble), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium fuscatum* (black highbush blueberry), *Vaccinium formosum* (southern blueberry), *Viburnum dentatum* (southern arrowwood), *Rhododendron viscosum* (swamp azalea), and *Viburnum nudum* var. *nudum* (possumhaw). The herb layer is also highly variable. Some stands have a rather sparse herbaceous flora, with scattered colonies and individuals of *Woodwardia areolata* (netted chainfern), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Woodwardia virginica* (Virginia chainfern), *Saururus cernuus* (lizard's tail), and various sedges. Others have a relatively dense graminoid-dominated herb layer with variable patch-dominance by *Chasmanthium laxum* (slender woodoats), *Carex debilis* var. *debilis* (white edge sedge), *Carex intumescens* (greater bladder sedge), *Carex seorsa* (weak stellate sedge), *Carex lonchocarpa* (southern long sedge), and more rarely, *Carex bullata* (button sedge) or *Carex striata* var. *brevis* (Walter's sedge). Many stands of this association have been degraded by cutting or ditching, and extensive areas of suitable habitat have been lost to agriculture, hydrologic alterations, and conversion of hardwood forests to silvicultural pine plantations.
Environmental Description: This association occurs on extensive, flat Coastal Plain terraces and very wide, ancient floodplains that are no longer subject to alluvial processes. Its hydrology is seasonally to nearly permanently saturated, with occasional ponding or groundwater

sheetflows, and is maintained by a high water table rather than riverine or estuarine flooding. Shallow channels and streams are sometimes evident, and hummock and hollow microtopography may be present. On the Eastern Shore of Virginia (Accomack County), it is found in isolated and extensive but shallow upland depressions. The stands here cover many hectares and occur in slight depressions with drainage impeded by an impermeable clay layer about half a meter below the soil surface. The habitat apparently has a seasonally high water table but ponds water only intermittently or for short periods (G. Fleming pers. comm.). Surficial soils occupied by this forest are extremely acidic and infertile silt or silty-clay loams.

Vegetation Description: The overstory of relatively undisturbed examples contain variable mixtures of hydrophytic oaks, most commonly *Quercus phellos* (willow oak), *Quercus pagoda* (cherrybark oak), and *Quercus michauxii* (swamp chestnut oak). Associated canopy species varying from site to site can include *Quercus alba* (white oak), *Quercus palustris* (pin oak), *Quercus lyrata* (overcup oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Pinus taeda* (loblolly pine), *Nyssa sylvatica* (blackgum), and *Fraxinus pennsylvanica* (green ash). *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), and *Pinus taeda* (loblolly pine) are often abundant in stands disturbed by cutting. The subcanopy layers are usually dominated by *Ilex opaca* var. *opaca* (American holly) and also contain *Magnolia virginiana* (sweetbay) and recruitment of the overstory trees. The shrub layer varies from open to dense, and most characteristically contains *Clethra alnifolia* (coastal sweetpepperbush), *Leucothoe racemosa* (swamp doghobble), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium fuscatum* (black highbush blueberry), *Vaccinium formosum* (southern blueberry), *Viburnum dentatum* (southern arrowwood), *Rhododendron viscosum* (swamp azalea), and *Viburnum nudum* var. *nudum* (possumhaw). The herb layer is also highly variable. Some stands have a rather sparse herbaceous flora, with scattered colonies and individuals of *Woodwardia areolata* (netted chainfern), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Woodwardia virginica* (Virginia chainfern), *Saururus cernuus* (lizard's tail), and various sedges. Others have a relatively dense graminoid-dominated herb layer with variable patch-dominance by *Chasmanthium laxum* (slender woodoats), *Carex debilis* var. *debilis* (white edge sedge), *Carex intumescens* (greater bladder sedge), *Carex seorsa* (weak stellate sedge), *Carex lonchocarpa* (southern long sedge), and more rarely, *Carex bullata* (button sedge) or *Carex striata* var. *brevis* (Walter's sedge). Many other hydrophytic herbs occur at low constancy and cover. The composition of this community is something of a "hybrid," with an overstory similar to that of oak-dominated floodplain forests and lower strata resembling those of an acidic seepage swamp.

Most Abundant Species:

Stratum	Lifeform	Species
Tree subcanopy	Broad-leaved evergreen tree	*Ilex opaca* var. *opaca* (American holly), *Magnolia virginiana* (sweetbay)
Herb (field)	Graminoid	*Carex debilis* var. *debilis* (white edge sedge), *Carex intumescens* (greater bladder sedge), *Carex lonchocarpa* (southern long sedge), *Carex seorsa* (weak stellate sedge), *Chasmanthium laxum* (slender woodoats)

Characteristic Species: *Clethra alnifolia* (coastal sweetpepperbush), *Ilex verticillata* (common winterberry), *Leucothoe racemosa* (swamp doghobble), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Quercus michauxii* (swamp chestnut oak), *Quercus pagoda* (cherrybark oak), *Quercus phellos* (willow oak), *Rhododendron viscosum* (swamp azalea), *Saururus cernuus* (lizard's tail), *Vaccinium corymbosum* (highbush blueberry),

Viburnum dentatum (southern arrowwood), *Viburnum nudum* var. *nudum* (possumhaw),
Woodwardia areolata (netted chainfern), *Woodwardia virginica* (Virginia chainfern).
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION
Range: This association is known from about 25 sites in 13 counties of the Virginia central and
northern Coastal Plain. It is not currently documented in Maryland, but requisite habitat
conditions are present (J. Harrison pers. comm.).
States/Provinces: VA:S2?
Federal Lands: DOD (Fort Lee); NPS (Colonial, Fredericksburg-Spotsylvania, George
Washington Birthplace, Richmond).

CONSERVATION STATUS
Rank: G2? (15-Aug-1997).
Reasons: This association is restricted to special wetland habitats and was probably never
common on the landscape. However, extensive areas of suitable habitat have been lost to
agriculture, hydrologic alterations, and conversion of hardwood forests to silvicultural pine
plantations. The largest known remaining stands are all on private lands and are not protected.
Mature, undisturbed examples of this type are rare.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: Classification of this type is based on intensive field investigation by the Virginia
Natural Heritage Program (VDNH) and analysis of a 1250-plot regional dataset assembled for
the NCR and mid-Atlantic national parks vegetation mapping projects. In that analysis, this
association was represented by 21 plots from the northern Coastal Plain of Virginia. The original
concept of this vegetation was based on field work by Bill Moorhead (VDNH), who investigated
several of the large, elliptical depressions that dot the flat landscape in Accomack County. There
are three plots that document this vegetation at two sites: "Dahl Swamp" and "The Lake" (G.
Fleming pers. comm.). The stands apparently cover many hectares and are associated with slight
depressions with drainage impeded by an impermeable clay layer about half a meter below the
soil surface. The habitat apparently has a seasonally high water table but ponds water only
intermittently or for short periods. Most of the areas seen by Bill Moorhead had been logged
some decades ago and had a very open (woodland-like) physiognomy due to poor restocking of
canopy trees. However, he also obtained information from local people that one of the areas was
known historically as "savanna land," suggesting that fire and hydrology maintained a woodland
physiognomy in the depressions (G. Fleming pers. comm.).
Similar Associations:
- *Carex striata* var. *brevis* Herbaceous Vegetation (CEGL004120).
- *Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa* Forest (CEGL006110)--is also
  found in Ecoregion 58.
- *Quercus michauxii - Quercus pagoda / Clethra alnifolia - Leucothoe axillaris* Forest (CEGL007449)--southern
  analogue found on mineral soils near the edge of extensive peat flats on the outer Coastal Plain terraces of
  southeastern Virginia and North Carolina; compositionally very similar to CEGL004644 but contains southern
  species such as *Quercus laurifolia, Leucothoe axillaris, Arundinaria gigantea* ssp. *tecta*, and *Sabal minor* that are
  absent from CEGL004644.

Related Concepts:

- *Quercus (michauxii, pagoda, phellos, alba) / Clethra alnifolia / Woodwardia virginica* Forest (VDNH 2003) =

SOURCES

Description Authors: G. P. Fleming, mod. M. Pyne and G. P. Fleming.

References: Fleming et al. 2001, Fleming pers. comm., J. Harrison pers. comm., Southeastern Ecology Working Group n.d., VDNH 2003.

Figure I12. Non-Riverine Saturated Forest (plot RICH.7) at Richmond National Battlefield Park. June 2004. NAD 1983 / UTM easting 300275, northing 4143239.

Figure I13. Non-Riverine Saturated Forest (plot RICH.11) at Richmond National Battlefield Park. April 2006. NAD 1983 / UTM easting 289254, northing 4162556.

COMMON NAME (PARK-SPECIFIC): **COASTAL PLAIN / PIEDMONT ACIDIC 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: Coastal Plain / Piedmont Acidic Seepage Swamp occurs as narrow features in small ravine bottoms and draws where seepage discharged at the ground surface is drained away as streamflow. These saturated, deciduous forests have acidic, nutrient-poor soils and are characterized by diffuse drainage with braided channels and *Sphagnum* spp. (sphagnum mosses) -covered hummocks in a sandy or peaty substrate.

Vegetation Description: Dominant overstory species are *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Liriodendron tulipifera* (tuliptree), *Liquidambar styraciflua* (sweetgum), and *Pinus taeda* (loblolly pine). Other species that occur in the canopy in lesser amounts include *Platanus occidentalis* (American sycamore), *Quercus alba* (white oak), *Quercus michauxii* (swamp chestnut oak), and *Quercus rubra* (northern red oak). The subcanopy and tall-shrub layers are dominated by mixtures of *Acer rubrum* (red maple), *Ilex opaca* var. *opaca* (American holly), and *Magnolia virginiana* (sweetbay). *Clethra alnifolia* (coastal sweetpepperbush) dominates the short-shrub layer and is often very dense. Other common and characteristic shrubs include *Alnus serrulata* (hazel alder), *Chionanthus virginicus* (white fringetree), *Ilex verticillata* (common winterberry), *Leucothoe racemosa* (swamp doghobble), *Rhododendron periclymenoides* (pink azalea), *Rhododendron viscosum* (swamp azalea), *Smilax rotundifolia* (roundleaf greenbrier), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium formosum* (southern blueberry), *Vaccinium fuscatum* (black highbush blueberry), and *Viburnum nudum* (possumhaw). The herb stratum is a dense mixture of graminoids, ferns, and forbs. Many examples are very rich in *Carex* spp. (sedges). Characteristic sedges include *Carex abscondita* (thicket sedge), *Carex atlantica* ssp. *atlantica* (prickly bog sedge), *Carex atlantica* ssp. *capillacea* (prickly bog sedge), *Carex collinsii* (Collins' sedge), *Carex crinita* (fringed sedge), *Carex debilis* (white edge sedge), *Carex intumescens* (greater bladder sedge), *Carex lonchocarpa* (southern long sedge), and *Carex radiata* (eastern star sedge). Other graminoid species include *Cinna arundinacea* (sweet woodreed), *Glyceria striata* (fowl mannagrass), *Juncus effusus* (common rush), and *Leersia virginica* (whitegrass). Common ferns are *Athyrium filix-femina* (common ladyfern), *Osmunda cinnamomea* var. *cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Thelypteris noveboracensis* (New York fern), and *Woodwardia areolata* (netted chainfern). Typical forbs include *Arisaema triphyllum* (Jack in the pulpit), *Chelone glabra* (white turtlehead), *Cicuta maculata* var. *maculata* (spotted water hemlock), *Eupatorium purpureum* var. *purpureum* (sweetscented joepyeweed), *Gratiola virginiana* (roundfruit hedgehyssop), *Lycopus virginicus* (Virginia water horehound), *Orontium aquaticum* (goldenclub), *Platanthera ciliaris* (yellow fringed orchid), *Platanthera clavellata* (small green wood orchid), *Platanthera flava* var. *flava* (palegreen orchid), *Platanthera lacera* (green fringed

orchid), *Saururus cernuus* (lizard's tail), *Symplocarpus foetidus* (skunk cabbage), *Uvularia sessilifolia* (sessileleaf bellwort), *Viola cucullata* (marsh blue violet), and *Viola X primulifolia* (primroseleaf violet).

Disturbed examples or examples with very dense shrub cover may lack herbaceous diversity.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Clethra alnifolia* (coastal sweetpepperbush)

Characteristic Species: *Acer rubrum* (red maple), *Clethra alnifolia* (coastal sweetpepperbush), *Magnolia virginiana* (sweetbay), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern), *Viburnum nudum* (possumhaw), *Woodwardia areolata* (netted chainfern).

Other Noteworthy Species:

Species	GRank	Type	Note
Carex collinsii (Collins' sedge)	-	plant	VA watchlist (S3)

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	S3?	=	1	Coastal Plain / Piedmont Acidic Seepage Swamp	Fleming et al. 2006

Local Range: Coastal Plain / Piedmont Acidic Seepage Swamp is mapped as seven polygons at Cold Harbor, Malvern Hill, and Fort Harrison. Examples smaller than 0.5 hectare (minimum mapping unit) are possible and not mapped in these areas. As mapped, this association covers 9 hectares (22 acres) in the park.

Classification Comments: This community is distinguished from other wetlands in Richmond National Battlefield Park by its distinctive species composition, its occurrence in narrow ravine bottoms, and by a saturated hydrology which is influenced predominantly by seepage rather than stream flooding. Hydric oaks may be present at low cover and are not typical. Other forested wetlands in Richmond National Battlefield Park are associated with active, temporarily flooded small stream floodplains or large, saturated to seasonally flooded flats.

Other Comments: High-quality examples of Coastal Plain / Piedmont Acidic Seepage Swamp are uncommon throughout the range of the association. Even though only one example of this association in Richmond National Battlefield Park meets the criteria to be considered a Natural Heritage exemplary natural community occurrence, all examples of this native plant association should be targets for conservation and management. These habitats are generally wet and somewhat protected from fire. Several uncommon odonates (dragonflies and damselflies) depend on forested seeps for breeding habitat. Coastal Plain / Piedmont Acidic Seepage Swamps are relatively small in size and threatened by beaver activities, agricultural pollutants, hydrologic disturbances, and logging.

Local Description Authors: K. D. Patterson.

Plots: RICH.2, RICH.6.

Richmond National Battlefield Park 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):   Northern Atlantic Coastal Plain Basin Peat Swamp (CES203.522).
                            Northern Atlantic Coastal Plain Pitch Pine Lowland (CES203.374).
                            Northern Atlantic Coastal Plain Stream and River (CES203.070).

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* (red maple) and *Nyssa sylvatica* (blackgum) in the canopy, which may be quite open in some examples. Canopy associates include *Magnolia virginiana* (sweetbay), *Liquidambar styraciflua* (sweetgum), and *Persea palustris* (swamp bay), plus occasional incidental *Liriodendron tulipifera* (tuliptree) or *Pinus taeda* (loblolly pine). Upland trees may occur on drier hummocks. The shrub layer is characterized by *Vaccinium corymbosum* (highbush blueberry), as well as *Clethra alnifolia* (coastal sweetpepperbush), *Ilex verticillata* (common winterberry), *Ilex opaca* var. *opaca* (American holly), *Viburnum nudum* var. *nudum* (possumhaw), *Lindera benzoin* (northern spicebush), and *Rhododendron viscosum* (swamp azalea). The herbaceous layer varies from dense to sparse and may include *Symplocarpus foetidus* (skunk cabbage), *Triadenum virginicum* (Virginia marsh St. Johnswort), *Osmunda regalis* var. *spectabilis* (royal fern), *Woodwardia areolata* (netted chainfern), *Carex folliculata* (northern long sedge), *Carex lonchocarpa* (southern long sedge), *Carex collinsii* (Collins' sedge), *Carex atlantica* ssp. *atlantica* (prickly bog sedge), *Bartonia paniculata* (twining screwstem), *Parnassia asarifolia* (kidneyleaf grass of Parnassus), *Helonias bullata* (swamppink), *Chelone glabra* (white turtlehead), *Oxypolis rigidior* (stiff cowbane), and *Osmunda cinnamomea* (cinnamon fern). *Sphagnum* spp. (sphagnum mosses) 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* (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* (red maple) and *Nyssa sylvatica*

(blackgum) are consistently dominant overstory species. *Liriodendron tulipifera* (tuliptree) is a frequent but minor overstory associate, and *Pinus taeda* or *Liquidambar styraciflua* is occasional in the canopy. *Magnolia virginiana* (sweetbay) is a frequent overstory associate and usually dominant in a subcanopy layer or codominant with *Ilex opaca* var. *opaca* (American holly).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* (possumhaw), *Vaccinium corymbosum* (highbush blueberry), *Smilax rotundifolia* (roundleaf greenbrier), *Ilex verticillata* (common winterberry), and *Lindera benzoin* (northern spicebush). In parts of the range, *Clethra alnifolia* (coastal sweetpepperbush) is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* (leatherleaf) and *Gaylussacia frondosa* (blue huckleberry) are present. Additional, less constant shrub associates are *Rhododendron viscosum* (swamp azalea), *Leucothoe racemosa* (swamp doghobble), *Chionanthus virginicus* (white fringetree), *Viburnum dentatum* (southern arrowwood), *Toxicodendron vernix* (poison sumac), and *Carpinus caroliniana* (American hornbeam). The herb layer varies from dense to sparse. *Osmunda cinnamomea* (cinnamon fern) and *Woodwardia areolata* (netted chainfern) are generally the most constant and abundant herbs, but *Symplocarpus foetidus* (skunk cabbage) is a patch-dominant in approximately two-thirds of the Virginia and Maryland stands. Additional characteristic herbs occurring at low cover include *Arisaema triphyllum* ssp. *pusillum* (Jack in the pulpit), *Carex atlantica* (prickly bog sedge), *Carex debilis* var. *debilis* (white edge sedge), *Carex folliculata* (northern long sedge), *Carex intumescens* (greater bladder sedge), *Carex lonchocarpa* (southern long sedge), *Carex seorsa* (weak stellate sedge), *Carex styloflexa* (bent sedge), *Chelone glabra* (white turtlehead), *Impatiens capensis* (jewelweed), *Lycopus virginicus* (Virginia water horehound), *Mitchella repens* (partridgeberry), *Osmunda regalis* var. *spectabilis* (royal fern), *Platanthera clavellata* (small green wood orchid), *Viola cucullata* (marsh blue violet), and *Viola X primulifolia* (primroseleaf violet). Regionally uncommon or rare species that may be locally abundant in this type include *Helonias bullata* (swamppink), *Parnassia asarifolia* (kidneyleaf grass of Parnassus), *Carex collinsii* (Collins' sedge), and *Bartonia paniculata* (twining screwstem).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Clethra alnifolia* (coastal sweetpepperbush), *Vaccinium corymbosum* (highbush blueberry)
Herb (field)	Fern or fern ally	*Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Woodwardia areolata* (netted chainfern)

Characteristic Species: *Acer rubrum* (red maple), *Magnolia virginiana* (sweetbay), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern).

Other Noteworthy Species:

Species	GRank	Type	Note
Helonias bullata (swamppink)	G3	plant	

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, PA, VA:S3?

Federal Lands: DOD (Fort A.P. Hill, Fort Belvoir); NPS (Assateague Island, Fredericksburg-Spotsylvania, George Washington Birthplace, National Capital-East, Petersburg, 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., Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., Golet et al. 1993, 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 I14. Coastal Plain / Piedmont Acidic Seepage Swamp (plot RICH.6) at Richmond National Battlefield Park. June 2004. NAD 1983 / UTM easting 300952, northing 4143952.

COMMON NAME (PARK-SPECIFIC):   BEAVER WETLAND COMPLEX

SYNONYMS
USNVC English Name: Smooth Alder Swamp Shrubland
USNVC Scientific Name: *Alnus serrulata* Swamp Shrubland
USNVC Identifier: CEGL005082

LOCAL INFORMATION

Environmental Description: Beaver Wetland Complex includes disturbed vegetation associated with beaver activities along stream channels and usually has open standing water due to hydrologic alterations. Areas without open water have saturated soil conditions.

Vegetation Description: Beaver Wetland Complex includes a physiognomic complex of saturated deciduous forest, saturated shrubland, saturated herbaceous vegetation, and open water. This vegetation complex is associated with the activities of beaver and the resulting hydrologic alterations within the small stream floodplain. Forested areas are commonly dominated by *Acer rubrum* (red maple) and *Salix nigra* (black willow), with standing dead trees, but other species can occur, such as *Betula nigra* (river birch), *Fagus grandifolia* (American beech), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Platanus occidentalis* (American sycamore), *Quercus pagoda* (cherrybark oak), and *Taxodium distichum* (bald cypress). The shrubland areas are typically dominated by *Alnus serrulata* (hazel alder) or *Salix nigra* (black willow), although other species, such as *Cephalanthus occidentalis* (common buttonbush) and *Rosa palustris* (swamp rose), are common. Herbaceous species that often occur as patch dominants are *Carex crinita* (fringed sedge), *Leersia oryzoides* (rice cutgrass), *Murdannia keisak* (wartremoving herb), *Microstegium vimineum* (Nepalese browntop), and *Sparganium americanum* (American bur-reed). Many other herbaceous species can occur. Some of the more typical include *Bidens frondosa* (devil's beggartick), *Boehmeria cylindrica* (smallspike false nettle), *Eupatorium fistulosum* (trumpetweed), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (jewelweed), *Peltandra virginica* (green arrow arum), *Polygonum arifolium* (halberdleaf tearthumb), *Polygonum sagittatum* (arrowleaf tearthumb), *Sagittaria latifolia* (broadleaf arrowhead), and *Typha latifolia* (broadleaf cattail).

Physiognomy varies from a closed forest to an open canopy of standing dead trees, to large expanses of wet, herbaceous vegetation. Shrubs are usually around the margins and open water is in the center.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	*Alnus serrulata* (hazel alder)
Herb (field)	Forb	*Murdannia keisak* (wartremoving herb)
Herb (field)	Graminoid	*Microstegium vimineum* (Nepalese browntop)

Characteristic Species: *Acer rubrum* (red maple), *Alnus serrulata* (hazel alder), *Microstegium vimineum* (Nepalese browntop), *Murdannia keisak* (wartremoving herb), *Salix nigra* (black willow), *Sparganium americanum* (American bur-reed).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNR	.	.	[not crosswalked]	.

Local Range: Beaver Wetland Complex is mapped as six polygons at Beaver Dam Creek, Gaines Mill (Watt House) and at Malvern Hill.

Classification Comments: Beaver Wetland Complex is associated with beaver activities along a stream channel and usually has open water. It has distinct species composition that differentiates it from other wetland vegetation in Richmond National Battlefield Park.

Other Comments: Information not available.

Local Description Authors: K. D. Patterson.

Plots: None.

Richmond National Battlefield Park 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	*Alnus serrulata* Seasonally Flooded Shrubland Alliance (A.994)
Alliance (English name)	Smooth Alder Seasonally Flooded Shrubland Alliance
Association	*Alnus serrulata* Swamp Shrubland
Association (English name)	Smooth Alder Swamp Shrubland
Ecological System(s):	Central Appalachian River Floodplain (CES202.608).
	Laurentian-Acadian Wet Meadow-Shrub Swamp (CES201.582).

GLOBAL DESCRIPTION

Concept Summary: This alder swamp is found widely throughout the northeastern United States south of near-boreal regions. These shrublands are found on muck overlying mineral soils (peat deposits are not typical) of upland marsh borders, at the edges of red maple swamps, or in acidic colluvium at bases of slopes. The pH of these systems is broadly circumneutral to somewhat calcareous. The vegetation is dominated by tall shrubs, characterized and usually dominated by *Alnus serrulata* (hazel alder), sometimes in a mixture with (or rarely replaced by) *Alnus incana* (gray alder). Associate shrubs vary somewhat with geography and include *Cornus sericea* (redosier dogwood), *Rosa palustris* (swamp rose), *Physocarpus opulifolius* (common ninebark), *Viburnum recognitum* (southern arrowwood), and *Salix* spp. (willows). Saplings of *Acer rubrum* (red maple) are typical. Short shrubs include *Spiraea alba* var. *latifolia* (white meadowsweet) and *Lindera benzoin* (northern spicebush). Less frequent shrubs include *Cephalanthus occidentalis* (common buttonbush), *Decodon verticillatus* (swamp loosestrife), *Ilex verticillata* (common winterberry), *Rhododendron viscosum* (swamp azalea), and *Sambucus canadensis* (= *Sambucus nigra* ssp. *canadensis*, common elderberry). Herbaceous associates include *Calamagrostis canadensis* (bluejoint), *Osmunda regalis* (royal fern), *Glyceria striata* (fowl mannagrass), *Thelypteris palustris* (eastern marsh fern), *Galium* spp. (bedstraws), *Typha latifolia* (broadleaf cattail), *Polygonum hydropiper* (marshpepper knotweed), *Bidens cernua* (nodding beggartick), *Galium tinctorium* (stiff marsh bedstraw), *Cicuta maculata* (spotted water hemlock), *Peltandra virginica* (green arrow arum), and *Carex stricta* (upright sedge).

Environmental Description: These shrublands are found on muck overlying mineral soils (peat deposits are not typical) of upland marsh borders, small upland depressions, at the edges of red maple swamps or other ponded drainages, or in colluvium at bases of slopes. The pH of these systems is broadly circumneutral to somewhat calcareous (Fike 1999).

Vegetation Description: The vegetation is dominated by tall shrubs and characterized by *Alnus serrulata* (hazel alder), *Alnus incana* (gray alder), *Physocarpus opulifolius* (common ninebark), *Viburnum recognitum* (southern arrowwood), *Cornus amomum* (silky dogwood), and *Salix* spp. (willows). Saplings of *Acer rubrum* (red maple) are typical. Short shrubs include *Spiraea alba* var. *latifolia* (white meadowsweet) and *Lindera benzoin* (northern spicebush). Other shrubs present include *Cephalanthus occidentalis* (common buttonbush), *Decodon verticillatus* (swamp loosestrife), *Ilex verticillata* (common winterberry), *Rhododendron viscosum* (swamp azalea), and *Sambucus canadensis* (= *Sambucus nigra* ssp. *canadensis*, common elderberry) (Anderson 1996, Fike 1999). Herbaceous associates include *Calamagrostis canadensis* (bluejoint), *Osmunda regalis* (royal fern), *Glyceria striata* (fowl mannagrass), *Thelypteris palustris* (eastern marsh fern), *Galium* spp. (bedstraws), *Typha latifolia* (broadleaf cattail), *Polygonum hydropiper* (marshpepper knotweed), *Bidens cernua* (nodding beggartick), *Galium tinctorium* (stiff marsh bedstraw), *Cicuta maculata* (spotted water hemlock), *Peltandra virginica* (green arrow arum), and *Carex stricta* (upright sedge).

Most Abundant Species:

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Alnus incana* (gray alder)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Alnus serrulata* (hazel alder), *Physocarpus opulifolius* (common ninebark), *Viburnum recognitum* (southern arrowwood)
Herb (field)	Forb	*Peltandra virginica* (green arrow arum)
Herb (field)	Graminoid	*Calamagrostis canadensis* (bluejoint)
Herb (field)	Fern or fern ally	*Osmunda regalis* (royal fern)

Characteristic Species: *Alnus serrulata* (hazel alder), *Cornus amomum* (silky dogwood), *Physocarpus opulifolius* (common ninebark), *Viburnum recognitum* (southern arrowwood).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This alder swamp is found widely throughout the northeastern United States, ranging from central New England south to New Jersey, and west to Ohio and Pennsylvania.

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

Federal Lands: NPS (Appomattox Court House, Delaware Water Gap, Fredericksburg-Spotsylvania, Minute Man, Petersburg, Richmond).

CONSERVATION STATUS

Rank: G4G5 (22-Mar-1999).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: This type overlaps with *Alnus incana* Swamp Shrubland (CEGL002381) where the ranges abut in Ohio, Pennsylvania, southern New England, and southern New York. Where both alder species are present, this type is distinguished from the *Alnus incana* (gray alder) nominal

type by the presence of species with a somewhat more Central Appalachian / Alleghenian affinity such as *Physocarpus opulifolius* (common ninebark), *Rhododendron viscosum* (swamp azalea), *Peltandra virginica* (green arrow arum), compared to CEGL002381 which is characterized by somewhat more northern species such as *Nemopanthus mucronatus* (catberry) and *Myrica gale* (sweetgale). Where they overlap, the relative dominance of the two alder species should be expected to vary. If *Alnus serrulata* (hazel alder) is present in more than token amounts, consider this type as opposed to CEGL002381.

Similar Associations:

- *Alnus incana* Swamp Shrubland (CEGL002381).
- *Alnus serrulata* Southeastern Seasonally Flooded Shrubland (CEGL008474).

Related Concepts:

- Smooth alder shrub thicket (CAP pers. comm. 1998) ?

SOURCES

Description Authors: L. A. Sneddon, mod. D. Faber-Langendoen and S. C. Gawler.
References: Anderson 1996, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Fike 1999, Swain and Kearsley 2001.

Figure I15. Beaver Wetland Complex at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 300169, northing 4143036.

Figure I16. Beaver Wetland Complex at Richmond National Battlefield Park. June 2004. NAD 1983 / UTM easting 301164, northing 4144030.

COMMON NAME (PARK-SPECIFIC): CULTURAL MEADOW

SYNONYMS
USNVC English Name: **Orchard Grass - Timothy - Fescue species - Goldenrod species Herbaceous Vegetation**
USNVC Scientific Name: ***Dactylis glomerata - Phleum pratense - Festuca* spp. - *Solidago* spp. Herbaceous Vegetation**
USNVC Identifier: **CEGL006107**

LOCAL INFORMATION

Environmental Description: This map class includes herbaceous-dominated vegetation that is maintained as open fields or agricultural leases. Historic battlefields in Richmond National Battlefield Park are maintained to keep an open landscape similar to conditions during the mid-19th century.

Vegetation Description: Cultural Meadows are vegetated by a mix of native and European grasses and forbs or by planted agricultural crops. Fields tend to be dense stands of sod-forming grasses such as *Lolium pratense* (meadow ryegrass), *Andropogon virginicus* (broomsedge bluestem), and *Dactylis glomerata* (orchardgrass). In areas that are mowed more closely, *Cynodon dactylon* (Bermudagrass), *Dactylis glomerata* (orchardgrass), *Digitaria sanguinalis* (hairy crabgrass), and *Echinochloa crus-galli* (barnyardgrass) are common. Planted crops can vary from year to year.

Areas mapped as Cultural Meadow may have below minimum mapping unit (<0.5 ha) inclusions of tree-dominated patches, windrows, shrub-dominated ditches or small wetland inclusions. These areas may also have cultural features such as walkways and monuments. Cultural Meadows near Beaver Wetland Complex may have seasonally flooded areas and associated wetland plant species.

Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	SNA	.	.	[not crosswalked]	.

Local Range: Cultural Meadow is mapped at Cold Harbor, Fort Darling, Gaines Mill (Watt House), Fort Harrison, and at Malvern Hill. It covers 81 hectares (200 acres) in Richmond National Battlefield Park.

Classification Comments: Cultural Meadow is a herbaceous-dominated mapping unit. It is distinguished from other mapping units by its physiognomy, by lacking associated buildings, human-created earthworks, and by not occurring as a linear strip along roadways or utility corridors. Lawns around buildings are mapped with the building and included in the mapping units Residential or Other Urban or Built-up Land. Mowed roadsides occurring as linear strips along roadways are included in the mapping unit Transportation, Communications, and Utilities. Earthworks that are vegetated with herbaceous species are included in the mapping unit Open Earthworks.

Other Comments: Areas mapped as Cultural Meadow were not included in quantitative sampling or accuracy assessment observations and species listed in this description do not appear in Appendix C.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park 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	*Dactylis glomerata - Rumex acetosella* Herbaceous Alliance (A.1190)
Alliance (English name)	Orchard Grass - Common Sheep Sorrel Herbaceous Alliance
Association	*Dactylis glomerata - Phleum pratense - Festuca* spp. - *Solidago* spp. Herbaceous Vegetation
Association (English name)	Orchard Grass - Timothy - Fescue species - Goldenrod species Herbaceous Vegetation
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This broadly defined vegetation type includes pastures and post-agricultural fields and is largely composed of nonnative cool-season grasses and herbs (generally of European origin) in the early stages of succession. The fields are typically mowed at least annually. Physiognomically, these grasslands are generally comprised of mid-height (1-3 feet tall) grasses and forbs, with occasional scattered shrubs. Species composition varies from site to site, depending on land-use history and perhaps soil type, but in general this vegetation is quite wide-ranging in northeastern and midwestern states and at higher elevations (610-1220 m [2000-4000 feet]) in the southeastern states. Dominant grasses vary from site to site but generally feature the nominal species. Other graminoid associates may include *Agrostis stolonifera* (creeping bentgrass), *Agrostis hyemalis* (winter bentgrass), *Elymus repens* (quackgrass), *Bromus inermis* (smooth brome), *Bromus tectorum* (cheatgrass), *Lolium perenne* (perennial ryegrass), *Poa pratensis* (Kentucky bluegrass), *Poa compressa* (Canada bluegrass), *Schizachyrium scoparium* (little bluestem) (not in abundance), and *Anthoxanthum odoratum* (sweet vernalgrass). Forbs scattered among the grasses are varied but include *Hieracium* spp. (hawkweeds), *Oxalis stricta* (common yellow oxalis), *Achillea millefolium* (common yarrow), *Asclepias syriaca* (common milkweed), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago nemoralis* (gray goldenrod), *Solidago juncea* (early goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago altissima* (tall goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Cerastium arvense* (field chickweed), *Oenothera biennis* (common evening-primrose), *Potentilla simplex* (common cinquefoil), *Symphyotrichum lateriflorum* (calico aster), *Symphyotrichum novae-angliae* (New England aster), *Symphyotrichum lanceolatum* (white panicle aster), *Daucus carota* (Queen Anne's lace), *Ambrosia artemisiifolia* (annual ragweed), *Vicia cracca* (bird vetch), *Trifolium* spp. (clovers), and many others.
Environmental Description: This association occurs on pastures and land that has been tilled. Generally the fields are mowed at least annually.

Vegetation Description: In addition to *Dactylis glomerata* (orchardgrass) and *Phleum pratense* (timothy), these grassy fields are characterized by graminoids including *Agrostis stolonifera* (creeping bentgrass), *Agrostis hyemalis* (winter bentgrass), *Elymus repens* (quackgrass), *Bromus inermis* (smooth brome), *Bromus tectorum* (cheatgrass), *Lolium perenne* (perennial ryegrass), *Poa pratensis* (Kentucky bluegrass), *Poa compressa* (Canada bluegrass), *Schizachyrium scoparium* (little bluestem) (not in abundance), and *Anthoxanthum odoratum* (sweet vernalgrass). Forbs scattered among the grasses are varied but include *Hieracium* spp. (hawkweeds), *Oxalis stricta* (common yellow oxalis), *Achillea millefolium* (common yarrow), *Asclepias syriaca* (common milkweed), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago nemoralis* (gray goldenrod), *Solidago juncea* (early goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago altissima* (tall goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Cerastium arvense* (field chickweed), *Oenothera biennis* (common evening-primrose), *Potentilla simplex* (common cinquefoil), *Symphyotrichum lateriflorum* (calico aster), *Symphyotrichum novae-angliae* (New England aster), *Symphyotrichum lanceolatum* (white panicle aster), *Daucus carota* (Queen Anne's lace), *Ambrosia artemisiifolia* (annual ragweed), *Vicia cracca* (bird vetch), *Trifolium* spp. (clovers), and many others.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Rumex acetosella* (common sheep sorrel)
Herb (field)	Graminoid	*Dactylis glomerata* (orchardgrass), *Festuca rubra* (red fescue), *Phleum pratense* (timothy)

Characteristic Species: *Achillea millefolium* (common yarrow), *Anthoxanthum odoratum* (sweet vernalgrass), *Dactylis glomerata* (orchardgrass), *Euthamia graminifolia* (flat-top goldentop), *Phleum pratense* (timothy), *Rumex acetosella* (common sheep sorrel), *Solidago altissima* (tall goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago rugosa* (wrinkleleaf goldenrod).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This vegetation is quite wide-ranging in northeastern and midwestern states and possibly occurs at higher elevations in the southeastern states.

States/Provinces: CT, DE, KY, MA, MD, ME, NB?, NH, NJ, NS?, NY, PA, QC?, RI, TN, VA, VT, WV.

Federal Lands: NPS (Allegheny Portage Railroad, Appomattox Court House, Booker T. Washington, Boston Harbor Islands, Cape Cod, Colonial, Delaware Water Gap, Fire Island, Fort Necessity, Fredericksburg-Spotsylvania, Friendship Hill, Gateway, George Washington Birthplace, Gettysburg, Johnstown Flood, Marsh-Billings-Rockefeller, Minute Man, Morristown, Petersburg, Richmond, Saint-Gaudens, Saratoga, Upper Delaware, Valley Forge, Weir Farm); USFWS (Aroostook, Assabet River, Carlton Pond, Erie, Great Meadows, Moosehorn, Nulhegan Basin, Oxbow, Parker River).

CONSERVATION STATUS

Rank: GNA (modified/managed) (8-Dec-2005).

Reasons: This vegetation type includes pasture and post-agricultural fields and is largely composed of nonnative grasses and herbs (generally of European origin).

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: *Schizachyrium scoparium - (Andropogon virginicus) - Solidago* spp. Herbaceous Vegetation (CEGL006333) is similar to this type but is dominated by warm-season grasses.

Similar Associations:

- *Lolium (arundinaceum, pratense)* Herbaceous Vegetation (CEGL004048).
- *Phleum pratense - Bromus pubescens - Helenium autumnale* Herbaceous Vegetation (CEGL004018).
- *Schizachyrium scoparium - (Andropogon virginicus) - Solidago* spp. Herbaceous Vegetation (CEGL006333)-- has a greater component of native species and occurs on drier soils.

Related Concepts: Information not available.

SOURCES

Description Authors: S. C. Gawler.

References: Clark 1986, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld 1977, Elliman 2003, Keever 1979, NRCS 2004, Newbold et al. 1988, Perles et al. 2006a, Perles et al. 2006b, Perles et al. 2006c, Perles et al. 2007, Sneddon et al. 1995, TDNH unpubl. data.

Figure I17. Cultural Meadow at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 298172, northing 4162614.

Figure I18. Cultural Meadow at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 301357, northing 4143497.

COMMON NAME (PARK-SPECIFIC): FORESTED EARTHWORKS

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Nonstandard**

LOCAL INFORMATION

Environmental Description: Information not available.
Vegetation Description: Information not available.
Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	NA	.	.	[not crosswalked, not ranked]	.

Local Range: Forested Earthworks are mapped at Fort Harrison where it covers 25 hectares (61.7 acres).
Classification Comments: Forested Earthworks is a map class used to indicate areas where Civil War era earthworks have become forested and the understory is maintained by mowing or other management. Species growing on the earthworks vary from site to site.
Other Comments: Information not available.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.

GLOBAL INFORMATION

Forested Earthworks is a park-specific, nonstandard type and has no global information.

Figure I19. Forested Earthworks at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 289478, northing 4146036.

COMMON NAME (PARK-SPECIFIC):   OPEN EARTHWORKS

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Nonstandard**

LOCAL INFORMATION

Environmental Description: Information not available.
Vegetation Description: Information not available.
Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	NA	.	.	[not crosswalked, not ranked]	.

Local Range: Open Earthworks are mapped at Chickahominy Bluff and Fort Harrison. They cover 4.7 hectares (11.6 acres) in these areas.
Classification Comments: Open Earthworks is a map class used to indicate Civil War era earthworks that are maintained in a non-forested condition by mowing or other management. Species growing on the earthworks vary from site to site.
Other Comments: Information not available.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.

GLOBAL INFORMATION

Open Earthworks is a park-specific, nonstandard type and has no global information.

Figure I20. Open Earthworks at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 290008, northing 4144944.

COMMON NAME (PARK-SPECIFIC): **SUCCESSIONAL MIXED SCRUB**

SYNONYMS
USNVC English Name: Not applicable
USNVC Scientific Name: Not applicable
USNVC Identifier: Nonstandard

LOCAL INFORMATION

Environmental Description: Successional Mixed Scrub includes low-statured woody vegetation composed of mixtures of native and exotic species and occurring along edges of roadways and Cultural Meadow.

Vegetation Description: The structure is overall shrubby, but examples may have scattered trees. Dominant species may vary from stand to stand, but composition usually includes the exotic species *Ailanthus altissima* (tree of heaven) and/or the native species *Liquidambar styraciflua* (sweetgum). Other common to dominant shrubs can include the exotic species *Ligustrum sinense* (Chinese privet) and *Paulownia tomentosa* (princesstree), along with the native successional species *Diospyros virginiana* (common persimmon), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Liriodendron tulipifera* (tuliptree), and *Ulmus alata* (winged elm). Vines, particularly *Lonicera japonica* (Japanese honeysuckle), *Rubus* spp. (blackberries), and *Toxicodendron radicans* (eastern poison ivy), can have high cover in the low-shrub and herb layers or cover trees and shrubs. Typical herbs in these successional shrublands include *Dichanthelium clandestinum* (deertongue), *Microstegium vimineum* (Nepalese browntop), and *Phytolacca americana* (American pokeweed).

Dominant species may vary within a polygon and from stand to stand. Some stands are dominated by *Liquidambar styraciflua* (sweetgum) without *Ailanthus altissima* (tree of heaven).

Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	NA	.	.	[not crosswalked, not ranked]	.

Local Range: Successional Mixed Scrub is mapped as three small stands at Gaines Mill (Watt House) and Malvern Hill.

Classification Comments: This vegetation is distinguished by its low, shrubland stature (less than 10 m tall), by being composed of a mix of exotic and early-successional species, and by its occurrence in disturbed areas.

Other Comments: Information not available.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.

GLOBAL INFORMATION

Successional Mixed Scrub is a park-specific, nonstandard type and has no global information.

Figure I21. Successional Mixed Scrub at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 301450, northing 4143504.

COMMON NAME (PARK-SPECIFIC):   SUCCESSIONAL SHRUB SWAMP

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Nonstandard**

LOCAL INFORMATION

Environmental Description: Successional Shrub Swamp is in a disturbed drainage surrounded by Cultural Meadow. The hydrology is seasonally saturated to saturated.
Vegetation Description: Successional Shrub Swamp is a dense shrubland approximately10 m tall. Dominant shrubs include *Platanus occidentalis* (American sycamore), *Alnus serrulata* (hazel alder), and *Salix nigra* (black willow). Small herbaceous-dominated openings include *Campsis radicans* (trumpet creeper), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (jewelweed), *Microstegium vimineum* (Nepalese browntop), *Polygonum sagittatum* (arrowleaf tearthumb), *Smilax rotundifolia* (roundleaf greenbrier), and *Typha latifolia* (broadleaf cattail).
Most Abundant Species:

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Platanus occidentalis* (American sycamore)

Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
VA	NA	.	.	[not crosswalked, not ranked]	.

Local Range: Successional Shrub Swamp occurs as a single polygon of 0.5 hectare (1.4 acres) at Malvern Hill.
Classification Comments: Information not available.
Other Comments: This vegetation may have once been a Coastal Plain / Piedmont Small-Stream Floodplain Forest prior to being cleared.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.

GLOBAL INFORMATION

Successional Shrub Swamp is a park-specific, nonstandard type and has no global information.

Figure I22. Successional Shrub Swamp at Richmond National Battlefield Park. May 2007.
NAD 1983 / UTM easting 300945, northing 4143494.

COMMON NAME (PARK-SPECIFIC):   OTHER URBAN OR BUILT-UP LAND

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Not applicable**

LOCAL DESCRIPTION

Local Range: Other Urban or Built-up Land is mapped at Cold Harbor, Gaines Mill (Watt House), Fort Harrison, and Malvern Hill.

Classification Comments: This map class includes areas with buildings or structures associated with park maintenance, recreation, or historic interpretation. This map class includes all buildings, walkways, minor roads, and their associated lawns and vegetation. It also includes forested areas with a mowed / maintained ground layer, as in the forested interpretation areas at Cold Harbor. This map class is equal to the Anderson et al. (1976) Level II unit 17, Other Urban or Built-up Land.

Other Comments: Mowed areas along roads are included in the map class Transportation, Communications, and Utilities.

Local Description Authors: **K. D. Patterson.**

Plots: None.

Richmond National Battlefield Park Inventory Notes: **Information not available.**

Citation: Anderson et al. 1976.

Figure I23. Other Urban or Built-up Land (Forested Evergreen) at Richmond National Battlefield Park. May 2007. NAD 1983 / UTM easting 298120, northing 4162999.

COMMON NAME (PARK-SPECIFIC):   **TRANSPORTATION, COMMUNICATIONS, AND UTILITIES**

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Not applicable**

LOCAL INFORMATION

Local Range: Areas mapped as Transportation, Communications, and Utilities occur throughout Richmond National Battlefield Park.
Classification Comments: This map class includes major paved roads and parking areas and utility line corridors. This map class is equal to the Anderson (1976) Level II unit 14, Transportation, Communications, and Utilities
Other Comments: Mowed roadsides are included in this map class, including those that are forested with a mowed ground layer. The comment field in the map attribute table indicates if a polygon represents transportation, utilities, or a maintained roadside area.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.
Citation: Anderson et al. 1976.

COMMON NAME (PARK-SPECIFIC):   RESIDENTIAL

SYNONYMS
USNVC English Name: **Not applicable**
USNVC Scientific Name: **Not applicable**
USNVC Identifier: **Not applicable**

LOCAL INFORMATION

Local Range: Areas mapped as Residential occur in the Fort Harrison unit of Richmond National Battlefield Park.
Classification Comments: This map class includes single family dwellings and associated outbuildings, maintained lawns and plantings. This map class is equal to the Anderson (1976) Level II unit 11, Residential.
   Other Comments: Information not available.
Local Description Authors: K. D. Patterson.
Plots: None.
Richmond National Battlefield Park Inventory Notes: Information not available.
Citation: Anderson et al. 1976.

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Appendix J. Field definitions for local and global descriptions of vegetation associations and other map classes.

Local descriptions describe vegetation associations as they occur at specific national parks. Data from field observation points and quantitative plots were used to write the local, park-specific descriptions. These descriptions were entered into NatureServe Central Databases, and reports with local and global descriptions for each association were generated for each park. The following document lists the content of those reports with definitions of each field in the report.

COMMON NAME (PARK-SPECIFIC): A common or colloquial name for the Association or map class. These names follow the Natural Communities of Virginia (Fleming et al 2006) or, if no appropriate name exists in Fleming et al (2006), the Association common name from the U.S. National Vegetation Classification (USNVC) was used, or a park-specific common name was assigned. Names for map classes not representing natural or semi-natural vegetation follow the Anderson Level II land use and land cover classification scheme (Anderson et al. 1976).

SYNONYMS

USNVC English Name: The standard Association name from USNVC databases, but with a translation of the scientific names using standard NatureServe Central Ecology-accepted common names for the plant taxa used in the name (see below).

USNVC Scientific Name: The standard Association name from USNVC databases, based on Latin names of dominant and diagnostic plant species. The Association is the finest level of the USNVC. 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.

USNVC Identifier: A unique identifier code for the Association from USNVC databases. Associations have a code that begins with the string "CEGL" (Community Element GLobal) followed by a unique 6-digit number. Units that are not defined in the USNVC are listed as "nonstandard" in this field.

LOCAL INFORMATION

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 in the park.

Most Abundant Species: Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the Association as it occurs in the park.

Stratum: For each component plant species, the stratum (or strata) in which it occurs in the Association within the park. 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 within the park. Lifeform definitions are from Table 3.1, page 37, of Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co. New York. 387 pp. Values for Lifeform are:

Needle-leaved tree	Palm shrub
Broad-leaved deciduous tree	Dwarf-shrub
Broad-leaved evergreen tree	Semi-shrub
Thorn tree	Succulent shrub
Evergreen schlerophyllous tree	Ephiphyte
Succulent tree	Vine/Liana
Palm tree	Forb

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

Species: Global scientific name (and common name) for each floristic component species of the Association as it occurs within the park.

Characteristic Species: Component plant species that are characteristic for the Association as it occurs within the park.

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

Subnational Distribution with Crosswalk Data

State: The two-letter postal code of the for U.S. state(s) in which the park occurs.

State Rank (SRank): The Heritage Conservation Subnational Rank that best characterizes the relative rarity or endangerment of the Association within the specified state. Values for State Rank are listed in Appendix E. An asterisk (*) indicates that the Subnational Rank is for the Natural Heritage Program (NHP) Element (nonstandard), not the USNVC Association (standard) (see below).

Relationship (Rel): The State Name (see below) is the name that the state NHP 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 (USNVC). 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

Confidence (Conf): Values for Confidence are: C - Certain; S - Somewhat certain; N - Not certain (null) - Not assessed or unknown.

State Name (SName): If the USNVC Association has been crosswalked to a state classification type and it is equivalent to the USNVC 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 USNVC Association has been identified. If a state type has been identified that is NOT equivalent to the USNVC 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.

Classification Comments: Comments about classification criteria used to define the Association or description of any remaining issues associated with its classification in the park.

Other Comments: Additional comments about the Association within the park.

Local Description Authors: Name(s) of the person(s) primarily responsible for authorship of the current description of this Association in the park.

Plots: List of plot codes for plots used in the identification and classification of the Association in the park.

Inventory Notes: Information regarding the sampling of the Association in the park.

GLOBAL INFORMATION

USNVC Classification

Physiognomic Class: The second level of the USNVC which is a vegetation structural classification adapted from UNESCO 1973 and Driscoll et al. 1984. This level is based on the structure of the vegetation. This is determined by the height and relative percentage of cover of the dominant life-forms: tree, shrub, dwarf-shrub, herbaceous, and nonvascular.

Physiognomic Subclass: The third level of the USNVC. This level is determined by the predominant leaf phenology of classes defined by a tree, shrub, or dwarf-shrub stratum, the persistence and growth form of herbaceous and nonvascular vegetation, and particle size of the substrate for sparse vegetation (e.g., consolidated rocks, gravel/cobble).

Physiognomic Group: The fourth level of the USNVC. The group generally represents a grouping of vegetation units based on leaf characters, such as broad-leaf, needle-leaf, microphyllous, and xeromorphic. These units are identified and named with broadly defined macroclimatic types to provide a structural-geographic orientation, but the ecological climate terms do not define the groups per se.

Physiognomic Subgroup: The fifth level of the USNVC represents a distinction between natural vegetation, including natural, semi-natural and some modified vegetation, and cultural vegetation (planted/cultivated).

Formation: The sixth level of the USNVC; represents a grouping of community types that share a definite physiognomy or structure and broadly defined environmental factors, such as elevation and hydrologic regime.

Classification Code (parenthetical following each of the above levels): The U.S. National Vegetation Classification (USNVC) 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: Level of USNVC reflecting a physiognomically uniform group of plant Associations sharing one or more diagnostic species (dominant, differential, indicator, or character), which (generally) are found in the uppermost stratum of the vegetation. 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), Egan (1987, 1989, 1990), Esslinger and Egan (1995), and Stotler and Crandall-Stotler (1977).

Alliance Key (parenthetical following Alliance): A unique identifier from the USNVC central database 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 NatureServe 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 diagnostic 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.

Ecological System(s): A list of the Ecological Systems of which the Association is a member (NatureServe 2003). 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 USNVC Alliance and Formation scales).

GLOBAL DESCRIPTION

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 distinguish 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 rangewide, and any additional comments relating to the vegetation.

Most Abundant Species: Component plant species that are dominant (i.e., most abundant in terms of percent cover) for the Association as it occurs rangewide.

Stratum: For each component plant species, the stratum (or strata) in which it occurs in the Association rangewide. <u>Values for Stratum are:</u>

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, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co. New York. 387 pp. <u>Values for Lifeform are:</u>

Needle-leaved tree	Palm shrub
Broad-leaved deciduous tree	Dwarf-shrub
Broad-leaved evergreen tree	Semi-shrub
Thorn tree	Succulent shrub
Evergreen schlerophyllous tree	Ephiphyte
Succulent tree	Vine/Liana
Palm tree	Forb
Tree fern	Graminoid

Bamboo	Succulent forb
Needle-leaved shrub	Aquatic herb (floating & submergent)
Broad-leaved deciduous shrub	Moss
Broad-leaved evergreen shrub	Alga
Thorn shrub	Lichen
Evergreen schlerophyllous shrub	Fern or fern ally
Other/unknown	Other herbaceous
Other shrub	Liverwort/hornwort

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

Characteristic Species: Component plant species that are characteristic for the Association as it occurs rangewide.

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

USFWS Wetland System: System developed for the classification of wetlands by the U.S. Fish and Wildlife Service. 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

Rank: The Heritage Conservation Status Global Rank which best characterizes the relative rarity or endangerment of the Association worldwide and the date the Global Rank was last reviewed (regardless of whether the rank was changed); values for Global Rank are listed in Appendix E.

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 USNVC.

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).

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

CLASSIFICATION INFORMATION

Status: The status of the Association in relation to the standard USNVC. 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 USNVC.

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 NatureServe Central Ecology.

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.

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 Association concept 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 Association 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 USNVC 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 Associations 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 USNVC 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

<u>Note</u>: Names used by the NHPs 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.

Appendix K. Key to the vegetation-map classes at Richmond National Battlefield Park.

1a   Land is covered by vegetation not maintained by mowing or active cultivation, without buildings, paved areas, or human-created earthworks. 2

1b   Land use includes buildings, paved areas, human-created earthworks, or vegetation maintained by mowing or active cultivation. 20

2a   Vegetation of uplands: vegetation not influenced by flooding or groundwater. 3

2b   Vegetation of wetlands: vegetation of swamps, floodplains, or groundwater seepage. 14

3a   Forested vegetation: vegetation dominated by trees (tall, single-stemmed woody plants) with canopy coverage of at least 25%. 4

3b   Non-forested vegetation: dominated by shrubs (shrublands or scrubby vegetation, short trees or multi- trunked woody plants) or herbaceous plants. 13

4a   Mostly deciduous forest: evergreen trees make up less than 30% of overall polygon (canopy). 5

4b   Evergreen or mixed evergreen-deciduous forest: Evergreen trees make up greater than 30% of the overall polygon (canopy). 10

UPLAND DECIDUOUS FORESTS

5a   Vegetation dominated by early successional or ruderal species such as tuliptree (*Liriodendron tulipifera)*, sweetgum (*Liquidambar styraciflua)*, red maple (*Acer rubrum*), black walnut (*Juglans nigra*); exotic species can be common to dominant such as tree-of-heaven (*Ailanthus altissima*), princesstree (*Paulownia tomentosa*), Nepalese browntop (*Microstegium vimineum*); stands may be very young or mature, but trees are often even-aged (i.e. of the same age class). 6

5b   Vegetation dominated by deciduous trees such as oaks (*Quercus* spp.), hickories (*Carya* spp.), American beech (*Fagus grandifolia)*, and/or tuliptree (*Liriodendron tulipifera*); stands are middle to late sucessional in age, diverse in woody species composition, with mixed age classes. 8

6a   Short (less than 20m), scrubby forests dominated by a mix of successional and exotic species; occurring along edges of roadways and Cultural Meadows. .... **Successional Mixed Scrub**

6b   Well developed (tall) forests; dominated by deciduous trees. 7

7a   Forest dominated by black walnut (*Juglans nigra*), sweetgum
(*Liquidambar styraciflua*), and common hackberry (*Celtis occidentalis*);
herbs include Nepalese browntop (*Microstegium vimineum*) and eastern
bottlebrush grass (*Elymus hystrix*). .... **Successional Black Walnut Forest**

7b   Forest dominated by tuliptree (*Liriodendron tulipifera)*, and/or sweetgum
(*Liquidambar styraciflua),* sometimes with co-dominance by red maple
(*Acer rubrum*); Vines can cover large areas, draping over trees and shrubs
and dominating canopy openings; herb layer often characterized by vines
or a carpet of stilt grass (*Microstegium vimineum*). .... **Successional Tuliptree Forest**

8a   Forests of xeric sites with canopies dominated with variable combinations
of white oak (*Quercus alba*), black oak (*Quercus velutina*), scarlet oak
(*Quercus coccinea*), and southern red oak (*Quercus falcata*), and with
huckleberries (*Gaylussacia* spp.) and blueberries (*Vaccinium* spp.), leaf
litter, or vines dominating the ground layer; few to no herbaceous species
present. .... **Coastal Plain Mixed Oak / Heath Forest**

8b   Forests of submesic to mesic sites with canopies dominated by oaks
(*Quercus* spp.), American beech (*Fagus grandifolia*), tuliptree
(*Liriodendron tulipifera*), and / or sweetgum (*Liquidambar styraciflua*) and
with hickories (*Carya* spp.) often prominent. 9

9a   Forests of mesic slopes and ravines dominated by various mixtures of
American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*),
sweetgum (*Liquidambar styraciflua*), white oak (*Quercus alba*), and/or
northern red oak (*Quercus rubra*); characteristic associates are mockernut
hickory (*Carya alba),* American holly (*Ilex opaca* var. *opaca)*; ground
layer may be bare or with only sparse herbs. .... **Mesic Mixed Hardwood Forest**

9b   Submesic forests of rolling uplands and lower slopes dominated by
mixtures of oaks (*Quercus* spp.) and hickories (*Carya* spp.); low shrub /
herb layer sparse in cover, but diverse in species with mixtures of woody
seedlings, vines, ericaceous shrubs, sedges, grasses, and forbs. .... **Acidic Oak - Hickory Forest**

UPLAND EVERGREEN OR MIXED EVERGREEN-DECIDUOUS FORESTS

10a   Forests of loblolly pine (*Pinus taeda*) with or without other tree species 11

10b   Forests of eastern redcedar (*Juniperus virginiana* var. *virginiana*) with or
without other species; bordering fields and residences. .... **Successional Red-cedar Forest**

11a   Early successional or planted evergreen forests of loblolly pine (*Pinus
taeda*) without deciduous trees in the canopy (uppermost stratum); young
successional hardwoods may occur in the shrub layer, polygon signature
is fine textured (i.e. evergreen with small tree crowns), trees often in
rows. .... **Loblolly Pine Plantation**

11b   Forests ranging from mostly evergreen to mixed evergreen-deciduous;
canopies mixtures of loblolly pine (*Pinus taeda*), sweetgum
(*Liquidambar styraciflua*), tuliptree (*Liriodendron tulipifera*), and/or
oaks (*Quercus* spp.). 12

12a   Forest tree canopy with variable mixtures of loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and/or tuliptree (*Liriodendron tulipifera*); sometimes with southern red oak (*Quercus falcata*); lacking dense ericaceous shrubs; associated species are often weedy or exotic. .... **Loblolly Pine - Hardwood Forest**

12b   Forests of xeric sites with canopies dominated by loblolly pine (*Pinus taeda*) with variable combinations of white oak (*Quercus alba*), black oak (*Quercus velutina*), and southern red oak (*Quercus falcata*), and with huckleberries (*Gaylussacia* spp.) and blueberries (*Vaccinium* spp.), leaf litter, or vines dominating the ground layer; few to no herbaceous species present. .... **Coastal Plain Mixed Oak / Heath Forest**

NON-FORESTED VEGETATION

13a   Vegetation dominated by herbs; trees and shrubs, if present, occur at less than 25% cover; open fields dominated by a dense mix of native and European grasses and forbs or planted with an agricultural crop. .... **Cultural Meadow**

13b   Dense thicket of tall shrubs or vines, or combination of both; bordering roads and meadows; typical species can include both nonnative species: tree of heaven (*Ailanthus altissima*), princesstree (*Paulownia tomentosa*, Japanese honeysuckle *(Lonicera japonica),* and native species: eastern redcedar (*Juniperus virginiana* var. *virginiana*), winged elm (*Ulmus alata*), eastern poison ivy (*Toxicodendron radicans),* frost grape *(Vitis vulpina),* and blackberries (*Rubus* spp.). .... **Successional Mixed Scrub**

WETLAND VEGETATION

14a   Wetland vegetation dominated by shrubs and small trees. 15

14a   Wetland vegetation dominated by trees with a forest canopy. 16

15a   Wetland vegetation of broad flooded areas, dominated by shrubs and small trees, with herbaceous openings and often with standing dead trees; typical species include red maple (*Acer rubrum*), hazel alder (*Alnus serrulata*), common buttonbush (*Cephalanthus occidentalis*), black willow (*Salix nigra*), occurring with wetland herbs. .... **Beaver Wetland Complex**

15b   Wetland vegetation of small disturbed drainages; dominated by dense, scrubby vegetation, approximately 10 meters tall with American sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), and hazel alder (*Alnus serrulata*). .... **Successional Shrub Swamp**

16a   Wetland forest with a mainly evergreen canopy of loblolly pine (*Pinus taeda*); associated species can include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), pin oak (*Quercus palustris)*, and willow oak (*Quercus phellos*). .... **Non-Riverine Saturated Forest - pine subtype**

16b   Wetland forest with canopy dominated by deciduous trees. 17

17a   Forests that are typically narrow features associated with stream banks, sandy stream terraces, or ravine bottoms / draws; hydric oaks, if present, are not typically common or dominant. 18

17b   Forests on broad flats or associated with beaver flooded wetlands. 19

18a   Vegetation associated with banks or floodplains of small streams, receiving at least occasional stream flooding; canopy is dominated by combinations of red maple (*Acer rubrum*), tuliptree (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*), occurring with river birch (*Betula nigra),* American sycamore *(Platanus occidentalis)*, black willow (*Salix nigra*); typical herbs are common ladyfern (*Athyrium filix-femina),* New York fern (*Thelypteris noveboracensis),* and netted chainfern (*Woodwardia areolata*), and smallspike false nettle (*Boehmeria cylindrica*). .... **Coastal Plain / Piedmont Small-Stream Floodplain Forest**

18b   Forests of narrow ravine bottoms or stream headwaters saturated with groundwater seepage; substrate sandy to mucky, with hummock and hollow microtopography and patches of peat mosses (*Sphagnum* spp.); canopy characterized by red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and black gum (*Nyssa sylvatica*); hydric oaks may be present but are not common; shrub layer often includes possumhaw (*Viburnum nudum*), sweetbay (*Magnolia virginiana*), coastal sweetpepperbush (*Clethra alnifolia*), or swamp doghobble (*Leucothoe racemosa)*; herb layer is a dense mixture of graminoids, ferns, and forbs. .... **Coastal Plain / Piedmont Acidic Seepage Swamp**

19a   Forests on broad flats with saturated or shallowly seasonally flooded hydrology; not associated with the main stream channel and never inundated by stream waters, although water table is at or near the surface during most of the growing season; often adjacent to beaver wetlands; canopy characterized by mixtures of red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and loblolly pine (*Pinus taeda*) with hydric oaks such as cherrybark oak (*Quercus pagoda),* willow oak *(Quercus phellos),* pin oak (*Quercus palustris),* and swamp chestnut oak (*Quercus michauxii)* are usually present either in the canopy, subcanopy, or shrub layers; the ground may be mostly bare, covered with matted leaf litter and mud, with scattered patches of wetland grasses and sedges. .... **Non-Riverine Saturated Forest**

19b   Forests on broad flooded areas with canopy varying from closed to open with standing dead trees; soils are saturated; red maple (*Acer rubrum*) and black willow (*Salix nigra*) are typical dominants; other trees can include river birch (*Betula nigra*), American beech (*Fagus grandifolia*), sweetgum (*Liquidambar styraciflua*), tuliptree (*Liriodendron tulipifera*), American sycamore (*Platanus occidentalis*), cherrybark oak (*Quercus pagoda*), and bald cypress (*Taxodium distichum*). .... **Beaver Wetland Complex**

LAND-USE CLASSES AND CULTURAL VEGETATION

20a   Land use includes buildings or paved areas with or without maintained lawns and plantings. 21

20b   Land use with no buildings or paved areas; vegetation maintained by mowing or active cultivation. 23

21a   Land use is primarily single family dwellings; including houses, outbuildings, and maintained lawns and plantings. .... **Residential**

21b   Land use is for park maintenance, recreation, or transportation corridors. 22

22a   Land use is primarily a transportation corridor with paved roadways,
parking areas, and mowed roadsides. .... **Transportation, Communications, and Utilities**
22b   Land use includes park structures for maintenance or recreation with
associated maintained lawns and plantings .... **Other Urban or Built-up Land**

23a   Area is forested with trees. 24
23b   Area with less than 10% cover by trees. 25

24a   Park land with historic human-created earthworks with cover by
trees. .... **Forested Earthworks**
24b   Park land with forest cover and with maintain grassland below,
associated with park interpretation. .... **Other Urban or Built-up Land**

25a   Open, non-forested park land with historic human-created earthworks. .... **Open Earthworks**
25b   Open, non-forested park land without historic human-created earthworks. 26

26a   Non-forested areas maintained by mowing for use as a utility
corridor. .... **Transportation, Communications, and Utilities**
26b   Non-forested areas maintained by mowing or planted in crops. .... **Cultural meadow**

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