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Vegetation Classification and Mapping Vicksburg National Military Park, Mississippi

Natural Resource Technical Report NPS/GULN/NRTR—2013/710

ON THE COVER

View toward Yazoo Diversion Canal (route of the Mississippi River in 1863) from Fort Hill overlook, Vicksburg National Military Park. View shows the transition from Mississippi Valley Loess Plain (Bluff Hills) Ecoregion (foreground and middle photo) to the Mississippi Alluvial Plain Ecoregion (background), as described in the Introduction. National Park Service photograph by Chris Lea.

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This report is available from the National Park Service Vegetation Inventory website (http://science.nature.nps.gov/im/inventory/veg/index.cfm) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

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Executive Summary

The National Park Service (NPS) Gulf Coast Inventory and Monitoring Network, with the support of the National Park Service Vegetation Inventory completed vegetation classification and mapping for Vicksburg National Military Park (VICK), in Warren County, Mississippi, from 2004 to 2010. VICK is one of more than 250 NPS units to be covered by the Vegetation Inventory. Methods and procedures follow those of the NPS Vegetation Inventory as of August, 2012 (http://science.nature.nps.gov/im/inventory/veg/index.cfm).

Ecologists collected floristic and environmental data from 45 vegetation field plots and classified and described 13 plant community types corresponding to US National Vegetation Classification (USNVC) associations from these data.

This classification was used to map 712 hectares (1,698 acres) of Vicksburg National Military Park, in ten map classes corresponding to vegetation associations and two non-vegetated land cover classes, from a digital orthomosaic created from 1:24,000 color infrared aerial photographs and digital elevation model (DEM) data. Methods used to delineate stands varied according to vegetation type and were a combination of incorporating stand boundaries from an existing map, new “heads-up” interpretation and modeling of digital environmental spatial data.

A thematic accuracy assessment collected vegetation data from 118 field observations stratified across the vegetation classes. The overall accuracy of the vegetation map was estimated to be 60.5% at the thematic level of USNVC association and 92.4% at the thematic level of USNVC group. Estimates of areas of vegetation types, as adjusted for mapping error, were calculated for all types mapped and/or observed during the thematic accuracy assessment.

An important finding of this study is that the composition of the forests of VICK is substantially different from that described by earlier, more qualitative, accounts. Implications of these findings and possible applications of the data for resource monitoring and management are presented.

This report summarizes the methods and general results of the Vegetation Inventory for Vicksburg National Military Park. Appendices include descriptions of vegetation types, a field key to the types, a list of plant species, and accuracy assessment contingency tables.

This report is supplemented by the project data, which include:

• spatial database containing map polygon attributes. Geospatial products are in Universal Transverse Mercator (UTM) projection, Zone 15, using the North American Datum of 1983.

• all field data (plot, observation point, and accuracy assessment point) stored in a

Microsoft Access database

• metadata for all digital products

The data and reports produced by this investigation reside at:

https://irma.nps.gov/App/ and/or at: http://biology.usgs.gov/npsveg/

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1.0 Introduction

1.1 National Park Service Vegetation Inventory

1.1.1 Legal and Policy Background

The National Parks Omnibus Management Act of 1998 established the legal mandate for development of natural resource inventory and monitoring studies and for integrating them into the management the national park system. The act charges the Secretary of the Interior to conduct "*inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources*" (Section 5934).

In the text of the federal fiscal year 2000 Appropriations bill, Congress reinforced this charge by noting that: *"a major part of protecting those resources is knowing what they are, where they are, how they interact with their environment and what condition they are in."*

In 2001 and 2006, National Park Service (NPS) Management Policies updated previous policy and stated that the NPS will "*identify, acquire, and interpret needed inventory, monitoring, and research, including applicable traditional knowledge, to obtain information and data that will help park managers accomplish park management objectives….,*" "*define, assemble, and synthesize comprehensive baseline inventory data describing the natural resources under its stewardship, and identify the processes that influence those resources,* " and " *use the resulting information to maintain-and, where necessary, restore-the integrity of natural systems*" (National Park Service 2006).

The primary purpose of natural resource inventories in units (hereafter referred to as "parks") of the National Park system is "to assess and document the current condition and knowledge of natural resources in the parks. Inventories allow comparison of existing conditions to the natural or desired state of parks and establish a solid baseline for making scientifically sound management decisions and long-term monitoring plans that ensure the future health of the parks." (http://science.nature.nps.gov/im/). NPS administers 12 basic natural resource inventories (themes) that are administered nationally and are conducted using standardized methodologies across the more than 270 NPS parks,

1.1.2 Administration

The NPS Vegetation Inventory (NPSVI), one of the 12 basic natural resource inventories, was established in 1994 (http://science.nature.nps.gov/im/inventory/veg/index.cfm). It is administered from Fort Collins, Colorado, and its staff oversees funding and provides technical guidance and oversight for individual park projects. Its objectives are to classify vegetation as ecological community types in each of more than 250 NPS units ("parks") in the United States outside of Alaska and to map vegetation in each park using the classification scheme developed for the park (Lea 2011). The primary data to be used for the vegetation classification are vegetation plot data that have been collected at or near the park using standard methods (The Nature Conservancy and Environmental Systems Research Institute 1994, Federal Geographic Data Committee 2008). The classified vegetation types also named within the context of the U.S. National Vegetation Classification (USNVC) (Federal Geographic Data Committee 2008, NatureServe 2012, http://usnvc.org, Table 1). The primary data to be used for mapping the types

Table 1. USNVC Hierarchy levels for natural and semi-natural vegetation, in descending taxonomic order (adapted from Federal Geographic Data Committee (2008). (Description of individual units in each level can be found at http:// usnvc.org).

USNVC LEVEL	DESCRIPTION OF CRITERIA FOR UNITS
Upper Levels: Physiognomic characters of vegetation play a predominant role.	
Level 1 – Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.
Level 2 - Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.
Level 3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
Middle Levels: Both floristic and physiognomic characters of vegetation play a significant role	
Level 4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
Level 5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
Level 6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes
Lower Levels: Floristic characters of vegetation play a predominant role**.**	
Level 7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
Level 8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

are remote sensing imagery, supplemented by ancillary field data used for formal or informal modeling. The final products are descriptions of the classified vegetation, a digital spatial database (map) of the vegetation, and quality control data. An essential part of the quality control is the data and results of a thematic accuracy assessment of each vegetation map class in the spatial database (Lea and Curtis 2010).

Vicksburg National Military Park (VICK) is administered by a park Superintendent and staff located in Vicksburg, Mississippi. VICK is one of eight parks served by the NPS Gulf Coast (GULN), whose primary office is in Lafayette, Louisiana. GULN is one of 32 networks of parks whose primary purpose of the networks is to administer long term natural resource monitoring programs in the network member parks. Staff of the networks and of parks also facilitates the administration, and sometimes technical aspects, of the nationally-directed natural resource inventories, including the NPSVI.

1.2 Vicksburg National Military Park

1.2.1 Setting and Area Description

Vicksburg National Military Park (VICK) was established in 1899 (30 Stat. 841) to commemorate the siege and defense of Vicksburg during the United States Civil War in 1863. VICK is comprised of about 726 hectares (1,795 acres) (National Park Service 2009). Most of the park's area (the main unit) lies in the northern and eastern parts of the city of Vicksburg in Warren County, Mississippi (Figure 1). This area includes about 47 hectares (116 acres) of the Vicksburg National Cemetery, the nation's largest interment of Civil War soldiers (more than 18,000). Four smaller tracts (satellite units), each comprising less than 1.5 hectares (3.7 acre), are located in south Vicksburg (Louisiana Circle, South Fort, and Navy Circle units) and on the west side of the Mississippi River in Madison Parish, Louisiana (Grant's Canal unit).

VICK lies mostly within the Bluff Hills [Level 4] Ecoregion of the Mississippi Valley Loess Plains [Level 3] Ecoregion (Chapman et al. 2004) (Figure 2). The Mississippi Valley Loess Plains Ecoregion is a north-south belt of irregular plains and rolling hills, bordering the alluvial valley of the Mississippi River from near the Ohio River in western Kentucky to Louisiana. Soils are often silt loams derived from thick deposits of loess (silt deposited by wind during the Pleistocene age) that are characteristic of this ecoregion. Soils in VICK and the immediate vicinity are classified mostly as silt loams of the Adler (a thermic Fluvaquentic Eutrudept), Memphis (a Typic Hapludalf), Morganfield (a Typic Udifluvent), Natchez (a thermic Typic Eutrudept)**,** and Wakeland series (a frigid Alfic Oxyaquic Fragiorthod) (Cole and Carter 1964 Natural Resources Conservation Service. 2013). Loess soils are highly susceptible to erosion, and near the Mississippi River (in the Bluff Hills), the terrain is more dissected, consisting of headlands with steep western slopes (see cover photo) that alternate with steep, narrow valleys of Mississippi River tributary streams (Figure 3), including Glass Bayou, Mint Springs Bayou, Stout's Bayou, and the upper tributaries of Durben Creek, the major drainage streams of VICK. The land cover in the Mississippi portion of this ecoregion is mostly a mosaic of croplands alternating with forests of oak-hickory, oak-hickory-pine, or mixed mesophytic forests (Chapman et al. 2004).

Small portions of the park, in Mississippi west of Washington Street and at Grants Canal, occupy the Northern Holocene Meander Belts and Northern Backswamps [Level 4] Ecoregions of the Mississippi Alluvial Plain [Level 3] Ecoregion (Chapman et al. 2004). The Mississippi Alluvial Plain [Level III] Ecoregion generally parallels the Mississippi Valley Loess Plains Ecoregion along its west side, from southern Illinois to the Gulf of Mexico. This area has relatively little topographic relief, generally in alluvial ridges of the current and prehistoric courses of the Mississippi River. The alluvial soils generally are finer-textured and more poorly drained (mostly clays, sandy clays, clay loams, and silt loams) than the upland soils of adjacent Bluff Hills Ecoregion, although coarser textured soils occur on natural levees. Much of the region's land cover is cropland, with some riparian forest (bald cypress, water tupelo, willow, mixed bottomland hardwoods) present. The majority of VICK lands in this ecoregion occupy a 0.8 kilometer reach of floodplain land along the Yazoo River Diversion Canal (the channel of the Mississippi River before 1863) which endures periodic, and often prolonged, flooding.

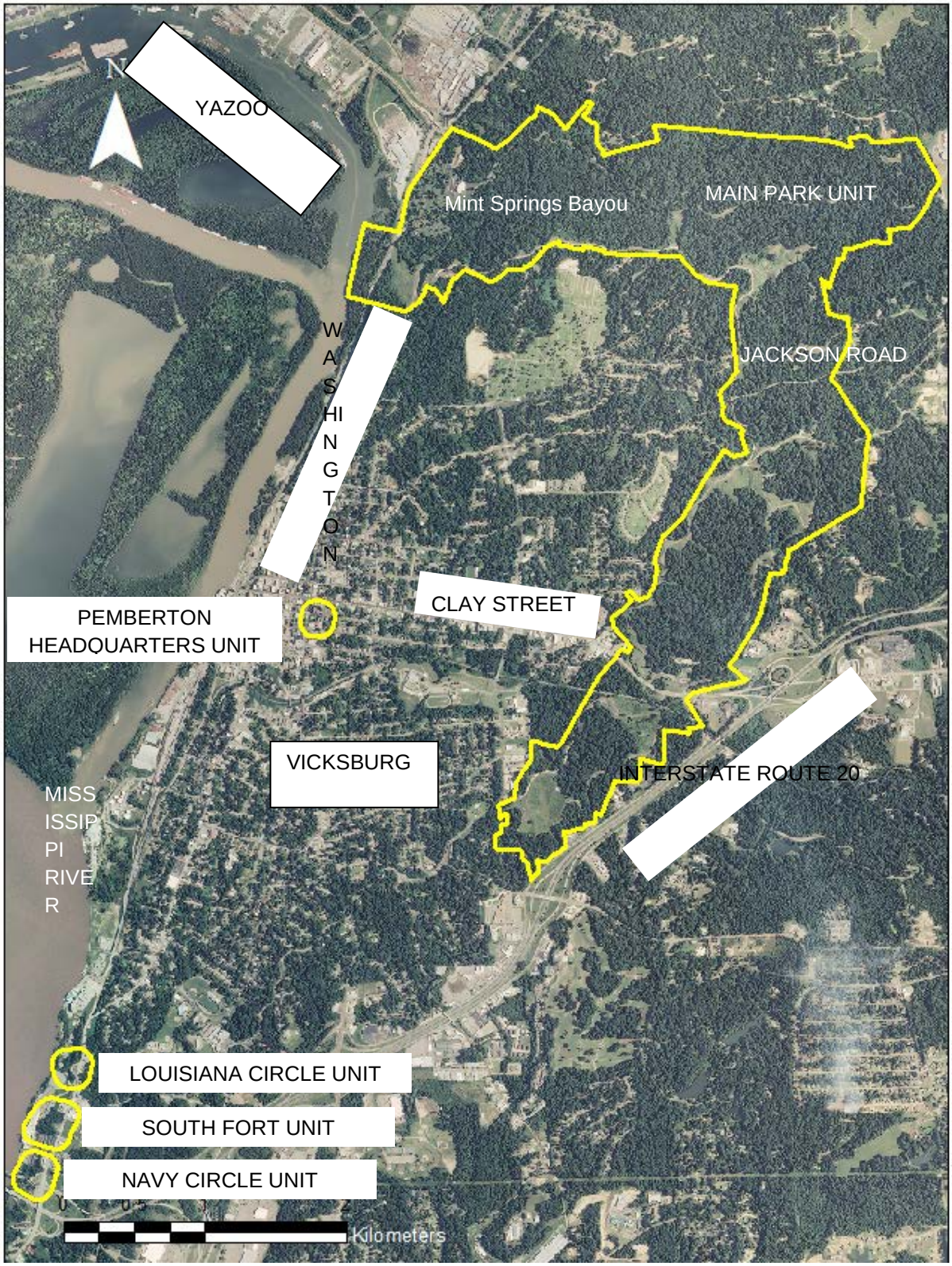


Figure 1. Aerial view of Vicksburg, Mississippi and Vicksburg National Military Park. Yellow lines delineate the boundary of main unit and the general location of satellite units. The Grant's Canal unit is not shown. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

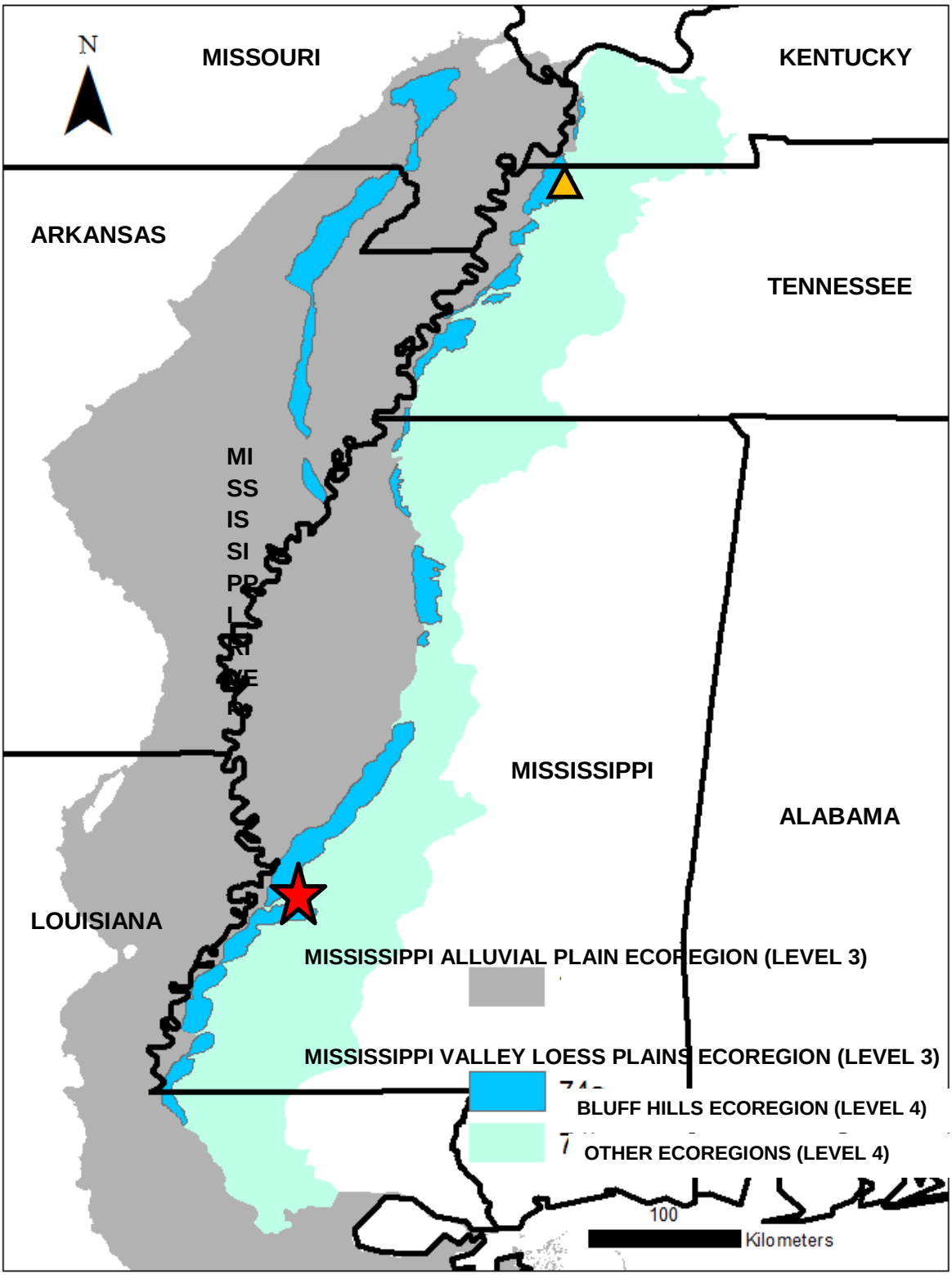


Figure 2. Location of Vicksburg National Military Park (red star) and extent of USEPA Bluff Hills (blue) and Mississippi Alluvial Plain (gray) Ecoregions. Orange triangle indicates location of Reelfoot Lake, Tennessee (Braun 1950) (see Chapter 4 discussion).

Vicksburg, Mississippi receives about 123 cm (49 inches) annual precipitation, without strong seasonal distribution. The city experiences a mean annual temperature of 18.3^{o} Celsius (65° F.) (Segura et al. 2007). Summers are relatively hot and humid, with an average of 95 days per year reaching 32° C. (90° F.) (Irish, *et al*., 2002). The average daily maximum temperature of 33° Celsius (92° F.) occur in July and August; the average daily low temperatures of 2° C. (35° F.) occur in January. The normal frost free period is mid to late March to mid to late November, equivalent to a 230 to 255 day growing season.

1.2.2 Vegetation Management Issues and Needs

Early photos of the area of VICK following the Civil War show a mostly treeless landscape (Cooper et al. 2004). Much land had been cleared by the time of the siege for needs of military defense of the town and the Mississippi River navigation route (http://www.nps.gov/vick/naturescience/plants.htm). At least some forested sections of VICK resulted from plantings by the Civilian Conservation Corp (CCC) during the 1930s (http://www.nps.gov/vick/naturescience/plants.htm). Changes in vegetation in the park since the establishment of the park have been attributed partly to such erosion control efforts and a lack of maintenance funds (Cooper et al. 2004).

This study (Tables 4 and 5) shows that VICK now is approximately 77% forested (Figures 3 and 5), 19% lawns and grasslands (Figure 4), and 3-4% unvegetated (i.e., mostly paved surfaces and buildings). Previous estimates had assessed the park to be one-third open lawns or grasslands and two-thirds forested (Irish et al. 2002). The paved roads of the park are mostly on the ridges between stream valleys and have lawn-like grass borders of varying width (Cooper et al. 2004) that the NPS maintains by mowing at intervals of varying frequency.

Figure 3 (*left*). Tributary stream to Glass Bayou, north of Jackson Road.

Figure 4 (*center*). Mowed grass border and edge of mature forest, Wisconsin Memorial.

Figure 5 (*right*). Cherrybark Oak – Water Oak Forest (described in Appendix A) near Hovey's Approach.

As of 2004, no rigorous quantitative or qualitative vegetation studies focused specifically at VICK had been done (Cooper et al. 2004, Segura et al. 2007). Walker (1997) conducted an inventory of the vascular flora of VICK during 1996 and 1997 and reported 299 species. In this report he gave a brief, qualitative summary of the dominant forest vegetation (see Section 4.2). Beginning in 2004, the U.S. Geological Survey National Wetlands Research Center (NWRC) created a land cover map (Rangoonwala et al. 2007) that was based, in part, on the classification described in this report.

Segura et al. (2007) listed three major natural resources for VICK. These are (1) the mixed mesophytic forest, (2) streams and associated vegetation, and (3) loess soils. They further described major natural resource management issues that are faced by the NPS at VICK as (1) erosion, (2) adjacent land use, (3) invasive species (Figure 6), and (4) changes in vegetation patterns from those of the time of the siege of Vicksburg. The data and reports of the NPSVI can provide a baseline for the first of the three major resources and are particularly germane to the first, third, and fourth major management issues.

Figure 6. Hardy orange (*Poncirus trifoliata*), an invasive non-native shrub common at Vicksburg National Military Park.

2.0 Methods

2.1 Vegetation Classification

2.1.1 Field Data Collection

Field plot data collection at VICK took place in August and September, 2004. Because VICK is relatively small and all locations within the park are relatively easy to reach by automobile and on foot, we made a reconnaissance that included the full geographic extent of the park in order to identify putative vegetation associations for plot sampling. Areas visited during reconnaissance were partly selected to ensure that plots represented a relatively complete range of the significant environmental gradients, including forest or non-forest, aspect, slope, and distance from a stream. We also referred to the USNVC content (NatureServe 2007, 2012) as guidance for recognizing and delimiting known or new association concepts.

Once we established putative associations, we located and sampled stands that we subjectively assessed to be representative of each association throughout VICK. In most cases, the sample size for a putative association was at least one plot and ranged from three to twelve plots for more widespread forest associations. Data were collected from a total of 45 plots at VICK, with 43 plots located in the main unit and two plots in the smaller outlying units (Figure 7).

The field data collection methods for individual plots at VICK generally followed The Nature Conservancy and Environmental Systems Research Institute (1994). Plots were rectangular quadrats from 250 m^2 (for shrublands and herbaceous vegetation) to 1,000 m^2 (for shrublands and herbaceous vegetation) in size. These plot sizes conform to NPS methods (The Nature Conservancy and Environmental Systems Research Institute 1994) and to other recommendations for describing units of the USNVC (Federal Geographic Data Committee 2008, Jennings et al. 2009). Within each plot, we collected comprehensive floristic composition data by identifying each individual vascular plant species within each of six vegetation strata (canopy tree, subcanopy tree, tall shrub, short shrub, herbaceous, and vine) and visually estimated and recorded its canopy cover in each stratum using the North Carolina Vegetation Survey cover class scale (Peet et al. 1998) (Table 2). We also estimated the total canopy cover of each species for the entire plot (the sum of all individual stratum cover values for a species

Table 2. North Carolina Vegetation Survey (NCVS) Cover Scale.

CONTINUOUS COVER (percentage of the entire plot area) RANGE AS OBSERVED IN FIELD	NCVS COVER CLASS ASSIGNED	NCVS COVER CLASS MIDPOINT (CONTINUOUS COVER SCALE)
0-1%; infrequent	1	0.1
0-1%; frequent	2	0.5
1-2%	3	1.5
2-5%	4	3.5
5-10%	5	7.5
10-25%	6	17.5
25-50%	7	37.5
50-75%	8	62.5
75-95%	9	87.5
95-100%	10	97.5

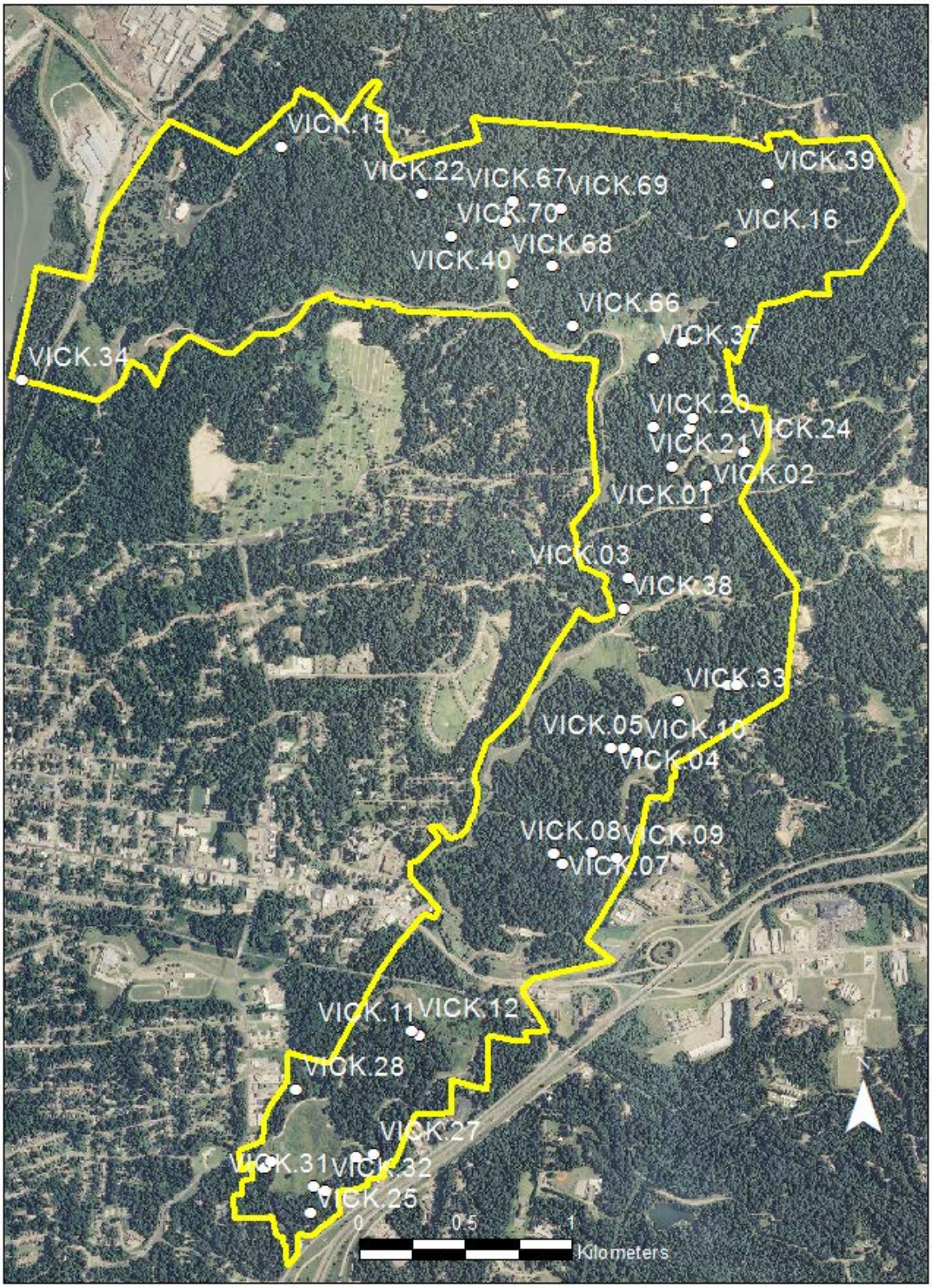


Figure 7. Locations of classification plots made in August 2004 in main unit of Vicksburg National Military Park. Plots VICK.35 and VICK.36 are located at South Fort and Louisiana Circle units (see Figure 1). Imagery is 2010 aerial photography from National Agricultural Inventory Program.

minus areas of cover in a stratum in which the same species overtops this area in a higher stratum). We recorded the height and total plant cover of each stratum. We recorded data on various environmental variables of the plot, including slope, aspect, landform, soil texture, soil drainage, and non-vegetated ground cover. Finally, we recorded the geographic position of each plot using a Garmin III+ Global Positioning System (GPS) receiver. Figure 17 (Appendix E) depicts an example of a data field form for classification plot data.

Plot data were entered into the NPS PLOTS standardized format database (http://science.nature.nps.gov/im/inventory/veg/plots.cfm).

2.1.2 Vegetation Classification

Because of the small sample size and limited number of associations, vegetation classes mostly were interpreted individually ("crosswalked") to recognized associations of the USNVC, where the USNVC were deemed to be a conceptually adequate match. The USNVC name was applied to the VICK classes or was modified, as needed, to be more descriptive of local conditions. We also applied a cluster analysis to the data, using flexible *beta* method (Bray-Curtis as the distance measure and with *beta* = -.0.25) (McCune and Grace 2002) in PC-ORD ® 4.0 (McCune and Mefford 1999). Cluster analysis helped to assess the ultimate assignment of some individual plots to types.

Because most mappable vegetation types identified corresponded to a single USNVC association (either as recognized by NatureServe (2009) or unrecognized types that were approximately equivalent), we chose to "lump" in a few borderline cases in which a vegetation type might be interpreted to either one or two USNVC associations, where cluster anlaysis was less definitive, and/or where cluster analysis results may have been influenced by suboptimal plot sampling and subjective field observations were more heavily relied upon. Although mappability was not a criterion for recognizing clearly distinctive vegetation types as associations, the consistent 1:1 relationship between mapped vegetation types and most associations made the use of the USNVC more applicable to park management.

2.1.3 Vegetation Descriptions

From the floristic and environmental data for all sets of plots classified similarly, we created the following information for each association recognized at VICK:

(1) The best fitting USNVC association name (NatureServe 2007, 2012) and identifier. In cases in which we could not determine a clear USNVC match for a classified VICK type, but the type was convincingly distinct from all others at VICK, we assigned a NPS name and identifier, following NPSVI protocols (Lea 2011).

(2) A park name (either the USNVC association name, if well suited to the vegetation at VICK, or a more suitable or meaningful name for the local level). (Appendix A).

(3) Placement of the association at all levels within the newly revised (Federal Geographic data Committee 2008) USNVC hierarchy (NatureServe 2012, http://usnvc.org) (Table 1).

(4) A vegetation synthesis table (measures of the constancy and the mean and range of each species in each association) derived from the classified plot data (Tables A1-A13, Appendix A).

(5) A written description of the floristic, environmental, geographic, and other characteristics (Appendix A). Park-specific information was derived from plot data and other observations made at VICK. Global (USNVC) information was derived from NatureServe (2009) and http://usnvc.org and edited, as needed, for this report.

For vegetation associations known or believed to represent vegetation of wetlands, in the sense of NPS policies (National Park Service 2012), we also placed the association within the Cowardin et al. (1979) classification. Section 4.4 further describes the process of this placement. No jurisdictional wetland delineations (e.g., U.S. Army Corps of Engineers 1987) were done as a part of this project.

We used sorting of the classified plot data in Microsoft Excel ® 2003 by individual species abundance and constancy as the primary means of writing a dichotomous field key to the associations at VICK (Appendix B). The field key serves as a diagnostic recognition tool for users of the classification at VICK, especially those who may have limited experience with the vegetation patterns, and also as a relatively objective and repeatable (between different observers) means of making reference data labels for the thematic accuracy assessment.

2.2 Vegetation Mapping

2.2.1 Imagery

In the course of developing a land cover map for VICK (Rangoonwala et al. 2007), the NWRC acquired leaf-on 3-band color infrared (CIR) photographic images of VICK from an aircraft platform on September 30, 2004 in nine photographic frames, at a scale of 1:24,000. NWRC created [presumably scanned the frames] a 1-meter resolution digital orthophoto mosaic image (.tif) of VICK and environs up to 100 meters from the park boundary (Rangoonwala et al. 2007). We used this imagery indirectly in employing the land cover map boundaries for thematically coarse land cover classes and directly for more accurately mapping forested vegetation associations for the NPSVI map for VICK.

2.2.2 Mapping Strategy

Our overall strategy for mapping USNVC associations at VICK consisted of several approaches.

(1) We assimilated highly accurate portions of an existing land cover map of VICK (Rangoonwala et al. 2007)

(2) We extracted highly distinct boundaries between obviously different major vegetation categories (e.g., forests and grasslands) using automated supervised methods.

(3) Within these major categories, we collected calibration (training) observations that identified stands at the association level. These and classification plot locations represented small areas in which we had high confidence of identity of an association, around which we could manually small stands. Image quality and limited observations limited this approach to mapping conservatively around associations that had reasonably distinct signatures and that usually occurred in smaller stands.

(4) For more extensive types for which observations suggested a correlation with landform, we employed terrain modeling based on the ability for the field observations to suggest thresholds in values of variables of topographic position.

The following subsections elaborate on specific methodology, in chronological order.

2.2.3 Calibration Observations, 2007

In early November 2007, we visited 74 sites(Figure 8) that we subjectively judged to be representative of the classified forest vegetation types and that were homogeneous as to vegetation type for an area of at least 30 meters around the site (i.e., were also at least 0.25 hectares in size). We identified the vegetation type within a 30 meter radius around each site. We recorded the GPS positions of each site using a Garmin 76S GPS receiver to average at least 100 positions (based on our extensive prior experience with this methodology in forested settings, it is estimated that 90% of all recorded positions are within 15 meters of the true position on the ground). Since these sites became a primary guide to developing map classes, they are termed calibration observations (= training observations).

Additionally, we examined the classification plot association assignments and species composition of the classification plots to further refine field diagnostic criteria (i.e., to help reduce field key errors, both for the end user and to reduce false errors in the reference data for the accuracy assessment and for other uses). Following this visit, we modified the field key to obtain more consistency between the key and the concepts (Appendix B).

2.2.4 Initial Mapping, 2008-2009

We used ERDAS Imagine ® Professional 9.2, ENVI ® 4.5, and ArcGIS ® 9.3 with Arc Workstation to develop the vegetation spatial database. Existing GIS datasets that we used to provide mapping information include a NPS park boundary shapefile for VICK (including a 100 meter buffer boundary around the Louisiana Circle, South Fort, and Navy Circle satellite units), a land cover shapefile created by the NWRC (Rangoonwala et al. 2007), and the National Elevation Dataset (NED) (used as the source of the 10-meter elevation model and derived streams, slope, and hillshade).

We used ERDAS Imagine ® to mask out the areas within VICK boundaries from the source image. We used the unsupervised classification program, ISODATA, to produce 10 preliminary map classes. We identified classes 1-7 as trees and classes 8-10 as other vegetation and unvegetated areas. We converted this 10-class raster file to a vector (polygon) file, with value 1 representing trees (raster classes 1-7) and value 2 representing other (raster classes 8-10).

We merged each individual polygon with class value 1 (trees) that had a total area of less than 10 m^2 (0.001 hectare) into adjacent non-tree polygons with which they shared the longest shared border. We used the resulting file to mask out trees from the source image and for reference.

We merged each polygon with class value 2 (other) with an area of less than 200 m^2 (0.02 hectare) into the adjacent polygon with which it shared the longest border. We rasterized the resulting file to 1 m^2 cells snapped to the original image. We used the resulting file to mask out “other” (non-tree) areas from the source image. We used the ENVI ® Feature Extraction module to identify boundaries for different “other” types in the masked image using a segmentation setting of 90 and a merge setting of 99.1. We clipped the resulting file by the park boundary and merged each polygon with class value 2

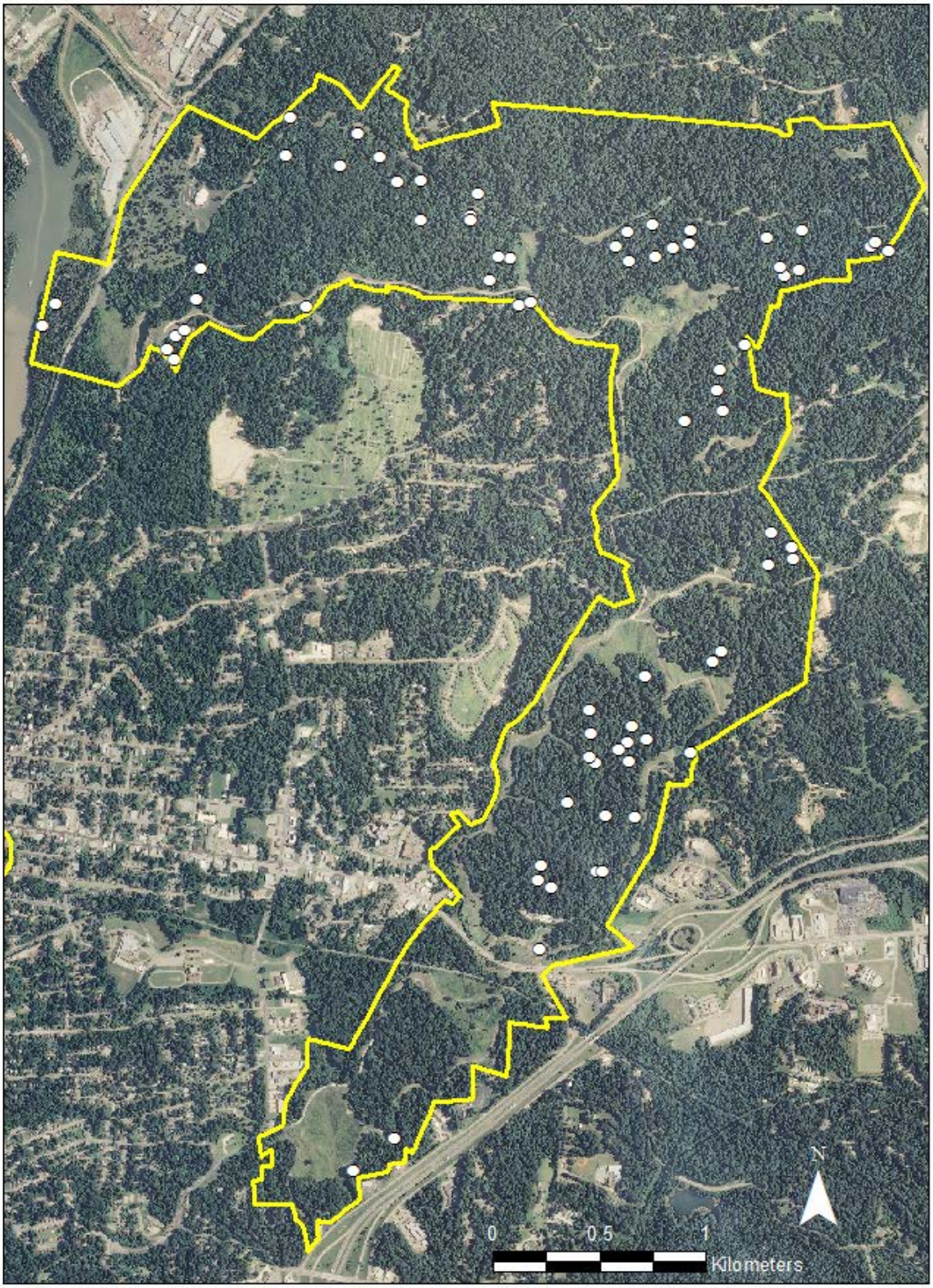


Figure 8. Locations of 74 original calibration observations (training sites) made in November 2007 for mapping vegetation associations at Vicksburg National Military Park. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

(other) with an area of less than 200 m^2 to the adjacent polygon with which it shared the longest boundary.

We used the NWRC (Rangoonwala et al. 2007) land cover database to derive the initial road and road-related polygons. We selected all polygons with the NWRC description "developed_bare" and with an area of greater than 500 m^2. We clipped these by the study area boundary and used Arcedit to on-screen digitize missing parts of features based on the source imagery. We inserted these "developed_bare" areas into the class value 2 dataset. We then merged all polygons with class value 2 and area less than 500 m^2 with the adjacent polygon with which it shared the longest boundary. The resulting dataset consisted of non-tree and road and road-related polygons.

We used the 10-meter NED data to derive a grid of slope values at 10 m^2 resolution, in order to model the occurrence of the Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest, which at VICK, is confined mostly to relatively level topographic bottoms along low order streams such as Mint Springs Bayou, the upper tributaries of Durben Creek, and Glass Bayou. Based on known occurrences recorded in the classification plot and calibration observations and our general knowledge of this vegetation type, we assessed that all areas in VICK with a slope of 0-6 degrees that were also within 30 meters of a streams of low order (i.e., all VICK streams except the Yazoo Diversion Channel and Mississippi River) would represent the habitat of this type well. This configuration also largely coincided with a darker tree signature along these streams than was seen on adjacent slopes in the 3 band imagery. While we are uncertain of the ultimate cause of the darker signature, such a phenomenon could be produced by crowns of trees that are better irrigated (with root systems nearer to a permanent water table) or possibly from a tree species that is relatively differential for this vegetation type, such as boxelder (*Acer negundo*). We converted a 0-6 degree slope grid to a vector file and clipped this by a file of a 30 meter buffer around all low order streams, by the study area boundary, and by all Class 1 (forested) polygons to produce the areas occupied by the Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest.

We used the field calibration observations collected in 2007, ocular recognition of signatures in the 3-band image, and parts of the NWRC land cover map to recognize stands of the Loblolly Pine Planted Woodland, Black Locust – Paper Mulberry Successional Forest, Boxelder Successional Upland Forest, Sweetgum Successional Forest, and Black Willow Floodplain Forest. Boundaries of these stands were digitized on-screen from within class value 1 areas, using the 3-band CIR image as a base. We designated all other forested areas as equivalent to the a combination of the Cherrybark Oak – Water Oak Forest and the Sweetgum - Chinkapin Oak – Water Oak Forest. Although we had observed a general pattern in the field of the Cherrybark Oak-Water Oak Forest occupying a slope position that is topographically higher than the Sweetgum-Pecan-Water Oak Forest at VICK, we were unable to distinguish between these two most abundant associations, either from image signature or by environmental modeling with the classification plots and calibration plots. We mapped these two associations as a unified class equivalent to the South-Central Coastal Plain Mesophytic Forest Group (Table 4).

Similarly, we used heads-up digitizing of areas on the 3-band image to delineate boundaries between stands of the Old Field Wooded Herbaceous Vegetation, and stands of the Bahia Grass Herbaceous Vegetation, within vegetated (non-road) parts of the class value 2 areas.

Except for well-defined and consistently land cover small features, including non-vegetated surfaces, we mapped only stands that were 0.25 hectares or larger.

We smoothed the polygon edges in the vector vegetation dataset in order to remove the stair-step effect of raster data by using polynomial approximation with exponential kernel (PAEK) with a tolerance setting of 15 meters.

Following this mapping phase, the project proceeded to the initial thematic accuracy assessment campaign in August 2009 (described in Section 2.3).

2.2.5 Mapping, 2009-2010

Following the collection of thematic accuracy assessment reference (field) data collection in 2009, we examined the locations of accuracy assessment observations with a reference data label of either Cherrybark Oak-Water Oak Forest or Sweetgum-Chinkapin Oak-Water Oak Forest (Figure 9). As discussed above, we had mapped these two individual associations together (as a unit equivalent to the South-Central Coastal Plain Mesophytic Forest Group) (Figure 9). We noted a stronger correlation in these data between association and slope position than our previously collected calibration data had suggested. Using USGS Digital Elevation Model (DEM) data, we created a hillshade model in ArcView 3.2 ® Spatial Analyst, using a solar azimuth of 225°, a solar elevation of 37°, and a z factor of 1. Hillshade values are reasonably correlated with site insolation (solar radiation received). The selected settings assign generally higher values to upper slopes and those with more a southern or western exposures, which would be favorable to the presumed drier site preference of the Cherrybark Oak-Water Oak Forest and lower values to lower slopes and those with more a northern or eastern exposures, which would be favorable to the presumed more mesic site preference of the Sweetgum-Chinkapin Oak-Water Oak Forest. We plotted these reference data locations on the pixels with hillshade values calculated and found a reasonably high correlation of occurrence of the Cherrybark Oak-Water Oak Forest on sites with hillshade values greater than 185 and the Sweetgum-Chinkapin Oak-Water Oak Forest on sites with hillshade values less than 196. We speculate that the improved correlation in the data may have been because of two possible factors: (1) the larger data set may have covered some portions of the hillshade gradient that had not been represented well in the data collected prior to 2009, (2) the random design may have corrected for some biases in the classification plot and land cover map assessment observations (all of which were subjectively selected) and more evenly covered the hillshade gradient, and (3) the improvements in the field key may have reduced the rate of “false errors” that were in the reference data (calibration data) prior to the 2009 accuracy assessment.

Because (1) the 2009 accuracy assessment data provided a better mapping model for these two vegetation types, (2) these two associations likely represented the two most abundant associations at VICK, and (3) all other map classes were equivalent to a single USNVC association level, we decided to remap the combined class into individual associations, using the hillshade model derived from examining the 2009 reference data. We converted 1 meter^{2} raster pixels to [square] polygons. Pixels with hillshade values greater than 190 were grouped together

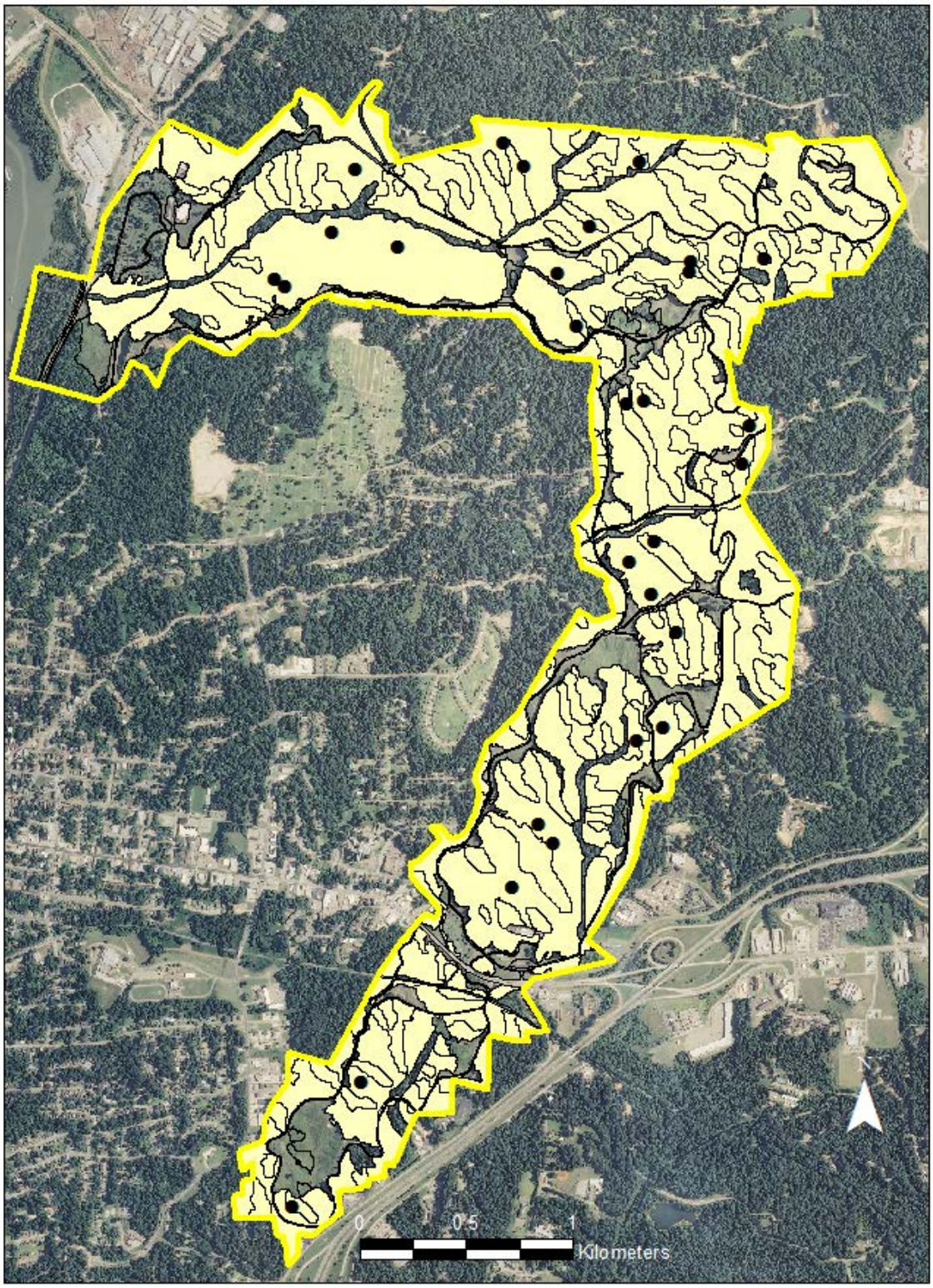


Figure 9. Locations of 29 supplementary calibration observations (training sites) made in August 2009 for hillshade modeling of the two largest forest associations at Vicksburg National Military Park. Four additional observations were made in South Fort and Navy Circle units (see Figure 1). Areas mapped in yellow depict inference area for this calibration and final map polygons. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

and mapped as Cherrybark Oak – Water Oak Forest and pixels with less than 190 were mapped as Sweetgum – Pecan – Water Oak Forest (Figure 10). To approximate a minimum size for stand recognition, we relabeled clusters of pixels that were [in aggregate] smaller than 0.25 hectares to that of the surrounding matrix.

Since we converted thematic accuracy observations within the remapped class for additional map calibration, we regenerated new observations to assess the new classes (see section 2.3).

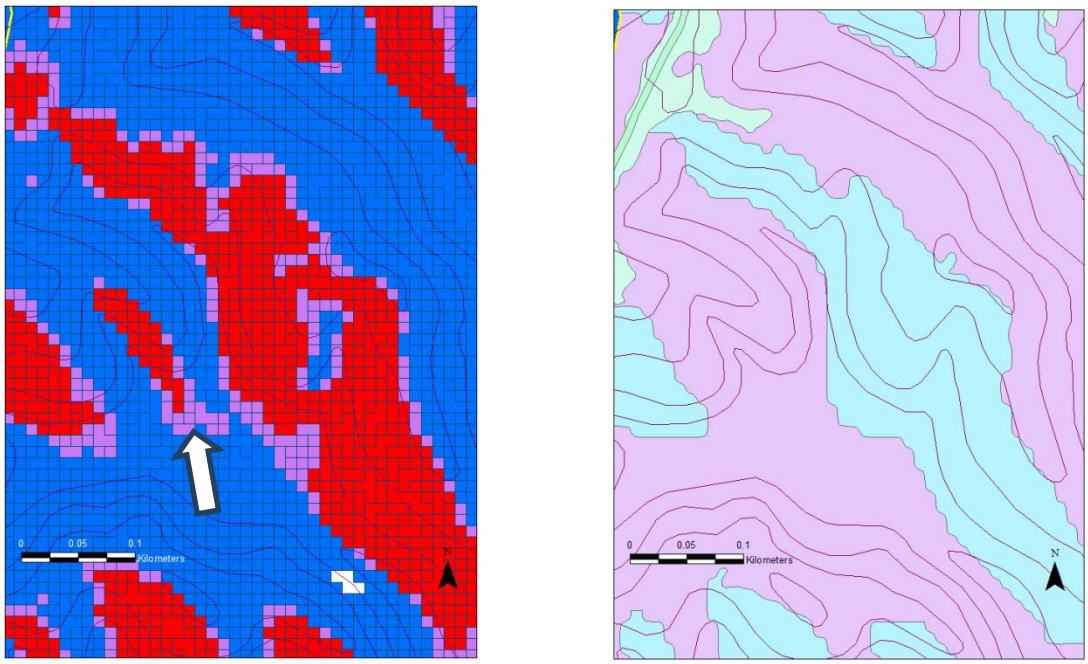


Figure 10. Example of hillshade modeling, showing hillshade raster model (left map) and finished polygons for same area (right map). In left map, hillshade values are less than 186 (blue), 186-195 (magenta) and greater than 195 (red). In right map, Cherrybark Oak–Water Oak Forest is shown in light blue and Sweetgum–Chinkapin Oak– Water Oak Forest is shown in magenta). Arrow in left map shows a cluster of pixels representing a total area smaller than 0.25 hectares that was "absorbed" into the surrounding matrix type for stand mapping purposes. Closed sets of elevation contour lines indicating ridge tops show prevalence of the former type as mapped on southwest-facing slopes and the latter type as mapped on northeast-facing slopes.

2.2.6 Final Mapping Adjustments, 2011-2012

Following accuracy assessment, we merged polygons of the Old Field Wooded Herbaceous Vegetation into those of the Bahia Grass Herbaceous Vegetation, since we could not distinguish the two reliably, since most areas that we mapped as the Old Field Wooded Herbaceous Vegetation were found to be Bahia Grass Herbaceous Vegetation and since the latter type dominates the mix of these two types.

In order to fulfill cultural landscape objectives, the National Park Service converted several stands of forest within the main unit of VICK to grassland vegetation, during 2005-2006 and again in 2011-2012, by tree cutting (Virginia Dubowy, VICK, pers. comm.). The 2005-2006 clearings took place after the image for most mapping was acquired, and the 2011-2012 clearings

took place after the map and AA were completed. The total area converted from forest to grassland was about 40 hectares. In order to maximize the currency of the spatial data for this project, we joined polygon files from GPS data collected by VICK staff that represented the perimeters of these areas to the corresponding forested area polygons and relabeled these polygons as the Old Field Wooded Herbaceous Vegetation (the presumed type occupying these areas following conversion). Because the conversion took place following mapping and accuracy assessment, these areas were assessed during accuracy assessment using the map class labels that existed prior to conversion (i.e., forests).

To make the entire spatial data set consistent with NPSVI policies to map only to park boundaries, we clipped the vegetation in and around the previously buffered areas around the Louisiana Circle, South Fort, and Navy Circle satellite unit NPS boundaries. We also added to the spatial database vegetation polygons for the previously omitted Grant's Canal satellite unit by heads-up digitizing this area from a National Agricultural Information Program (NAIP) image.

2.3 Thematic Accuracy Assessment

2.3.1 Overview of Accuracy Assessment

The thematic accuracy assessment followed the NPS methods described by Lea and Curtis (2010) for assessing the user's and producer's accuracies of individual map classes and combining the observations made for individual classes to derive an estimate of the overall accuracy of the map.

Thematic accuracy assessment selects a random sample of all possible locations from each mapped class and labels these observations with the map class from which they were selected (the sample data label). Ground observers, who do not know the sample data labels, navigate to these locations, evaluate and classify the vegetation at the location as it appears in the field in an area of predetermined size around the location, and record the vegetation class (the reference data label). Since classification attributes for vegetation usually can be discerned more accurately in the field than from the remote sensing perspective used to create the map, the field label is assumed to be correct. The map label and field label are compared for each observation (location), and matches between map class labels and field class labels are considered correctly mapped observations. The percentage of correctly mapped observations within any selected inference population (e.g., an individual map class, an individual field class, the entire map) is an estimate of the accuracy of that inference population.

The rate of matches between the sample data and reference data, *as grouped by each sample data class*, is the "user's accuracy" for that map class. User's accuracy for an individual map class is an estimate of the probability that the map class represents what was found on the ground and is equal to 100% accuracy minus the rate of "errors of commission." The rate of matches between the sample data and reference data, *as grouped by each reference data class*, is the "producer's accuracy" for that vegetation type. Producer's accuracy for an individual vegetation type is an estimate of the probability that the vegetation type has been mapped correctly, wherever it is found in the project area, and is equal to 100% minus the rate of "errors of omission." Note that the terms user's accuracy and producer's accuracy are applied to and have meaning only in reference to a specific map class or vegetation type.

Ideally, a map (sample data) class or vegetation (reference data) class has both high user's and high producer's accuracy. High producer's accuracy combined with low user's accuracy indicates that the map class is over-mapped (i.e., is rarer on the ground than the map indicates). Conversely, low producer's accuracy combined with high user's accuracy indicates that a vegetation type is under-mapped (i.e., is more abundant on the ground than the map indicates). Producer's accuracies, as calculated from population contingency tables, combined with GIS map class area measurements, allow for estimations of map class areas, as corrected for over-mapping or under-mapping error (Lea and Curtis 2010, Czaplewski 2003).

User's accuracy is important to anyone using the vegetation map because the "user" can assess the reliability of the map for each map class (or vegetation type). Given that individual map classes can vary greatly in accuracy and that there may be consequences in relying on a map that is inaccurate at a given location, these values can be important for the decision-making process by land managers. Despite its name, producer's accuracy can also be important to map users because it is an estimate of how abundant each vegetation type is, within the mapped area (accounting for mapping error). Producer's accuracy can be used to derive a more accurate estimate of the area of a given vegetation type than the map indicates, although it cannot predict with certainty where the type will occur (since map classes are not 100% accurate, as measured by user's accuracy, the map classes themselves also can be considered predictions of the occurrence of the mapped type at a specific location, rather than as a certain indicator of what is there). The nature of the management focus will usually dictate which type of accuracy measure is more germane to the user: user's accuracy is more often applied when one is concerned about management *at a specific location*; producer's accuracy is more often applied when one is concerned about management *of a specific vegetation type*.

User's and producer's accuracies may be assessed at different levels of thematic resolution, including different levels of the USNVC hierarchy. This has practical management application because map accuracy and thematic resolution are inversely related to each other and different applications of the map may require more of one attribute than of the other.

The entire set of observations may be combined into an estimate of overall accuracy for the map. Overall accuracy is the probability that any location on the ground in the project area is correctly mapped. It is computed by pooling the individual observations used to assess individual map class accuracy, after weighting their contributions to account for the stratified design based on map classes (Lea and Curtis 2010).

2.3.2 Sample Data Preparation

We assigned a sample size to each VICK map class using the allocations recommended by Lea and Curtis (2010) (Table 3), with a maximum sample size for a class of 30 observations. A sample of this size provides a reasonably precise accuracy estimate without requiring an inordinate amount of field access and observation, and is sought for as many classes as possible.

Achieving this total for smaller classes is not always possible because the requirement that (1) independent observation areas do not overlap and (2) the observation area be contained entirely within the assigned map class limit the number of possible observations to a smaller sample size than 30.

Table 3. Sample size allocations for NPS Vegetation Inventory thematic accuracy assessment, based on map class area (from Lea and Curtis 2010).

MAP CLASS TOTAL AREA*	NUMBER OF OBSERVATIONS PER MAP CLASS*
> 50 hectares	30**
8.33 to 50 hectares	0.6 per hectare**
< 8.33 hectares	5**

* - as measured before buffering for map class boundary.
** - or as many spatially independent (non-overlapping) observation sites as map class area, MMU size and other considerations will allow.

Using ArcView ® 3.2, we calculated areas (in hectares) for all map classes prior to the classes being reduced in size through buffering for site allocation requirements of field navigation error and positioning of entire plot within the map class. Final sample sizes for each map class at VICK are listed in Tables 6, D1, and D3.

Because of the small size of VICK and the relatively few classes mapped, we used an observation area size of 0.25 hectare for each field observation plot (a circular plot around each location selected in the samples with a radius of 30 meters). This observation area size and shape combination allowed for more observations in smaller classes, while providing an adequate area to observe vegetation attributes for the relatively few types at VICK.

In order to assure that a single map class label can be unambiguously applied to each observation (i.e., that the observation plot area does not "straddle" areas represented two or more map classes, areas near thematic map class (polygon) boundaries are often excluded. For the VICK accuracy assessment plot center locations, we employed a buffer distance of 35 meters followed the recommended equation of Lea and Curtis (2010):

$$\text{Buffer Distance} = \sqrt{R^2 + F^2 + M^2}$$

In this equation, R is the radius distance of the observation area (30 meters for VICK), F is the expected maximum field positioning (GPS) error distance (15 meters), and M is the expected maximum positional error distance in the map. The value for the term M may be generalized to 12 meters for all NPS Vegetation Inventory projects that meet National Map Accuracy Standard

We used ArcView ® 3.2 geoprocessing wizard to prepare the sampling population for each map class, as follows:

(1) We created a 35 meter buffer inside the boundary of all polygons of all map classes except for those mapped as the Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest. With the conditions described above, locating plot centers at least this far from map class boundaries ensures that a 30 meter radius observation plot will almost always be located entirely within the target map class and nearly eliminates the possibility that the plot center itself would fall outside the target class due to field positioning error, The Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest map class is reasonably extensive and an important vegetation type at VICK, but is uniformly narrow and often narrower than 35 meters. In order to allow selection of the recommended number of observations from a representative percentage of the class, we employed a 25 meter buffer, for this class, and we did not reduce the size of the observation area

(since 0.25 hectare is somewhat minimal for observing representative portions of forest stands). This design tolerated more probability of the observation area incorporating small portions of adjoining map classes and more probability of rejection of an individual observation due to the recorded field position of the plot center being located outside the target map class. The reason for this rule is that in such a case, positioning error due to test methodology being great enough would likely be the cause of or a contribution to an apparent mismatch between sample data label and reference data label (thematic error). On the other hand, the possibility of a true mapping error (e.g., a stand boundary being drawn in the "wrong" place) also could not be ruled out in such a situation.

(2) We created a union theme of the original map classes and this buffer theme.

(3) We selected the portions of all polygons that were within the 35 meter buffer and deleted them from this union theme. The result of this geoprocessing step was a polygon theme (sampling population) that was comprised of the interiors of all polygons (all areas more than 35 meters from a boundary with a different map class).

Using the buffered polygon interiors for each map class, we located individual AA locations (plot centers) by allocating the specified number of points for each map class to the modified union theme derived from the operations above, using the "Select Random Features" function in the National Park Service Alaskapak tools package for ArcView® 3.2 (updated version available at National Park Service 2008).

For logistical convenience, accuracy assessment locations near one another usually are visited sequentially by the same observer. In these cases, it is important that the observation areas do not overlap, since the observer's reference data label on the first observation made would understandably influence the label on the subsequent overlapping observations, which would share vegetation with the first observation (i.e., the reference data labels for the two or more observations would not be mutually independent). When two or more selected accuracy assessment locations were near enough to one another to produce overlapping observation areas (i.e., within 60 meters of one another for classes to be observed at the 0.25 hectare scale), one site at a time was selected randomly (using the random numbers function in Microsoft® Excel) and deleted. A replacement location was generated for each site so deleted, using the "Select Random Features" function (as above). If the replacement location were near enough to a previously located site, so as to produce overlapping observation areas (as above), it was rejected, and the process repeated, until either (1) the full complement of locations for the map class was assigned or (2) it was determined that the map class was saturated (could accommodate no more locations without observation area overlap between one or more accuracy assessment plots).

All vegetation classes, except the Loblolly Pine Planted Woodland (which was too small to accommodate an observation area following buffering) had at least one accuracy assessment observation. As recommended by Lea and Curtis (2010), we did not assess non-vegetated map classes; these are believed to be near 100% accurately mapped, from both a user's and producer's accuracy perspective. Thus, the assessment results apply to the vegetation classes included in this study, rather than for the entire area depicted by the map. Vegetation classes that were not mapped were included as possible reference data labels because these are vegetation

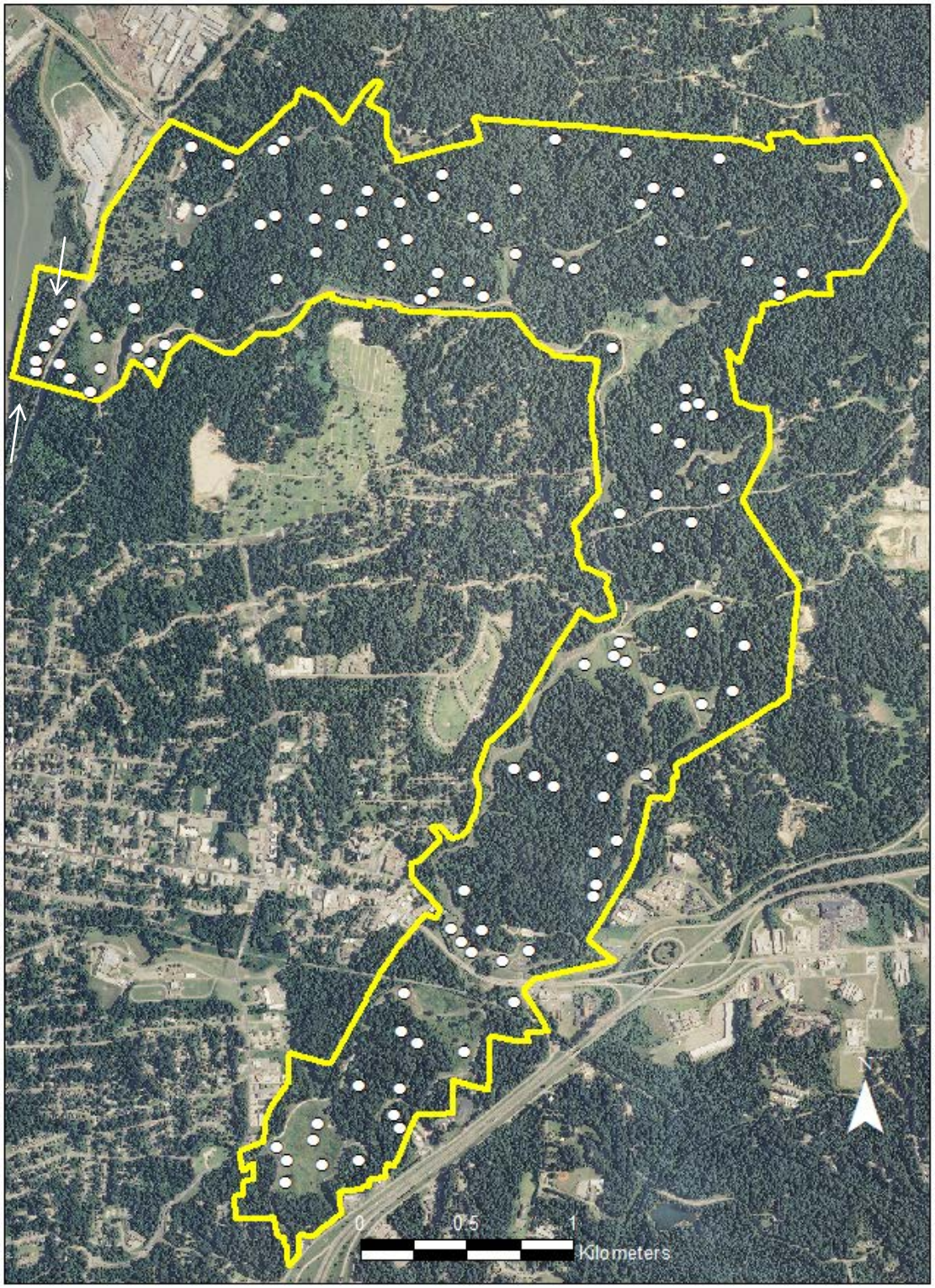


Figure 11. Locations of 116 thematic accuracy assessment observations made in August 2009 and in June 2010 at Vicksburg National Military Park. Two additional observations were made in Louisiana Circle and Navy Circle units (see Figure 1). *Ad hoc* locations (described in text) on Yazoo Diversion Canal floodplain are those between the arrows. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

types recognized at VICK, and our [implicit] assumption in the mapping process that they always occur less than 0.25 hectare is part of the hypothesis testing of the AA.

The finalized sample locations (Figure 11), but not the sample data labels, were provided to field observers, who entered these locations as waypoints into a GPS receiver.

Because the sample allocated in 2009 to the South-Central Coastal Plain Mesophytic Forest Group was used to inform remapping of this class into its two component associations, these 2009 data were not applied to the thematic accuracy assessment, and a new sample of the each of the two new classes were created (as described in Subsection 2.3.2). These samples were assessed and labeled in June 2010, using the methods described above. Because no other map classes were changed, the rest of the 2009 reference data and the six 2010 observations along the Yazoo Diversion Canal (for all other classes) were used in the accuracy estimations.

For clarification, we note that a small number of accuracy assessment observations are not part of the final inference area, in a strict statistical sense, and that small parts of the final spatial data were not included in the accuracy assessment inference population. These situations include several observations immediately outside park boundaries within the 100 meter buffer around satellite units, prior to clipping these areas from the final map to the park boundaries, several observations whose map class and reference data labels were recorded in forested areas prior to management conversion of those forests to non-forests, and the small Grant's Canal unit, which was mapped after accuracy assessment. These areas comprise small differences from the accuracy assessment inference areas to the final map population, and the inference areas of the map classes as sampled by the accuracy assessment is considered to be representative of those of the final map classes.

2.3.3 Reference Data Collection and Labeling

Field observers navigated to the accuracy assessment locations in the field at VICK in August 2009. They applied the reference data (vegetation class) labels to a circular plot 30 meters in radius (=0.25 hectare) around the accuracy assessment location by keying the vegetation using a dichotomous field key (see Appendix B). Observers recorded the positions of the plot centers on the ground, using the methods described in Subsections 2.1.1 and 2.2.3. Observers recorded reference data labels on a field form (Figure 18, Appendix E) in 2009 and electronically using a GPS receiver in 2010.

Because the field observer collecting data in 2010 was part of the mapping team, threshold values in the field key were strictly applied, to minimize possible interpretation. The field key employs vegetation criteria only; for this reason, environmental criteria (e.g., topographic position, riparian setting) that were employed to map vegetation and could cause auto-correlation in reference data labeling cannot be applied as reference data criteria.

Six accuracy assessment locations proved to be inaccessible due to flooding along the Yazoo Diversion Canal, west of the railroad embankment west of Washington Street in both August 2009 and June 2010. Accuracy assessment locations in this vicinity were known to occur in a single map class that likely extended from the water's edge to the locations and did not occur elsewhere at VICK, requiring innovation in the field in order to collect data for this map class safely. We replaced the original accuracy assessment locations for these six observations with *ad*

hoc observation locations in the field in June 2010 by (1) navigating as closely to the original locations as safely possible (to the water's edge at the base), (2) treating each revised (*ad hoc*) location as a point 30 meters from the navigation stopping point and in the azimuth of the original location, and (3) keying the vegetation type in the plot by looking across it (60 meters from the water's (and the plot's edge), estimating the extent of the plot boundaries from a distance, and (4) recording the actual observation position reached (the edge of the plot) by GPS. Because the vegetation identified for these six plots was very distinct and unambiguous from all other possibilities (virtually monospecific black willow, which is distinct from all other tree species at VICK, even at some distance) and required identification of tree species only (the herbaceous layer was submerged), the reference data values are deemed to be as accurate as for those observations collected elsewhere at VICK. Because the location of the *ad hoc* locations were derived from a random selection, and the map class proved to be homogeneous across the entire flooded area, we considered these observations to adequately represent the entire map class, even though the inference area for this individual map class was actually the subset of locations within the class that could be approached safely. The *ad hoc* locations are shown in Figure 11, and the extent of the Black Willow Floodplain Forest map class so evaluated is shown in Figure 12.

Three observation sites for which reference data labels were recorded in 2009 were inadvertently revisited by another observer and recorded in 2010 (i.e., two duplicate independent reference data labels were applied to two non-independent sites). For most of these, the two reference data labels matched, but, for one site (AA073), two different reference data labels were applied to the same observation (the observation areas likely overlapped but were not identical, due to field positioning discrepancies). Because each reference data was independent and equally valid, but the locations are not independent sites (unique observations), the reference data label for this single sample data observation was split between the two associations, with each reference data label receiving 0.5 observation for this single sample data observation.

One observation (AA063) received a reference data label that was a match with the sample data label of the target class of Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest, but its plot center position was recorded 3 meters outside of this class. This observation was removed from analysis for reasons of field positioning ambiguity, as described in subsection 2.3.2.

2.3.4 Accuracy Rate Estimation

We calculated user's and producer's accuracies for each vegetation association, estimates of the true area of each association (accounting for map error), overall accuracy for the map, and *kapp*a index of overall accuracy for the map, using methods described by Lea and Curtis (2010).

We converted the GPS positions and reference data labels collected from the field observations to a GIS point theme. For the six ad hoc observations with *ad hoc* locations (described above), we determined the plot center positions by adding 30 meters along the azimuth from the recorded GPS locations to the original plot locations (i.e., by projecting the plot center out into the flooded area). We made a spatial join of a theme with the vegetation map polygon theme to apply the map class labels as sample data labels to this point theme. We converted the point theme table with sample and reference data label fields to Microsoft Excel ® 2003 and created a pivot table as the sample (raw counts) contingency table. User's accuracies for each individual map class are derived from the simple random sampling design within each map class, and can be calculated as

the number of correctly mapped observations for that class (i.e., observations for which the reference data and sample data match) divided by the total number of observations made in that class. Except in the rare case in which there are no mapping errors, individual observations that are pooled to calculate producer's accuracies and overall accuracies come from different strata in a stratified random design (i.e., the map classes to which they were assigned were sampled at the different densities of the individual map classes). These are calculated from a population (proportional) contingency table that adjusts the contribution of individual observations by the size of the map classes from which they were derived, using more complex formulae (Lea and Curtis 2010).

In order to provide information for uses of the map that may demand more accuracy and less thematic resolution, we estimated the per class user's and producer's accuracies and estimated area (accounting for mapping error) for individual USNVC groups and overall map accuracy at the USNVC group level by aggregating the applicable cell proportions in the population contingency table for their member associations (Lea and Curtis 2010). Each association at VICK is assigned to a different USNVC alliance, so that there is no change in thematic resolution or accuracy for this map when employing alliance level map labels. Similarly, we calculated overall accuracy and estimated individual unit area (accounting for mapping error) at higher levels of the USNVC hierarchy (macrogroup to class).

3.0 Results

The data produced by this investigation consists primarily of this report and its appendices, a spatial (Geographic Information Systems) database, and a database of the classification plots, accuracy assessment plots, and other field observations. Products were created in accordance with National Park Service Vegetation Inventory procedures in place as of August, 2012 (http://science.nature.nps.gov/im/inventory/veg/index.cfm). Digital versions of these data reside at:

https://irma.nps.gov/App/
and/or at:
http://biology.usgs.gov/npsveg/

3.1 Classification Statistics

We documented 13 associations at VICK (Tables 4 and 5), eight of which could be confidently assigned to a corresponding USNVC association, and five of which were documented unrecognized (but probably widespread) vegetation types that should eventually be covered by the USNVC at some level. All associations were represented by at least one classification plot. The 13 USNVC associations currently are in 12 alliances (but each association will be unique to an alliance following expected USNVC revisions), in seven USNVC groups, in five USNVC macrogroups, divisions, and formations, and in two USNVC subclasses and classes.

3.2 Mapping Statistics

We mapped 687 hectares (1698 acres) of vegetation and 25 hectares (62 acres) of non-vegetated land cover classes, in 342 polygons. The mean polygon size is 2.01 hectares, and the median polygon size is 0.83 hectare. Tables 4 and 5 summarize the areas mapped and the estimated true areas (accounting for mapping error) of each vegetation type, at each level of the USNVC hierarchy (the association areas are also summarized in terms of the local park names in Table D2). We mapped 11 of the 13 vegetation associations described. Nine of these 11 associations were both evaluated as map classes and were recorded in the field during accuracy assessment. The two unmapped associations are assumed to occur entirely or mostly in stands that are less than the assessed area of 0.25 hectares (the effective minimum mapping unit size for this project). In the spatial database, the polygons are labeled at USNVC levels, to allow use at different levels of thematic resolution and accuracy (see Figures 12 and 13), and by local names.

3.3 Accuracy Assessment Statistics

Overall accuracy for the vegetation portion of the map at the finest thematic resolution mapped (USNVC association) is 60.5%. This accuracy rate is also the alliance level accuracy, since the associations at VICK are mostly assigned to one USNVC alliance and no within-alliance mapping errors occurred. Accuracy at the thematic level of USNVC group (and macrogroup, division, and formation) is 92.4%, and accuracy is 100% at the levels of USNVC subclass and class. Individual class user's and producer's accuracies for associations and groups are depicted in Table 6, and sample and population contingency tables appear in Appendix D.

Table 4. Vicksburg National Military Park vegetation types and estimated abundances, by USNVC hierarchy level, for USNVC Forest and Woodland Vegetation Class. Hierarchy level unit names descend from class to association, with higher unit totals summarized from their component lower unit levels.

USNVC OR LOCAL (FOR ASSOCIATIONS) VEGETATION CLASS NAME	AREA MAPPED FOR TYPE (hect.)	ESTIMATE OF TRUE AREA* (hect.)
Forest & Woodland Class / (Temperate Forest Subclass)	**551.3**	**551.3**
Warm Temperate Forest Formation / Southeastern North American Warm Temperate Forest Division		
Southeastern North American Ruderal Forest & Plantation Macrogroup	**14.8**	**37.2**
Southeast Conifer & Hardwood Plantation Group	**0.2**	**0.2[a]**
Pinus taeda Planted Forest Alliance		
Local Association Name: Loblolly Pine Planted Woodland =*Pinus taeda* Planted Forest	**0.2**	**0.2[a]**
Southeast Conifer & Hardwood Ruderal Forest Group	**14.6**	**38.1**
Robinia pseudoacacia Forest Alliance		
Local Association Name: Black Locust – Paper Mulberry Successional Forest =(*Robinia pseudoacacia – Broussonetia papyrifera*) Forest	**10.6**	**8.8**
Alliance unrecognized		
Local Association Name: Boxelder Successional Upland Forest =*Acer negundo – (Liriodendron tulipifera)* Successional Upland Forest	**2.8**	**22.4**
Liquidambar styraciflua Forest Alliance		
Local Association Name: Sweetgum Successional Forest =*Liquidambar styraciflua* Forest	**1.3**	**6.9**
Cool Temperate Forest Formation / Eastern North American Cool Temperate Forest Division		
Central Mesophytic Hardwood Forest Macrogroup	**507.0**	**458.0**
South-Central Coastal Plain Mesophytic Forest Group	**507.0**	**458.0**
Quercus pagoda – Quercus nigra Forest Alliance		
Local Association Name: Cherrybark Oak – Water Oak Forest =*Quercus pagoda – Quercus nigra* Forest	**153.3**	**167.2**
Liquidambar styraciflua Forest Alliance		
Local Association Name: Sweetgum - Chinkapin Oak – Water Oak Forest =*Liquidambar styraciflua - Carya illinoinensis - Quercus nigra* Forest	**353.5**	**290.8**
Temperate Flooded & Swamp Forest Formation / Eastern N. American Flooded & Swamp Forest Division		
Northern & Central Floodplain Forest & Scrub Macrogroup	**29.5**	**54.3**
Silver Maple – Green Ash – Sycamore Floodplain Group	**20.2**	**45.1**
Platanus occidentalis - (Fraxinus pennsylvanica, Celtis laevigata, Acer saccharinum) Temporarily Flooded Forest Alliance		
Local Association Name: Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest = *Platanus occidentalis - Liquidambar styraciflua - (Ulmus americana) / (Crataegus viridis)* Forest	**20.2**	**45.1**
Eastern Cottonwood – Black Willow Flooded & Swamp Group	**9.2**	**9.2**
Salix nigra Temporarily Flooded Forest Alliance		
Local Association Name: Black Willow Floodplain Forest = *Salix nigra* Large River Floodplain Forest	**9.2**	**9.2**

*- as adjusted for mapping error by accuracy assessment results.

a –map class was not evaluated during accuracy assessment (estimate is the same as area mapped).

Table 5. Vicksburg National Military Park vegetation types and estimated abundances, by USNVC hierarchy level, for USNVC Shrubland and Grassland Class. Hierarchy level unit names descend from class to association, with higher unit totals summarized from their component lower unit levels.

USNVC VEGETATION CLASS NAME	AREA MAPPED FOR TYPE (hect.)	ESTIMATE OF TRUE AREA (hect.)*
Shrubland & Grassland Class **Temperate & Boreal Shrubland & Grassland Subclass**	**135.7**	**135.7**
Temperate Grassland, Meadow & Shrubland Formation / ***Southeastern North American Grassland & Shrubland Division***		
Southeastern Ruderal Grassland & Shrubland Macrogroup	**135.7**	**135.7**
Southeastern Old Field Group	**135.7**	**135.7**
Pueraria montana var. *lobata* Vine-Shrubland Alliance		
Local Association Name: Kudzu Vine-Shrubland **=*Pueraria montana* var. *lobata* Vine-Shrubland**	**0.0**	**0.0[b]**
Alliance undefined		
Local Association Name: Mixed Vine-Shrubland **=*Ampelopsis cordata – Vitis cinerea – Mixed Vines* Vine-Shrubland**	**0.2**	**0.2[a]**
Paspalum notatum Herbaceous Alliance		
Local Association Name: Bahia Grass Herbaceous Vegetation **=*Paspalum notatum* Herbaceous Vegetation**	**94.9**	**67.5**
Alliance undefined		
Local Association Name: Old Field Wooded Herbaceous Vegetation **=(*Solidago canadensis - Sorghum halepense - Schedenorus phoenix*)** **Wooded Herbaceous Vegetation**	**40.3[c]**	**68.7[c]**
Temperate & Boreal Freshwater Wet Meadow & Marsh Formation / ***Eastern North American Freshwater Wet Meadow, Riparian & Marsh Division***		
Eastern North American Wet Meadow and Marsh Macrogroup	**0.0**	**0.0**
Eastern North American Wet Meadow Group	**0.0**	**0.0**
Alliance undefined		
Local Association Name: Sand Spikerush Herbaceous Vegetation **=*Eleocharis montevidensis* Herbaceous Vegetation**	**0.0**	**0.0[d]**
Non-vegetated (Land Cover Classes) (no USNVC units)	**25.2**	**25.2**
Developed, High Intensity (mostly roads and buildings)	**25.0**	**25.0[a]**
Open Water	**0.2**	**0.2[a]**

* - as adjusted for mapping error by accuracy assessment results.
a - map class was not evaluated during accuracy assessment (estimate is the same as area mapped).
b - this association is known to occupy at least 0.12 hectares (from two classification plots)
c – About 40 hectares of this association was added to the map, after the map and accuracy assessment had been completed (management clearing of forest for cultural landscape restoration) and was not evaluated. This unevaluated area is estimated to be equivalent to the mapped area for purposes of estimating true area of the association.
d - this association is known to occupy at least 0.03 hectares (from one classification plot)

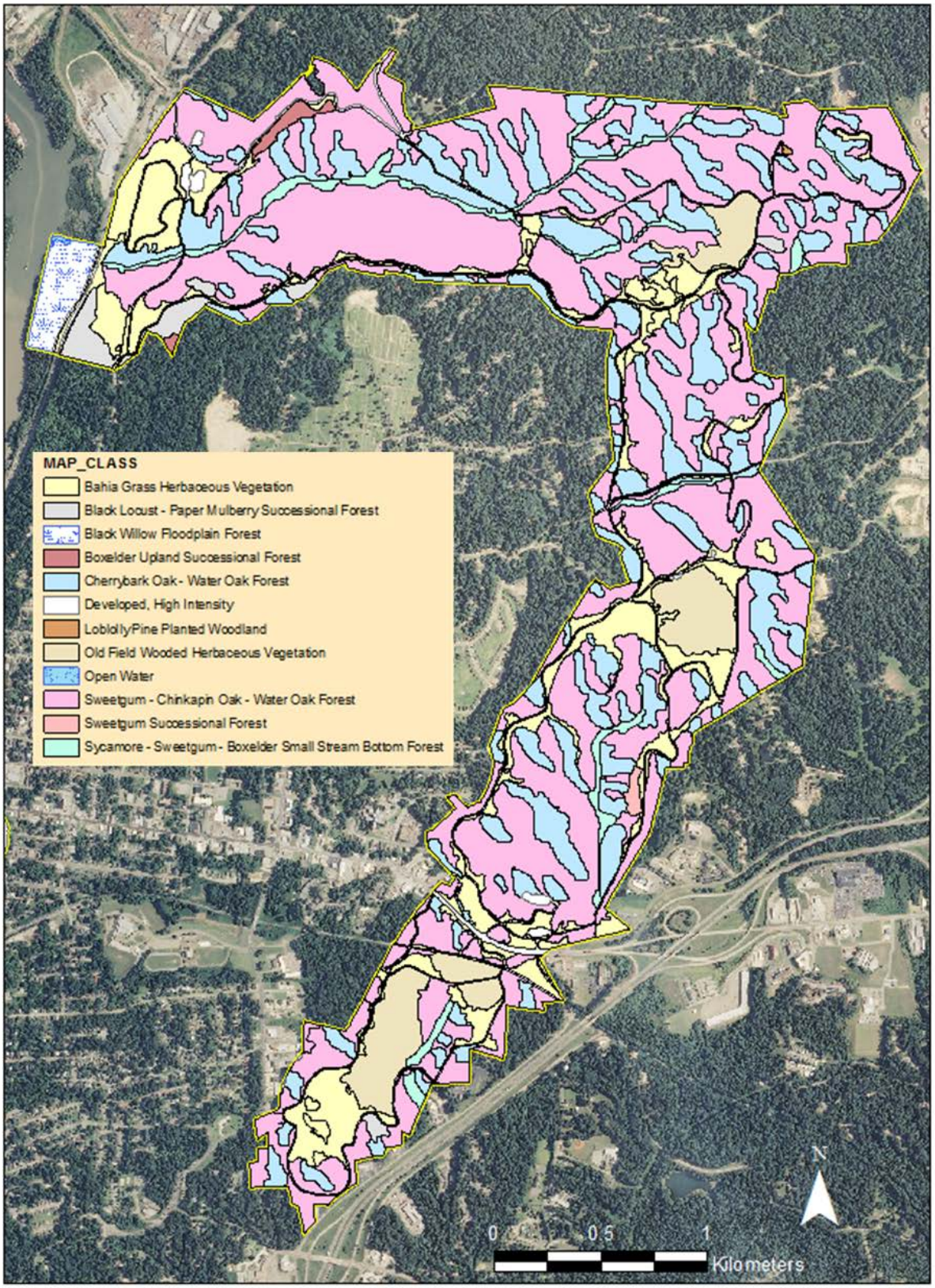


Figure 12. USNVC association level vegetation map and legend for Vicksburg National Military Park. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

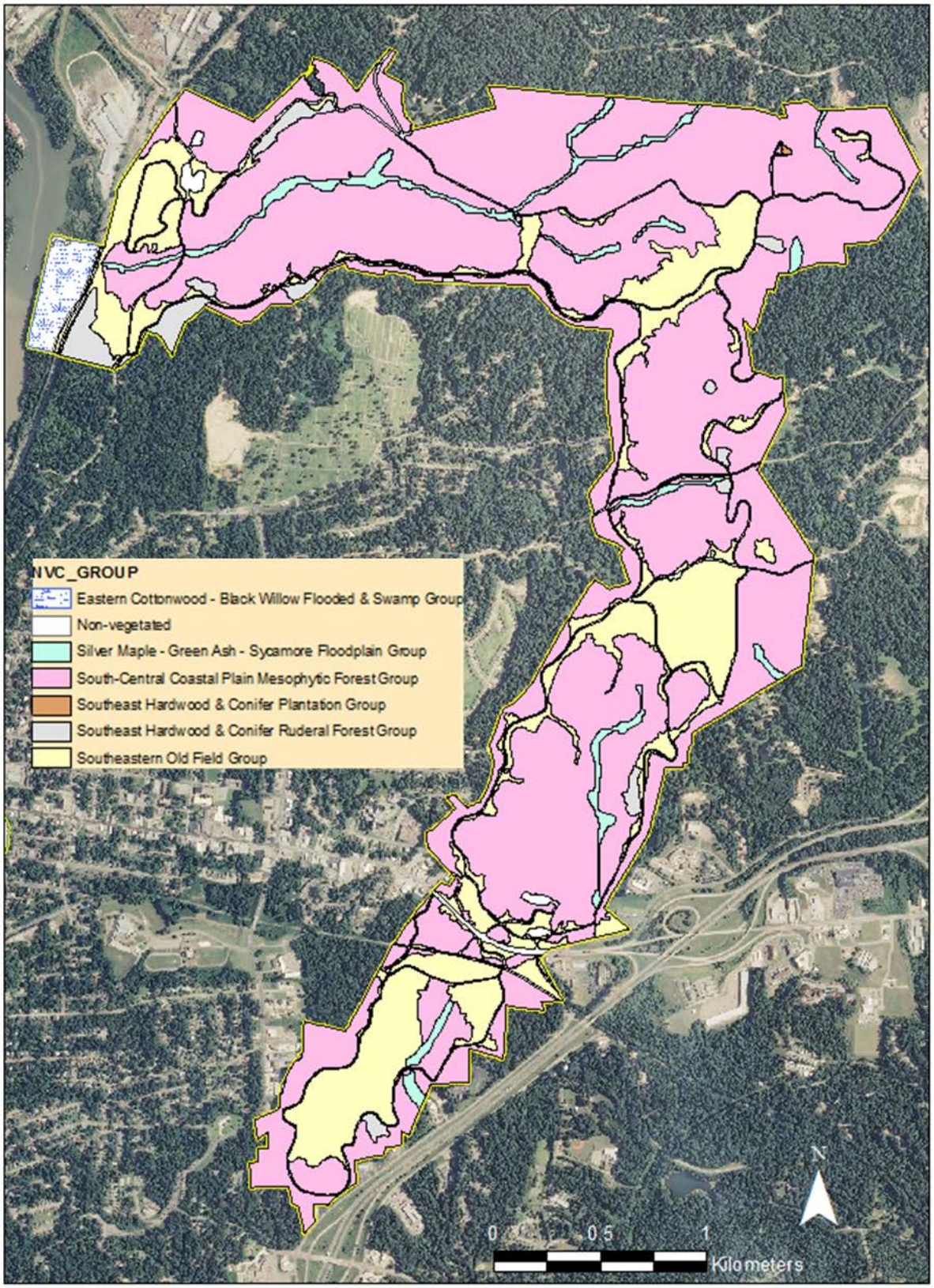


Figure 13. USNVC group level vegetation map and legend for Vicksburg National Military Park. Imagery is 2010 aerial photography from National Agricultural Inventory Program.

Table 6. User and producer accuracies for each map class of USNVC group (red) and association (black) levels.

USNVC VEGETATION CLASS NAME AND IDENTIFIER	USER'S ACCURACY (n^1)	PRODUCER'S ACCURACY (n^2)
Southeast Conifer & Hardwood Plantation Group (G029)	**N/A[3] (0)**	**N/F[4] (0)**
Loblolly Pine Planted Woodland =*Pinus taeda* Planted Forest (CEGL007179)	**N/A[3] (0)**	**N/F[4] (0)**
Southeast Conifer & Hardwood Ruderal Forest Group (G031)	**100% (9)**	**26% (13.5)**
Black Locust – Paper Mulberry Successional Forest =(*Robinia pseudoacacia – Broussonetia papyrifera*) Forest (NPSVICK004)	**83% (6)**	**100% (5)**
Boxelder Successional Upland Forest =*Acer negundo – (Liriodendron tulipifera)* Successional Upland Forest (NPSVICK001)	**50% (2)**	**12% (6)**
Sweetgum Successional Forest =*Liquidambar styraciflua* Forest (CEGL007216)	**100% (1)**	**19% (2.5)**
South-Central Coastal Plain Mesophytic Forest Group (G166)	**89% (64)**	**99% (61.5)**
Cherrybark Oak – Water Oak Forest =*Quercus pagoda – Quercus nigra* Forest (CEGL004109)	**49% (33)**	**45% (25)**
Sweetgum - Chinkapin Oak – Water Oak Forest =*Liquidambar styraciflua - Carya illinoinensis - Quercus nigra* Forest (CEGL004122)	**61% (31)**	**74% (36.5)**
Silver Maple – Green Ash – Sycamore Floodplain Group (G040)	**54% (11)**	**25% (9)**
Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest = *Platanus occidentalis - Liquidambar styraciflua - (Ulmus americana) / (Crataegus viridis*) Forest (CEGL007335)	**55% (11)**	**25% (9)**
Eastern Cottonwood – Black Willow Flooded & Swamp Group (G041)	**100% (6)**	**100% (6)**
Black Willow Floodplain Forest = *Salix nigra* Large River Floodplain Forest (CEGL007410)	**100% (6)**	**100% (6)**
Southeastern Old Field Group (G583)	**100% (27)**	**100% (27)**
Mixed Vine-Shrubland = *Ampelopsis cordata – Vitis cinerea* – Mixed Vines Vine-Shrubland (NPSVICK005)	**N/A[3] (0)**	**N/F[4] (0)**
Bahia Grass Herbaceous Vegetation =*Paspalum notatum* Herbaceous Vegetation (CEGL004700)	**70% (27)**	**100% (19)**
Old Field Wooded Herbaceous Vegetation = (*Solidago canadensis - Sorghum halepense - Schedenorus phoenix*) Wooded Herbaceous Vegetation (NPSVICK002)	**N/A[3] (0)**	**0% (8)**

1 - sample size (number of observations with this sample data label)
2 - frequency of occurrence (number of observations with this reference data label)
3 - not assessed (no accuracy computed)
4 - not found during reference data collection (no accuracy computed)

Table 7. Summary of vegetation field observations made at Vicksburg National Military Park, 2004-2010.

MONTH, YEAR	PURPOSE OF OBSERVATION	NUMBER	SAMPLE DESIGN	OBSERVATION AREA SIZE (HECTARES)
August, 2004	Vegetation Classification	45	subjective	0.02 to 0.10
November, 2007	Map Calibration	74	subjective	0.25
August, 2009	Map Calibration	33	random	0.25
August, 2009	Map Accuracy Assessment	46	random	0.25
June, 2010	Map Accuracy Assessment	72	random	0.25

4.0 Discussion

4.1 Summary

This project succeeded in providing a descriptive and quantitative inventory of vegetation for Vicksburg National Military Park. The inventory consists of a vegetation map that was derived from a field-based quantitative and well-described vegetation classification and was subjected to rigorous quality control procedures (i.e., the thematic accuracy assessment). The estimated overall accuracy of the map met current NPSVI requirements of 60% at the USNVC association or alliance level and 70% at the USNVC group level. This accuracy is respectable, since our time in the park devoted to developing a mapping model was limited to six days, and since the available imagery was limiting for individual species recognition, forcing us to rely more heavily on modeling.

Several findings of the inventory may have management applications.

4.2 Application #1: Baseline Information on the Composition of the Mixed Mesophytic Forest

Integrating multiple sets of data from the NPSVI project at VICK, we can increase and improve NPS and public understanding about the "mixed mesophytic forest," one of the major resources of VICK (Segura et al. 2007) by offering some improvements on earlier, more anecdotal, assessments.

With the exception of the Black Willow Floodplain Forest on the Yazoo Diversion Canal (Mississippi River) floodplain (about 9 hectares), most of the mature forests of VICK might be described as a "mixed mesophytic" forest (in the sense of Walker (1997)). The mesic and relatively late successional Sweetgum – Chinkapin Oak - Water Oak Forest and the dry-mesic Cherrybark Oak – Water Oak Forest have tree compositions that are relatively diverse (both species rich and species even) and currently are placed in the USNVC South-Central Coastal Plain Mesophytic Forest Group of the Central Mesophytic Hardwood Forest macrogroup. These two associations together, which occupy an estimated 459 hectares (1,134 acres) at VICK, would approximate the narrowest definition of the mixed mesophytic forest. The Sycamore – Sweetgum – Boxelder Forest is an occasionally flooded small stream bottom type that has a larger component of wetland and riparian plant species that shares a number of tree species with the other two associations and has some mixed mesophytic characters; it occupies an estimated 46 hectares (114 acres) at VICK. Finally, the early successional associations, dominated by sweetgum, tuliptree, paper mulberry, black locust, and/or boxelder, would be expected to succeed (or be restored) to either the Sweetgum – Chinkapin Oak - Water Oak Forest or the dry-mesic Cherrybark Oak – Water Oak Forest. These early successional associations occupy another [estimated] 33 hectares (91 acres). Therefore, the extent of this resource at VICK might be estimated from about 459 hectares (1,134 acres) to about 542 hectares (1,339 acres), depending on the circumscription of the "mixed mesophytic forest."

In a brief qualitative description of the park's vegetation as background to creating a vascular plant species list for VICK, Walker (1997) described southern red oak (*Quercus falcata*) and white oak (*Quercus alba*) as being the dominant trees at VICK, with southern sugar maple (*Acer barbatum*), basswood (*Tilia americana*), black oak (*Quercus velutina*), and northern red oak (*Quercus rubra*) common in the overstory. He listed ironwood (*Carpinus caroliniana*), dogwood (*Cornus florida*), redbud (*Cercis canadensis*), pawpaw (*Asimina triloba*), and sassafras (*Sassafras albidum*) among the common understory (subcanopy) tree species. In a similarly cursory and qualitative description for context to a

herpetological study at VICK, Keiser (2002) noted that white oak (*Quercus alba*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), [southern] sugar maple (*Acer barbatum*), and basswood (*Tilia americana*) were among the species dominating the overstory, with sassafras (*Sassafras albidum*), dogwood (*Cornus florida*), redbud (*Cercis canadensis*), box elder (*Acer negundo*), red maple (*Acer rubrum*), red cedar (*Juniperus virginiana*), and saplings of the overstory trees being characteristic of the tree understory.

Plot data and our observations from this project show that white oak and southern red oak, species that typically are dominant forest trees well-drained uplands elsewhere on the East Gulf Coastal Plain are, in fact, notably absent from most of the forests of VICK. White oak was recorded in only one of 45 classification plots (at less than 2% cover) and southern red oak was not recorded in any plot. During accuracy assessment, in which we covered much more of the park's forests, we recall encountering a total of two white oak and no southern red oak trees.*

We also found that previous anecdotal descriptions of VICK vegetation, which are sometimes repeated in other assessments and descriptions of the park (e.g., Chapman et al. 2004, Cooper et al. 2004, Segura et al. 2007) failed to record many of the most abundant tree species that do comprise the forests of VICK. Using the mean canopy cover for each species in each association as recorded in the classification plots and averaged for the synthesis tables (Appendix A) and using the map and accuracy assessment data (to correct for mapping error) to estimate areas of each association, we can make reasonably objective estimates of the total canopy cover (which reflects species abundance) throughout all VICK forests (Table 8). We offer the caveat that these estimates have some degree of sampling variability associated with the plot data collection and the area estimation, and, therefore, that the rank order of species is somewhat relative (e.g., species such as tuliptree and eastern cottonwood are likely over-represented in plots compared to their abundance in the park). Nevertheless, this is a reasonably robust representation of the most abundant tree species at VICK (e.g., despite some estimation uncertainty, sweetgum and water oak are undoubtedly the two most abundant species in the park, as measured by canopy cover).

Our data indicate that, while the species mentioned in these previous accounts (other than white oak and southern red oak) are indeed frequent forest trees at VICK, only boxelder, listed by Keiser (2002), is among the ten most abundant species (as quantitatively estimated by this study). Additionally, only four of the estimated 20 most abundant tree species, as estimated by this study, were named by these accounts, combined.

The intent of our analysis is not to be overly critical of these observers, who were mostly giving a very general vegetation context in studies of other biological phenomena. Rather, we use these findings as an example of how the rigorously collected quantitative data from multiple disciplines, as prescribed by the NPSVI protocols, can change perspectives that may have persisted from anecdotal observations and how they can significantly change and improve upon the understanding of NPS resources. We also use these findings to offer alternative hypotheses to those of Walker (1997) that may explain why the composition of VICK forests varies from those of Braun's "western mesophytic" forest.

* Cherrybark oak (*Quercus pagoda*), which is often a dominant forest tree at VICK, has been treated by some authors as a variety of southern red oak (as *Quercus falcata* var. *pagodifolia*). However, Walker's species list names both *Q. falcata* and *Q. pagoda* as separate collections. Therefore, his concept of the taxon *Q. falcata* is, as is ours, that of the strict sense and does not include *Q. pagoda*. Most current taxonomic treatments treat *Q. pagoda* at the species level, as it is both morphologically and ecologically quite distinct from *Q. falcata*.

Table 8. Estimated canopy cover for the most abundant tree species in forests of VICK, as estimated from NPS Vegetation Inventory data, by abundance rank. Species mentioned by previous studies (cited in text) as being common are denoted by bold print.

RANK	SPECIES LATIN NAME	COMMON NAME	TOTAL ESTIMATED AREA (hectares)
1	*Liquidambar styraciflua*	sweetgum	153
2	*Quercus nigra*	water oak	101
3	*Quercus pagoda*	cherrybark oak	54
4	*Quercus muehlenbergii*	chinkapin oak	42
5	*Ulmus rubra*	slippery elm	40
6	***Acer negundo***	**boxelder**	38
7	*Liriodendron tulipifera*	tuliptree	38
8	*Celtis laevigata*	sugarberry	29
9	*Carya illinoinensis*	pecan	27
10	*Morus rubra*	red mulberry	23
11	*Ulmus alata*	winged elm	21
12	*Prunus serotina*	black cherry	18
13	***Cercis canadensis***	**redbud**	13
14	***Sassafras albidum***	**sassafras**	13
15	*Carya cordiformis*	bitternut hickory	12
16	*Prunus caroliniana*	Carolina laurel cherry	11
17	*Robinia pseudoacacia*	black locust	9
18	*Ulmus americana*	American elm	9
19	***Tilia americana var. caroliniana***	**Carolina basswood**	8
20	*Platanus occidentalis*	American sycamore	8
21	*Fraxinus americana*	white ash	8
22	*Salix nigra*	black willow	8
23	*Quercus shumardii*	Shumard oak	6
24	***Cornus florida***	**flowering dogwood**	6
25	*Gleditsia triacanthos*	honeylocust	5
26	***Quercus velutina***	**black oak**	5
27	*Populus deltoides*	eastern cottonwood	5
28	***Quercus rubra***	**northern red oak**	4
29	*Broussonetia papyrifera*	paper mulberry	4
30	*Magnolia grandiflora*	southern magnolia	4
31	*Carya glabra*	pignut hickory	4
32	***Acer barbatum***	**southern sugar maple**	3
33	*Carpinus caroliniana*	American hornbeam	3
34	*Quercus michauxii*	swamp chestnut oak	3
35	***Asimina triloba***	**common pawpaw**	2
36	***Juniperus virginiana***	**eastern redcedar**	2
39	***Acer rubrum***	**red maple**	1
43	***Quercus alba***	**white oak**	0.3
NR	***Quercus falcata***	**southern red oak**	<0.01

Walker (1997) noted that Braun (1950) had placed the Blufflands (Bluff Hills Ecoregion) in the Mixed Mesophytic Forest Region (Braun actually defined this region as being part of the Western Mesophytic Forest Region, rather than her Mixed Mesophytic Forest Region, which is limited to the Appalachian Plateaus). He noted that some species that she listed as having significant cover in that forest were very rare (e.g., beech (*Fagus grandfolia*)) or absent (e.g., cucumber tree (*Magnolia acuminata*)) at VICK; these assessments concur with our own observations for those species. He speculated that past [anthropogenic] disturbance and recent recovery might be the cause for this variance from Braun's description.

While not discounting that relatively recent forest clearing probably has altered species composition, it should be noted that the loess hills span considerable latitude (Figure 1) and that Braun's description was from a forest in the Blufflands near Reelfoot Lake, Tennessee, more than 480 kilometers (300 miles) north of VICK. Braun (1950) observed that the southern end of the Blufflands in eastern Louisiana represented some transition to her Southeastern Evergreen Forest Region. Thus, we can offer one alternative or supplemental explanation to that of Walker: that the natural factor of geography may be an important reason for the variance in species composition at VICK from those of mesophytic forests to the north.

First, while the forests of VICK are mesophytic in the sense that they are analogous in many aspects to Braun's mesophytic forests (e.g., tree species diversity, mesic settings), their location near the southern end of the Western Mesophytic Forest Region places them within the range of many elements of Braun's Oak-Pine and Southeastern Evergreen Forest regions. In this inventory, we found some of the generally distributed species of the Western Mesophytic Forest Region (slippery elm, tuliptree, basswood, black cherry, sassafras, white ash) to be frequent at VICK, but also found that few of these were among the more abundant species (Table 8). On the other hand, we found a number of species that Braun (1950) often listed for settings within her more southern Oak-Pine and Southeastern Evergreen Forest Regions (e.g., sweetgum, water oak, cherrybark oak, sugarberry, pecan) to be among the most abundant tree species in VICK forests (Table 8). These species have a distribution that is strongly austroriparian (Dice 1943, Udvardy 1975, McLaughlin 2007), i.e., coincides with the Coastal Plain of the southeastern United States and Mississippi embayment. Additionally, some elements of the Western Mesophytic Forest Region (northern sugar maple, cucumber tree) are absent from VICK – evidently because Vicksburg is near or beyond their southern range limits (Kartesz 2011). It is also notable that the basswood present at VICK is a variety of American basswood (Carolina basswood, *Tilia americana* var. *caroliniana*) with a more strongly austroriparian distribution than the varieties (var. *heterophylla*, var. *americana*) that prevail in more northern parts of the Western Mesophytic Forest Region.

Natural soil factors may also influence forest composition for mesophytic forests at VICK and perhaps elsewhere in the Blufflands. Six of our estimated ten most abundant species at VICK (sweetgum, water oak, cherrybark oak, boxelder, sugarberry, and pecan) tend to occur (at least in a facultative sense) in bottomland and riparian settings, rather than on upland slopes, coves, and ridges. These species are seldom considered elements of any mesophytic forests (e.g., Braun 1950). We speculate that the loess soils of the Bluff Hills, which are likely denser and more poorly drained than most upland soils throughout the mixed mesophytic region, may select for dominance by some facultative "bottomland" tree species in upland mesic settings. While these species often are considered to be "early successional" in most upland settings, they persist in what are considered natural late successional forests in riparian

settings. Qualities of the loess soils of VICK and elsewhere in the Bluff Hills may tilt the competitive balance of these species toward longer persistence in upland settings. Similarly, qualities of the "heavy" loess soils, more than the length of time for succession or human management, may help explain the relative rarity of species that are otherwise frequent to dominant on well-drained upland soils in other areas of the Gulf Coastal Plain and should not be limited by climate in the vicinity of VICK (e.g., white oak, southern red oak, beech, loblolly pine, mockernut hickory).

For these reasons, we suggest that variances in forest tree composition of VICK from compositions of other "mixed mesophytic forests" could be more from natural large scale (climate) and local scale (soil) factors than from human management. In the time that has elapsed since the Civil War and since the Civilian Conservation Corps activities, species that would be naturally dominant in local forests would be expected to establish themselves to a greater extent than is currently the case at VICK, even if not at full "natural" abundance. The character of the southern Bluff Hills forests might be regarded as a fairly unique (and more geographically restricted) version or analog of the more northern expressions of the Western Mesophytic Forest of Braun (1950) with austroriparian (Dice 1943, McLaughlin 2007) and bottomland species elements. The Cherrybark Oak – Water Oak Forest, described from this project, has a global conservation of G3? (possibly vulnerable) (NatureServe 2007, 2012), and the known ranges of this type and of the Sweetgum – Chinkapin Oak – Water Oak Forest (= Sweetgum – Pecan – Water Oak Forest), the most mixed and most mesophytic forest type at VICK, are restricted. Within the National Park system, these forest associations currently are known only from Vicksburg National Military Park and the southernmost portion of the Natchez Trace Parkway and globally they are known only from the Bluff Hills ecoregion.

Additionally, while the influence of CCC plantings and erosion control activities is often cited as being profound, some observations made during this study suggest that reforestation may have been influenced as much or more by natural succession and physical factors of the site. These observations include the following:

-Such accounts are generally not specific as to what the CCC planted or how the organization's activities influenced composition.

-We observed that a relatively high proportion of VICK forests consist of large trees that are likely to have started growing before the CCC era (i.e., appeared to be more than 70-80 years old) and had moderately high structural diversity characteristic of older forests.

-Photographs during the CCC era show what appear to be relatively mature and sometimes extensive forest stands. For example the area immediately to the north of the old park administration building was forested during field work for this project in 2010 (much of it was cleared for cultural landscape in 2011-2012). This same area appears to be relatively mature forest in a 1937 photograph (Figure 14). We would conservatively estimate the trees in the photograph to be at least 40 years old in 1937, and the area has clearly remained forested since then. It seems likely that many stands at VICK exceed 100 years in age, with some possibly dating to shortly after the end of the Vicksburg siege.

-Other photographs from the CCC era suggest that erosion control activities were somewhat limited to small areas of severely eroding headwater cutting and slumping, rather than more general and widespread plantings. From "before and after" photographs of one such site (Figures 15 and 16), it appears that

revegetation and restoration was comprised of filling an eroded, unvegetated cut and planting this formerly unvegetated area with grasses. In contrast to the conversion of unvegetated soil to grasses over this relatively limited area, the erosion control activity does not appear to have involved tree planting in the adjacent areas, and the tree species composition and tree distribution appear not to have been changed.

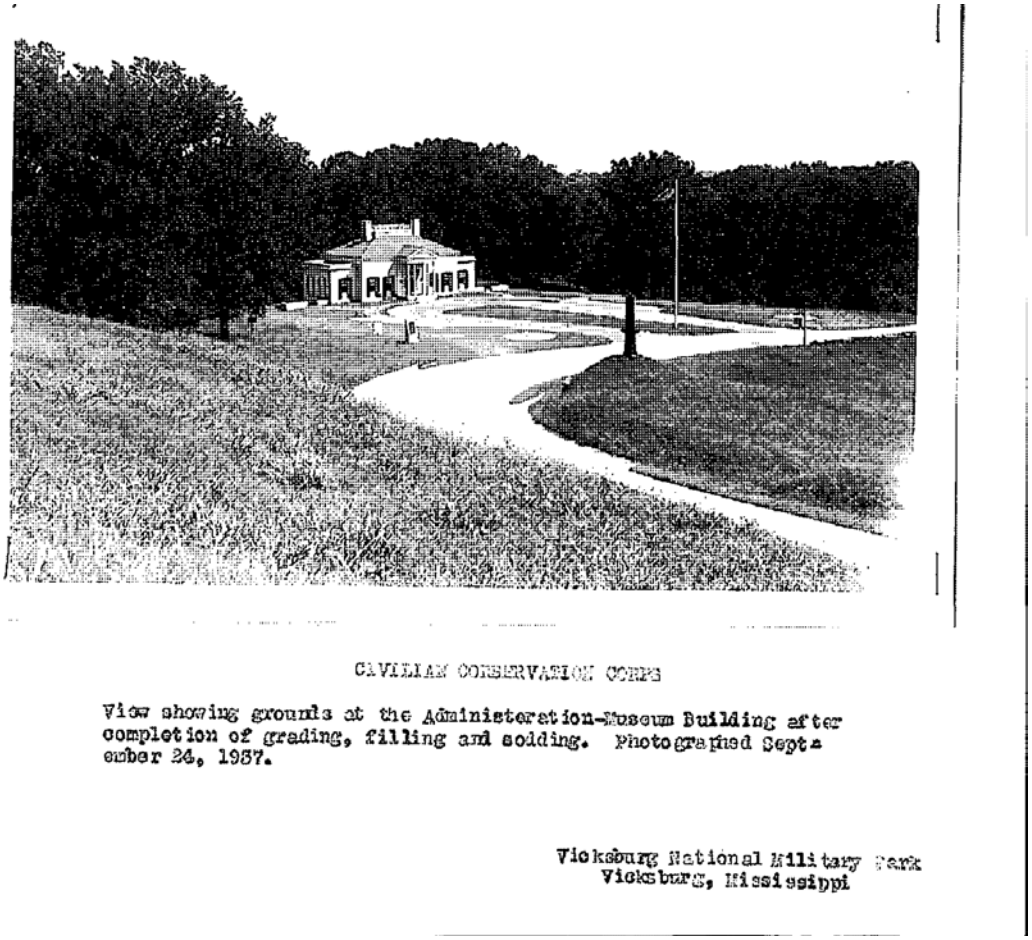


Figure 14. View of park Administration Building/Museum along Pemberton Avenue and surrounding landscape with mature forest in September1937 (archived photograph from National Park Service (undated)).

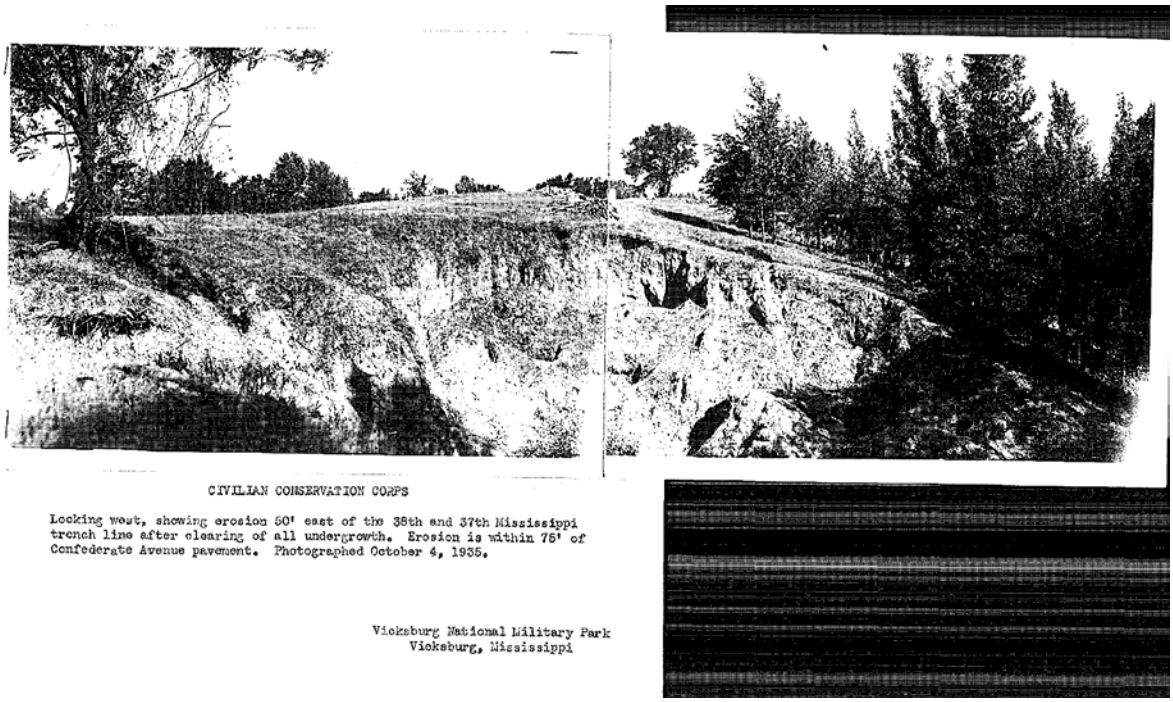


Figure 15. View of Civilian Conservation Corps erosion control project at Vicksburg National Military Park in October 1935 (archived photograph from National Park Service (undated).

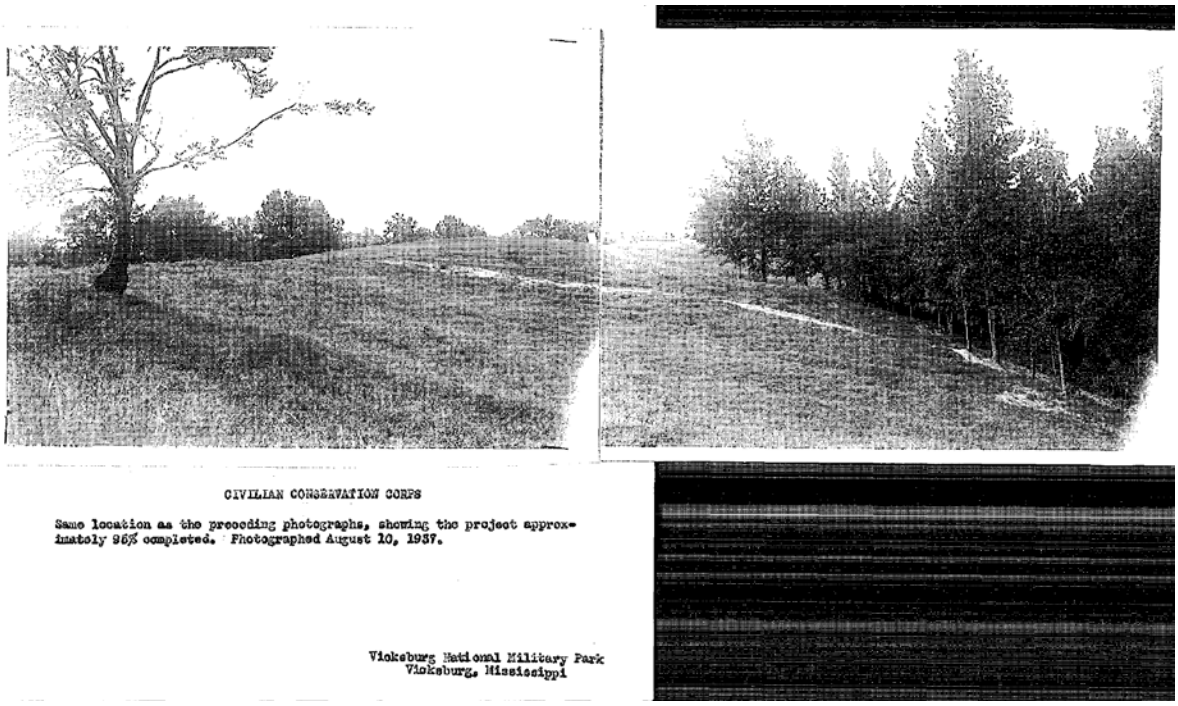


Figure 16. Same view of Civilian Conservation Corps erosion control project at Vicksburg National Military Park (as in Figure 15) in August 1937 (archived photograph from National Park Service (undated).

-It seems unlikely that at least some forest stands would not reclaim substantial areas of what is now VICK in the nearly 80 years between the Civil War and CCC era, after the need to manage vegetation for military defense purposes had ceased.

-Although the composition of VICK forests is said to be greatly influenced by CCC activities, forests of similar tree species composition can be observed on loess soils along the Natchez Trace Parkway.

-The composition of many of the forests of VICK is quite diverse, with a number of species important species. This is suggestive of natural recruitment; for tree planting efforts, it is often impractical to impossible for the planters to obtain many species.

Noting that terrestrial vegetation and related vital signs are an element of the GULN monitoring plan (Segura et al. 2007), we recommend that the findings of this inventory be considered as that plan is implemented. Specifically for VICK, monitoring data might be able to resolve the issue of how much of the current mesophytic forest composition is due to natural factors as opposed to past land management. More specifically, to what degree do the "bottomland" or "early successional" species that currently prevail in the mixed mesophytic forests of VICK, replace themselves relative to the species more widely accepted as "upland" or "late successional" species? The data from this inventory may help to specify monitoring (and, ultimately, management) targets.

4.3 Application #2: Estimation of Invasive Non-native Plant Species Abundance

Segura et al. (2007) listed invasive species as a major management issue for VICK. Using the same estimation methods as described above for forest tree abundance, we can make an estimate of the abundance (canopy cover) of non-native (including invasive) plant species, as documented by plots, for forests (Table 9) and all vegetated habitats (Table 10). As with the tree abundance estimates, we draw attention to the same caveats about inferring a large degree of precision with these estimates. Additionally, with the non-native species, there may be some biases in the plot data, including that the plots were placed away from transitional forest edges, where invasive non-native species might be more abundant. For drawing more precise estimates of individual species cover, plots estimating species cover using more precise cover estimates might be employed, using the vegetation map data to stratify the park forests. This would eliminate some sources of error (field key errors, field key interpretation errors) inherent in our methodology due to not having strata defined when we collected the classification plot data).

While the same concerns about true representativeness and sampling variability should preclude relying on these estimates as more than rough assessments, they may provide the best current assessment of which species are the most abundant non-invasive plants at VICK, and are certainly useful as an "order-of-magnitude" measure of abundance and in broad ranking of the prevalence of invasive plant species. It is almost certain that the top two species listed (Chinese privet and Japanese honeysuckle), are the most abundant non-native plant species in VICK forests and also that they cover, in aggregate, an appreciable proportion of VICK forests, while the other species, though quite frequent, are much less numerous in these forests. Such data may provide a basis for prioritizing species for management (e.g., with limited staffing, relatively frequent, but less abundant, species might be targeted as more feasible to reduce or eradicate).

Table 9. Estimated areal cover for the eight most abundant non-native plant species in forests (only) of VICK, as estimated from NPS Vegetation Inventory data.

RANK	SPECIES	COMMON NAME	ESTIMATED AREA (hectares)
1	*Ligustrum sinense*	Chinese privet	133
2	*Lonicera japonica*	Japanese honeysuckle	75
3	*Poncirus trifoliata*	hardy orange	18
4	*Broussonetia papyrifera*	paper mulberry	4
5	*Nandina domestica*	sacred bamboo	2
6	*Hedera helix*	English ivy	2
7	*Ligustrum japonicum*	Japanese privet	2
8	*Cyrtomium fortunei*	Asian netvein hollyfern	2

Table 10. Estimated areal cover for the eight most abundant non-native plant species in all vegetated areas of VICK, as estimated from NPS Vegetation Inventory data.

RANK	SPECIES	COMMON NAME	ESTIMATED AREA (hectares)
1	*Ligustrum sinense*	Chinese privet	133
2	*Lonicera japonica*	Japanese honeysuckle	77
3	*Paspalum notatum*	bahia grass	67
4	*Sorghum halepense*	Johnson grass	22
5	*Poncirus trifoliata*	hardy orange	18
6	*Schedenorus phoenix*	tall fescue	4
7	*Broussonetia papyrifera*	paper mulberry	4
8	*Nandina domestica*	sacred bamboo	2

4.4 Application #3: Improving Wetland Inventory

NPSVI maps have proven to be useful as wetland inventories or preliminary wetland determinations. They often more accurately depict probable wetland occurrences than do wetland maps delineated from small scale imagery and limited ground-truthing (Schirokauer and Parravano 2004, National Park Service 2012). Such applications require a reasonably accurate and unambiguous crosswalk between mapped vegetation types and wetland classes. For purposes of complying with Presidential Executive Order 11990 (Carter 1977), NPS wetland inventories and preliminary determinations, employ the wetland definition and the classification of Cowardin et al. (1979) (National Park Service 2012). This wetland definition generally is broader than that required for “jurisdictional” wetlands for compliance with Section 404 of the Clean Water Act) (U.S. Army Corps of Engineers 1987). Therefore, to serve as or to enhance wetland inventories, classes used for NPSVI maps must be translated (“crosswalked”), in a reasonably unambiguous manner, to the classification system of Cowardin et al. (1979).

Two mapped classes and associations for this project, the Black Willow Floodplain Forest and the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest crosswalk reasonably well with Palustrine [System], Forested [Class], Broad-leaved Deciduous [Subclass] wetlands of Cowardin et al. (1979).

The Black Willow Floodplain Forest is inundated by waters of the Yazoo Diversion Canal for weeks to months during the growing season (as was observed during this project in August 2009 and June 2010). Data from the single plot established by this study indicate a strongly hydrophytic vegetation composition, when a hydrophytic prevalence index from weighted averages of individual species indicator status (Wentworth et al. 1988, Gage and Cooper 2010) is applied (a score of 1.1, for a possible range of 1 to 5, with 3 the approximate upper limit for hydrophytic vegetation). This vegetation type clearly occurs in Palustrine Forested Broad-leaved Deciduous wetlands, and likely has seasonally flooded hydrology.

The American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest occurs at VICK along low reaches of order streams, with drainage areas on the order of several hundred to perhaps 1,000 hectares, (e.g., Glass Bayou, Mint Springs Bayou). These streams have modest gradient (10-15 meters/km) and their associated forested bottoms may or may not be flooded every year. Additionally, prevalence indices from weighted averages for the four classification plots assigned to this association show vegetation that is largely facultative (i.e., hydrophytic prevalence index scores for the plots range from 2.87-3.32, with only two of four plots scoring less than 3.00), and weakly hydrophytic, at best. However, this vegetation largely corresponds to the giant cane – sycamore riverine wetland community of Kovalenko and Dibble (2007) and also includes (as a variant) the concept of the scouring rush – boxelder riverine wetland community of those authors. Kovalenko and Dibble considered both of their forested types wetland vegetation.

In using the results of this study and that of Kovalenko and Dibble (2007) for wetland management, we recommend using both for describing the floristic composition of wetlands at VICK. Our description of the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest (Appendix A, including Table A7) is based on four plots and may not have captured as many of the wetter stand expressions of this type as did Kovalenko and Dibble (2007). On the other hand, Kovalenko and Dibble (2007) did not describe (although they clearly visited and mapped) the second largest wetland type at VICK, the Black Willow Floodplain Forest. Each study described small patch (i.e., not mappable using remote sensing methods) community types that the other did not, including forested seepage wetlands of Kovalenko and Dibble (2007) and the Sand Spikerush Herbaceous Vegetation, a non-forested vegetation type observed during this study (Appendix A).

While neither the map created by this study (NPSVI/USGS) nor that created by Kovalenko and Dibble (2007) is without errors in mapping hydrophytic vegetation types at VICK, comparison of the two maps using the accuracy assessment data collected for this study suggest that the map produced for this study (NPSVI/USGS) map more accurately distinguishes wetland vegetation from non-wetland vegetation. In this comparison, we assume that one of the three wetland indicators of Cowardin et al. (1979), wetland soils, will never be present without hydrophytic or near-hydrophytic vegetation. This assumption is largely supported by Kovalenko and Dibble (2007), who found soil and hydrology indicators somewhat inconclusive in their two riverine forested wetland types.

Kovalenko and Dibble (2007) mapped approximately 184 hectares of wetlands at VICK (nearly 25% of the park), while this study mapped about 28 hectares of wetland vegetation (i.e., the combined areas of the Black Willow Floodplain Forest and the American Sycamore – Sweetgum – Boxelder Small Stream

Bottom Forest). The true area of these types, as calculated from producer's accuracy as stratified by NPSVI/FORT map classes, is estimated to be 54 hectares (there is some uncertainty associated with this estimate). Therefore, the Kovalenko and Dibble (2007) map may overestimate wetland vegetation at VICK by about 130 hectares, while the map produced by this study may undermap it by an estimated 26 hectares. To put this comparison in another perspective, there were 19 instances where an observation of non-wetland vegetation fell in an area mapped as wetlands by Kovalenko and Dibble (2007) (i.e., an error of commission), compared to one instance in which an observation of wetland (or potentially wetland) vegetation fell in an area mapped as non-wetland (i.e., an error of omission). In comparison, for the NPSVI/USGS map, there were five individual observations that were errors of commission for wetland and three errors of omission. While the estimated areas of overmapping or undermapping are dependent on the size of the classes in which the errors occur, rather than on absolute error counts (see Lea and Curtis 2010), the balance of errors suggests less directional bias (toward overmapping or undermapping) in the NPSVI/USGS map.

Additionally, it may be that the accuracy assessment of 54 hectares for the two forested wetland associations may be somewhat high for true wetland vegetation, and, thus, that the NPSVI/USGS map area estimate may be closer to the true areas. Our concept of the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest used during the accuracy assessment includes stands that do not have hydrophytic (i.e., a prevalence index < 3.00) vegetation, and the type as a whole is not strongly hydrophytic. Non-hydrophytic stands of this type, usually on lower gentle slopes, rather than on flat bottoms, are unlikely to have wetland soil indicators, as well (per Cowardin et al. (1979), hydrology is not considered where soil is present).

In summary, we recommend the descriptive information of both studies as being useful for wetland management (as each contains some information missing in the other), but the NPSVI/USGS map as more accurate for spatial discrimination of wetlands from non-wetlands. The vegetation polygons of this map are attributed with most likely Cowardin et al. (1979) classification unit.

4.5 Future Mapping

As with most NPSVI projects, much is learned about how one might further improve the mapping accuracy by the time the project approaches a point of diminishing returns and must be completed. We offer some guidance to future attempts that might be made to update and/or improve the map, using the classification established.

Assuming that a major objective would be to improving the overall association level accuracy, using the vegetation types described in this report, three mapping error combinations account for about 90% of all incorrectly mapped areas at the association level (39.4% of all mapped areas at VICK). These combinations can be identified as having the largest off-diagonal proportions in the population contingency table (Table D2). Attention to these would yield the greatest accuracy gains.

The largest source of the reported mapping error, representing an estimated 63% of all mapping errors (about 25% of the Table D2 total), is confusion between the two mature (and most abundant) upland forest associations, the mesic Sweetgum – Chinkapin Oak - Water Oak Forest and the dry-mesic Cherrybark Oak – Water Oak Forest. Subsection 2.2.5 describes our modestly successful methods for differentiating between the two types by hillshade modeling. A more

sophisticated modeling effort, perhaps incorporating slope shape (convex/concave) and site drainage area, might more successfully differentiate the two types. We also speculate that early season imagery might help differentiate the two by taking advantage of the tendency of the leaves of oaks (*Quercus* spp.), which are a more abundant component of the Cherrybark Oak – Water Oak Forest to expand later in the spring than most other tree species. Such an effort will likely require a large number of calibration sites. The differential criteria employed by the field key appear to be fairly reliable, but these could be further tested for correlation to site to accommodate unusual or successional expressions of the two associations.

An estimated 15% of the reported mapping error (about 6% of Table D2 total) is confusion between the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest and the Sweetgum – Chinkapin Oak - Water Oak Forest. As discussed in Section 4.4, t accuracy assessment estimated the former type to be undermapped relative to the latter, but this is likely an artifact of the much larger area of the latter type. We believe the environmental setting parameters used for mapping the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest, described in Subsection 2.2.4, to be fairly accurate. Some accuracy assessment errors are likely "false errors," caused by gaps in knowledge of differential species, in turn caused by light and somewhat inadequate sampling of the range of expressions of the American Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest. We noted that additional, but inconstant, differential species, such as *Populus deltoides* (eastern cottonwood) may help to improve the accuracy of the field key. Also, future modeling might seek to better establish the upstream limits of this type; in steeper, upper reaches of small streams, it is eventually largely replaced by the Sweetgum – Chinkapin Oak - Water Oak Forest.

About 11% of the reported mapping error (about 4% of Table D2 total) is confusion between Bahia Grass Herbaceous Vegetation and the Old Field Wooded Herbaceous Vegetation. The former occurs in a regularly mowed ("lawn") setting, whereas the latter occurs in infrequently mowed settings and is the less abundant of the two types at VICK. This project had relatively little opportunity to calibrate signatures of these two types, which are undoubtedly different. Calibration observations made well into or late in the growing season within the parent unit of these associations, the Southeastern Old Field Group, would likely enable differentiation.

Literature Cited

Braun, E. L. 1950. Deciduous forests of eastern North America. 1964 reprint. Hafner Press, New York, NY, USA.

Carter, J. 1977. Executive Order 11990. Protection of wetlands. 42: 26961. Federal Register, Washington, DC, USA.

Chapman, S. S, G. E. Griffith, J. M. Omernik, J. A. Comstock, M.C. Beiser, and D. Johnson. 2004. Ecoregions of Mississippi, (color poster with map, descriptive text, summary tables, and photographs, map scale 1:1,000,000). U.S. Geological Survey, Reston VA, USA.

Cole, W. A. and R. C. Carter. 1964. Soil survey of Warren County, Mississippi. Series 1961, No. 9. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with The Mississippi Agricultural Experiment Station. U.S. Government Printing Office, Washington, DC, USA.

Cooper, R. J, S. B. Cederbaum, and J. J. Gannon. 2004. Natural Resource Summary for Vicksburg National Military Park (VICK). Report to National Park Service. Warnell School of Forest Resources, University of Georgia, Athens, GA, USA.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Dice, L. R. 1943. The biotic provinces of North America. University of Michigan Press, Ann Arbor, MI, USA.

Faber-Langendoen, D., J. Drake, S. Gawler, M. Hall, G. Kittel, S. Menard, C. Nordman, M. Pyne, M. Reid, L. Sneddon, K. Schulz, J. Teague, M. Russo, K. Snow, P. Comer. 2011. Macrogroups and groups for the revised U.S. National Vegetation Classification (lower 48 states) + appendices. Report to the National Park Service and LANDFIRE. NatureServe, Arlington, VA, USA. (content partially available at http://usnvc.org).

Federal Geographic Data Committee. 1997. Vegetation Subcommittee. Vegetation Classification Standard. FGDC-STD-005. Federal Geographic Data Committee, U.S. Geological Survey, Reston, VA, USA. (http://www.fgdc.gov/standards/documents/standards/vegetation/vegclass.pdf).

Federal Geographic Data Committee. 2008. Vegetation Subcommittee. National Vegetation Classification Standard, Version 2. FGDC-STD-005-2008. Federal Geographic Data Committee, U.S. Geological Survey, Reston, VA, USA.

Gage, E. and D. J. Cooper. 2010. Vegetation sampling for wetland delineation: a review and synthesis of methods and sampling issues. Report to U.S. Army Corps of Engineers. Colorado State University, Fort Collins, CO, USA.

Irish, R., T. Winschel, and S. R. Allen. 2002. Confederate Avenue bridge removal, Vicksburg National Military Park, Vicksburg, Mississippi. U.S. Department of the Interior, National Park Service, Vicksburg National Military Park, Vicksburg, MS, USA.

Jennings, M. D., D. Faber-Langendoen, O.L. Loucks, R. K. Peet, and D. Roberts. 2009. Standards for associations and alliances of the U.S. National Vegetation Classification. Ecological Monographs 79: 173-199

Kartesz, J.T., The Biota of North America Program (BONAP). 2011. *North American Plant Atlas* (http://www.bonap.org/MapSwitchboard.html). Chapel Hill, N.C.

Keiser, E. D. 2002. Survey of the amphibians and reptiles of Vicksburg National Military Park. Report to National Park Service. Ecological Consulting, Oxford, MS, USA.

Kovalenko, K. and E. Dibble. 2007. Vicksburg National Military Park Wetland Delineation. Report to the National Park Service, Gulf Coast Network. Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS, USA.

Lea, C. 2011. Vegetation classification guidelines: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/NRPC/NRR—2011/374. National Park Service, Fort Collins, CO, USA. (http://science.nature.nps.gov/im/inventory/veg/guidance.cfm).

Lea, C. and A. C. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/NRPC/NRR—2010/204. National Park Service, Fort Collins, CO, USA. (http://science.nature.nps.gov/im/inventory/veg/guidance.cfm).

McCune, B. and J.B. Grace. 2002. Analysis of ecological communities. MjM Software Design, Gleneden Beach, OR, USA.

McCune, B. and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data, version 4.0. [software application]. MjM Software Design, Gleneden Beach, OR, USA.

McLaughlin, S. P. 2007. Tundra to tropics: the floristic plant geography of North America. Sida, Botanical Miscellany No. 30. Botanical Research Institute of Texas, Fort Worth, TX, USA.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York, NY, USA.

National Park Service. Undated. Vicksburg National Military Park File No. 503. Monthly reports of the Civilian Conservation Corps. 1936-1937. Vicksburg National Military Park, Vicksburg, MS, USA.

National Park Service. 2006. 2006 Management Policies. National Park Service, Washington, DC, USA.

National Park Service. 2008. Alaskapak v2.2 for ArcGIS 9.x. Software application. (http://science.nature.nps.gov/im/gis/alaskapak.cfm).

National Park Service. 2009. The National Parks: Index 2009–2011. Revised July 2009. National Park Service Office of Public Affairs and Harpers Ferry Center, U.S. Department of the Interior, Washington, DC, USA. (http://www.nps.gov/history/history/online_books/nps/index2009_11.pdf).

National Park Service. 2012. National Park Service procedural manual #77-1: wetland protection. National Park Service Water Resource Division, Fort Collins, CO, USA. (http://nature.nps.gov/water/policies/policies.cfm).

Natural Resources Conservation Service. 2013. Official Soil Series Descriptions. Soil Survey Staff, United States Department of Agriculture. Available online at http://soils.usda.gov/technical/classification/osd/index.html. Accessed [2/17/2013].

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA, USA. [Available: http://www.natureserve.org/explorer].

Peet, R. K., T. R. Wentworth, and P. S. White. 1998. The North Carolina Vegetation Survey protocol: a flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262-274.

Rangoonwala, A., E. Ramsey III, and S. LaFontaine. 2007. The Vicksburg National Military Park landcover map: Based on the National Vegetation Classification System and high spatial resolution image data. Agreement number 14431A53200000. Final Report. IAP World Services Inc. and U.S. Geological Survey, National Wetlands Research Center, Lafayette, LA, USA.

Schirokauer, D. and A. Parravano. 2004. Enhanced wetlands mapping and inventory in Point Reyes National Seashore and Golden Gate National Recreation Area. Park Science 23(1): 34-40.

Segura, M., R. Woodman, J. Meiman, W. Granger, and J. Bracewell. 2007. Gulf Coast Network Vital Signs Monitoring Plan. Natural Resource Report NPS/GULN/NRR–2007/015. National Park Service, Fort Collins, CO, USA.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed September 20, 2011.

The Nature Conservancy and Environmental Systems Research Institute. 1994. Field Methods for Vegetation Mapping: USGS/NPS Vegetation Mapping Program. Report prepared for the U.S. Geological Survey and National Park Service, Redlands, CA Santa Barbara, CA, and Arlington, VA, USA. (http://biology.usgs.gov/npsveg/standards/fieldmethodsrpt.pdf).

Udvardy, M. D. F. 1975. World biogeographic provinces. IUCN Occasional Paper No. 18.

U.S. Army Corps of Engineers. 1987. Corps of Engineers wetland delineation manual. Technical Report Y-87-1. Environmental Laboratory, Army Corps of Engineers, Vicksburg, MS, USA.

Walker, S. A. 1997. The vascular flora of Vicksburg National Military Park, Vicksburg, Mississippi. The Nature Conservancy, MS, USA.

Wentworth, T. R, G. P. Johnson, and R. L. Kologiski. 1988. Designation of wetlands by weighted averages of vegetation data – a preliminary evaluation. Water Resources Bulletin 24(2): 389-396.

Appendix A. Descriptions of Vegetation Associations

DESCRIPTIONS OF DATA FIELDS:
USNVC CLASSIFICATION: current placement of the association within the USNVC hierarchy (from NatureServe 2007, Faber-Langendoen et al. 2011 (http://usnvc.org)).
ASSOCIATION CONCEPT (from NatureServe 2007).
A diagnostic summary of the association concept across its known range.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: If applicable, wetland System, Class, Subclass, and the most likely water regime modifier. For purpose of compliance with Executive Order 11990, the NPS defines wetlands in the sense of Cowardin et al. (1979). No jurisdictional wetland delineations (Environmental Laboratory 1987) were done as part of this project.
Vicksburg National Military Park Environment: A description of the environmental setting, and, if applicable, the specific range, of the association at VICK (from field observations).
Global Environment: A description of the environmental setting of the association across its known range (from NatureServe 2007).

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: A description of the floristic composition of the association at VICK (from field observations, including classification plot data).
Global Vegetation: A description of the floristic composition of the association across its known range (from NatureServe 2007).
Synthesis Table: Table of constancy (frequency of occurrence) and mean and range of abundance (canopy cover) across all classification plots for each of the most constant plant species recorded in the plots from VICK that are assigned to that association.
CONSERVATION STATUS RANK: Association status in an ordinal ranking system of global rarity/vulnerability (1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure, GNA = no conservation rank assigned) (from NatureServe 2007).
CLASSIFICATION COMMENTS: Notes on classification issues, if any, either across the global range of the association or in the application of an association concept at VICK (from NatureServe 2007 and local observations).

ASSOCIATION DISTRIBUTION (from NatureServe 2007).
Global Range: A description of the known range of the association.
States/Provinces: A list of U.S. states and Canadian provinces in which the association is known or believed to occur.
Federal Lands: A list of federal agency land management areas in which the association is known to occur.

GLOBAL DESCRIPTION SOURCES (from NatureServe 2007).
Global Description Authors: Person who wrote global description.
References: A list of references that describe the association or similar vegetation.

PARK NAME: LOBLOLLY PINE PLANTED WOODLAND

USNVC CLASSIFICATION
USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Warm Temperate Forest (1.C.1)
USNVC Division: Southeastern North American Warm Temperate Forest (D006)
USNVC MacroGroup: Southeastern North American Ruderal Forest & Plantation (M305)
USNVC Group: Southeast Conifer & Hardwood Plantation Group (G029)
USNVC Alliance: *Pinus taeda* Planted Forest Alliance (A.99)
USNVC Alliance (English name): Loblolly Pine Planted Forest Alliance
USNVC Association: *Pinus taeda* Planted Forest (CEGL007179)
USNVC Association (English name): Loblolly Pine Planted Forest
USNVC Association (Common name): Loblolly Pine Plantation

ASSOCIATION CONCEPT
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
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This association occurs in a small area, at Sherman Circle, in the northeast part of VICK, where it has apparently been established by planting. Unlike most stands covered in the global concept, it was established for ornamental, recreational and/or memorial purposes, rather than for forestry.
Global Environment: No information.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: The single stand at VICK varies from most of the global concept, in that it is an open woodland, rather than a closed canopy forest, with a partial canopy of *Pinus taeda* (loblolly pine) and *Juniperus virginiana* (eastern redcedar), over a regularly mowed lawn

comprised mostly of *Paspalum notatum* (Bahia grass), with *Digitaria filiformis* (slender crabgrass) also present. The management promotes low species diversity; the woody species *Ulmus alata* (winged elm), *Parthenocissus quinquefolia* (Virginia creeper), *Lonicera japonica* (Japanese honeysuckle), *Smilax bona-nox* (saw greenbrier), *Smilax glauca* (cat greenbrier), *Toxicodendron radicans* (eastern poison-ivy), and *Vitis cinerea* (graybark grape) and the herbaceous species *Carex cherokeensis* (Cherokee sedge), *Lactuca floridana* (woodland lettuce), basketgrass (*Oplismenus hirtellus*), *Oxalis dillenii* (slender yellow woodsorrel), and *Viola sororia* (common blue violet were observed (Table A1).

Table A1. Synthesis table for all plant species recorded in Loblolly Pine Planted Woodland at Vicksburg National Military Park (# plots=1; VICK.39).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
Pinus taeda	loblolly pine	Tree	100%	25-50
Juniperus virginiana	eastern redcedar	Tree	100%	10-25
Ulmus alata	winged elm	Shrub	100%	trace -1
Parthenocissus quinquefolia	Virginia creeper	Vine	100%	2-5
*Lonicera japonica**	Japanese honeysuckle	Vine	100%	trace -1
Smilax bona-nox	saw greenbrier	Vine	100%	trace -1
Toxicodendron radicans	eastern poison-ivy	Vine	100%	trace -1
Vitis cinerea	graybark grape	Vine	100%	trace -1
*Paspalum notatum**	bahia grass	Herb	100%	50-75
Digitaria filiformis	Slender crabgrass	Herb	100%	5-10
Viola sororia	common blue violet	Herb	100%	1-2
Oplismenus hirtellus	basketgrass	Herb	100%	trace -1
Carex cherokeensis	Cherokee sedge	Herb	100%	trace
Lactuca floridana	woodland lettuce	Herb	100%	trace
Oxalis dillenii	slender yellow woodsorrel	Herb	100%	trace
Smilax glauca	cat greenbrier	Herb	100%	trace

* - non-native species 1 – range of cover class value for plot (all strata totaled)

Global Vegetation: 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* (hillside 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* (supplejack), *Vitis* (grape) spp., *Smilax* (greenbrier) spp., 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 spikegrass),

Schizachyrium scoparium (little bluestem), *Danthonia spicata* (poverty oatgrass), *Tephrosia virginiana* (goat's-rue), *Lespedeza* (bushclover) spp., *Symphyotrichum patens* (late purple aster), *Eupatorium* (boneset, Joe-pyeweed, thoroughwort) spp., and others. In Oklahoma, associates include *Rhus copallinum* (winged sumac), *Hypericum densiflorum* (bushy St. John's-wort), *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).

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (cultural) (8-Aug-2000). 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 COMMENTS

At Arnold Air Force Base, Coffee and Franklin counties, Tennessee, *Pinus taeda* 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* plantations. *Pinus taeda* 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* 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* Forest Alliance (A.130). Plantations occur in obvious rows in the aerial photos of the Delmarva Peninsula in Maryland.

ASSOCIATION DISTRIBUTION

Global Range: This association is found throughout the southeastern United States.
States/Provinces: AL, AR, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA (?)
Federal Lands: Department of Defense (Arnold, Fort Benning, Fort Bragg, Fort Gordon, Fort Stewart); Department of Energy (Savannah River Site); National Park Service (Chickamauga-Chattanooga(?), Natchez Trace Parkway, Obed, Vicksburg); U.S. Forest Service (Angelina, Bankhead(?), Bienville, Cherokee, Conecuh, Croatan, Davy Crockett, De Soto, Delta, Francis Marion, Kisatchie, Land Between the Lakes, Oconee, Ouachita, Ozark, Sabine NF, Sam Houston, St. Francis(?), Sumter, Talladega, Tuskegee); US Fish and Wildlife Service (Blackwater, Chesapeake Marshlands, Eufaula)

GLOBAL DESCRIPTION SOURCES

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

PARK NAME: BLACK LOCUST- PAPER MULBERRY SUCCESSIONAL FOREST

USNVC CLASSIFICATION
USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Warm Temperate Forest (1.C.1)
USNVC Division: Southeastern North American Warm Temperate Forest (D006)
USNVC MacroGroup: Southeastern North American Ruderal Forest & Plantation (M305)
USNVC Group: Southeast Hardwood & Conifer Ruderal Forest Group (G029)
USNVC Alliance: *Robinia pseudoacacia* Forest Alliance (A.256)
USNVC Alliance (English name): Black Locust Forest Alliance
NPS Association: (*Robinia pseudoacacia - Broussonetia papyrifera*) Successional Forest (NPSVICK004)
NPS Association (English name): (Black Locust – Paper Mulberry) Successional Forest
NPS Association (Common name): Black Locust – Paper Mulberry Successional Forest

ASSOCIATION CONCEPT
This is a local description for early successional, semi-natural forest forests dominated by some combination of *Robinia pseudoacacia* (black Locust) and/or *Broussonetia papyrifera* (paper mulberry) at Vicksburg National Military Park. Stands may establish on old fields or around old home sites. Associated woody species vary from site to site. Herbaceous vegetation is highly variable depending on site history and can include a number of non-native species.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This forest occurs throughout VICK, mostly on upper slopes and ridge crests which have been cleared in the recent patch. Stands are most extensive in the northern part of VICK, north of Confederate Avenue.
Global Environment: Not known.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: The tree canopy is dominated by *Robinia pseudoacacia* (black locust) (most commonly) or by the non-native *Broussonetia papyrifera* (paper mulberry). Where both species are present, *R. pseudoacacia* often comprises most of the tree canopy, over a subcanopy or tall shrub layer of *B. papyrifera*. *Acer negundo* (boxelder) is usually present. Associated tree species vary from site to site (Table A2) and include (most commonly), *Ulmus americana* (American elm), *Celtis laevigata* (sugarberry), *Ulmus rubra* (slippery elm), and *Quercus nigra* (water oak). The non-native invasive *Ligustrum sinense* (Chinese privet) and/or Broussonetia *papyrifera* (paper mulberry) may have locally high covert in the shrub layer. The most frequent and most abundant native shrubs is *Prunus caroliniana* (Carolina laurel cherry); *Arundinaria gigantea* (giant cane), *Ulmus alata* (winged elm), and *Sambucus nigra* ssp. *canadensis* (American black elderberry) are less regularly present. Woody vines are common, with the non-native *Lonicera japonica* (Japanese honeysuckle) and native *Cocculus carolinus* (Carolina coralbead) and *Parthenocissus quinquefolia* (Virginia creeper) most constant. The native *Vitis cinerea* (graybark grape), *Toxicodendron radicans* (eastern poison-ivy), *Ampelopsis arborea* (peppervine), and non-native *Hedera helix* (English ivy) also may be present. The herbaceous layer is

variable in composition and includes shade-tolerant forest species (more prevalent in older stands with more complete canopy closure) and heliophytic ruderal species (in more open stands), with few species highly constant. The most frequently recorded species are *Geum canadense* (white avens), *Elymus virginicus* (Virginia wildrye), *Phytolacca americana* (American pokeweed), and *Carex cherokeensis* (Cherokee sedge).

Global Vegetation: No description available.

Table A2. Synthesis table for most constant plant species recorded in Black Locust – Paper Mulberry Successional Forest at Vicksburg National Military Park (# plots=3; VICK.26, VICK.27, VICK.33, VICK.35, VICK.37).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Robinia pseudoacacia	black locust	Tree	100%	34% (1-95)
Acer negundo	boxelder	Tree	80%	7% (0-25)
*Broussonetia papyrifera**	paper mulberry	Tree	60%	44% (0-100)
Ulmus americana	American elm	Tree	40%	8% (0-50)
Celtis laevigata	sugarberry	Tree	40%	8% (0-50)
Ulmus rubra	slippery elm	Tree	40%	4% (0-25)
Quercus nigra	Water oak	Tree	40%	1% (0-5)
*Ligustrum sinense**	Chinese privet	Shrub	80%	25% (0-95)
Prunus caroliniana	Carolina laurel cherry	Shrub	80%	6% (0-25)
Arundinaria gigantea	giant cane	Shrub	40%	11% (0-50)
Ulmus alata	winged elm	Shrub	40%	1% (0-5)
Sambucus nigra	black elderberry	Shrub	40%	0.2% (0-1)
*Lonicera japonica**	Japanese honeysuckle	Vine	80%	3% (0-10)
Cocculus carolinus	Carolina coralbead	Vine	80%	1% (0-5)
Parthenocissus quinquefolia	Virginia creeper	Vine	60%	1% (0-5)
Vitis cinerea	graybark grape	Vine	40%	2% (0-10)
Toxicodendron radicans	eastern poison-ivy	Vine	40%	2% (0-10)
Ampelopsis arborea	peppervine	Vine	40%	2% (0-10)
*Hedera helix**	English ivy	Vine	40%	0.2% (0-1)
Geum canadense	white avens	Herb	60%	0.3% (0-1)
Elymus virginicus	Virginia wildrye	Herb	40%	2% (0-10)
Phytolacca americana	American pokeweed	Herb	40%	0.2% (0-1)
Carex cherokeensis	Cherokee sedge	Herb	40%	0.1% (0-1)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

CONSERVATION STATUS RANK

None (ruderal).

CLASSIFICATION COMMENTS

This local type was originally segregated into a component with *Robinia pseudoacacia* (black locust) dominant in the canopy and a component with *Broussonetia papyrifera* (paper mulberry) dominant in the

canopy, with the former expression significantly more abundant at VICK. Both expressions share a similar environmental setting and a number of floristic components at VICK, and dense understory stands of the invasive tree *Broussonetia papyrifera* can occur in either expression. Additionally, the USNVC *Robinia pseudoacacia* Forest (CEGL007279) is applied over a large geographic area in the eastern United States, most of which does not represent conditions in southern Mississippi. We found no reliable way to differentiate the two expressions in mapping. Therefore, it seemed practical for management to describe a single early successional forest type that can have *R. pseudoacacia*, *B. papyrifera*, or both, as a dominant tree. This is the only forest type at VICK in which the invasive *B. papyrifera* was seen to attain dominance.

ASSOCIATION DISTRIBUTION
Global Range: Unknown.
States/Provinces: MS
Federal Lands: National Park Service (Vicksburg).

PARK NAME: BOXELDER SUCCESSIONAL UPLAND FOREST

USNVC CLASSIFICATION
USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Warm Temperate Forest (1.C.1)
USNVC Division: Southeastern North American Warm Temperate Forest (D006)
USNVC MacroGroup: Southeastern North American Ruderal Forest & Plantation (M305)
USNVC Group: Southeast Hardwood & Conifer Ruderal Forest Group (G029)
USNVC Alliance: unknown
NPS Association: *Acer negundo - (Liriodendron tulipifera)* Successional Upland Forest (NPSVICK001)
NPS Association (English name): Boxelder – (Tulip Tree) Successional Upland Forest
NPS Association (Common name): Boxelder Successional Upland Forest

ASSOCIATION CONCEPT
As there is no USNVC association that describes boxelder-dominated upland vegetation, this local description is a placeholder for early successional forests and shrublands dominated by *Acer negundo* (boxelderon uplands, rather than floodplain settings. Occasionally, *Liriodendron tulipifera* (tulip tree) is co-dominant. This vegetation is usually associated with vegetation recovery following recent land clearing on nutrient-rich soils in the eastern and central United States.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: At VICK, stands are scattered in small patches throughout the park on middle to lower slopes and occasionally on small stream bottoms that have been cleared in the recent past.
Global Environment: Incompletely known but presumably on uplands with nutrient-rich soils that have been cleared in the recent past (e.g., old fields being invaded by boxelder).

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: At VICK, the physiognomy of this vegetation ranges from closed canopy forests to tall shrublands, dominated by even-aged *Acer negundo* (boxelder), and occasionally co-dominated by *Liriodendron tulipifera* (tuliptree). The plots used to derive the synthesis table (Table A3) underestimate the contribution of *Acer negundo*, relative to that of *Liriodendron tulipifera*, throughout VICK. Other [usually early successional] tree species may be present, but are usually at low cover. The most constant and abundant shrubs are *Arundinaria gigantea* (giant cane) and the non-native *Ligustrum sinense* (Chinese privet). Vines are common and variable in species composition, with *Vitis cinerea* (graybark grape) and the non-native *Lonicera japonica* (Japanese honeysuckle) and *Hedera helix* (English ivy) most constant. Herbaceous species composition is very variable; the ferns *Athyrium filix-femina ssp. asplenioides* (southern ladyfern), *Cystopteris protrusa* (lowland bladder fern), *Cyrtomium fortunei* (Asian netvein hollyfern), and the forb *Ageratina altissima* (white snakeroot) were most constant. *Thelypteris kunthii* (Kunth's maiden fern) contributed high cover in one plot.
Global Vegetation: No description available.

Table A3. Synthesis table for most constant plant species recorded in Boxelder Successional Upland Forest at Vicksburg National Military Park (# plots=2; VICK.15, VICK.66).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Liriodendron tulipifera	tuliptree	Tree	100%	38% (25-50)
Acer negundo	boxelder	Tree	100%	36% (25-50)
Liquidambar styraciflua	sweetgum	Tree	50%	9% (1-25)
Populus deltoides	eastern cottonwood	Tree	50%	9% (1-25)
Acer rubrum	red maple	Tree	50%	4% (0-10)
*Albizzia julibrissin**	parasol tree	Tree	50%	2% (0-10)
Fraxinus americana	white ash	Tree	50%	4% (0-10)
Quercus michauxii	swamp chestnut oak	Tree	50%	4% (0-10)
Quercus nigra	water oak	Tree	50%	2% (0-10)
Arundinaria gigantea	giant cane	Shrub	100%	9% (0.1-25)
*Ligustrum sinense**	Chinese privet	Shrub	100%	4% (2-5)
Asimina triloba	common pawpaw	Shrub	50%	4% (0-10)
Callicarpa americana	American beautyberry	Shrub	50%	0.8% (0-2)
Morus rubra	red mulberry	Shrub	50%	0.8% (0-2)
Ulmus americana	American elm	Shrub	50%	0.8% (0-2)
*Hedera helix**	English ivy	Vine	100%	5% (1-10)
Vitis cinerea	graybark grape	Vine	100%	3% (1-5)
*Lonicera japonica**	Japanese honeysuckle	Vine	100%	2% (0.1-5)
Toxicodendron radicans	eastern poison-ivy	Vine	50%	4% (0-10)
Parthenocissus quinquefolia	Virginia creeper	Vine	50%	2% (0-10)
Passiflora lutea	yellow passionflower	Vine	50%	0.8% (0-2)
Vitis rotundifolia	muscadine grape	Vine	50%	0.8% (0-2)
*Cyrtomium fortunei**	Asian netvein hollyfern	Herb	100%	9% (0.1-25)
Athyrium filix-femina	common lady fern	Herb	100%	4% (2-5)
Cystopteris protrusa	lowland bladder fern	Herb	100%	2% (0.1-5)
Ageratina altissima	white snakeroot	Herb	100%	0.5% (trace-1)
Thelypteris kunthii	Kunth's maiden fern	Herb	50%	19% (0-50)
Boehmeria cylindrica	smallspike falsenettle	Herb	50%	0.8% (0-2)
Diplazium pycnocarpon	glade fern	Herb	50%	0.8% (0-2)
Polystichum acrostichoides	Christmas fern	Herb	50%	0.8% (0-2)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

CONSERVATION STATUS RANK

Not ranked.

CLASSIFICATION COMMENTS

Most forests dominated by *Acer negundo* at VICK are early successional upland stands that are not closely to forests dominated by *Acer negundo* that occur in floodplain settings (e.g., CEGL05033). Such early successional upland stands are fairly wide-ranging in the eastern and central United States. Within recognized USNVC associations, the vegetation at VICK described here probably is most closely

analogous to the USNVC *Liriodendron tulipifera – Acer (negundo, rubrum) / Asimina triloba* Forest (CEGL007184), but the description for that type is from the Appalachian and mid-Atlantic regions and for stands that occur primarily on floodplains. Rather than make a crosswalk of the vegetation at VICK to a concept that does not represent the situation at VICK, we follow NPS guidelines (Lea 2011) in recognizing this vegetation as a local expression of a concept that can be applied to a vegetation type over a larger range, but that is not yet addressed well by the USNVC. Since all USNVC alliance concepts are under review at the time of this report, no alliance membership is suggested.

ASSOCIATION DISTRIBUTION

Global Range: Not known, since the limits of this concept are not known. If described broadly as early successional forests, woodlands, and shrublands in non-floodplain settings that are dominated by *Acer negundo*, the type is likely to be widespread in the eastern and central United States.

States/Provinces: MS

Federal Lands: National Park Service (Vicksburg).

PARK NAME: SWEETGUM SUCCESSIONAL FOREST

USNVC CLASSIFICATION
USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Warm Temperate Forest (1.C.1)
USNVC Division: Southeastern North American Warm Temperate Forest (D006)
USNVC MacroGroup: Southeastern North American Ruderal Forest & Plantation (M305)
USNVC Group: Southeast Hardwood & Conifer Ruderal Forest Group (G029)
USNVC Alliance: *Liquidambar styraciflua* Forest Alliance (A.234)
USNVC Alliance (English name): Sweetgum Forest Alliance
USNVC Association: *Liquidambar styraciflua* Forest (CEGL007216)
USNVC Association (English name): Sweetgum Forest
USNVC Association (Common name): Successional Sweetgum Forest

ASSOCIATION CONCEPT
This early-successional upland forest results from succession following human activities, such as logging and clearing. Stands are dominated by *Liquidambar styraciflua* (Sweetgum), often present as many dense, even-aged saplings or pole-sized trees, sometimes to the exclusion of other species.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: These forests occur in small patches in areas that have been cleared in the recent past, on the upper slopes throughout the park.
Global Environment: This association is found in uplands that have been heavily impacted by agriculture or other severe disturbances and are recovering.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: In the single stand observed at VICK, sapling *Liquidambar styraciflua* (sweetgum) was a strongly dominant tree (Table A4). *Quercus pagoda* (cherrybark oak) and *Liriodendron tulipifera* (tuliptree) contributed less, but substantial, cover. Tree species contributing lesser amounts of cover included *Celtis laevigata* (sugarberry), *Morus rubra* (red mulberry), *Quercus nigra* (water oak), *Quercus michauxii* (swamp chestnut oak), *Acer negundo* (boxelder), *Ulmus rubra* (slippery elm), and *Fraxinus americana* (white ash) were present at lower cover. Native shrubs were represented by *Arundinaria gigantea* (giant cane), *Asimina triloba* (common pawpaw), *Lindera benzoin* (northern spicebush), *Ulmus americana* (American elm), *Euonymus americanus* (bursting-heart), *Hydrangea quercifolia* (oakleaf hydrangea), *Carya cordiformis* (bitternut hickory), *Cercis canadensis* (eastern redbud), and *Sambucus canadensis* ssp. *nigra* (American black elderberry). Native vines included *Clematis virginiana* (devil's darning-needles), *Smilax tamnoides* (bristly greenbrier), and *Toxicodendron radicans* (eastern poison-ivy). Native herbaceous species included *Cystopteris protrusa* (lowland bladder fern), *Polystichum acrostichoides* (Christmas fern), *Asplenium platyneuron* (ebony spleenwort), *Athyrium filix-femina ssp. asplenioides* (southern lady fern), *Boehmeria cylindrica* (smallspike falsenettle), *Prunus serotina* (black cherry), and *Sanicula canadensis* (Canada blacksnakeroot). Exotic plants found in this stand included *Ligustrum sinense* (Chinese privet),

Lonicera japonica (Japanese honeysuckle), *Hedera helix* (English ivy), *Poncirus trifoliata* (hardy orange), and *Cyrtomium fortunei* (Asian netvein hollyfern).

Table A4. Synthesis table for all plant species recorded in Sweetgum Successional Forest at Vicksburg National Military Park (# plots=1; VICK.69).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
Liquidambar styraciflua	sweetgum	Tree	100%	50-75
Quercus pagoda	cherrybark oak	Tree	100%	10-25
Liriodendron tulipifera	tuliptree	Tree	100%	10-25
Celtis laevigata	sugarberry	Tree	100%	5-10
Morus rubra	red mulberry	Tree	100%	5-10
Quercus nigra	water oak	Tree	100%	5-10
Quercus michauxii	swamp chestnut oak	Tree	100%	2-5
Acer negundo	boxelder	Tree	100%	2-5
Ulmus rubra	slippery elm	Tree	100%	2-5
Fraxinus americana	white ash	Tree	100%	1-2
*Ligustrum sinense**	Chinese privet	Shrub	100%	10-25
Arundinaria gigantea	giant cane	Shrub	100%	5-10
Asimina triloba	common pawpaw	Shrub	100%	5-10
Lindera benzoin	northern spicebush	Shrub	100%	2-5
Ulmus americana	American elm	Shrub	100%	1-2
Euonymus americana	bursting-heart	Shrub	100%	1-2
Hydrangea quercifolia	oakleaf hydrangea	Shrub	100%	1-2
Carya cordiformis	bitternut hickory	Shrub	100%	1-2
*Poncirus trifoliata**	hardy orange	Shrub	100%	trace -1
Cercis canadensis	eastern redbud	Shrub	100%	trace -1
Sambucus nigra	black elderberry	Shrub	100%	trace -1
Zanthoxylum americanum	common pricklyash	Shrub	100%	trace -1
*Lonicera japonica**	Japanese honeysuckle	Vine	100%	25-50
Toxicodendron radicans	eastern poison-ivy	Vine	100%	5-10
*Hedera helix**	English ivy	Vine	100%	1-2
Clematis virginiana	devil's darning needles	Vine	100%	trace -1
Smilax tamnoides	bristly greenbrier	Vine	100%	trace -1
Cystopteris protrusa	lowland bladder fern	Herb	100%	2-5
Polystichum acrostichoides	Christmas fern	Herb	100%	trace -1
Asplenium platyneuron	ebony spleenwort	Herb	100%	trace -1
Athyrium filix-femina	southern lady fern	Herb	100%	trace -1
Boehmeria cylindrica	smallspike falsenettle	Herb	100%	trace -1
*Cyrtomium fortunei**	Asian netvein hollyfern	Herb	100%	trace -1
Prunus serotina	black cherry	Herb	100%	trace -1
Sanicula canadensis	Canada blacksnakeroot	Herb	100%	trace -1

* - non-native species 1 – range of cover class value for plot (all strata totaled)

Global Vegetation: Stands are dominated by *Liquidambar styraciflua* (sweetgum), sometimes to the exclusion of other species.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

This association currently is a member of the *Liquidambar styraciflua* Forest Alliance (A.234), along with the *Liquidambar styraciflua – Carya illinoinensis – Quercus nigra* Forest (CEGL004122). The revision of the USNVC has placed these two associations in different formations, divisions, macrogroups and groups (i.e., at four USNVC higher hierachy levels than alliance). Therefore, the alliance assignment of at least one of these associations will change, following revisions of USNVC alliances that are needed to adapt to the upper level revisions.

ASSOCIATION DISTRIBUTION

Global Range: This association may be found throughout the southeastern United States, in the coastal plains and interior ecoregions. It is also attributed to New Jersey with the merger of CEGL006927. The status in intervening states (e.g., Delaware, Maryland) needs to be assessed.
States/Provinces: AL, AR(?), GA, KY, LA, MS, NC, NJ, OK, SC, TN, VA
Federal Lands: National Park Service (Big South Fork, Chickamauga-Chattanooga(?), Cowpens, Guilford Courthouse, Kings Mountain, Mammoth Cave, Natchez Trace Parkway, Ninety Six, Shiloh, Vicksburg); U.S. Forest Service (Oconee(?), St. Francis(?)); US Fish and Wildlife Service (Great Swamp)

GLOBAL DESCRIPTION SOURCES

Global Description Authors: R. White, mod. M. Pyne
References: NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

PARK NAME: CHERRYBARK OAK- WATER OAK FOREST

USNVC CLASSIFICATION
USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Cool Temperate Forest (1.C.2)
USNVC Division: Eastern North American Cool Temperate Forest (D008)
USNVC MacroGroup: Central Mesophytic Hardwood Forest (M153)
USNVC Group: South-Central Coastal Plain Mesophytic Forest Group (G166)
USNVC Alliance: *Quercus shumardii - Quercus pagoda* Forest Alliance (A.252)
USNVC Alliance (English name): Shumard Oak - Cherrybark oak Forest Alliance
USNVC Association: *Quercus pagoda - Quercus nigra* Forest
USNVC Association (English name): Cherrybark oak - Water Oak Forest (CEGL004109)
USNVC Association (Common name): Cherrybark oak - Water Oak Loess Bluff Forest

ASSOCIATION CONCEPT
This forest is characterized by a mixed canopy generally with *Quercus pagoda* (cherrybark oak) and *Quercus nigra* (Water Oak) as codominants. High cover of *Quercus pagoda* (cherrybark oak) in an upland setting is diagnostic. It occurs on the loess bluffs of the Mississippi River area of Mississippi, especially at Vicksburg National Military Park.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This is an upland forest which occurs widely throughout VICK on mostly gentle to moderately steep upper slopes and ridge crests, generally above elevations occupied by CEGL004122. It was likely more extensive within the local area in the past (prior to the Civil War), as the park roads and cleared areas associated with them now occupy much of these landforms.
Global Environment: This forest occurs on the loess bluffs of the Mississippi River area of Mississippi, especially at Vicksburg National Military Park, Warren County, Mississippi.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: This forest is characterized by a mixed canopy generally with *Quercus pagoda* (cherrybark oak) and *Quercus nigra* (water oak) as codominants (Table A5). *Liquidambar styraciflua* (sweetgum) is also constant, but contributes generally less cover than the oaks. Less constant and lower cover canopy species include, *Ulmus rubra* (slippery elm), *Celtis laevigata* (sugarberry), *Carya illinoinensis* (pecan), *Carya cordiformis* (bitternut hickory), and *Fraxinus americana* (white ash). Relatively inconstant canopy species include *Quercus shumardii* (Shumard oak), *Sassafras albidum* (sassafras), *Pinus taeda* (loblolly pine), and *Robinia pseudoacacia* (black locust). Subcanopy trees contributing the most cover include *Ulmus rubra* (slippery elm), *Prunus serotina* (black cherry), *Morus rubra* (red mulberry), *Carya cordiformis* (bitternut hickory), *Celtis laevigata* (sugarberry), *Cercis canadensis* (eastern redbud), *Ulmus alata* (winged elm), *Ulmus americana* (American elm), *Quercus muehlenbergii* (chinkapin oak), and *Acer negundo* (boxelder). *Liriodendron tulipifera* (tuliptree), *Tilia americana* var. *caroliniana* (Carolina basswood), and *Ostrya virginiana* (eastern hophornbeam) are

Table A5. Synthesis table for most constant plant species recorded in Cherrybark Oak - Water Oak Forest at Vicksburg National Military Park (# plots=8; VICK.3, VICK.7, VICK.10, VICK.12, VICK.13, VICK.20, VICK.25, VICK.30).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Quercus nigra	water oak	Tree	100%	35% (0.1-75)
Liquidambar styraciflua	sweetgum	Tree	100%	11% (1-25)
Quercus pagoda	cherrybark oak	Tree	88%	25% (0-50)
Ulmus rubra	slippery elm	Tree	75%	9% (0-25)
Celtis laevigata	sugarberry	Tree	75%	6% (0-25)
Prunus serotina	black cherry	Tree	75%	6% (0-25)
Carya illinoinensis	pecan	Tree	63%	5% (0-10)
Morus rubra	red mulberry	Tree	63%	2% (0-10)
Carya cordiformis	bitternut hickory	Tree	50%	3% (0-25)
Ulmus americana	American elm	Tree	50%	3% (0-10)
Fraxinus americana	white ash	Tree	50%	2% (0-25)
Acer negundo	boxelder	Tree	50%	2% (0-10)
Quercus muehlenbergii	chinkapin oak	Tree	50%	2% (0-10)
*Ligustrum sinense**	Chinese privet	Shrub	100%	20% (0.1-95)
*Nandina domestica**	sacred bamboo	Shrub	100%	0.6% (0.1-2)
Ulmus alata	winged elm	Shrub	88%	6% (0-25)
Cercis canadensis	eastern redbud	Shrub	88%	4% (0-25)
Prunus caroliniana	Carolina laurel cherry	Shrub	88%	2% (0-10)
Cornus drummondii	roughleaf dogwood	Shrub	75%	4% (0-25)
Frangula caroliniana	Carolina buckthorn	Shrub	75%	4% (0-25)
Sideroxylon lycioides	buckthorn bully	Shrub	75%	1% (0-5)
Arundinaria gigantea	giant cane	Shrub	50%	3% (0-25)
Cornus florida	flowering dogwood	Shrub	50%	1% (0-5)
Diospyros virginiana	eastern persimmon	Shrub	50%	0.4% (0-2)
*Lonicera japonica**	Japanese honeysuckle	Vine	100%	11% (1-25)
Toxicodendron radicans	eastern poison-ivy	Vine	88%	20% (0-50)
Parthenocissus quinquefolia	Virginia creeper	Vine	88%	4% (0-10)
Vitis cinerea	graybark grape	Vine	75%	6% (0-25)
Vitis rotundifolia	muscadine grape	Vine	75%	2% (0-5)
Bignonia capreolata	crossvine	Vine	75%	1% (0-5)
Berchemia scandens	Alabama supplejack	Vine	50%	0.7% (0-5)
Rubus argutus	sawtooth blackberry	Vine	50%	0.6% (0-5)
Cocculus carolinus	Carolina coralbead	Vine	50%	0.4% (0-2)
Smilax glauca	cat greenbrier	Vine	50%	0.3% (0-1)
Oplismenus hirtellus	basketgrass	Herb	75%	0.4% (0-1)
Asplenium platyneuron	ebony spleenwort	Herb	75%	0.3% (0-1)
Sanicula canadensis	Canada blacksnakeroot	Herb	50%	0.1% (0-1)
Polystichum acrostichoides	Christmas fern	Herb	38%	0.3% (0-2)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

inconstant, but may also occur. An unusual stand that is considered a variant of this association that was seen along Confederate Avenue had *Celtis laevigata* (sugarberry) as a strongly dominant tree, with *Quercus nigra* (water oak) second in importance and relatively few other species contributing cover. The invasive non-native *Ligustrum sinense* (Chinese privet) an especially common shrub at VICK, sometimes dominating this layer. The non-native *Nandina domestica* (sacred bamboo) is also constant, but at lower abundance than the privet. The most frequent native shrubs include *Prunus caroliniana* (Carolina laurel cherry), *Cornus drummondii* (roughleaf dogwood), *Frangula caroliniana* (Carolina buckthorn), *Sideroxylon lycioides* (buckthorn bully), *Cercis canadensis* (eastern redbud), *Ulmus alata* (winged elm), *Arundinaria gigantea* (giant cane), *Cornus florida* (flowering dogwood), and *Diospyros virginiana* (eastern persimmon). Woody vines are common, with the non-native *Lonicera japonica* (Japanese honeysuckle) and the native *Toxicodendron radicans* (eastern poison-ivy) most constant and producing locally high cover. Other frequent native woody vines include *Parthenocissus quinquefolia* (Virginia creeper), *Vitis cinerea* (graybark grape), *Vitis rotundifolia* (muscadine grape), *Bignonia capreolata* (crossvine), *Berchemia scandens* (Alabama supplejack), *Rubus argutus* (sawtooth blackberry), *Cocculus carolinus* (Carolina coralbead), and *Smilax glauca* (cat greenbrier). *Ampelopsis arborea* (Peppervine), *Smilax bona-nox* (saw greenbrier), *Smilax tamnoides* (bristly greenbrier), *Smilax rotundifolia* (roundleaf greenbrier) and *Celastrus scandens* (American bittersweet) are less constant. The herbaceous layer of this vegetation has less cover and species richness than most other upland associations at VICK. The most constant herbaceous plants are *Oplismenus hirtellus ssp. setarius* (basketgrass), *Asplenium platyneuron* (ebony spleenwort), *Sanicula canadensis* (Canada blacksnakeroot), *Polystichum acrostichoides* (Christmas fern), *Geum canadense* (white avens), *Desmodium perplexum* (perplexed ticktrefoil), *Phytolacca americana* (American pokeweed), and *Lactuca floridana* (woodland lettuce).

Global Vegetation: This forest is characterized by a mixed canopy generally with *Quercus pagoda* (cherrybark oak) and *Quercus nigra* (water oak) as codominants. Also present as canopy trees are *Quercus shumardii* (Shumard oak), *Ulmus rubra* (slippery elm), *Sassafras albidum* (sassafras), *Carya illinoinensis* (pecan), *Liquidambar styraciflua* (sweetgum), *Pinus taeda* (loblolly pine), *Robinia pseudoacacia* (black locust), and *Fraxinus americana* (white ash). Subcanopy trees can additionally include *Acer negundo* (boxelder), *Quercus muehlenbergii* (chinkapin oak), *Tilia americana var. caroliniana* (Carolina basswood), *Carya cordiformis* (bitternut hickory), *Prunus serotina* (black cherry), *Ulmus alata* (winged elm), *Ulmus americana* (American elm), *Liriodendron tulipifera* (tuliptree), *Cercis canadensis* (eastern redbud), *Quercus michauxii* (swamp chestnut oak), *Celtis laevigata* (sugarberry), *Morus rubra* (red mulberry), *Cornus florida* (flowering dogwood), *Ostrya virginiana* (eastern hophornbeam), and in Adams and Jefferson counties, Mississippi, *Magnolia grandiflora* (southern magnolia). Shrubs (in addition to many of the above-mentioned species) include *Carpinus caroliniana* (American hornbeam), *Acer rubrum* (red maple), *Callicarpa americana* (beautyberry), *Vaccinium arboreum* (farkleberry), *Vaccinium elliottii* (mayberry), *Frangula caroliniana* (Carolina buckthorn), *Toxicodendron radicans* (eastern poison-ivy), *Euonymus americanus* (bursting-heart), *Cornus foemina* (stiff dogwood), *Viburnum rufidulum* (rusty blackhaw), *Lindera benzoin* (northern spicebush), *Asimina triloba* (common pawpaw), *Sideroxylon lycioides* (buckthorn bully), *Juniperus virginiana* (eastern redcedar), *Diospyros virginiana* (eastern persimmon), *Arundinaria gigantea* (giant cane), *Acer barbatum* (southern sugar maple), *Juglans nigra* (black walnut), *Hydrangea quercifolia* (oakleaf hydrangea), *Cornus drummondii* (roughleaf dogwood), and *Sambucus nigra ssp. canadensis* (American black elderberry) The exotic shrub *Ligustrum sinense* (Chinese privet) is especially common, sometimes completely dominating the forest understory. *Ligustrum japonicum* (Japanese privet), *Nandina domestica*

(sacred bamboo), *Firmiana simplex* (Chinese parasoltree), and *Poncirus trifoliata* (hardy orange) are occasional. The native vines include *Toxicodendron radicans* (eastern poison-ivy), *Gelsemium sempervirens* (evening trumpetflower), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax bona-nox* (saw greenbrier), *Ampelopsis arborea* (peppervine), *Cocculus carolinus* (Carolina coralbead), *Smilax tamnoides* (bristly greenbrier), *Vitis rotundifolia* (muscadine grape), *Vitis cinerea* (graybark grape), *Smilax glauca* (cat greenbrier), *Bignonia capreolata* (crossvine), *Smilax rotundifolia* (roundleaf greenbrier), *Berchemia scandens* (Alabama supplejack), and *Celastrus scandens* (American bittersweet). Exotic vines include *Lonicera japonica* (Japanese honeysuckle) and *Hedera helix* (English ivy). The most abundant herbaceous plants are *Oplismenus hirtellus ssp. setarius* (basketgrass), *Polystichum acrostichoides* (Christmas fern), *Passiflora lutea* (yellow passionflower), *Athyrium filix-femina ssp. asplenioides* (southern ladyfern), and *Phytolacca americana* (American pokeweed).

CONSERVATION STATUS RANK

G3? (21-Feb-2013). This association is limited to a small area of the loess bluffs of the Mississippi River. Unprotected occurrences are threatened by timber harvest and conversion to loblolly pine plantations. The invasive shrub *Ligustrum sinense* is common in many examples of the association; its increasing abundance represents another threat to the community and its conservation.

ASSOCIATION DISTRIBUTION

Global Range: This association is found on loess bluffs of the Mississippi River and elsewhere in the Upper East Gulf Coastal Plain, south of the Mississippi Delta.
States/Provinces: MS
Federal Lands: National Park Service (Natchez Trace Parkway, Vicksburg)

GLOBAL DESCRIPTION SOURCES

Global Description Authors: C.W. Nordman
References: Southeastern Ecology Working Group n.d.

PARK NAME: SWEETGUM – CHINKAPIN OAK – WATER OAK FOREST

USNVC CLASSIFICATION

USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Cool Temperate Forest (1.C.2)
USNVC Division: Eastern North American Cool Temperate Forest (D008)
USNVC MacroGroup: Central Mesophytic Hardwood Forest (M153)
USNVC Group: South-Central Coastal Plain Mesophytic Forest Group (G166)
USNVC Alliance: *Liquidambar styraciflua* Forest Alliance (A.234)
USNVC Alliance (English name): Sweetgum Forest Alliance
USNVC Association: *Liquidambar styraciflua* - *Carya illinoinensis* - *Quercus nigra* Forest
USNVC Association (English name): Sweetgum - Pecan - Water Oak Forest (CEGL004109)
USNVC Association (Common name): Loess Bluff Sweetgum - Pecan - Water Oak Forest

ASSOCIATION CONCEPT

This association is an upland forest which occurs on moderate to steep sloping loess bluffs associated with the Mississippi River in the Upper East Gulf Coastal Plain. This upland deciduous hardwood forest association is characterized by relatively high (in richness and evenness) species diversity of mostly mesophytic tree species, including *Liquidambar styraciflua* (sweetgum), *Carya illinoinensis* (pecan), *Quercus nigra* (water oak), *Quercus pagoda* (cherrybark oak), *Quercus shumardii* (Shumard oak), *Quercus velutina* (black oak), *Quercus rubra* (northern red oak), *Quercus muehlenbergii* (chinkapin oak), *Celtis laevigata* (sugarberry), *Ulmus rubra* (slippery elm), *Gleditsia triacanthos* (honeylocust), *Fraxinus americana* (white ash), and others. The rarity or absence of *Quercus alba* (white oak), which is otherwise common in this region and setting, is diagnostic.

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This is an upland forest which occurs widely throughout VICK on moderate to steep lower to middle slopes. It forms the matrix upland forest of most of VICK. Soils are erosive, well-drained silt loams formed from loess.
Global Environment: This is an upland forest which occurs on moderate to steep sloping loess bluffs associated with the Mississippi River in the Upper East Gulf Coastal Plain. Soils are erosive, well-drained silt loams formed from loess.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: At VICK this forest association is characterized by a mix of mesic upland tree species, although some stands are somewhat strongly dominated by *Liquidambar styraciflua* (sweetgum), which is always to nearly always present in the canopy and is, overall, the most abundant tree species in this association (Table A6). *Quercus nigra* (water oak), *Quercus muehlenbergii* (chinkapin oak), and *Celtis laevigata* (sugarberry), are also constant and can contribute substantial cover to the canopy. Typical associates that may contribute high cover locally include *Liriodendron tulipifera* (tuliptree), *Carya illinoinensis* (pecan), *Carya cordiformis* (bitternut hickory), *Prunus serotina* (black cherry), *Sassafras albidum* (sassafras), *Quercus shumardii* (Shumard oak), *Quercus velutina* (black oak), *Quercus rubra* (northern red oak), and/or *Fraxinus americana* (white

Table A6. Synthesis table for most constant plant species recorded in Sweetgum – Chinkapin Oak - Water Oak Forest at Vicksburg National Military Park (# plots=15; VICK.1, VICK.2, VICK.11, VICK.14, VICK.16, VICK.17, VICK.18, VICK.19, VICK.21, VICK.22, VICK.23, VICK.24, VICK.29,VICK.67,VICK.68).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Liquidambar styraciflua	sweetgum	Tree	100%	41% (1-75)
Quercus nigra	water oak	Tree	93%	12% (0-50)
Celtis laevigata	sugarberry	Tree	87%	6% (0-50)
Prunus serotina	black cherry	Tree	87%	2% (0-10)
Quercus muehlenbergii	chinkapin oak	Tree	73%	13% (0-50)
Acer negundo	boxelder	Tree	80%	7% (0-50)
Morus rubra	red mulberry	Tree	80%	6% (0-50)
Liriodendron tulipifera	tuliptree	Tree	67%	9% (0-50)
Ulmus rubra	slippery elm	Tree	67%	7% (0-50)
Carya cordiformis	bitternut hickory	Tree	60%	2% (0-10)
Carya illinoinensis	pecan	Tree	40%	5% (0-50)
Sassafras albidum	sassafras	Tree	40%	4% (0-25)
Quercus pagoda	cherrybark oak	Tree	33%	3% (0-25)
Fraxinus americana	white ash	Tree	27%	1% (0-25)
*Ligustrum sinense**	Chinese privet	Shrub	93%	25% (0-95)
Arundinaria gigantea	giant cane	Shrub	87%	22% (0-75)
Prunus caroliniana	Carolina laurel cherry	Shrub	73%	2% (0-25)
Ulmus alata	winged elm	Shrub	67%	4% (0-25)
Cercis canadensis	eastern redbud	Shrub	60%	2% (0-25)
Asimina triloba	Common pawpaw	Shrub	53%	0.4% (0-5)
Cornus drummondii	roughleaf dogwood	Shrub	47%	1% (0-10)
Frangula caroliniana	Carolina buckthorn	Shrub	47%	1% (0-10)
Poncirus trifoliata	hardy orange	Shrub	47%	6% (0-50)
Hydrangea quercifolia	oakleaf hydrangea	Shrub	40%	5% (0-50)
Lindera benzoin	northern spicebush	Shrub	40%	0.6% (0-5)
Toxicodendron radicans	eastern poison-ivy	Vine	100%	15% (1-50)
*Lonicera japonica**	Japanese honeysuckle	Vine	93%	18% (0-75)
Bignonia capreolata	crossvine	Vine	87%	1% (0-5)
Parthenocissus quinquefolia	Virginia creeper	Vine	67%	3% (0-25)
Matelea sp.	milkvine	Vine	60%	0.2% (0-1)
Vitis cinerea	graybark grape	Vine	53%	7% (0-50)
Vitis rotundifolia	muscadine grape	Vine	53%	1% (0-10)
Berchemia scandens	Alabama supplejack	Vine	53%	1% (0-10)
Asplenium platyneuron	ebony spleenwort	Herb	80%	0.5% (0-2)
Oplismenus hirtellus	basketgrass	Herb	73%	0.3% (0-1)
Polystichum acrostichoides	Christmas fern	Herb	53%	0.3% (0-2)
Sanicula canadensis	Canada blacksnakeroot	Herb	60%	0.2% (0-1)
Geum canadense	white avens	Herb	47%	0.2% (0-1)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

ash). *Morus rubra* (red mulberry), *Ulmus rubra* (slippery elm), and *Acer negundo* (boxelder) *Liquidambar styraciflua* (sweetgum), *Quercus nigra* (water oak), and *Celtis laevigata* (sugarberry), are the most constant and abundant subcanopy tree species. *Quercus pagoda* cherrybark oak) may be present in the canopy or subcanopy at low cover, but its presence in abundance in stands is more diagnostic of the Cherrybark Oak- Water Oak Forest. Less constant subcanopy species include *Liriodendron tulipifera* (tuliptree), *Ulmus alata* (winged elm), *Magnolia grandiflora* (southern magnolia), *Quercus muehlenbergii* (chinkapin oak), and *Sassafras albidum* (sassafras), *Acer barbatum* (southern sugar maple), *Ulmus americana* (American elm), *Quercus michauxii* (swamp chestnut oak), *Robinia pseudoacacia* (black locust), *Quercus shumardii* (Shumard oak), *Quercus velutina* (black oak), *Carya cordiformis* (bitternut hickory), *Quercus rubra* (northern red oak), *Cornus florida* (flowering dogwood), *Tilia americana var. caroliniana* (Carolina basswood), *Juniperus virginiana* (eastern redcedar), *Carpinus caroliniana* (American hornbeam), and *Prunus serotina* (black cherry). The most constant and abundant shrubs are the invasive non-native *Ligustrum sinense* (Chinese privet) and the native woody grass *Arundinaria gigantea* (giant cane). Other shrubs often present at low cover are *Prunus caroliniana* (Carolina laurel cherry), *Ulmus alata* (winged elm), *Cercis canadensis* (eastern redbud), *Frangula caroliniana* (Carolina buckthorn), *Asimina triloba* (common pawpaw), *Cornus drummondii* (roughleaf dogwood), and the invasive non-native *Poncirus trifoliata* (hardy orange). Less constant shrubs include *Hydrangea quercifolia* (oakleaf hydrangea), *Ulmus alata* (winged elm), *Cornus florida* (flowering dogwood), *Diospyros virginiana* (eastern persimmon), *Juniperus virginiana* (eastern redcedar), *Lindera benzoin* (northern spicebush), *Sideroxylon lycioides* (buckthorn bully), *Ostrya virginiana* (eastern hophornbeam), *Ilex decidua* (possumhaw), *Magnolia grandiflora* (southern magnolia), *Euonymus americanus* (bursting-heart), *Aralia spinosa* (devil's walkingstick), *Cornus alternifolia* (alternateleaf dogwood), *Sambucus nigra* ssp. *canadensis* (American black elderberry), and the non-native *Nandina domestica* (sacred bamboo). Cover by woody vines is low to substantial, with the non-native *Lonicera japonica* (Japanese honeysuckle) and native *Toxicodendron radicans* (eastern poison-ivy) the most constant species and also contributing locally substantial cover. Frequent, generally low cover, species include the native *Bignonia capreolata* (crossvine), *Vitis cinerea* (graybark grape), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis rotundifolia* (muscadine grape) *Berchemia scandens* (Alabama supplejack), *Matelea* sp. (milkvine), and *Smilax tamnoides* (bristly greenbrier). The herbaceous layer consists of a relatively large pool of [usually] low cover species. The most frequently observed are *Asplenium platyneuron* (ebony spleenwort), *Oplismenus hirtellus* (basketgrass), *Polystichum acrostichoides* (Christmas fern), *Sanicula canadensis* (Canada blacksnakeroot), and *Geum canadense* (white avens). Other species include *Boehmeria cylindrica* (smallspike falsenettle), *Athyrium filix-femina ssp. asplenioides* (southern ladyfern), *Aristolochia serpentaria* (Virginia snakeroot), *Ageratina altissima* (white snakeroot), *Polygonum virginianum* (jumpseed), *Eupatorium serotinum* (late thoroughwort), *Botrychium dissectum* (cutleaf grapefern), *Elymus virginicus* (Virginia wildrye), *Elephantopus carolinianus* (Carolina elephantsfoot), *Cystopteris protrusa* (lowland bladder fern), *Leersia virginica* (whitegrass), *Bidens bipinnata* (Spanish-needles), *Carex oxylepis* (sharpscale sedge), *Carex cherokeensis* (Cherokee sedge), *Amphicarpaea bracteata* (American hogpeanut), *Botrychium virginianum* (rattlesnake fern), *Phryma leptostachya* (American lopseed), *Arisaema triphyllum* (jack-in-the-pulpit), *Dioscorea villosa* (wild yam), *Lactuca floridana* (woodland lettuce), *Clematis virginiana* (devil’s darning-needles), *Cynoglossum virginianum* (wild comfrey), *Arisaema dracontium* (Green Dragon), *Desmodium perplexum* (perplexed ticktrefoil), *Dichanthelium boscii* (Bosc's panicgrass), *Passiflora lutea* (yellow passionflower), *Carex digitalis* (slender wood sedge), and *Symphyotrichum undulatum* (wavyleaf aster). Walker (1997) reported *Trillium*

viride (more likely the green form of stinking trillium (*T. foetidissimum*)) as one of the common herbaceous species at VICK. Although not recorded in the plot data (above ground parts would senesce by the time of the late summer sampling), *Trillium* spp. (trilliums) may occur in this type.

Global Vegetation: This upland deciduous hardwood forest association is dominated by *Liquidambar styraciflua* (sweetgum), *Carya illinoinensis* (pecan), and to a lesser extent *Quercus nigra* (water oak). Other less dominant trees are *Quercus pagoda* (cherrybark oak), *Quercus shumardii* (Shumard oak), *Quercus velutina* (black oak), *Quercus rubra* (northern red oak), *Quercus muehlenbergii* (chinkapin oak), *Celtis laevigata* (sugarberry), *Ulmus rubra* (slippery elm), *Gleditsia triacanthos* (honeylocust), and *Fraxinus americana* (white ash). Other canopy trees include *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry), *Sassafras albidum* (sassafras), and *Quercus michauxii* (swamp chestnut oak). Subcanopy trees with the highest cover include *Liquidambar styraciflua* (sweetgum), *Quercus nigra* (water oak), *Morus rubra* (red mulberry), *Acer negundo* (boxelder), *Liriodendron tulipifera* (tuliptree), *Celtis laevigata* (sugarberry), *Ulmus alata* (winged elm), *Magnolia grandiflora* (southern magnolia), *Quercus muehlenbergii* (chinkapin oak), and *Sassafras albidum* (sassafras). Other subcanopy trees are *Acer barbatum* (southern sugar maple), *Ulmus americana* (American elm), *Ulmus rubra* (slippery elm), *Quercus michauxii* (swamp chestnut oak), *Robinia pseudoacacia* (black locust), *Quercus pagoda* (cherrybark oak), *Quercus shumardii* (Shumard oak), *Quercus velutina* (black oak), *Carya cordiformis* (bitternut hickory), *Quercus rubra* (northern red oak), *Cornus florida* (flowering dogwood), *Tilia americana var. caroliniana* (Carolina basswood), *Juniperus virginiana* (eastern redcedar), *Carpinus caroliniana* (American hornbeam), and *Prunus serotina* (black cherry). The absence or extreme rarity of *Quercus alba* (white oak) and *Fagus grandifolia* (beech) is notable and helps separate this from other associations. This association can have high cover of trees and shrubs in the tall-shrub layer. The invasive exotic plant *Ligustrum sinense* (Chinese privet) had the highest cover of any woody plant in the tall-shrub layer; in about half of the sampled plots it had over 25% cover and in about 20% of the plots it had over 75% cover. The most abundant native woody plants in the tall-shrub layer include *Liquidambar styraciflua* (sweetgum), *Cercis canadensis* (eastern redbud), *Hydrangea quercifolia* (oakleaf hydrangea), and *Arundinaria gigantea* (giant cane). Other less abundant species include *Quercus nigra* (water oak), *Carya illinoinensis* (pecan), *Acer negundo* (boxelder), *Acer barbatum* (southern sugar maple), *Ulmus americana* (American elm), *Frangula caroliniana* (Carolina buckthorn), *Ulmus alata* (winged elm), *Ulmus rubra* (slippery elm), *Morus rubra* (red mulberry), *Celtis laevigata* (sugarberry), *Liriodendron tulipifera* (tuliptree), *Robinia pseudoacacia* (black locust), *Carya cordiformis* (bitternut hickory), *Cornus drummondii* (roughleaf dogwood), *Quercus muehlenbergii* (chinkapin oak), *Quercus shumardii* (Shumard oak), *Sassafras albidum* (sassafras), *Cornus florida* (flowering dogwood), *Juniperus virginiana* (eastern redcedar), *Prunus caroliniana* (Carolina laurel cherry), *Asimina triloba* (common pawpaw), and least commonly *Prunus serotina* (black cherry), *Lindera benzoin* (northern spicebush), *Quercus michauxii* (swamp chestnut oak), *Sideroxylon lycioides* (buckthorn bully), *Ostrya virginiana* (eastern hophornbeam), *Ilex decidua* (possumhaw), *Diospyros virginiana* (eastern persimmon), *Magnolia grandiflora* (southern magnolia), and the exotic plants *Ligustrum japonicum* (Japanese privet) and *Poncirus trifoliata* (hardy orange). The short shrub with the highest cover is *Toxicodendron radicans* (eastern poison-ivy); additional short shrubs include *Euonymus americanus* (bursting- heart), *Aralia spinosa* (devil's walkingstick), *Juglans nigra* (black walnut), *Cornus alternifolia* (alternateleaf Dogwood), *Sambucus nigra* ssp. *canadensis* (American black elderberry), plus the exotic escaped ornamental plants *Nandina domestica* (sacred bamboo), *Lonicera japonica* (Japanese honeysuckle), and *Ligustrum sinense* (Chinese privet). Herbaceous plants are generally sparse and include *Asplenium platyneuron* (ebony spleenwort),

Oplismenus hirtellus (basketgrass), *Matelea* sp. (milkvine), *Boehmeria cylindrica* (smallspike falsenettle), *Geum canadense* (white avens), *Athyrium filix-femina ssp. asplenioides* (southern ladyfern), *Aristolochia serpentaria* (Virginia snakeroot), *Ageratina altissima* (white snakeroot), *Sanicula canadensis* (Canada blacksnakeroot), *Polygonum virginianum* (jumpseed), *Eupatorium serotinum* (late thoroughwort), *Polystichum acrostichoides* (Christmas fern), *Botrychium dissectum* (cutleaf grapefern), *Elymus virginicus* (Virginia wildrye), *Elephantopus carolinianus* (Carolina elephantsfoot), *Cystopteris protrusa* (lowland bladder fern), *Leersia virginica* (whitegrass), *Bidens bipinnata* (Spanish-needles), *Carex oxylepis* (sharpscale sedge), *Carex cherokeensis* (Cherokee sedge), *Amphicarpaea bracteata* (American hogpeanut), *Botrychium virginianum* (rattlesnake fern), *Phryma leptostachya* (American lopseed), *Arisaema triphyllum* (jack-in-the-pulpit), *Dioscorea villosa* (wild yam), *Lactuca floridana* (woodland lettuce), *Clematis virginiana* (devil's darning-needles), *Cynoglossum virginianum* (wild comfrey), *Arisaema dracontium* (green dragon), *Desmodium perplexum* (perplexed ticktrefoil), *Dichanthelium boscii* (Bosc's panicgrass), *Passiflora lutea* (yellow passionflower), *Carex digitalis* (slender wood sedge), *Vinca major* (bigleaf periwinkle), and *Symphyotrichum undulatum* (wavyleaf aster), and exotics *Hedera helix* (English ivy), *Cyrtomium fortunei* (Asian netvein hollyfern), and *Liriope* (lilyturf) sp.

CONSERVATION STATUS RANK

GNA (28-Sep-2005). This association is currently only known from the Loess Bluffs of the Mississippi River in Mississippi, documented at Vicksburg National Military Park. Areas outside the park are only protected to the extent that they are hard to access for logging due to moderate to steep slopes. Many of these forests are successional in nature, having been cleared during the Civil War and at other times. This would suggest that these forests may not be so rare within the specialized habitat of the loess bluffs in Mississippi. The dominant trees are all early-successional species.

CLASSIFICATION COMMENTS

This association currently is a member of the *Liquidambar styraciflua* Forest Alliance (A.234), along with the *Liquidambar styraciflua* Forest (CEGL007216). The revision of the USNVC has placed these two associations in different formations, divisions, macrogroups and groups (i.e., at four USNVC higher hierachy levels than alliance). Therefore, the alliance assignment of at least one of these associations will change, following revisions of USNVC alliances that are needed to adapt to the upper level revisions. Chinkapin oak (*Quercus muehlenbergii*), which is more abundant, constant, and diagnostic than pecan (*Carya illinoinensis*) in stands of this association at VICK (Table A6), replaces pecan in the local name for the association.

Three plots at VICK originally were assigned to the *Liriodendron tulipifera / (Cercis canadensis) / (Lindera benzoin)* Forest (CEGL007220). These plots grouped closely together in cluster analysis, but this group fused with plots rather early in the clustering. Due to the floristic similarities and settings of these stands to more widespread forest types, the difficulty in diagnosing them from these types, and the very limited extent within VICK of stands with *Liriodendron tulipifera* (tuliptree) important, it seemed more practical to regard most of these stands as tuliptree–rich variants of the association described here. *L. tulipifera* also can occasionally contribute high cover in the Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest (CEGL007335), and the Boxelder Successional Upland Forest (NPSVICK001)

ASSOCIATION DISTRIBUTION

Global Range: This association is currently only known from the Loess Bluffs of the Mississippi River in Mississippi, documented at Vicksburg National Military Park.
States/Provinces: MS
Federal Lands: National Park Service (Natchez Trace Parkway, Vicksburg)

GLOBAL DESCRIPTION SOURCES

Global Description Authors: C.W. Nordman
References: Southeastern Ecology Working Group n.d.

PARK NAME: SYCAMORE – SWEETGUM – BOXELDER SMALL STREAM BOTTOM FOREST

USNVC CLASSIFICATION

USNVC Classification

USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Temperate Flooded & Swamp Forest (1.C.3)
USNVC Division: Eastern North American Flooded & Swamp Forest (D011)
USNVC MacroGroup: Northern & Central Floodplain Forest & Scrub (M029)
USNVC Group: Silver Maple - Green Ash - Sycamore Floodplain Group (G040)
USNVC Alliance: *Platanus occidentalis - (Fraxinus pennsylvanica, Celtis laevigata, Acer saccharinum)* Temporarily Flooded Forest Alliance (A.288)
USNVC Alliance (English name): Sycamore - (Green Ash, Sugarberry, Silver Maple) Temporarily Flooded Forest Alliance
USNVC Association: *Platanus occidentalis - Liquidambar styraciflua - (Ulmus americana) / (Crataegus viridis)* Forest (CEGL007335)
USNVC Association (English name): Sycamore - Sweetgum - (American Elm) / (Green Hawthorn) Forest
USNVC Association (Common name): Gulf Coastal Plain Sycamore - Sweetgum Floodplain Forest

ASSOCIATION CONCEPT

This seasonally to temporarily flooded floodplain forest of the Upper East and West Gulf coastal plains has a canopy dominated by *Platanus occidentalis* (American sycamore) and *Liquidambar styraciflua* (sweetgum). Examples may be found on stabilized natural levees, point bars and first bottoms of large streams and rivers and first bottoms of small- to large-sized streams and rivers in the Gulf Coastal Plain.

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Kovalenko and Dibble (2007) determined this vegetation to be Palustrine Forested wetlands. The hydroperiod for these small stream bottom settings is somewhat flashy and is clearly shorter than the Black Willow Floodplain Forest. Wetlands characterized by this vegetation would most likely be classified as Palustrine, Forested, Broadleaf, Temporarily Flooded. The hydrophytic (weighted averages) prevalence indices (Gage and Cooper 2010) calculated for the four classification plots assigned to this association are 2.87, 2.91, 3.11, and 3.33 (i.e., more or less facultative and requiring consideration of other factors for wetland determination).

Vicksburg National Military Park Environment: At VICK, this forest occurs throughout the park in linear stands along narrow bottoms of small (first to second order) streams, mostly along Mint Springs Bayou and the two branches of Durben Creek that arise within VICK.

Global Environment: This forest occurs on stabilized natural levees, point bars and first bottoms of small- to large-sized alluvial streams and rivers in the Gulf Coastal Plain from Texas as far eastward as Alabama and Georgia. Soils are seasonally/temporarily flooded.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: Vicksburg stands of vegetation attributed to this association at VICK have an upper canopy usually dominated by *Platanus occidentalis* (American

sycamore) and *Liquidambar styraciflua* (sweetgum), and, to a lesser extent, *Quercus nigra* (water oak) (Table A7). *Acer negundo* (boxelder) is constantly present at moderate to high cover in the subcanopy. Fairly constant tree species present at lower cover include *Ulmus rubra* (slippery elm), *Celtis laevigata* (sugarberry), *Ulmus americana* (American elm), and *Morus rubra* red mulberry). Other species recorded, some of which can contribute locally high cover include *Carya illinoinensis* (pecan), *Liriodendron tulipifera* (tuliptree), *Juglans nigra* (black walnut), and *Quercus michauxii* (swamp chestnut oak). Kovalenko and Dibble (2007) also recorded *Quercus phellos* (willow oak) and *Carpinus caroliniana* (American hornbeam) as occasional associate tree species. The shrub layer usually is heavily dominated by the non-native invasive *Ligustrum sinense* (Chinese privet). Other shrub species include *Lindera benzoin* (northern spicebush), *Sambucus nigra* ssp. *canadensis* (American black elderberry), *Arundinaria gigantea* (giant cane), *Ostrya virginiana* (eastern hophornbeam), *Prunus serotina* (black cherry), *Euonymus americanus* (bursting-heart), and *Prunus caroliniana* (Carolina laurel cherry). The non-native invasive *Poncirus trifoliata* (hardy orange) is also sometimes present. Woody vines may reach high cover and are represented by the native *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison-ivy), *Berchemia scandens* (Alabama supplejack), *Bignonia capreolata* (crossvine)), *Vitis rotundifolia* (muscadine grape) and the non-native invasive *Lonicera japonica* (Japanese honeysuckle). The herb layer is moderately diverse, with a number of low cover, often nutrient-demanding species represented. *Oplismenus hirtellus* (basketgrass) and *Leersia virginiana (*whitegrass) are the most frequent grasses, while *Sanicula canadensis (*Canada blacksnakeroot), *Arisaema dracontium* (green dragon), *Arisaema triphyllum* (jack-in-the-pulpit), *Boehmeria cylindrica* (smallspike falsenettle), *Geum canadense* (white avens), *Phytolacca americana* (American pokeweed), and *Polygonum virginianum* (jumpseed) are the most frequent forbs. Ferns are relatively diverse, and are represented by the native *Asplenium platyneuron* (ebony spleenwort), *Athyrium filix-femina* ssp. *asplenioides* (southern lady fern), *Cystopteris protrusa* (lowland bladder fern), and *Polystichum acrostichoides* (Christmas fern). The non-native ferns *Cyrtomium fortunei* (Asian netvein hollyfern) and *Pteris multifida* (spiderbrake) occasionally establish within this vegetation, especially on steep, bare stream banks. Walker (1997) observed that *Galium aparine* (cleavers) was one of the more common herbaceous species at VICK and collected it at Mint Springs Bayou, at a site consistent with this association. *G. aparine* is a winter annual that may be present in this type at VICK, but would not have been visible to be recorded during the late summer plot sampling period. A single forest stand regarded as a variant of this vegetation occurs on the lower reaches of Mint Springs Bayou. This variant is strongly dominated by *Acer negundo* (boxelder) in the tree canopy and *Equisetum hyemale* (scouringrush horsetail) is prominent in the herbaceous layer, but have many minor species that are indicative of this type. This variant was also observed by Kovalenko and Dibble (2007).

Global Vegetation: The canopy of stands of this association is dominated by *Platanus occidentalis* (Sycamore) and *Liquidambar styraciflua* (sweetgum). The canopy cover ranges from 60-100%. Other canopy associates may include *Carya illinoinensis* (pecan), *Nyssa biflora* (swamp blackgum), *Celtis laevigata* (sugarberry), *Populus deltoides* (eastern cottonwood), *Quercus nigra* (water oak), *Salix nigra* (black willow), *Fraxinus pennsylvanica* (green ash), *Betula nigra* (river birch), *Acer negundo* (boxelder), and *Carya aquatica* (water hickory). *Ulmus americana* (American elm) may also be present in some examples and may have been a historically common component of this type. However, *Ulmus americana* (American elm) is currently less abundant due to a vascular fungus (Dutch elm disease) that has severely reduced populations of this species (Harlow et al. 1991). Shrubs are sparse to moderately dense in this

Table A7. Synthesis table for most constant plant species recorded in Sycamore - Sweetgum – Boxelder Small Stream Bottom Forest at Vicksburg National Military Park (# plots=4; VICK.4, VICK.5, VICK.6, VICK.70).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Liquidambar styraciflua	sweetgum	Tree	100%	23% (10-50)
Acer negundo	boxelder	Tree	100%	20% (5-50)
Quercus nigra	water oak	Tree	100%	11% (0.1-25)
Platanus occidentalis	American sycamore	Tree	75%	18% (0-50)
Ulmus rubra	slippery elm	Tree	75%	6% (0-25)
Morus rubra	red mulberry	Tree	75%	2% (0-5)
Ulmus americana	American elm	Tree	50%	2% (0-5)
Celtis laevigata	sugarberry	Tree	50%	1% (0-5)
*Ligustrum sinense**	Chinese privet	Shrub	100%	57% (10-95)
Lindera benzoin	northern spicebush	Shrub	100%	1% (0.1-5)
Sambucus nigra	black elderberry	Shrub	75%	0.3% (0-1)
*Poncirus trifoliata**	hardy orange	Shrub	50%	2% (0-5)
Ostrya virginiana	eastern hophornbeam	Shrub	50%	1% (0-5)
Prunus serotina	black cherry	Shrub	50%	1% (0-5)
Arundinaria gigantea	giant cane	Shrub	50%	0.5% (0-2)
Euonymus americanus	bursting-heart	Shrub	50%	0.5% (0-2)
Prunus caroliniana	Carolina laurel cherry	Shrub	50%	0.5% (0-2)
Frangula caroliniana	Carolina buckthorn	Shrub	50%	0.3% (0-1)
*Nandina domestica**	sacred bamboo	Shrub	50%	0.1% (0-1)
Sideroxylon lycioides	buckthorn bully	Shrub	50%	0.1% (0-1)
Parthenocissus quinquefolia	Virginia creeper	Vine	100%	1% (0.1-5)
*Lonicera japonica**	Japanese honeysuckle	Vine	75%	7% (0-25)
Bignonia capreolata	Crossvine	Vine	75%	0.5% (0-2)
Toxicodendron radicans	eastern poison-ivy	Vine	50%	3% (0-10)
Berchemia scandens	Alabama supplejack	Vine	50%	1% (0-5)
Vitis rotundifolia	muscadine grape	Vine	50%	0.8% (0-2)
Cocculus carolinus	Carolina coralbead	Vine	50%	0.5% (0-2)
Oplismenus hirtellus	basketgrass	Herb	100%	0.4% (trace-1)
Sanicula canadensis	Canada blacksnakeroot	Herb	100%	0.3% (trace-1)
Athyrium filix-femina	southern lady fern	Herb	75%	2% (0-5)
Asplenium platyneuron	ebony spleenwort	Herb	75%	0.2% (0-1)
Arisaema triphyllum	jack-in-the-pulpit	Herb	50%	0.3% (0-1)
Boehmeria cylindrica	smallspike falsenettle	Herb	50%	0.3% (0-1)
Cystopteris protrusa	lowland bladder fern	Herb	50%	0.3% (0-1)
Geum canadense	white avens	Herb	50%	0.3% (0-1)
Leersia virginiana	whitegrass	Herb	50%	0.3% (0-1)
Polygonum virginianum	jumpseed	Herb	50%	0.3% (0-1)
Polystichum acrostichoides	Christmas fern	Herb	50%	0.3% (0-1)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

community with covers ranging from 10-40%. Species may include *Crataegus viridis* (green hawthorn), *Ilex decidua* (possumhaw), *Lindera benzoin* (northern spicebush), *Carpinus caroliniana* (American hornbeam), and *Aesculus pavia var. pavia* (red buckeye). Characteristic herbs include *Elymus hystrix* (bottlebrush grass), *Boehmeria cylindrica* (smallspike falsenettle), *Chasmanthium latifolium* (river-oats), and *Viola* spp. (violets). Patches of *Arundinaria gigantea* (giant cane) can be common in this community. The rare plant *Amsonia ludoviciana* (Louisiana bluestar), ranked G3 (globally vulnerable) is known from this vegetation.

CONSERVATION STATUS RANK

G3G4 (25-Feb-2004). There is little data available to support a comprehensive evaluation of this forest association. It has a potentially large range from the West Gulf Coastal Plain across the Mississippi River to the Upper East Gulf Coastal Plain. However, intact flooding regimes of coastal plain rivers are necessary to perpetuate this type, and most such rivers within this type's range have been altered through dam construction and/or channelization. The extent to which this forest will continue to exist under altered flow regimes is unknown. More data are needed to determine the stability of this natural forest, as opposed to non-natural examples with similar species composition. Given these factors a rank of G3G4 has been assigned.

CLASSIFICATION COMMENTS

Most of the mapped palustrine forested wetlands described and mapped by Kovalenko and Dibble (2007), including their scouring rush-boxelder riverine wetland community and giant cane-sycamore riverine wetland community, fit this association closely. Their descriptions include several more hydric indicators than the NPSVI plots indicate; we incorporate these findings into this description.

This association was originally defined to cover a very broad geographic range (from western Texas to the Coastal Plain of North Carolina and Virginia) and may need substantial revision. Its range has subsequently become more restricted (currently to the Upper East Gulf Coastal Plain, and the Upper West Gulf Coastal Plain and West Gulf Coastal Plain from Georgia and Alabama west to Texas). Additionally, the current concept of both large river floodplain vegetation and small stream bottom vegetation (as at VICK) in a single association may be overly broad.

One of the nominal species in the USNVC name for this association, *Crataegus viridis* (green hawthorn), is not known to occur at VICK.

ASSOCIATION DISTRIBUTION

Global Range: This community ranges across the Gulf Coastal Plain from Georgia to Texas, but is apparently absent from the Mississippi River Alluvial Plain (but possibly in the Red River Plain). It may occur as far north as western Tennessee.

States/Provinces: AL, AR(?), GA, LA, MS, TN, TX

Federal Lands: Department of Defense (Fort Benning); National Park Service (Natchez Trace Parkway, Shiloh, Vicksburg); U.S. Forest Service (Angelina, Bienville, Davy Crockett, Holly Springs, Kisatchie, Sabine NF, Sam Houston, St. Francis(?), Tombigbee(?))

GLOBAL DESCRIPTION SOURCES

Global Description Authors: J.E. Mohan, mod. K.D. Patterson and S. Landaal, mod. R.E. Evans.

References: Allard 1990, Diamond 1993, Eyre 1980, Harlow et al. 1991, NatureServe Ecology - Southeastern U.S. unpubl. data, Oberholster 1993, Schotz pers. comm., Smith 1988, Smith 1996, Southeastern Ecology Working Group n.d., TDNH unpubl. data, USFS 1988, Wharton et al. 1982, Wieland 1994, Wieland 2000

PARK NAME: BLACK WILLOW FLOODPLAIN FOREST

USNVC CLASSIFICATION

USNVC Classification

USNVC Class: Forest and Woodland (1)
USNVC Subclass: Temperate Forest (1C)
USNVC Formation: Temperate Flooded & Swamp Forest (1.C.3)
USNVC Division: Eastern North American Flooded & Swamp Forest (D011)
USNVC MacroGroup: Northern & Central Floodplain Forest & Scrub (M029)
USNVC Group: Eastern Cottonwood - Black Willow Flooded & Swamp Group (G041)
USNVC Alliance: *Salix nigra* Temporarily Flooded Forest Alliance (A.297)
USNVC Alliance (English name): Black Willow Temporarily Flooded Forest Alliance
USNVC Association: *Salix nigra* Large River Floodplain Forest
USNVC Association (English name): Black Willow Large River Floodplain Forest (CEGL007410)
USNVC Association (Common name): Black Willow Large River Floodplain Forest

ASSOCIATION CONCEPT

This riparian association is dominated or codominated by *Salix nigra* (black willow). Often, *Salix nigra* is the sole dominant with few other tree species present. It occurs on recently deposited ground in the Mississippi River Alluvial Plain and other large river floodplains. Globally, the association concept also includes some "sandbar forest" examples with *Platanus occidentalis* (American sycamore) and *Populus deltoides* (eastern cottonwood) sharing dominance with *Salix nigra* (black willow).

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Palustrine, Forested, Broadleaf, Seasonally Flooded. The hydrophytic (weighted averages) prevalence indices (Gage and Cooper 2010) calculated for the single plot assigned to this association is 1.13 (i.e., strongly hydrophytic).
Kovalenko and Dibble (2007) mapped this vegetation as Palustrine Forested wetlands, but did not describe the vegetation type separately from other forested wetland community types.

Vicksburg National Military Park Environment: At VICK, this forest is limited to a single moderately large stand (about 10 hectares) on the Mississippi River floodplain along the Yazoo River Diversion Canal west of Washington Street.
Global Environment: This riverine willow community occurs on recently deposited ground in large river floodplains. This includes "sandbar forests dominated by *Salix nigra*, with *Platanus occidentalis* and *Populus deltoides*" in the Mississippi River Alluvial Plain (formerly included in CEGL007908). Heineke (1987) mentions "riverfront areas and frontlands of islands which are actively accreting" with *Salix nigra* and *Populus deltoides*. Landward stands may be pure *Salix nigra*. In addition, he mentions "older, higher sites with more coarse-grained sediments" which are dominated by the mixture of *Salix nigra* and *Populus deltoides*.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: In the single stand at VICK, *Salix nigra* (black willow) is the sole dominant tree (Table A8). Shrubs contributing substantial cover in the single classification

plot observed in this stand include *Forestiera acuminata* (eastern swampprivet), *Cephalanthus occidentalis* (common buttonbush), and *Planera aquatica* (planer tree). Woody vines are common and include *Brunnichia ovata* (American buckwheat), *Vitis vulpina* (frost grape), and, *Toxicodendron radicans* (eastern poison-ivy). In the herbaceous layer, *Saururus cernuus* (lizard's tail) contributes the highest cover in the herbaceous layer. A number of other forbs are present at low cover including *Boehmeria cylindrica* (smallspike falsenettle), *Hibiscus moscheutos* (crimsoneyed rosemallow), *Xanthium strumarium* (rough cocklebur), and the non-native invasive *Alternanthera philoxeroides* (alligatorweed). Also present at low cover are seedlings of the trees *Carya aquatica* (water hickory), *Gleditsia triacanthos* (honeylocust), and *Taxodium distichum* (bald cypress) and of the herbaceous vines *Sicyos angulatus* (oneseed bur cucumber) and *Cynanchum laeve* (honeyvine).

Table A8. Synthesis table for all plant taxa recorded in Black Willow Floodplain Forest at Vicksburg National Military Park (# plots=1; VICK.34).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
Salix nigra	black willow	Tree	100%	75-95
Forestiera acuminata	eastern swampprivet	Shrub	100%	25-50
Cephalanthus occidentalis	common buttonbush	Shrub	100%	25-50
Planera aquatica	planer tree	Shrub	100%	10-25
Brunnichia ovata	American buckwheat vine	Vine	100%	5-10
Vitis vulpina	frost grape	Vine	100%	5-10
Toxicodendron radicans	eastern poison-ivy	Vine	100%	trace-1
Saururus cernuus	lizard's tail	Herb	100%	5-10
*Alternanthera philoxeroides**	Alligatorweed	Herb	100%	1-2
Leersia sp.	cutgrass	Herb	100%	1-2
Carya aquatica	water hickory	Herb	100%	trace -1
Gleditsia triacanthos	honey locust	Herb	100%	trace -1
Boehmeria cylindrica	smallspike falsenettle	Herb	100%	trace -1
Hibiscus moscheutos	crimsoneyed rosemallow	Herb	100%	trace -1
Sicyos angulatus	oneseed bur cucumber	Herb	100%	trace -1
Taxodium distichum	bald cypress	Herb	100%	trace -1
Xanthium strumarium	rough cocklebur	Herb	100%	trace -1
Cynanchum laeve	honeyvine	Herb	100%	trace

* - non-native species 1 – range of cover class value for plot (all strata totaled)

Global Vegetation: *Salix nigra* (black willow) may be the sole dominant in stands of this type, with few other species present. This association also includes some examples with *Platanus occidentalis* (American sycamore) and *Populus deltoides* (eastern cottonwood). Heineke (1987) mentions "riverfront areas and frontlands of islands which are actively accreting" with *Salix nigra* (black willow) and *Populus deltoides* (eastern cottonwood). Landward stands may be pure *Salix nigra* (black willow). In addition, he mentions "older, higher sites with more coarse-grained sediments" which are dominated by the mixture of *Salix nigra* (black willow) and *Populus deltoides* (eastern cottonwood).

CONSERVATION STATUS RANK
G3G5 (14-Feb-2001). This is often an early-successional community, but its regeneration and survival depend on natural flooding and hydrologic regimes being maintained.

CLASSIFICATION COMMENTS
Apparently originally conceived of as a community of riverine point-bar succession, this concept more properly placed in Temporarily Flooded [e.g., A.297, to which CEGL007410 is now moved 2001-06-24]. Heineke (1987) mentions "riverfront areas and frontlands of islands which are actively accreting" with *Salix nigra* and *Populus deltoides*. Landward stands may be pure *Salix nigra*. In addition, he mentions "older, higher sites with more coarse-grained sediments" which are dominated by the mixture of *Salix nigra* and *Populus deltoides*. This is often an early successional community, but its regeneration and survival depends on natural flooding and hydrologic regimes being maintained.

ASSOCIATION DISTRIBUTION
Global Range: This community is known from the Mississippi River and similar large river floodplains of Arkansas, Tennessee, Kentucky, Mississippi, Louisiana and possibly Texas(?).
States/Provinces: AL, AR, FL(?), KY, LA, MS, SC(?), TN, TX(?)
Federal Lands: National Park Service (Vicksburg); U.S. Forest Service (Angelina(?)), Apalachicola?, Davy Crockett?, De Soto, Delta, Francis Marion(?), Holly Springs, Kisatchie, Ocala(?), Sabine NF(?), Sam Houston(?), St. Francis, Tombigbee); US Fish and Wildlife Service (Chickasaw NWR, Reelfoot(?))

GLOBAL DESCRIPTION SOURCES
Global Description Authors: M. Evans and M. Pyne
References: Evans 1991, Heineke 1987, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

PARK NAME: KUDZU VINE-SHRUBLAND

USNVC CLASSIFICATION

USNVC Class: Shrubland & Grassland (2)
USNVC Subclass: Temperate & Boreal Shrubland & Grassland (2C)
USNVC Formation: Temperate Grassland, Meadow & Shrubland (2.C.1)
USNVC Division: Southeastern North American Grassland & Shrubland (D102)
USNVC MacroGroup: Southeastern Ruderal Grassland & Shrubland (M307)
USNVC Group: Southeastern Old Field Group (M583)
USNVC Alliance: *Pueraria montana* Vine-Shrubland Alliance (A.904)
USNVC Alliance (English name): Kudzu Vine-Shrubland Alliance
USNVC Association: *Pueraria montana* var. *lobata* Vine-Shrubland (CEGL003882)
USNVC Association (English name): Kudzu Vine-Shrubland
USNVC Association (Common name): Kudzu Vineland

ASSOCIATION CONCEPT

This vine-dominated vegetation is dominated by *Pueraria montana var. lobata* (kudzu vine), a fast-growing vine native to Asia. The species was introduced into the United States in 1885, primarily as an ornamental and as a potential source for cattle forage. It was subsequently widely used for erosion control in the southeastern United States. This association occupies a variety of sites throughout most physiographic provinces in the Southeast, ranging in size from less than a hectare to 5-10 hectares or more. It chokes out existing vegetation. Edges of examples of this vegetation may consist of small to large trees in the process of being overwhelmed by kudzu.

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: At VICK, this association has occurred in small patches in forest gaps and around cleared areas throughout the park. At the time of this vegetation inventory, it has apparently largely been eliminated from within park boundaries by management control of the exotic kudzu vine, although it persists in areas that are likely smaller than the minimum mapping unit for this project (0.25 hectare). It occurs in larger stands just beyond park boundaries and may readily expand its current area within the park in the absence of continued control.
Global Environment: The association occupies a variety of sites throughout most physiographic provinces in the southeastern U.S., with examples ranging in size from less than one hectare to 5-10 hectares or more. It chokes out existing vegetation. Edges of examples of this vegetation may consist of small to large trees in the process of being overwhelmed by kudzu vine.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: *Pueraria montana var. lobata* (kudzu vine), a densely growing, semi-woody vine, dominated the two classification plots recorded at VICK (Table A9). A small number of low cover herbs were recorded, with *Ambrosia trifida* (giant ragweed) occurring in both plots and *Digitaria ciliaris* (southern crabgrass), *Phytolacca americana* (American pokeweed), and the non-natives *Polygonum convolvulus* (black bindweed) and *Solanum ptycanthum* (West Indian nightshade) in one plot each.

Global Vegetation: This vine-dominated vegetation is dominated by *Pueraria montana var. lobata* (kudzu vine), a fast-growing vine native to Asia.

Table A9. Synthesis table for all plant species recorded in Kudzu Vine-Shrubland at Vicksburg National Military Park (# plots=2; VICK.28, VICK.36).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]
Pueraria montana var.*lobata**	kudzu vine	Vine	100%	90% (75-100)
Ambrosia trifida	giant ragweed	Herb	100%	2% (0.1-5)
*Polygonum convolvulus**	black bindweed	Herb	50%	2% (0-5)
*Solanum ptycanthum**	West Indian nightshade	Herb	50%	2% (0-5)
Digitaria ciliaris	southern crabgrass	Herb	50%	0.8% (0-2)
Phytolacca americana	American pokeweed	Herb	50%	0.8% (0-2)

* - non-native species 2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

CONSERVATION STATUS RANK

GNA (invasive) (24-May-2000). This vegetation is dominated by an exotic species, is of anthropogenic origin, and is thus not a conservation priority. *Pueraria montana var. lobata*, native to Asia, was introduced into the United States in 1885, primarily as an ornamental and as a potential source for cattle forage. More than 2 million acres of forest land in Alabama, Georgia, Mississippi, Tennessee, North Carolina, and South Carolina are estimated to be infested with kudzu.

CLASSIFICATION COMMENTS

A single plot (VICK.38) that was assigned to the Successional boxelder is dominanted by other vine species including the native *Vitis cinerea* and Ampelopsis arborea and by the non-native *Polygonum convolvulus* We follow NPS guidelines (Lea 2011) in recognizing this vegetation as a local expression of a concept that can be applied to a vegetation type over a larger range, but that is not yet addressed well by the USNVC. Since all USNVC alliance concepts are under review at the time of this report, no alliance membership is suggested. Previously, the USNVC association concepts of CEGL004048 (*Lolium* (*arundinaceum, pratense*)) Herbaceous Vegetation), CEGL004108 (*Sorghum halepense* Herbaceous Vegetation), and *Cynodon dactylon* Herbaceous Vegetation (CEGL004701) were proposed applied to various individual stands, due to patch dominance of individual species. Until more local and global information are available, it seems more practical to treat this as a generalized “old field” type described locally and as a “placeholder” type. The concept of this provisional type is intended to be restricted at least to the range of its USNVC Group (i.e., the southeastern United States).

ASSOCIATION DISTRIBUTION

Global Range: This vegetation is known to occur in the southeastern United States from central Kentucky, Virginia, and Maryland, south through Tennessee, North Carolina, South Carolina, Georgia, and Alabama to Florida and west through Mississippi and Louisiana to eastern Texas, Arkansas, and Oklahoma (Edwards 1982).

States/Provinces: AL, AR, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA

Federal Lands: Department of Defense (Fort Benning); National Park Service (Chickamauga-Chattanooga(?), Cumberland Gap, Natchez Trace, New River Gorge, Vicksburg); Tennessee Valley

Authority (Tellico); U.S. Forest Service (Bankhead, Cherokee, Daniel Boone, George Washington, Jefferson, Oconee(?), Ouachita, Ozark, Talladega)

GLOBAL DESCRIPTION SOURCES

Global Description Authors: A.S. Weakley

References: CAP pers. comm. 1998, Edwards 1982, Fleming and Coulling 2001, Hoagland 1998b, Hoagland 2000, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

PARK NAME: MIXED VINE-SHRUBLAND

USNVC CLASSIFICATION
USNVC Class: Shrubland & Grassland (2)
USNVC Subclass: Temperate & Boreal Shrubland & Grassland (2C)
USNVC Formation: Temperate Grassland, Meadow & Shrubland (2.C.1)
USNVC Division: Southeastern North American Grassland & Shrubland (D102)
USNVC MacroGroup: Southeastern Ruderal Grassland & Shrubland (M307)
USNVC Group: Southeastern Old Field Group (M583)
USNVC Alliance: Unknown
USNVC Association: *Ampelopsis cordata – Vitis cinerea* – Mixed Vines Vine-Shrubland (NPSVICK005)
USNVC Association (English name): Heartleaf Peppervine – Graybark Grape - Mixed Vines Vine-Shrubland
USNVC Association (Common name): Mixed Vine-Shrubland

ASSOCIATION CONCEPT
This is a local description designed as a placeholder for "grape holes" and other vine-dominated vegetation in the vicinity of VICK and perhaps elsewhere in the southeastern United States that is not dominated by native species, or a mix of native and non-native species, rather than by the non-native *Pueraria montana var. lobata* (kudzu vine).

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: At VICK, this association was found in the main unit along Confederate Avenue, just south of Jackson Road, and also in the vicinity of Navy Circle, where it extends outside VICK. It probably occurs elsewhere in small patches along forest edges and in forest canopy gaps. It occurs in small patches that are occasionally larger than the minimum mapping unit for this project (0.25 hectare). It occurs on both relatively level sites and on steep hillsides.
Global Environment: Not known, but, as described, it is likely to occur in similar settings in the southern Bluff Hills and elsewhere on the Gulf Coastal Plain.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: The two stands observed (one classification plot and one 0.25 hectare observation) were dominated by clambering woody and herbaceous vines, with *Vitis cinerea* (graybark grape) and *Ampelopsis cordata* (heartleaf peppervine) at high cover in both stands. *Clematis virginiana* (devil's darning-needles) and the non-native *Polygonum convolvulus* (black bindweed) are important in one stand each. Other vines present in at least one stand are *Ampelopsis arborea* (peppervine), *Brunnichia ovata* (American buckwheat), *Cocculus carolinus* (Carolina coralbead), and the non-native *Lonicera japonica* (Japanese honeysuckle). Trees may be present at low (<40%) cover. American sycamore (*Platanus occidentalis*) and tulip tree (*Liriodendron tulipifera*) each had at least 5% cover at one site. Among low cover shrubs and short trees, the non-native *Melia azedarach* (Chinaberrytree) was present at both sites, while *Acer negundo* (boxelder), the non-native *Broussonetia papyrifera* (paper mulberry), and *Sambucus nigra* ssp. *canadensis* (American black elderberry) occur at

one site. The non-native shrub *Ligustrum sinense* (Chinese privet) has high cover in one stand. Herbaceous stratum cover is low and species composition probably variable.
Global Vegetation: Not known.

Table A10. Synthesis table for all plant species recorded in Mixed Vine-Shrubland at Vicksburg National Military Park (# plots=1; VICK.38).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
Liriodendron tulipifera	tuliptree	Tree	100%	5-10
Acer negundo	boxelder	Shrub	100%	1-2
Melia azedarach	Chinaberrytree	Shrub	100%	1-2
Broussonetia papyrifera	paper mulberry	Shrub	100%	0-1
Sambucus nigra	black elderberry	Shrub	100%	0-1
Ampelopsis cordata	heartleaf peppervine	Vine	100%	25-50
Vitis cinerea	graybark grape	Vine	100%	25-50
*Polygonum convolvulus**	black bindweed	Vine	100%	10-25
Ampelopsis arborea	peppervine	Vine	100%	2-5
Cocculus carolinus	Carolina coralbead	Vine	100%	1-2
*Sorghum halepense**	Johnson grass	Herb	100%	0-1

* - non-native species 1 – range of cover class value for plot (all strata totaled)

CONSERVATION STATUS RANK
Not ranked.
CLASSIFICATION COMMENTS
We follow NPS guidelines (Lea 2011) in recognizing this vegetation as a local expression of a concept that can be applied to a vegetation type over a larger range, but that is not yet addressed well by the USNVC. The single classification plot was originally assigned to a forest type, but is clearly vine-dominated, and the validity and need for a non-native vine-dominated type, at least to be applied at VICK, was confirmed by a similar stand observed in 2009 that did not fit other described types at all.

ASSOCIATION DISTRIBUTION
Global Range: Not known, since the limits of this concept are not known. If described broadly as mixed vine shrublands of forest gaps and edges or invading old fields, the type is likely to be widespread in the southeastern United States.
States/Provinces: MS
Federal Lands: National Park Service (Vicksburg)

PARK NAME: OLD FIELD WOODED HERBACEOUS VEGETATION

USNVC CLASSIFICATION

USNVC Class: Shrubland & Grassland (2)
USNVC Subclass: Temperate & Boreal Shrubland & Grassland (2C)
USNVC Formation: Temperate Grassland, Meadow & Shrubland (2.C.1)
USNVC Division: Southeastern North American Grassland & Shrubland (D102)
USNVC MacroGroup: Southeastern Ruderal Grassland & Shrubland (M307)
USNVC Group: Southeastern Old Field Group (M583)
USNVC Alliance: Unknown
NPS Association: (*Solidago canadensis, Sorghum halepense, Schedonorus phoenix)* Wooded Herbaceous Vegetation (NPSVICK002)
NPS Association (English name): (Canada goldenrod, Johnson Grass, Tall Fescue) Wooded Herbaceous Vegetation (NPSVICK002)
NPS Association (Common name): Old Field Wooded Herbaceous Vegetation

ASSOCIATION CONCEPT

This association includes infrequently mowed fields, rights-of-way, and other herbaceous vegetation at Vicksburg National Military Park, comprised of native and non-native grasses and forns, with occasional patch dominance by invading shrubs. These communities can have low to relatively high species richness. Because the settings receive an intermediate level of anthropogenic diosturbance, individual stands can be quite variable in floristic composition.

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This association occurs in small patches throughout the park. They are mowed by machine from one to three times a year or by hand once every two years (compared to approximately once every two weeks for sites that usually are occupied by the Bahia Grass Herbaceous Vegetation) (Virginia Dubowy, National Park Service – VICK, pers. comm.).
Global Environment: Similar vegetation occupies abandoned fields and pastures and regularly, but infrequently, mowed fields and rights-of-way elsewhere in the southeastern United States.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: This vegetation type is compositionally variable, and undoubtedly includes many more frequent species than the plot data reflect. The abundance of some species across all plots attributed to this type probably reflects the relatively small sample size and some plot placement on stands with local patch dominance (e.g., *Rhus glabra*, *Sorghum halepense*). Generally, the vegetation is herbaceous and dominated by some combination of non-native grasses, including *Sorghum halepense* (Johnson grass), *Schedonorus phoenix* (Tall Fescue), and *Paspalum notatum* (bahia grass) are dominant. The native graminoids such as *Carex cherokeensis* (Cherokee sedge), *Andropogon virginicus* (broomsedge bluestem), and *Tridens flavus* (purpletop tridens), and other species may be present at low cover or may contribute locally high cover. Bermuda grass (*Cynodon dactylon*) may be locally important where it has been seeded for temporary stabilization from erosion. *Solidago canadensis* (Canada goldenrod) is often present and may be patch-dominant. A variety of low cover native forbs

(Table A11) is usually present, and tree seedlings may be present at low cover. Less frequently mowed stands may be partially invaded by successional woody species, particularly *Rhus glabra* (smooth sumac) and *Robinia pseudoacacia* (black locust). Additionally, woody and herbaceous vines often contribute significant cover at less frequently mowed sites, with *Ampelopsis arborea* (peppervine), *Toxicodendron*

Table A11. Synthesis table for all plant species recorded in Old Field Herbaceous Vegetation at Vicksburg National Military Park (# plots=3; VICK.8, VICK.32, VICK.40).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[2]	
Solidago canadensis	Canada goldenrod	Herb	67%	33%	(0-75)
*Sorghum halepense**	Johnson grass	Herb	67%	31%	(0-95)
*Schedonorus phoenix**	tall fescue	Herb	67%	6%	(0-25)
Carex cherokeensis	Cherokee sedge	Herb	67%	0.7%	(0-2)
Quercus nigra [s]	water oak	Herb	67%	0.2%	(0-1)
Elephantopus carolinianus	Carolina elephantsfoot	Herb	33%	3%	(0-10)
*Paspalum notatum**	bahia grass	Herb	33%	3%	(0-10)
Ambrosia trifida	giant ragweed	Herb	33%	0.2%	(0-1)
Andropogon virginicus	broomsedge bluestem	Herb	33%	0.2%	(0-1)
Carya illinoinensis [s]	pecan	Herb	33%	0.2%	(0-1)
*Digitaria ischaemum**	smooth crabgrass	Herb	33%	0.2%	(0-1)
Robinia pseudoacacia [s]	black locust	Herb	33%	0.2%	(0-1)
Sambucus nigra [s]	black elderberry	Herb	33%	0.2%	(0-1)
Setaria parviflora	marsh bristlegrass	Herb	33%	0.2%	(0-1)
Symphyotrichum pilosum	hairy white oldfield aster	Herb	33%	0.2%	(0-1)
Tridens flavus	purpletop tridens	Herb	33%	0.2%	(0-1)
Vernonia gigantea	giant ironweed	Herb	33%	0.2%	(0-1)
Cyperus croceus	Baldwin's flatsedge	Herb	33%	0.01%	(0-trace)
Desmodium perplexum	perplexed ticktrefoil	Herb	33%	0.01%	(0-trace)
Erechtites hieraciifolia	American burnweed	Herb	33%	0.01%	(0-trace)
Lactuca floridana	woodland lettuce	Herb	33%	0.01%	(0-trace)
Quercus pagoda [s]	cherrybark oak	Herb	33%	0.01%	(0-trace)
Solanum carolinense	Carolina horsenettle	Herb	33%	0.01%	(0-trace)
Ulmus alata[s]	winged elm	Herb	33%	0.01%	(0-trace)
Ampelopsis arborea	peppervine	Vine	67%	6%	(0-25)
Toxicodendron radicans	eastern poison-ivy	Vine	67%	3%	(0-10)
*Lonicera japonica**	Japanese honeysuckle	Vine	67%	2%	(0-5)
Cocculus carolinus	Carolina coralbead	Vine	67%	0.3%	(0-1)
Melothria pendula	Guadeloupe cucumber	Vine	33%	3%	(0-10)
Passiflora incarnata	purple passionflower	Vine	33%	3%	(0-10)
Ampelopsis cordata	heartleaf peppervine	Vine	33%	0.5%	(0-2)
Passiflora lutea	yellow passionflower	Vine	33%	0.2%	(0-1)
Rubus argutus	sawtooth blackberry	Vine	33%	0.2%	(0-1)
Rhus glabra	smooth sumac	Shrub	33%	28%	(0-95)

*-non-native species s-primarily seedlings only

2 – mean of single plot cover class midpoint values (all strata); cover range in ()s

radicans (eastern poison-ivy), and *Lonicera japonica* (Japanese honeysuckle) and *Cocculus carolinus* (Carolina coralbead) among the most frequent species.
Global Vegetation: Composition unknown, but undoubtedly dominanted by a mixed of native and non-native, shade intolerant grasses and forbs.

CONSERVATION STATUS RANK
Not ranked.

CLASSIFICATION COMMENTS
We follow NPS guidelines (Lea 2011) in recognizing this vegetation as a local expression of a concept that can be applied to a vegetation type over a larger range, but that is not yet addressed well by the USNVC. Since all USNVC alliance concepts are under review at the time of this report, no alliance membership is suggested. Previously, the USNVC association concepts of CEGL004048 (*Lolium* (*arundinaceum, pratense*)) Herbaceous Vegetation), CEGL004108 (*Sorghum halepense* Herbaceous Vegetation), and *Cynodon dactylon* Herbaceous Vegetation (CEGL004701) were proposed applied to various individual stands, due to patch dominance of individual species. Until more local and global information are available, it seems more practical to treat this as a generalized "old field" type described locally and as a "placeholder" type. The concept of this provisional type is intended to be restricted at least to the range of its USNVC Group (i.e., the southeastern United States).

ASSOCIATION DISTRIBUTION
Global Range: Not known, since the limits of this concept are not known. If described broadly as later successional shrublands or shrub/herbaceous mixes invading old fields, the type is likely to be widespread in the southeastern United States.
States/Provinces: MS
Federal Lands: National Park Service (Vicksburg)

PARK NAME: BAHIA GRASS HERBACEOUS VEGETATION

USNVC CLASSIFICATION
USNVC Class: Shrubland & Grassland (2)
USNVC Subclass: Temperate & Boreal Shrubland & Grassland (2C)
USNVC Formation: Temperate Grassland, Meadow & Shrubland (2.C.1)
USNVC Division: Southeastern North American Grassland & Shrubland (D102)
USNVC MacroGroup: Southeastern Ruderal Grassland & Shrubland (M307)
USNVC Group: Southeastern Old Field Group (M583)
USNVC Alliance: *Paspalum notatum* Herbaceous Alliance (A.1219)
USNVC Alliance (English name): Bahia Grass Herbaceous Alliance
USNVC Association: *Paspalum notatum* Herbaceous Vegetation (CEGL004700)
USNVC Association (English name): Bahia Grass Herbaceous Vegetation

ASSOCIATION CONCEPT
This association represents improved pastures, roadsides and lawns of the southeastern United States Coastal Plain dominated by the introduced grass *Paspalum notatum* (bahia grass), on a wide variety of soils and sites. Various remnant native species occur to varying degrees and are sometimes codominant.

ENVIRONMENTAL DESCRIPTION
Cowardin et al. (1979) Wetland Classification: Not a wetland.
Vicksburg National Military Park Environment: This association occurs throughout VICK, mostly along frequently mowed roadsides and monument areas on ridge crests. The sites are mowed by machine approximately once every two weeks during the growing (compared to three times a year to once every two years for sites that usually are occupied by the Old Field Wooded Herbaceous Vegetation) (Virginia Dubowy, National Park Service – VICK, pers. comm.).
Global Environment: This improved pasture association occurs on a wide variety of soils and sites in uplands of the southeastern Coastal Plain.

VEGETATION DESCRIPTION
Vicksburg National Military Park Vegetation: This vegetation is strongly dominated by *Paspalum notatum* (bahia grass). Occasionally, the native sedges, *Carex cherokeensis* (Cherokee sedge) or *Carex oxylepis* (sharpscale sedge) and/or other grasses may be patch-dominant. A relatively low diversity pool of native and non-native forbs and grasses usually is present at low cover (Table A12).
Global Vegetation: These improved pastures, roadsides and lawns are dominated by *Paspalum notatum* (bahia grass), with varying degrees of native composition remaining. Various remnant native species occur to varying degrees and are sometimes codominant.

CONSERVATION STATUS RANK
GNA (invasive) (25-Jun-1997). This vegetation is dominated by species not native to North America.

ASSOCIATION DISTRIBUTION
Global Range: This improved pasture, roadside, and lawn vegetation is found in the southeastern Coastal Plain, including the states of Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

Table A12. Synthesis table for all plant taxa recorded in Bahia Grass Herbaceous Vegetation at Vicksburg National Military Park (# plots=1; VICK.9).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
*Paspalum notatum**	bahia grass	Herb	100%	95-100
Bowlesia incana	hoary Bowlesia	Herb	100%	trace -1
*Digitaria ischaemum**	smooth crabgrass	Herb	100%	trace -1
Kyllinga sp.	spikesedge	Herb	100%	trace -1
Paspalum praecox	early paspalum	Herb	100%	trace -1
Carex cherokeensis	Cherokee sedge	Herb	100%	trace
Oxalis dillenii	slender yellow woodsorrel	Herb	100%	trace
Sporobolus sp.	dropseed	Herb	100%	trace

* - non-native species 1 – range of cover class value for plot (all strata totaled)

States/Provinces: AL, FL, GA, LA, MS, SC, TX
Federal Lands: Department of Defense (Fort Benning); National Park Service (Natchez Trace Parkway, Vicksburg); U.S. Forest Service (Ocala)

GLOBAL DESCRIPTION SOURCES
Global Description Authors: A.S. Weakley
References: Mulligan pers. comm., Schotz pers. comm., Southeastern Ecology Working Group n.d., Wolfe 1990

PARK NAME: SAND SPIKERUSH HERBACEOUS VEGETATION

USNVC CLASSIFICATION

USNVC Class: Shrubland & Grassland (2)
USNVC Subclass: Temperate & Boreal Shrubland & Grassland (2C)
USNVC Formation: Temperate & Boreal Freshwater Wet Meadow & Marsh (2.C.5)
USNVC Division: Eastern North American Freshwater Wet Meadow, Riparian & Marsh (D030)
USNVC MacroGroup: Eastern North American Wet Meadow and Marsh (M069)
USNVC Group: Eastern North American Wet Meadow Group (G112)
USNVC Alliance: unknown
NPS Association: *Eleocharis montevidensis* Herbaceous Vegetation (NPSVICK003)
NPS Association (English name): Sand Spikerush Herbaceous Vegetation

ASSOCIATION CONCEPT

This is a locally described placeholder for a herbaceous wetland type dominated by *Eleocharis montevidensis* (sand spikerush).

ENVIRONMENTAL DESCRIPTION

Cowardin et al. (1979) Wetland Classification: Palustrine, Emergent, Persistent (probably), Saturated. The hydrophytic (weighted averages) prevalence indices (Gage and Cooper 2010) calculated for the single plot assigned to this association is 1.99 (i.e., hydrophytic).
Vicksburg National Military Park Environment: This vegetation was found in a single small patches, below the size of the minimum mapping unit of 0.25 hectare. It occurs in the main unit of VICK, south of Clay Street. It is an area of groundwater seepage that is also kept open by mowing.
Global Environment: Unknown.

VEGETATION DESCRIPTION

Vicksburg National Military Park Vegetation: This vegetation is strongly dominated by *Eleocharis montevidensis* (sand spikerush), a wetland sedge. A non-native grass that frequently invades wetlands, *Agrostis stolonifera* (creeping bentgrass) is present at substantial cover in the sampled stand. A modest number of other herbs, including wetland species and generalist ruderal opportunists occur at low cover (Table A13).
Global Vegetation: This vegetation type is not recognized by the USNVC at the association level; therefore, no global description is available.

CONSERVATION STATUS RANK

This vegetation type is not recognized by the USNVC at the association level; therefore, no conservation status rank is available. As it occurs at VICK, it is evidently ruderal (maintained by mowing).

CLASSIFICATION COMMENTS

This vegetation is unrelated to other associations observed at VICK, but we found no USNVC association concept that clearly encompasses such vegetation, We follow NPS guidelines (Lea 2011) in recognizing this vegetation as a local expression of a concept that can be applied to a vegetation type over a larger range, but that is not yet addressed well by the USNVC. Since all USNVC alliance concepts are under

Table A13. Synthesis table for all plant species recorded in Sand Spikerush Herbaceous Vegetation at Vicksburg National Military Park (# plots=1; VICK.31).

SPECIES LATIN NAME	SPECIES COMMON NAME	PRIMARY STRATUM	CONSTANCY	ESTIMATED % COVER[1]
Eleocharis montevidensis	sand spikerush	Herb	100%	95-100
*Agrostis stolonifera**	creeping bentgrass	Herb	100%	10-25
Carex cherokeensis	Cherokee sedge	Herb	100%	trace -1
Paspalum leave	field paspalum	Herb	100%	trace -1
Phyla lanceolata	lanceleaf fogfruit	Herb	100%	trace -1
Salix nigra	black willow	Herb	100%	trace
Boehmeria cylindrica	smallspike falsenettle	Herb	100%	trace
*Schedonorus phoenix**	tall fescue	Herb	100%	trace
Mikania scandens	climbing hempvine	Herb	100%	trace
Pluchea odorata	Sweetscent	Herb	100%	trace

* - non-native species 1 – range of cover class value for plot (all strata totaled)

review at the time of this report, no alliance membership is suggested.

ASSOCIATION DISTRIBUTION

Global Range: The range of this vegetation is unknown. As a species, *Eleocharis montevidensis* occurs throughout southern United States along the Gulf Coast, and in the southern Great Plains, arid Southwest, and California.

States/Provinces: MS

Federal Lands: National Park Service (Vicksburg)

Literature Cited (Appendix A only)

ALNHP [Alabama Natural Heritage Program]. 2002. Eufaula National Wildlife Refuge: Natural community and rare plant survey. Alabama Natural Heritage Program, The Nature Conservancy, Montgomery, AL, USA.

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

CAP [Central Appalachian Forest Working Group]. 1998. Central Appalachian Working group discussions. The Nature Conservancy, Boston, MA, USA.

Cowardin, L.M., V. Carter V., F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Report No. FWS/OBS/-79/31.Washington, DC, USA.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin, TX, USA.

Doyle, K. M., and D. J. Allard. 1990. Applying an ecosystem classification on national forest land in the southeastern United States: A pilot study.

Edwards, M. B. 1982. Kudzu--ecological friend or foe: Pueraria lobata in the southern United States. Proceedings of the Southern Weed Science Society 35:232-236.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical report Y-87-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA.

Evans, M. 1991. Kentucky ecological communities. Draft report to the Kentucky Nature Preserves Commission.

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

Faber-Langendoen, D., J. Drake, S. Gawler, M. Hall, G. Kittel, S. Menard, C. Nordman, M. Pyne, M. Reid, L. Sneddon, K. Schulz, J. Teague, M. Russo, K. Snow, P. Comer. 2011. Macrogroups and groups for the revised U.S. National Vegetation Classification (lower 48 states) + appendices. Report to the National Park Service and LANDFIRE. NatureServe, Arlington, VA, USA. (content partially available at http://usnvc.org).

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

Harlow, W. M., E. S. Harrar, F. M. White, and J. W. Hardin. 1991. Textbook of dendrology: Covering the important forest trees of the United States and Canada. 7th edition. McGraw-Hill, Inc., New York, NY, USA.

Heineke, T. E. 1987. The flora and plant communities of the middle Mississippi River Valley. Ph.D. dissertation, Southern Illinois University, Carbondale, IL, USA.

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

Hoagland, B. W. 1998a. Classification of Oklahoma vegetation types. Working draft. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman, OK, USA.

Hoagland, B. W. 1998b. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. Oklahoma Biological Survey. University of Oklahoma, Norman, OK, USA.

Jones, S. M., D. H. Van Lear, and S. K. Cox. 1981. Major forest community types of the Savannah River Plant: A field guide. USDE Savannah River Plant, National Environmental Research Park Program. Report No. SRO-NERP-9.

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

Lea, C. 2011. Vegetation classification guidelines: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/NRPC/NRR—2011/374. National Park Service, Fort Collins, CO, USA.

Mulligan, Maureen. Personal communication. Ecologist, TNC Fort Benning Project, PO Box 52452, Fort Benning, GA, USA.

National Park Service. 2012. National Park Service Procedural Manual #77-1: Wetland Protection.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA, USA. Data current as of 6 April 2007.

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

Oberholster, C. 1993. Preliminary list of natural communities of Alabama. Unpublished document. Alabama Department Conservation and Natural Resources, Natural Heritage Section, Montgomery, AL, USA.

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

Smith, L. M. 1988. The natural communities of Louisiana. Unpublished document. Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, Baton Rouge, LA, USA.

Smith, L. M., compiler. 1996. Natural plant communities in Louisiana currently recognized by the Louisiana Natural Heritage Program. Unpublished document. Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, Baton Rouge, LA, USA.

Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC, USA.

TDNH [Tennessee Division of Natural Heritage].Unpublished data. Tennessee Division of Natural Heritage, Nashville, TN, USA.

TNC [The Nature Conservancy]. 1998. An investigation and assessment of the vegetation of Arnold Air Force Base. Coffee and Franklin counties, Tennessee. The Nature Conservancy, Tennessee Field Office, Nashville, TN, USA.

USFS [U.S. Forest Service]. 1988. Silvicultural examination and prescription field book. USDA Forest Service, Southern Region. Atlanta, GA, USA.

VDNH [Virginia Division of Natural Heritage]. No date. Unpublished data. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA, USA.

Walker. Stephen A. 1997. The vascular flora of Vicksburg National Military Park. Vicksburg, MS, USA.

Wharton, C. H., W. M. Kitchens, E. C. Pendleton, and T. W. Sipe. 1982. The ecology of bottomland hardwood swamps of the Southeast: A community profile. U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS-81/37. Washington, DC, USA.

Wieland, R. G. 1994. Mississippi Natural Heritage Program: Ecological communities. Unpublished document. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson, MS, USA.

Wieland, R. G. 2000. Ecological communities of Mississippi: Mississippi Natural Heritage Program. Unpublished document. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson, MS, USA.

Wolfe, S. H., editor. 1990. An ecological characterization of the Florida Springs Coast: Pithlachascotee to Waccasassa rivers. USDI Fish & Wildlife Service, Biological Report 90(21). Slidell, LA, USA.

Appendix B. Vegetation Field Key, Vicksburg National Military Park

Instructions on use of key:

This key is dichotomous and hierarchical. The user is directed through a number of couplets, starting with couplet 1 and should select whichever side of the couplet (a or b) fits the vegetation best. The user should read ***both*** sides of the couplet (both a and b) before evaluating and proceeding. At several places in this key, the user is asked to consider multiple (2-4) criteria on each side of the couplet. Where these multiple, independent criteria are to be evaluated, criteria on both sides of the couplet may prove to be correct (i.e., the criteria on each couplet side are not necessarily mutually exclusive). In these cases, the user should evaluate each individual criterion independently from the others, consider all criteria on each side of the couplet, and select the couplet side that ***best*** represents the vegetation before proceeding. Answers to couplets will lead to either another couplet to be evaluated in progression or to a vegetation type (final answer). Note that there may be more than one path through the key to arriving at an individual vegetation type.

In some individual statements, the user is asked to estimate the combined (aggregate) cover of several species. In these cases, one, some or all of the named species may be present. For purposes of estimating cover, these multiple species should be considered a single species; if A and B are both species in such a species aggregate, and a part of the cover of species B is overtopped by part of the cover for species A, this portion of the cover for species B should not be counted.

This key is designed to be used in relatively homogeneous stands of vegetation within Vicksburg National Military Park and to be optimally accurate when vegetation is observed at a scale of 0.25 to 1.0 hectares. It will become progressively less reliable at smaller scales. It may not be reliable outside of Vicksburg National Military Park.

It is expected that users of the key can identify all species named in the key (and potential species with which they may be confused at Vicksburg National Military Park). For users with more limited knowledge of the full flora of this site, the keys will likely work adequately if the user omits evaluating all key criteria (e.g., shrub, vine, and herbaceous species for someone who recognizes only trees) that refer to any species unknown to him/her. Do not use a criterion, if you know some, but not all, individual species named in a single criterion. The key also assumes that the user can estimate plant cover relatively accurately and precisely (repeatably).

Keys are imperfect. It is always a good idea to confirm a final keyed answer by reading the corresponding vegetation description corresponding to the keyed type. If an answer seems implausible, one should re-key the stand, examining other possible couplets from those selected the first time through the key.

GLOSSARY OF TERMS USED IN THIS KEY:

Absolute cover: The proportion of an observed area that is underneath (covered by) the canopy of an individual plant species (or a group of plant species). "Underneath" means under the vertical projection down to the ground of the horizontal outline of the foliar crown of the plant species or group. Absolute cover is often regarded as the area outlined by the "drip line" of the crown; small openings between branches and leaves within this outline are generally not subtracted from this area in estimating cover. Cover of individuals of the same applicable species (or the same applicable group) that is overtopped by cover of that same species or group is not counted. As an example of how to estimate absolute cover, if the observation area is 0.25 hectare (2,500 square meters), and the canopy of any eastern red cedar (*Juniperus virginiana*) covers an estimated 150 square meters of this area, then the absolute cover of eastern red cedar over this observation area is calculated and recorded as 6% (150 divided by/ 2,500). Absolute cover for an individual species may not exceed 100% for an observation area (or an individual stratum within an observation area), but the combined absolute cover of multiple or all species may exceed 100%.

Relative cover: The proportion of the total of all absolute cover (all species in the observation area or all species within a specified layer in the observation area) area that is comprised of the species or species group. If a tree layer is comprised of 40% absolute cover of boxelder (*Acer negundo*), 20% cover of sweetgum (*Liquidambar styraciflua*) and 20 % cover of American sycamore (*Platanus occidentalis*), then the ***relative*** cover of boxelder for the observed area is 50% (40% divided by the sum of 40% + 20% + 20%) and the relative cover of the other two species is 25% each. The relative cover for all species for an observation area, or for a specified stratum in an observation area must sum to 100%.

Dominant (dominated by): For purposes of this key, the individual species (or species group) having the highest absolute or relative cover (i.e., the plurality of all cover) of any species or species group within the observation area.

Layer: A grouping of plants within a vegetation stand that have a similar life form and height range. The layers used in this key are tree, shrub, vine, and herbaceous, with the life form groups are defined individually below. Layer is synonymous with stratum.

Trees: For purposes of this key, woody plants generally more than 5 meters tall and usually have multiple stems only in response to past physical damage to the main stem.

Vines: Woody or herbaceous plants with elongated (e.g., more than 1 meter) aerial stems that are not self-supporting. Vines are supported by other plants or creep on the ground.

Shrubs: For purposes of this key, woody plants generally less than 5 meters tall. Shrubs often produce multiple stems in the absence of physical damage to a main stem.

Herbaceous: Non-woody vascular plant species. For purposes of this key, seedlings of woody species that are less than 0.5 meter tall also are included in the herbaceous layer.

Forbs: For purposes of this key, broad-leaved herbaceous plant species (excludes grasses, sedges, and rushes).

Wetlands: Vegetation types in which wetland plant species (those ranked OBL or FACW on National List of plants that occur in wetlands) have higher total cover than do upland plant species (see below).

Uplands: Vegetation types in which non-wetland plant species (those ranked FAC, FACU, or UPL (not listed) on National List of plants that occur in wetlands) have higher total cover than do wetland plant species (see below).

GENERAL VEGETATION KEY

1a. The vegetation is dominated by trees (absolute cover of all tree species combined is greater than or equal to 25%).....go to couplet 2 (Forests Key)

1b. The vegetation is not dominated by trees (absolute cover of all tree species combined is less than 25%.....go to couplet 14 (Shrublands and Herbaceous Vegetation Key)

FORESTS KEY
VICKSBURG NATIONAL MILITARY PARK, MISSISSIPPI

2a. The combined absolute cover of all evergreen tree species exceeds combined absolute cover of all deciduous tree species. Combined absolute cover of evergreens (loblolly pine (*Pinus taeda*) and/or eastern red cedar (*Juniperus virginiana*)) is greater than or equal to 25%. Vegetation is an open canopy of evergreen trees over a herbaceous layer that is dominated by low (less than 0.5 meters tall) grasses…….....**Loblolly Pine Planted Woodland**

2b. Vegetation is not as above. Combined absolute cover of all deciduous tree species exceeds combined absolute cover of all evergreen species. Combined absolute cover of evergreens (loblolly pine (*Pinus taeda*) and/or eastern red cedar (*Juniperus virginiana*)) is less than 25%. Tree layer is closed to partially open. Herbaceous layer dominated by the tall grass giant cane (*Arundinaria gigantea*) or by some mix of grasses and forbs …..……...go to 3

3a. Black willow (*Salix nigra*) is the most abundant species in the tree layer .....…….…….……**Black Willow Floodplain Forest**

3b. Vegetation is not as above. Black willow (*Salix nigra*) is absent or unimportant ……..…….……...go to 4

4a. The combined absolute cover of black locust (*Robinia pseudoacacia*) and/or paper mulberry (*Broussonetia papyrifera*) is greater than 35%..... .....……**Black Locust – Paper Mulberry Successional Forest**

4b. The combined absolute cover of black locust (*Robinia pseudoacacia*) and/or paper mulberry (*Broussonetia papyrifera*) is less than or equal to 35%….....…...go to 5

5a. Boxelder (*Acer negundo*) is the most abundant species in the tree layer…….go to 6

6a. The combination of boxelder (*Acer negundo*) and/or tuliptree (*Liriodendron tulipifera*) has greater than or equal to 40% relative cover and greater than or equal to 40% absolute cover)…….....…**Boxelder Successional Upland Forest**

6b. The combination of boxelder (*Acer negundo*) and/or tuliptree (*Liriodendron tulipifera*) has less than 40% relative cover or less than 40% absolute cover).....go to 7

5b. A species other than boxelder (*Acer negundo*) has the highest absolute cover of any species in the tree layer……....…….…go to 7

7a. Sweetgum (*Liquidambar styraciflua*) has greater than or equal to 50% relative cover and greater than or equal to 60% absolute cover……..……...…… …….....**Sweetgum Successional Forest**

7b. Sweetgum (*Liquidambar styraciflua*) has less than 50% relative cover or less than 60% absolute cover or both……...…….....go to 8

8a. The combined absolute cover of sweetgum (*Liquidambar styraciflua*) and chinkapin oak (*Quercus muehlenbergii*) is less than the combined absolute cover of water oak (*Quercus nigra*) and cherrybark oak (*Quercus pagoda*) ……..……...……**Cherrybark Oak-Water Oak Forest**

8b. The combined absolute cover of sweetgum (*Liquidambar styraciflua*) and chinkapin oak (*Quercus muehlenbergii*) is greater than the combined absolute cover of water oak (*Quercus nigra*) and cherrybark oak (*Quercus pagoda*)…….. go to 9

9a. Consider all four of the following criteria equally:

(1) The combined absolute cover of American sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), and/or red mulberry (*Morus rubra*) is greater than or equal to 20%.

(3) The combined absolute cover of oakleaf hydrangea (*Hydrangea quercifolia*), eastern redbud (*Cercis canadensis*), and/or dogwoods (*Cornus* spp.) is less than 5%.

(4) Either jumpseed (*Polygonum virginianum*) and/or common ladyfern (*Athyrium filix-femina*) are present……..…… ……..…**Sycamore – Sweetgum – Boxelder Small Stream Bottom Forest**

9b. Consider all four of the following criteria equally:

1) The combined absolute cover of American sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), and/or red mulberry (*Morus rubra*) is less than 20%.

(3) The combined absolute cover of oakleaf hydrangea (*Hydrangea quercifolia*), eastern redbud (*Cercis canadensis*), and/or dogwoods (*Cornus* spp.) is greater than or equal to 5%

(4) Jumpseed (*Polygonum virginianum*) and/or common ladyfern (*Athyrium filix-femina*) are both absent……...…… .....**Sweetgum – Chinkapin Oak – Water Oak Forest**

SHRUBLANDS AND HERBACEOUS VEGETATION KEY
VICKSBURG NATIONAL MILITARY PARK, MISSISSIPPI

14a. Vegetation is characterized by shrubs or vines (the absolute cover of all shrub and/or vine species combined is greater than or equal to 35%)……..……...…go to 15

15a. The absolute cover of all vine species combined exceeds the absolute cover of all shrub species combined .....go to 16

16a. The absolute cover of kudzu vine (*Pueraria montana*) is higher than that of all other vine species combined…….……..…...**Kudzu Vine-Shrubland**

16b. The combined total cover of all other vine species is equal to or greater than that of kudzu vine (*Pueraria montana*).…….…..**Mixed Vine-Shrubland**

15b. The absolute cover of all shrub species combined is equal to or exceeds the absolute cover of all vine species combined …...…….……..…….go to 17

17a. Boxelder (*Acer negundo*) (may be shrubby) has the highest absolute cover of all woody species……..**Boxelder Successional Upland Forest (**shrubby variant of this forest type)

17b. A species other than boxelder (*Acer negundo*) has the highest absolute cover of all woody species; smooth sumac (*Rhus glabra*) may be important……... ……..…….……**Old Field Wooded Herbaceous Vegetation**

14b. Vegetation is characterized by herbaceous vegetation (the absolute cover of all shrub and/or vine species combined is less than 35%)……..……...go to 18

18a. Vegetation of wetlands (the absolute cover of obligate and/or facultative wetland species is equal to or exceeds the absolute cover of facultative upland and/or upland species)……..……..... **Sand Spikerush Herbaceous Vegetation**

18b. Vegetation of uplands ((the absolute cover of obligate and/or facultative wetland species is less than the absolute cover of facultative upland and/or upland species) ……..……..……..go to 19

19a. Bahia grass (*Paspalum notatum*) has the highest absolute cover among grass species…….….....…….…….……**Bahia Grass Herbaceous Vegetation**

19b. Neither bahia grass (*Paspalum notatum*) nor Johnson grass (*Sorghum halepense*) has the highest absolute cover among grass species…… ……...……....……..**Old Field Wooded Herbaceous Vegetation**

Appendix C. Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park

Table C1. Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park.

Latin Name	Common (English) Name	Family
Acalypha rhomboidea Raf.	common threeseed mercury	*Euphorbiaceae*
Acer barbatum Michx.	southern sugar maple	*Aceraceae*
Acer negundo L.	boxelder	*Aceraceae*
Acer rubrum L.	red maple	*Aceraceae*
*Ageratina altissima (*L.) King & H. Rob.	white snakeroot	*Asteraceae*
Agrostis stolonifera L.	creeping bentgrass	*Poaceae*
Albizia julibrissin Durazz.	silktree	*Fabaceae*
Allium canadense L.	meadow garlic	*Liliaceae*
Alternanthera philoxeroides (Mart.) Griseb.	alligatorweed	*Amaranthaceae*
Ambrosia trifida L.	great ragweed	*Asteraceae*
*Ampelopsis arborea (*L.) Koehne	peppervine	*Vitaceae*
Ampelopsis cordata Michx.	heartleaf peppervine	*Vitaceae*
Amphicarpaea bracteata (L.) Fernald	American hogpeanut	*Fabaceae*
Andropogon virginicus L.	broomsedge bluestem	*Poaceae*
Aralia spinosa L.	devil's walkingstick	*Araliaceae*
Arisaema dracontium (L.) Schott	green dragon	*Araceae*
Arisaema triphyllum (L.) Schott	Jack in the pulpit	*Araceae*
Aristolochia serpentaria L.	Virginia snakeroot	*Aristolochiaceae*
Arundinaria gigantea (Walter) Muhl.	giant cane	*Poaceae*
Asimina triloba (L.) Dunal	pawpaw	*Annonaceae*
Asplenium platyneuron (L.) Britton, Sterns & Poggenb.	ebony spleenwort	*Aspleniaceae*
Athyrium filix-femina (L.) Roth	common ladyfern	*Dryopteridaceae*
Berchemia scandens (Hill) K. Koch	Alabama supplejack	*Rhamnaceae*
Bidens bipinnata L.	Spanish needles	*Asteraceae*
Bignonia capreolata L.	crossvine	*Bignoniaceae*
Boehmeria cylindrica (L.) Sw.	smallspike false nettle	*Urticaceae*
Botrychium biternatum (Sav.) Underw.	sparselobe grapefern	*Ophioglossaceae*
Botrychium dissectum Spreng.	cutleaf grapefern	*Ophioglossaceae*
Botrychium virginianum (L.) Sw.	rattlesnake fern	*Ophioglossaceae*
Bowlesia incana Ruiz & Pav.	hoary bowlesia	*Apiaceae*
Broussonetia papyrifera (L.) L'Hér. ex Vent.	paper mulberry	*Moraceae*
Brunnichia ovata (Walter) Shinners	American buckwheat vine	*Polygonaceae*
Callicarpa americana L.	American beautyberry	*Verbenaceae*
Calycocarpum lyonii (Pursh) A. Gray	cupseed	*Menispermaceae*
Carex cephalophora Muhl. *ex* Willd.	oval-leaf sedge	*Cyperaceae*
Carex cherokeensis Schwein.	Cherokee sedge	*Cyperaceae*
Carex digitalis Willd.	slender woodland sedge	*Cyperaceae*
Carex oxylepis Torr. & Hook.	sharpscale sedge	*Cyperaceae*
Carpinus caroliniana Walter	American hornbeam	*Betulaceae*

Table C1 (cont.). Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park.

Latin Name	Common (English) Name	Family
Carya aquatica (Michx. *f.*) Nutt.	water hickory	*Juglandaceae*
Carya cordiformis (Wangenh.) K. Koch	bitternut hickory	*Juglandaceae*
Carya glabra (Mill.) Sweet	pignut hickory	*Juglandaceae*
Carya illinoinensis (Wangenh.) K. Koch	pecan	*Juglandaceae*
Celastrus scandens L.	American bittersweet	*Celastraceae*
Celtis laevigata Willd.	sugarberry	*Ulmaceae*
Cephalanthus occidentalis L.	common buttonbush	*Rubiaceae*
Cercis canadensis L.	eastern redbud	*Fabaceae*
Clematis virginiana L.	devil's darning needles	*Ranunculaceae*
Cocculus carolinus (L.) DC.	Carolina coralbead	*Menispermaceae*
Conoclinium coelestinum (L.) DC.	blue mistflower	*Asteraceae*
Cornus alternifolia L. *f.*	alternateleaf dogwood	*Cornaceae*
Cornus drummondii C.A. Mey.	roughleaf dogwood	*Cornaceae*
Cornus florida L.	flowering dogwood	*Cornaceae*
Cryptotaenia canadensis (L.) DC.	Canada honewort	*Apiaceae*
Cynanchum laeve (Michx.) Pers.	honeyvine	*Asclepiadaceae*
Cynoglossum virginianum L.	wild comfrey	*Boraginaceae*
Cyperus croceus Vahl	Baldwin's flatsedge	*Cyperaceae*
Cyrtomium fortunei J. Sm.	Asian netvein hollyfern	*Dryopteridaceae*
Cystopteris protrusa (Weath.) Blasdell	lowland bladderfern	*Dryopteridaceae*
Desmodium canescens (L.) DC.	hoary ticktrefoil	*Fabaceae*
Desmodium perplexum B.G. Schub.	perplexed ticktrefoil	*Fabaceae*
Dichanthelium boscii (Poir.) Gould & C.A. Clark	Bosc's panicgrass	*Poaceae*
Dichanthelium longiligulatum (Nash) Freckmann	coastal plain panicgrass	*Poaceae*
Dichondra carolinensis Michx.	Carolina ponysfoot	*Convolvulaceae*
Digitaria ciliaris (Retz.) Koeler	southern crabgrass	*Poaceae*
Digitaria filiformis (L.) Koeler	slender crabgrass	*Poaceae*
Digitaria ischaemum (Schreb.) Schreb. *ex* Muhl.	smooth crabgrass	*Poaceae*
Dioscorea villosa L.	wild yam	*Dioscoreaceae*
Diospyros virginiana L.	eastern persimmon	*Ebenaceae*
Diplazium pycnocarpon (Spreng.) Broun	glade fern	*Dryopteridaceae*
Duchesnea indica (Andrews) Focke	Indian strawberry	*Rosaceae*
Eleocharis montevidensis Kunth	sand spikerush	*Cyperaceae*
Elephantopus carolinianus Raeusch.	Carolina elephantsfoot	*Asteraceae*
Elephantopus tomentosus L.	devil's grandmother	*Asteraceae*
Elymus virginicus L.	Virginia wildrye	*Poaceae*
Erechtites hieraciifolia (L.) Raf. *ex* DC.	American burnweed	*Asteraceae*
Euonymus americanus L.	bursting-heart	*Celastraceae*
Eupatorium serotinum Michx.	late thoroughwort	*Asteraceae*
Firmiana simplex (L.) W. Wight	Chinese parasoltree	*Sterculiaceae*
Fleischmannia incarnata (Walter) King & H. Rob.	pink thoroughwort	*Asteraceae*
Forestiera acuminata (Michx.) Poir.	eastern swampprivet	*Oleaceae*
Frangula caroliniana (Walter) A. Gray	Carolina buckthorn	*Rhamnaceae*

Table C1 (cont.). Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park.

Latin Name	Common (English) Name	Family
Fraxinus americana L.	white ash	*Oleaceae*
Gelsemium sempervirens (L.) W.T. Aiton	evening trumpetflower	*Loganiaceae*
Geum canadense Jacq.	white avens	*Rosaceae*
Gleditsia triacanthos L.	honeylocust	*Fabaceae*
Hedera helix L.	English ivy	*Araliaceae*
Hibiscus moscheutos L.	crimsoneyed rosemallow	*Malvaceae*
Hydrangea arborescens L.	wild hydrangea	*Hydrangeaceae*
Hydrangea quercifolia Bartram	oakleaf hydrangea	*Hydrangeaceae*
Ilex decidua Walter	possumhaw	*Aquifoliaceae*
Juglans nigra L.	black walnut	*Juglandaceae*
Juniperus virginiana L.	eastern redcedar	*Cupressaceae*
Lactuca canadensis L.	Canada lettuce	*Asteraceae*
Lactuca floridana (L.) Gaertn.	woodland lettuce	*Asteraceae*
Lagerstroemia indica L.	crapemyrtle	*Lythraceae*
Leersia virginica Willd.	whitegrass	*Poaceae*
Ligustrum japonicum Thunb.	Japanese privet	*Oleaceae*
Ligustrum lucidum W.T. Aiton	glossy privet	*Oleaceae*
Ligustrum sinense Lour.	Chinese privet	*Oleaceae*
Lindera benzoin (L.) Blume	northern spicebush	*Lauraceae*
Linum striatum Walter	ridged yellow flax	*Linaceae*
Liquidambar styraciflua L.	sweetgum	*Hamamelidaceae*
Liriodendron tulipifera L.	tuliptree	*Magnoliaceae*
Lonicera fragrantissima Lindl. & Paxton	sweet breath of spring	*Caprifoliaceae*
Lonicera japonica Thunb.	Japanese honeysuckle	*Caprifoliaceae*
Magnolia grandiflora L.	southern magnolia	*Magnoliaceae*
Mahonia bealei (Fortune) Carrière	Beale's barberry	*Berberidaceae*
Matelea gonocarpos (Walter) Shinners	angularfruit milkvine	*Asclepiadaceae*
Melia azedarach L.	Chinaberrytree	*Meliaceae*
Melothria pendula L.	Guadeloupe cucumber	*Cucurbitaceae*
Microstegium vimineum (Trin.) A. Camus	Nepalese browntop	*Poaceae*
Mikania scandens (L.) Willd.	Climbing hempvine	*Asteraceae*
Morus rubra L.	red mulberry	*Moraceae*
Nandina domestica Thunb.	sacred bamboo	*Berberidaceae*
Oplismenus hirtellus (L.) P. Beauv.	basketgrass	*Poaceae*
Ostrya virginiana (*Mill.*) K. Koch	eastern hophornbeam	*Betulaceae*
Oxalis dillenii Jacq.	slender yellow woodsorrel	*Oxalidaceae*
Oxalis stricta L.	common yellow oxalis	*Oxalidaceae*
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	*Vitaceae*
Paspalum laeve Michx.	field paspalum	*Poaceae*
Paspalum notatum Flueggé	bahia grass	*Poaceae*
Paspalum praecox Walter	early paspalum	*Poaceae*

Table C1 (cont.). Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park.

Latin Name	Common (English) Name	Family
Passiflora incarnata L.	purple passionflower	*Passifloraceae*
Passiflora lutea L.	yellow passionflower	*Passifloraceae*
Perilla frutescens (L.) Britton	beefsteakplant	*Lamiaceae*
Phaseolus polystachios (L.) Britton, Sterns & Poggenb.	thicket bean	*Fabaceae*
Phryma leptostachya L.	American lopseed	*Verbenaceae*
Phyla lanceolata (Michx.) Greene	lanceleaf fogfruit	*Verbenaceae*
Phytolacca americana L.	American pokeweed	*Phytolaccaceae*
Pilea pumila (L.) A. Gray	Canadian clearweed	*Urticaceae*
Pinus taeda L.	loblolly pine	*Pinaceae*
Planera aquatica J.F. Gmel.	planertree	*Ulmaceae*
Platanus occidentalis L.	American sycamore	*Platanaceae*
Pleopeltis polypodioides (L.) Andrews & Windham	resurrection fern	*Polypodiaceae*
Pluchea odorata (L.) Cass.	sweetscent	*Asteraceae*
Polygonum convolvulus L.	black bindweed	*Polygonaceae*
Polygonum punctatum Elliot	dotted smartweed	*Polygonaceae*
Polygonum virginianum L.	jumpseed	*Polygonaceae*
Polystichum acrostichoides (Michx.) Schott	Christmas fern	*Dryopteridaceae*
Poncirus trifoliata (L.) Raf.	hardy orange	*Rutaceae*
Populus deltoides Bartram *ex* Marsh.	eastern cottonwood	*Salicaceae*
Prunus caroliniana Aiton	Carolina laurelcherry	*Rosaceae*
Prunus serotina Ehrh.	black cherry	*Rosaceae*
Pteris multifida Poir.	spider brake	*Pteridaceae*
Pueraria montana (Lour.) Merr.	kudzu	*Fabaceae*
Quercus alba L.	white oak	*Fagaceae*
Quercus michauxii Nutt.	swamp chestnut oak	*Fagaceae*
Quercus muehlenbergii Engelm.	chinkapin oak	*Fagaceae*
Quercus nigra L.	water oak	*Fagaceae*
Quercus pagoda Raf.	cherrybark oak	*Fagaceae*
Quercus rubra L.	northern red oak	*Fagaceae*
Quercus shumardii Buckley	Shumard's oak	*Fagaceae*
Quercus velutina Lam.	eastern black oak	*Fagaceae*
Ranunculus recurvatus Poir.	blisterwort	*Ranunculaceae*
Rhus glabra L.	smooth sumac	*Anacardiaceae*
Robinia pseudoacacia L.	black locust	*Fabaceae*
Rubus argutus Link	sawtooth blackberry	*Rosaceae*
Rubus flagellaris Willd.	northern dewberry	*Rosaceae*
Rubus trivialis Michx.	southern dewberry	*Rosaceae*
Salix nigra Marsh.	black willow	*Salicaceae*
Sambucus nigra L. *ssp. canadensis* (L.) R. Bolli	American black elderberry	*Caprifoliaceae*
Sanicula canadensis L.	Canadian blacksnakeroot	*Apiaceae*
Sassafras albidum (Nutt.) Nees	sassafras	*Lauraceae*
Saururus cernuus L.	lizard's tail	*Saururaceae*

Table C1 (cont.). Vascular Plant Species Observed in Vegetation Plots, Vicksburg National Military Park.

Latin Name	Common (English) Name	Family
Schedonorus phoenix (Scop.) Holub	tall fescue	*Poaceae*
Scleria oligantha Michx.	littlehead nutrush	*Cyperaceae*
Setaria parviflora (Poir.) Kerguélen	marsh bristlegrass	*Poaceae*
Sicyos angulatus L.	oneseed bur cucumber	*Cucurbitaceae*
Sideroxylon lycioides L.	buckthorn bully	*Sapotaceae*
Smallanthus uvedalius (L.) Mack. *ex* Small	hairy leafcup	*Asteraceae*
Smilax bona-nox L.	saw greenbrier	*Smilacaceae*
Smilax glauca Walter	cat greenbrier	*Smilacaceae*
Smilax rotundifolia L.	roundleaf greenbrier	*Smilacaceae*
Smilax smallii Morong	lanceleaf greenbrier	*Smilacaceae*
Smilax tamnoides L.	bristly greenbrier	*Smilacaceae*
Solanum carolinense L.	Carolina horsenettle	*Solanaceae*
Solanum ptycanthum Dunal	West Indian nightshade	*Solanaceae*
Solidago canadensis L.	Canada goldenrod	*Asteraceae*
Sorghum halepense (L.) Pers.	Johnson grass	*Poaceae*
Symphyotrichum drummondii (Lindl.) G.L. Nesom	Drummond's aster	*Asteraceae*
Symphyotrichum lateriflorum (L.) A. Löve & D. Löve	calico aster	*Asteraceae*
Symphyotrichum pilosum (Willd.) G.L. Nesom	hairy white oldfield aster	*Asteraceae*
Symphyotrichum undulatum (L.) G.L. Nesom	wavyleaf aster	*Asteraceae*
Taxodium distichum (L.) Rich.	bald cypress	*Cupressaceae*
Thelypteris kunthii (Desv.) Morton	Kunth's maiden fern	*Thelypteridaceae*
Tilia americana L. var. *caroliniana* (Mill.) CastigL.	Carolina basswood	*Tiliaceae*
Toxicodendron radicans (L.) Kuntze	eastern poison ivy	*Anacardiaceae*
Trachelospermum difforme (Walter) A. Gray	climbing dogbane	*Apocynaceae*
Tridens flavus (L.) Hitchc.	purpletop tridens	*Poaceae*
Ulmus alata Michx.	winged elm	*Ulmaceae*
Ulmus americana L.	American elm	*Ulmaceae*
Ulmus rubra Muhl.	slippery elm	*Ulmaceae*
Verbesina occidentalis (L.) Walter	yellow crownbeard	*Asteraceae*
Vernonia gigantea (Walter) Trel.	giant ironweed	*Asteraceae*
Viburnum rufidulum Raf.	rusty blackhaw	*Caprifoliaceae*
Vinca major L.	bigleaf periwinkle	*Apocynaceae*
Viola affinis Leconte	sand violet	*Violaceae*
Viola sororia Willd.	common blue violet	*Violaceae*
Viola triloba Schwein.	three-lobe violet	*Violaceae*
Viola walteri House	prostrate blue violet	*Violaceae*
Vitis cinerea (Engelm.) Engelm. *ex* Millard	graybark grape	*Vitaceae*
Vitis rotundifolia Michx.	muscadine grape	*Vitaceae*
Vitis vulpina L.	frost grape	*Vitaceae*
Wisteria sinensis (*Sims*) DC.	Chinese wisteria	*Fabaceae*
Woodsia obtusa (*Spreng.*) Torr.	bluntlobe cliff fern	*Dryopteridaceae*
Xanthium strumarium L.	rough cocklebur	*Asteraceae*
Zanthoxylum americanum Mill.	common pricklyash	*Rutaceae*

Appendix D. Thematic Accuracy Assessment Contingency Tables

Table D1. Sample (raw counts) Contingency Table, USNVC Association Level, Vicksburg National Military Park.

	Loblolly Pine Planted Woodland	Black Locust – Paper Mulberry Successional Forest	Boxelder Upland Successional Forest	Sweetgum Successional Forest	Cherrybark Oak - Water Oak Forest	Sweetgum - Pecan - Water Oak Forest	Sycamore-Sweetgum-Boxelder Small Stream Bottom Forest	Black Willow Floodplain Forest	Bahia Grass Herbaceous Vegetation	Old Field Wooded Herbaceous Vegetation	GRAND TOTALS, SAMPLE DATA VALUES ($n_{i\bullet}$)
Loblolly Pine Planted Woodland											**0**
Black Locust – Paper Mulberry Successional Forest		5	1								**6**
Boxelder Upland Successional Forest			2								**2**
Sweetgum Successional Forest				1							**1**
Cherrybark Oak - Water Oak Forest			1	1	16	15					**33**
Sweetgum - Pecan - Water Oak Forest			1		8	19	3				**31**
Sycamore-Sweetgum-Boxelder Small Stream Bottom Forest			1	0.5	1	2.5	6				**11**
Black Willow Floodplain Forest								6			**6**
Bahia Grass Herbaceous Vegetation									19	8	**27**
Old Field Wooded Herbaceous Vegetation											**0**
GRAND TOTALS, REFERENCE DATA VALUES ($n_{\bullet j}$)	**0**	**5**	**6**	**2.5**	**25**	**36.5**	**9**	**6**	**19**	**8**	**Total (n): 117**

Sample data (map class) counts in rows by class. Reference data (field class) counts in columns by class. Gray cells are correctly mapped combinations. One observation was split between two different reference data labels (see Subsection 2.3.3).

Table D2. Population Contingency Table and Thematic Accuracy Statistics, USNVC Association Level, Vicksburg National Military Park.

1 - Confidence limits are reported as 0%, if calculated value is less than 0%; confidence limits are reported as 100%, if calculated value exceeds 100%.	Loblolly Pine Planted Woodland	Black Locust – Paper Mulberry Successional Forest	Boxelder Upland Successional Forest	Sweetgum Successional Forest	Cherrybark Oak - Water Oak Forest	Sweetgum - Pecan - Water Oak Forest	Sycamore-Sweetgum-Boxelder Small Stream Bottom Forest	Black Willow Floodplain Forest	Bahia Grass Herbaceous Vegetation	Old Field Wooded Herbaceous Vegetation	MAP AREAS ($A_{i\bullet}$) (hectares)	POINT ESTIMATE OF MAP CLASS USERS' ACCURACY	LOWER LIMIT, 90% CONFIDENCE INTERVAL	UPPER LIMIT, 90% CONFIDENCE INTERVAL
Loblolly Pine Planted Woodland	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.2	N/A	N/A	N/A
Black Locust – Paper Mulberry Successional Forest	0%	1.37%	0.27%	0%	0%	0%	0%	0%	0%	0%	10.6	83.3%	50.0%	100.0%
Boxelder Upland Successional Forest	0%	0%	0.43%	0%	0%	0%	0%	0%	0%	0%	2.8	100.0%	75.0%	100.0%
Sweetgum Successional Forest	0%	0%	0%	0.20%	0%	0%	0%	0%	0%	0%	1.3	100.0%	50.0%	100.0%
Cherrybark Oak - Water Oak Forest	0%	0%	0.72%	0.72%	11.54%	10.82%	0%	0%	0%	0%	153.5	48.5%	32.7%	64.3%
Sweetgum - Pecan - Water Oak Forest	0%	0%	1.76%	0%	14.10%	33.49%	5.29%	0%	0%	0%	353.5	61.3%	45.3%	77.3%
Sycamore-Sweetgum-Boxelder Small Stream Bottom Forest	0%	0%	0.29%	0.14%	0.29%	0.71%	1.71%	0%	0%	0%	20.2	54.5%	25.3%	83.8%
Black Willow Floodplain Forest	0%	0%	0%	0%	0%	0%	0%	1.43%	0%	0%	9.2	100.0%	91.7%	100.0%
Bahia Grass Herbaceous Vegetation	0%	0%	0%	0%	0%	0%	0%	0%	10.35%	4.36%	95.9	70.4%	54.1%	86.7%
Old Field Wooded Herbaceous Vegetation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40.3	N/A	N/A	N/A
TRUE AREA ESTIMATE (A_j) (hectares)	0.2	8.8	22.4	6.9	167.2	290.8	45.1	9.2	66.8	68.7	OVERALL ACCURACY: 60.5% 90% CONF. INTERVAL: 51.6%-69.4%			
POINT ESTIMATE, PRODUCER'S ACCURACY	N/A	100.0%	12.3%	18.7%	44.5%	74.4%	24.5%	100.0%	100.0%	0.0%				
LOWER LIMIT, 90% CONFIDENCE INTERVAL	N/A	99.6%	11.4%	18.6%	37.5%	68.2%	21.2%	100.0%	98.1%	0.0%	KAPPA ACCURACY: 54.4% 90% CONF. INTERVAL: 45.2%-63.7%			
UPPER LIMIT, 90% CONFIDENCE INTERVAL	N/A	100.0%	13.2%	18.9%	51.5%	80.6%	27.7%	100.0%	100.0%	0.0%				

Sample data (map class) totals in rows and reference data (field class) totals in columns by class. Gray cells are correctly mapped combinations

Table D3. Sample (raw counts) Contingency Table, USNVC Group Level, Vicksburg National Military Park.

	Southeast Conifer & Hardwood Plantation Group	Southeast Hardwood & Conifer Ruderal Forest Group	South-Central Coastal Plain Mesophytic Forest Group	Silver Maple - Green Ash - Sycamore Floodplain Group	Eastern Cottonwood - Black Willow Flooded & Swamp Group t	Southeastern Old Field Group	GRAND TOTALS, SAMPLE DATA VALUES ($n_{i\bullet}$)
Southeast Conifer & Hardwood Plantation Group							**0**
Southeast Hardwood & Conifer Ruderal Forest Group		**9**					**9**
South-Central Coastal Plain Mesophytic Forest Group		**3**	**58**	**3**			**64**
Silver Maple - Green Ash - Sycamore Floodplain Group		**1.5**	**3.5**	**6**			**11**
Eastern Cottonwood - Black Willow Flooded & Swamp Group					**6**		**6**
Southeastern Old Field Group						**27**	**27**
GRAND TOTALS, REFERENCE DATA VALUES ($n_{\bullet j}$)	**0**	**12.5**	**61.5**	**9**	**6**	**27**	**Total Observations (n): 117**

Sample data (map class) counts in rows by class. Reference data (field class) counts in columns by class. Gray cells are correctly mapped combinations. One observation was split between two different reference data labels (see Subsection 2.3.3).

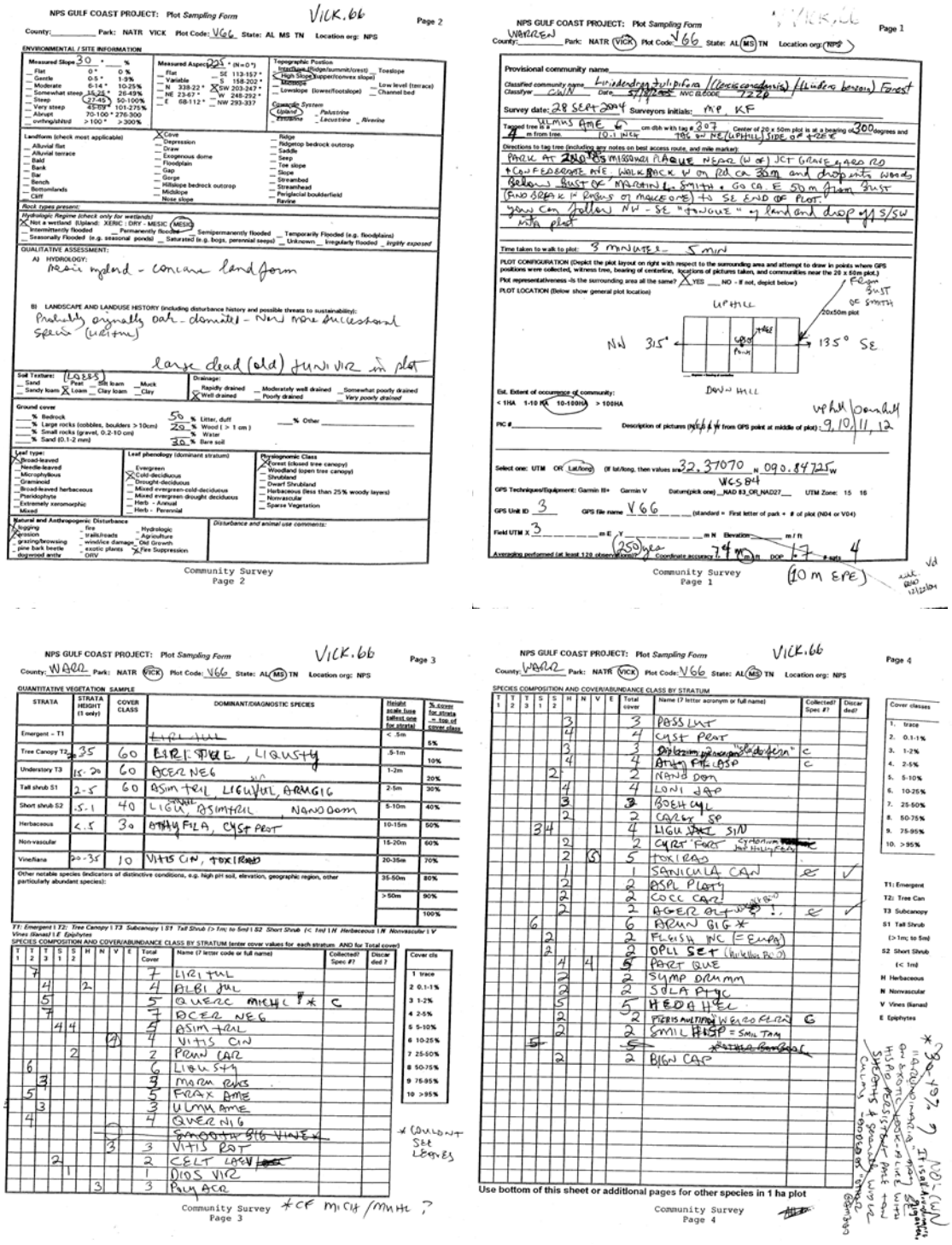
Note that cell totals are, in some cases, aggregations of individual simple random samples, and parts of the cell totals have been sampled at different densities (i.e., constitute a stratified design).

Table D4. Population Contingency Table and Thematic Accuracy Statistics, USNVC Group Level, Vicksburg National Military Park.

1 - Confidence limits are reported as 0%, if calculated value is less than 0%; confidence limits are reported as 100%, if calculated value exceeds 100%.	Southeast Conifer & Hardwood Plantation Group	Southeast Hardwood & Conifer Ruderal Forest Group	South-Central Coastal Plain Mesophytic Forest Group	Silver Maple - Green Ash - Sycamore Floodplain Group	Eastern Cottonwood - Black Willow Flooded & Swamp Group t	Southeastern Old Field Group	MAP AREAS ($A_{i\bullet}$) (hectares)	POINT ESTIMATE OF MAP CLASS USERS' ACCURACY	LOWER LIMIT, 90% CONFIDENCE INTERVAL[1]	UPPER LIMIT, 90% CONFIDENCE INTERVAL[1]
Southeast Conifer & Hardwood Plantation Group	0%	0%	0%	0%	0%	0%	0.2	N/A	N/A	N/A
Southeast Hardwood & Conifer Ruderal Forest Group	0%	4.53%	0%	0%	0%	0%	14.7	100.0%	94.4%	100.0%
South-Central Coastal Plain Mesophytic Forest Group	0%	3.21%	69.96%	5.29%	0%	0%	507.0	89.2%	84.5%	93.9%
Silver Maple - Green Ash - Sycamore Floodplain Group	0%	0.43%	1.00%	1.71%	0%	0%	20.2	58.3%	39.9%	76.7%
Eastern Cottonwood - Black Willow Flooded & Swamp Group	0%	0%	0%	0%	1.43%	0%	9.2	100.0%	91.7%	100.0%
Southeastern Old Field Group	0%	0%	0%	0%	0%	14.71%	136.2	100.0%	98.1%	100.0%
TRUE AREA ESTIMATE (A_j) (hectares)	0.2	38.1	458.0	45.1	9.2	135.5	OVERALL ACCURACY: 92.4%			
POINT ESTIMATE, PRODUCER'S ACCURACY	N/A	26.1%	98.7%	24.5%	100.0%	100.0%	90% CONF. INTERVAL: 82.6%-100.0%			
LOWER LIMIT, 90% CONFIDENCE INTERVAL, PRODUCERS' ACCURACY[1]	N/A	8.7%	96.4%	5.7%	91.7%	98.1%				
UPPER LIMIT, 90% CONFIDENCE INTERVAL, PRODUCERS' ACCURACY[1]	N/A	43.5%	100.0%	43.3%	100.0%	100.0%				

Sample data (map class) counts in rows by class. Reference data (field class) counts in columns by class. Gray cells indicate correctly mapped combinations.

Appendix E. Examples of Field Forms



Fgure 17. Example of vegetation classification plot field form used at Vicksburg National Military Park.

NPS VEGETATION MAPPING PROGRAM: ACCURACY ASSESSMENT POINT FORM 07-08

Park Code: VICK State Code: MS County Name Warren

Survey Date 8/10/2009 Time 6:16 pm

Surveyors Carl Nordman

Database Point Name VICK_AA_76 New Field Point Name V76

Choose one: LAT/LON / (UTM); Choose one: (NAD83) / NAD27 / WGS84; WAAS enabled (Y) N

GPS Unit: Garmin V # 300 Averaging? (Y) N 180 iterations

GPS DATA: X 0701688 Y 3579863 **GPS Accuracy** ±3 m

Elev 182 m/(ft) UTM ZONE (15) 4 Satellites

Is the area of the veg type being assessed around the point at least equivalent to 1 MMU? **Y N**
(e.g. is the vegetation very patchy; and/or is the point near the edge of buffered polygon)

Is the polygon at least 1 MMU? **Y N** (STRI MMU = 0.5 ha)

Provisional Veg Assoc Name Liquidambar styraciflua Forest Veg Key Fit: (H) **M L**

Final Veg Assoc Name (OFFICE USE ONLY)

Fit: (H) **M L** Confidence: (H) **M L**

Classification Comments *(explain Veg Key Fit if it is M or L)*:

Choose one: (Forest) Woodland Shrubland Herbaceous

List % cover each species >= 10% cover, to the closest 10% (i.e. 5%, 10%, 20%, 30%)

Dominant Canopy Trees: Liquidambar sty 60% Carya ill 10%
Liriodendron tul 10%

Dominant subcanopy Trees: Acer neg 20% Liquidambar sty 20%

Dominant Shrubs: Ligustrum sinense 30%

Dominant Herbaceous:

Notes (continue on back if needed); map or diagram of polygon and area of assessment

Figure 18. Example of thematic accuracy assessment field form used at Vicksburg National Military Park in 2009.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

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