



Vegetation Mapping at Moores Creek National Battlefield

Natural Resource Data Series NPS/SECN/NRDS—2012/319



ON THE COVER

Bridge crossing in Moores Creek National Battlefield.
Photograph by Rachel McManamay

Vegetation Mapping at Moores Creek National Battlefield

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May 2012

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

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Please cite this publication as:

McManamay, R. H., A. Curtis, and M. W. Byrne. 2012. Vegetation mapping at Moores Creek National Battlefield. Natural Resource Data Series NPS/SECN/NRDS—2012/319. National Park Service, Fort Collins, Colorado.

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Executive Summary

The Southeast Coast Network (SECN) worked with the support of the National Park Service (NPS) Vegetation Inventory Program (VIP) to describe and map vegetation at Moores Creek National Battlefield (MOCR). This mapping effort was accomplished through collaboration with the Southeast regional office of NatureServe (Raleigh/Durham, NC).

The mapping area is 70 hectares (173 ac), encompassing the entire boundary of MOCR and an additional buffered area of adjacent private lands. NatureServe ecologists identified plant associations for MOCR and a remote sensing specialist from the SECN completed the vegetation mapping using 1:12,000-scale, color infrared aerial photography and digital orthophotography. NatureServe collected vegetation and environmental data from 12 vegetation classification plots, and the remote sensing specialist assessed 35 observation points. SECN network staff conducted an accuracy assessment (AA), which entailed sampling 54 additional points. Fieldwork and mapping were completed between 2005 and 2011.

A total of 17 map classes were developed to map the vegetation and general land cover of MOCR and surroundings, including the following: 10 map classes representing natural/semi-natural vegetation at the association level in the National Vegetation Classification System (NVCS), one map class representing cultural vegetation (e.g., developed) in the NVCS, and six map classes representing non-vegetated units (e.g., open water bodies, buildings, roads, etc.). Features were interpreted using 1:12,000 scale digital color-infrared aerial photography (flown 31 May 2009) through heads-up-digitizing in ArcGIS (Version 9.3, © 2008 Environmental Systems Research Institute, Redlands, California). Polygons were mapped to a 0.5-ha minimum mapping unit (MMU).

A geodatabase containing various feature class layers and tables show the locations of vegetation types and general land cover (vegetation map), vegetation plot samples, AA sites, project boundary extent, and aerial photographic centers. The feature class layer for the MOCR vegetation map provides 83 polygons of detailed attribute data covering 70 ha, with an average polygon size of 2.2 hectares (5.4 ac). Of the area mapped, 49 polygons (59% of all polygons) represent natural/semi-natural vegetation types in the NVCS, encompassing 52.1 hectares (128.7 ac, 75.8%) of the total map extent.

Summary reports generated from the vegetation map layer indicate that the Early to Mid-Successional Loblolly Pine Forest dominates the vegetated landscape (22 polygons covering 57.6 ac), with the Atlantic Coastal Plain Bald-cypress-Blackgum Swamp also covering a considerable portion of the park (four polygons totaling 40.6 ac). The Early-to Mid-Successional Loblolly Pine Forest is common on the drier upland areas, whereas the Atlantic Coastal Plain Bald-cypress-Blackgum Swamp is generally found along the floodplain of Moores Creek.

A thematic accuracy assessment (AA) study was conducted on the nine map classes within the boundary of MOCR representing floristic types within the NVCS. Results present an over-all accuracy of 97.7% (Kappa statistic = 86.9%) based on data from 54 AA sites.

Products resulting from the MOCR vegetation mapping project include:

Available in this report:

- Project summary of methods and results
- Illustrated photo-interpretation guide
- Detailed descriptions of vegetation associations
- Samples of field forms

Available elsewhere¹:

- Geodatabase containing map polygon attribute, aerial photography flight lines, plot data and monument and project boundaries.
- Ground photography of vegetation plots, observation points, and accuracy assessment points in hard copy and digital formats.
- All field data (plot, observation point, and accuracy assessment point) stored in the Microsoft Access PLOTS database.
- Hard copy vegetation maps.
- Hard copy orthophotographs in DOQQ format and stereo aerial photograph prints.
- Metadata for all digital products.

Geospatial products are in the Universal Transverse Mercator (UTM) projection, Zone 17, using the North American datum of 1983.

¹ Products and additional information can be found at the following websites
<http://irma.nps.gov/Reference.mvc/Profile?Code=209727>
<http://biology.usgs.gov/npsveg/>

Acknowledgments

Funding for this project was provided by the National Park Service Vegetation Inventory Program. The Southeast regional office of NatureServe (Raleigh/Durham, NC) completed the field survey and other tasks associated with the vegetation classification portion of the mapping project. The Southeast Coast Network completed the vegetation mapping and accuracy assessment. Special thanks to the staff of Moores Creek National Battlefield for their cooperation with this project. Specific thanks to Integrated Resource Manager James Sutton for his time answering questions regarding historical and current vegetation management activities within the park.

Introduction

Moore's Creek National Battlefield Vegetation Mapping Project

The Moore's Creek National Battlefield (MOCR) Vegetation Mapping project was organized and coordinated by the Southeast Coast Network (SECN) between 2005 and 2011, with assistance from the Southeast regional office of NatureServe for the vegetation classification portion of the project. The purpose of this project was to inventory and map existing plant associations on approximately 35.6 hectares (88 ac) of MOCR and a buffered area surrounding the park. The mapping information is provided in written, tabular, digital, and spatial formats that are useful to resource managers, the SECN, and others. The mapping product will serve as a baseline of vegetation information that will assist park natural- and cultural-resource stewardship. The identification and description of plant communities also provides habitat information important to understanding associated organisms (reptiles, amphibians, mammals, etc.) and providing inference to the location and abundance of species that are characteristic of each community.

The Vegetation Inventory Program

The Vegetation Inventory Program (VIP) is an effort by the National Park Service (NPS) to classify, describe, inventory, and map vegetation communities in more than 270 national park units across the United States. The primary objective of the VIP is to produce high-quality, standardized maps and associated data sets of vegetation and other land-cover occurring within parks. Since vegetation species and communities are unique from park to park, the inventory of these resources assists park managers on a wide array of management issues. For more information about the Vegetation Inventory Program, visit <http://science.nature.nps.gov/im/inventory/veg/index.cfm>.

Vegetation Inventory Program Standards

The NPS and VIP established guidance and standards for all vegetation mapping projects in a series of documents:

Protocols

- National Vegetation Classification System (TNC and ESRI 1994a, NatureServe 2003)
- Field methods and mapping procedures (TNC and ESRI 1994b)
- Statistically rigorous and consistent accuracy assessment procedures (ESRI and TNC 1994, Lea and Curtis 2010)
- Guidelines for using existing vegetation data (TNC 1996)

Standards

- The National Vegetation Classification Standard (FGDC 1997, FGDC 2008, NatureServe 2009)
- Spatial Data Transfer Standard (FGDC 1998b)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System (U.S. Department of Agriculture)
- Program-defined standards for map attribute accuracy and minimum mapping unit

National Vegetation Classification Standard

The National Vegetation Classification Standard (NVCS) is the mapping standard used in SECN vegetation mapping projects. The NVCS, adopted by the Federal Geographic Data Committee (FGDC 1997), evolved from work conducted by The Nature Conservancy, NatureServe, and the Natural Heritage Program network over more than two decades. The NVCS standard supports the development and use of a consistent national vegetation classification throughout the NPS and other organizations. Such a standard facilitates the production of uniform statistics about vegetation resources across the nation and makes cooperation on vegetation management issues across jurisdictional boundaries possible (Grossman et al. 1998). The FGDC Vegetation Subcommittee works to keep the standard relevant and current. Revisions made to the upper levels of the NVCS hierarchy adopted by the Vegetation Subcommittee as Version 2 (FGDC 2008) were not used in this project because the vegetation mapping inventory discussed herein was completed before the revised NVCS hierarchy was available.

Vegetation classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVCS is a hierarchical system that incorporates physiognomic characters and floristic data to define seven levels of terrestrial vegetation classification. The five upper levels (class, subclass, group, subgroup, and formation) are based on physiognomic features. The two lower levels (alliance and association) are distinguished by differences in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). The physiognomic levels of the NVCS are based on physical, structural, and environmental characteristics identifiable from satellite imagery, aerial photography, or ground observations (Table 1). Specific criteria defining these physiognomic units are based on ecologic characteristics that vary among major vegetation groups (FGDC 1997).

The alliance and association levels form the base of the NVCS hierarchy and are determined by the most abundant or diagnostic species comprising the various layers of a homogenous vegetation community. An association is here defined as a plant community type with a consistent species composition, uniform physiognomy, and similar habitat conditions (Flahault and Schroter 1910). Species composition differentiates associations (TNC and ESRI 1994a). An alliance is "a physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation" (Reid and Comer 1998). NatureServe coordinates plant association data for the SECN vegetation mapping projects. Associations are added to the NVCS and older concepts are refined as new data become available.

For more information about the NVCS, see the USGS-NPS Vegetation Mapping Program standards (<http://biology.usgs.gov/npsveg/standards.html>) or Grossman et al. (1998).

Table 1. Example of National Vegetation Classification (NVCS) hierarchy for terrestrial vegetation (FGDC 1997).

Level	Criteria Delineating Level	Example
Class	Structure (height, cover) of dominant vegetation strata.	Forest
Subclass	Growth form characteristics including leaf type (evergreen, deciduous) for woody plants and persistent (perennial, annual) herbaceous species.	Evergreen forest
Group	Leaf morphology (broad leaf, microphyllous, xeromorphic), leaf phenology, and climatic conditions.	Temperate or subpolar needle-leaved evergreen forest
Subgroup	Relative degree of human disturbance.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest
Formation	Additional physiognomic characteristics, general environmental conditions, relative landscape position, and hydrologic regimes.	Rounded-crowned temperate or subpolar needle-leaved evergreen forest
Alliance	Dominant or diagnostic species of uppermost or dominant stratum.	<i>Pinus taeda</i> Forest Alliance
Association	Other dominant or diagnostic species from any stratum.	<i>Pinus taeda</i> / <i>Liquidambar styraciflua</i> - <i>Acer rubrum</i> var. <i>rubrum</i> / <i>Vaccinium stamineum</i> Forest

Federal Geographic Data Committee Standards

In addition to vegetation classification, the Federal Geographic Data Committee (FGDC) sets standards for map spatial accuracy and for metadata employed in NPS vegetation mapping projects. Standards for map products stipulate map scales of 1:24,000 or finer, and minimum polygon size of 0.5 hectare (1.24 ac). Positional accuracy for vegetation maps must meet National Map Accuracy Standards, which specify horizontal errors of less than 10.2 meters (33.5 ft) on the ground for 1:12,000-scale maps.

All digital vegetation products resulting from this project are accompanied by FGDC-compliant metadata. Metadata are “data about the data,” and describe the content, quality, condition, and other characteristics of the spatial dataset. Metadata are critical elements that expedite the interpretation and exchange of information among users.

Methods

Study Area

Location

MOCR is in Pender County, about 20 miles (12.4 km) northwest of Wilmington, North Carolina within the Atlantic Coastal Plain in the Cape Fear River Valley Basin (Figure 1).

History

MOCR was created to commemorate the February 27, 1776 battle at the bridge crossing Moores Creek (see Figure 2 and cover photograph) where Patriot militia defeated a loyalist army. This Patriot victory was integral in that it delayed a full-scale British invasion of the area for several years. The state of North Carolina purchased the site in 1897 and created the Moores Creek Monument Association to develop and maintain the site as a public park. In 1926, Moores Creek National Military Park was formed. The NPS took over management of the park in 1933 (Capps and Davis 1999). The park is approximately 88 acres (40.1 ha). Although Moores Creek National Battlefield's primary purpose is to interpret the pivotal Revolutionary War battle that occurred there, it hosts a variety of natural resources, including several state-listed plant species and a wide variety of wildlife species.

Vegetation

A wide variety of vegetation communities are represented in MOCR relative to its size. The park is considered one of the most bio-diverse areas along the eastern seaboard north of the Florida Everglades and south of the pine barrens of New Jersey, and the landscape of the park exhibits several distinct ecosystems and vegetation zones that exist on the coastal plain (NPS 2011). The vegetation within the eastern section of the park is dominated by upland loblolly pine forest (Figure 3). Upland areas of the park have been altered considerably by drainage ditches that were introduced during timbering activities, as well as when Hwy 210 went through the park. Uplands in the southeast section of the park are slowly returning to pre-ditching conditions, but will have assistance in the future with some hydrologic and geomorphic restoration. Within the center of the park, just west of the Visitor Center, a pine savanna wetland exists (Figure 4). Prior to the early 20th century when the area was drained, the wetland habitat contained a number of diverse and rare plant species. Restoration efforts on this savanna have been underway since 1996. More than 25,000 bunchgrass plants (*Aristida stricta* and *Ctenium aromaticum*) were re-introduced between 2003 and 2005, and a regular schedule of prescribed burns are utilized to maintain the savanna's open structure (for more see: <http://www.nps.gov/mocr/index.htm>). The wetland area that dominates the western section of the park is influenced by Moores Creek, which is a tidally influenced "black water" low flow stream with considerable bald cypress (*Taxodium distichum* (L.) Rich.) growth (Figure 5).

Climate and Weather

Summer months at MOCR are hot and humid. The mean monthly maximum temperature in July ranges 30.1–31.0° C (86.2–87.8° F; 1961-1990). Winter months at MOCR are typically mild with only brief cold spells. The mean monthly minimum temperature in January ranges 1.9–0° C (28.6–32.0° F; 1961-1990). Precipitation mostly comes in the form of rain from storm fronts in winter and spring months, and from thunderstorms, tropical storms, and hurricanes in the summer and

fall months. MOCR receives an average precipitation amount that ranges 1,000–1,200 millimeters/year (39.4 – 47.2 in/year; 1961-1990; Davey et al. 2007).

**Moore's Creek National Battlefield
North Carolina**

**National Park Service
U.S. Department of the Interior**

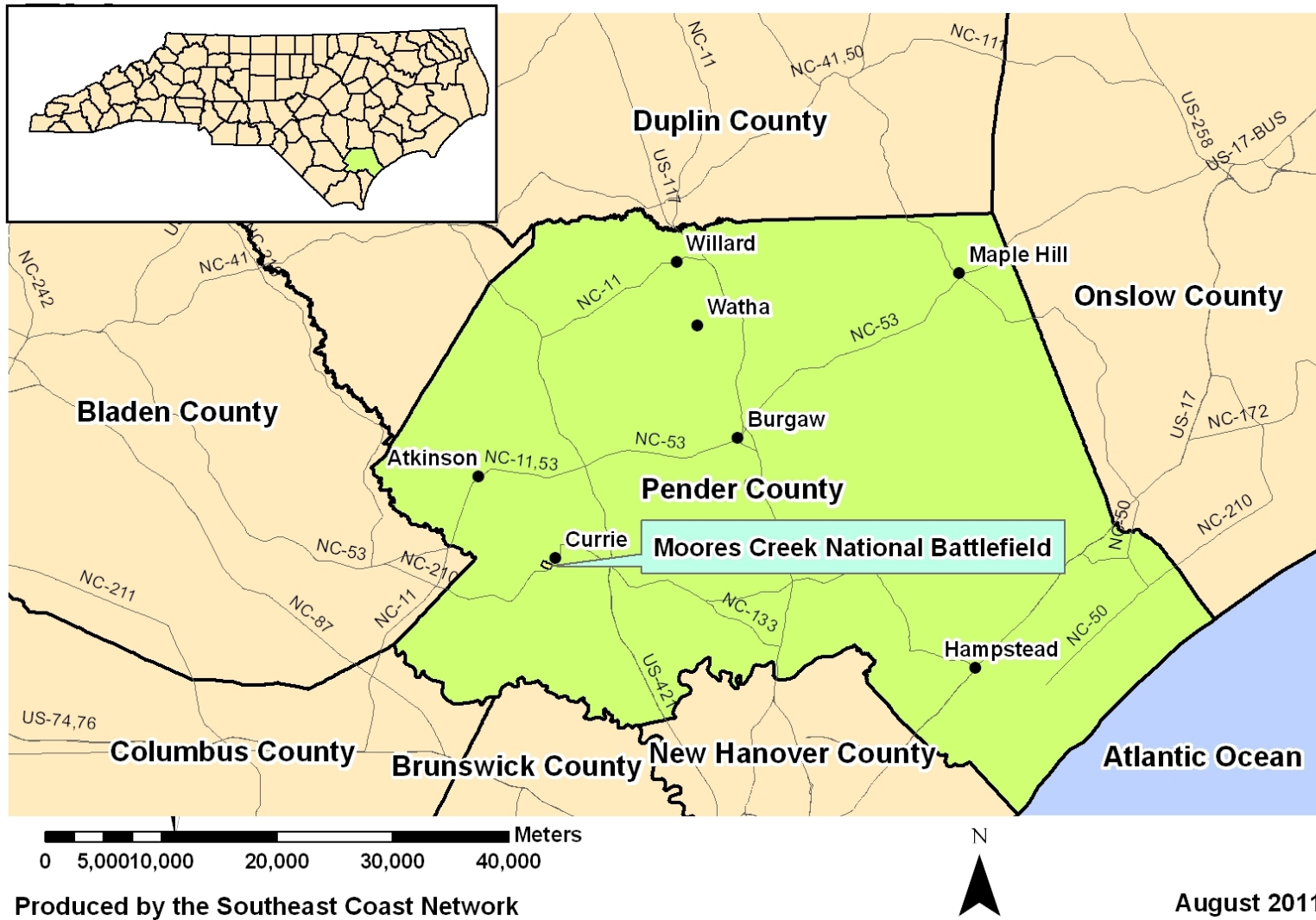


Figure 1. Location of Moore's Creek National Battlefield in southeastern North Carolina.

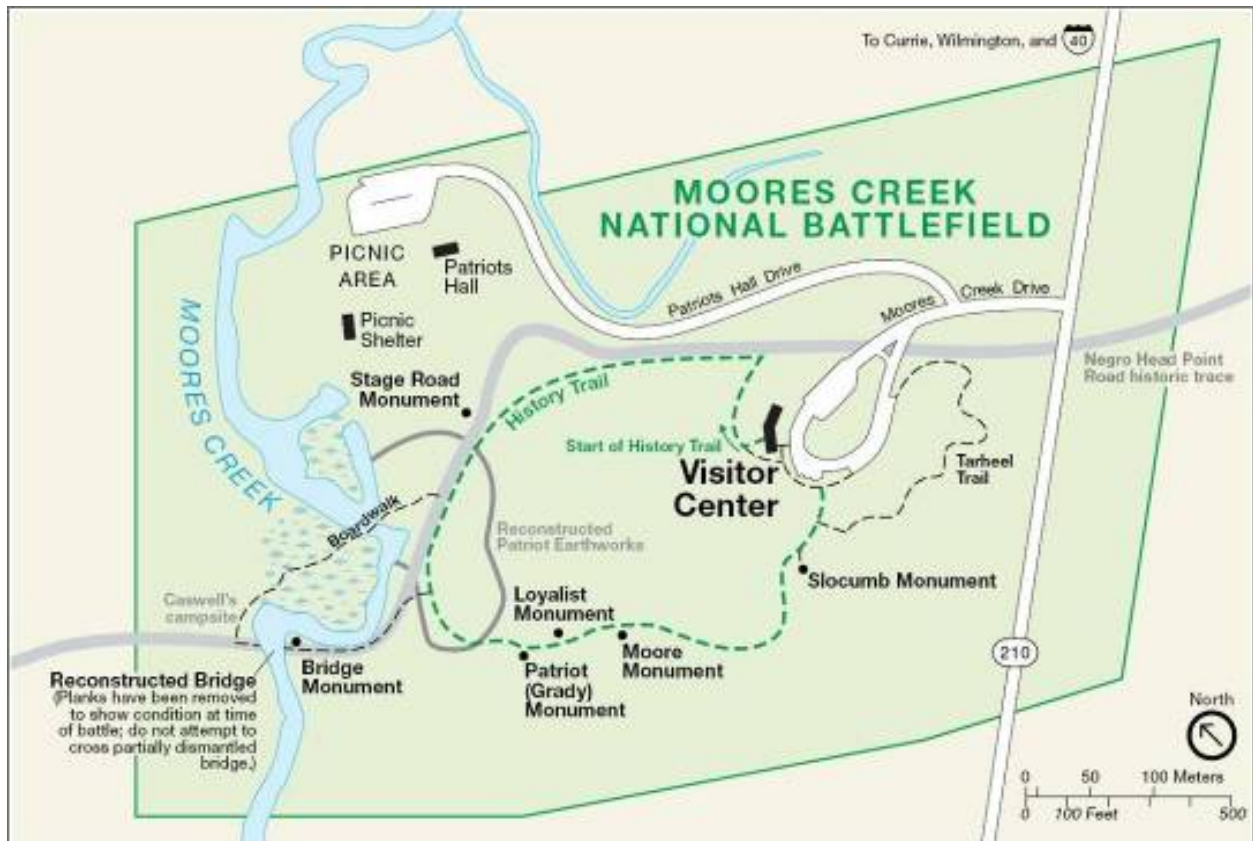


Figure 2. Moores Creek National Battlefield (courtesy NPS.gov).



Figure 3. Early to Mid-Successional Loblolly pine (*Pinus taeda*) forest dominate the eastern portion of Moores Creek National Battlefield.



Figure 4. A wet savanna restoration area west of the Visitor's Center in Moores Creek National Battlefield.



Figure 5. Riparian areas of Moores Creek are dominated by bald cypress (*Taxodium distichum*) and swamp tupelo (*Nyssa biflora*).

Geology and Soils

The geology of the portion of the Atlantic Coastal Plain where MOCR lies is comprised largely of sediments that were deposited 130 million years ago via fluvial processes (NPS 2011). The unconsolidated to partially cemented deposits found in MOCR are separated into the following seven units (from oldest to youngest): Duplin, Bear Bluff, Waccamaw, Penholoway, Canepatch, Socastee, and Wando Formations (Thornberry-Ehrlich 2006; Figure 6).

The coastal plain region of southeastern North Carolina is only a few feet above current sea levels, and consists largely of low nitrogen sandy loam soils (NPS 2011). The most abundant soil type in MOCR is Alpin fine sand (29.8 ac) which occurs on 1–6% slopes and is excessively drained. Muckalee loam (26.9 ac) is found along the floodplain of Moores Creek and is poorly drained. Other fine sands include Autryville fine sand (5 ac), which is found on 1–4% slopes, and Leon fine sand (19.4 ac), which is found on 0–2% slopes. Torhunta mucky fine sandy loam (11.2 ac) is poorly drained and often found on stream terraces. Finally, Marvyn and Craven soils (7.4 ac) are well drained soils that occur on side slopes and uplands (USDA-SCS 1990; Figure 7).

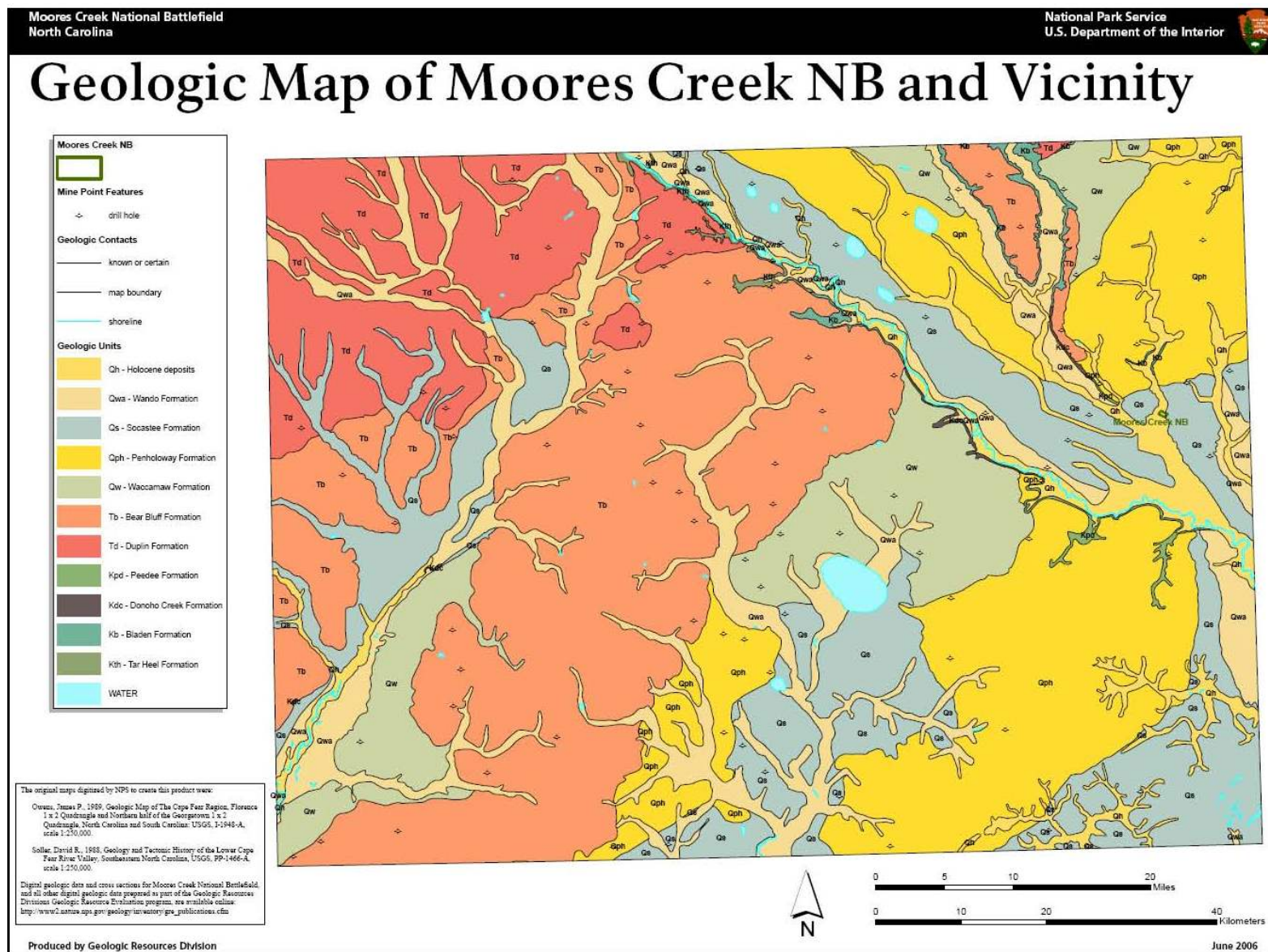


Figure 6. Geologic Map of Moore's Creek National Battlefield (Thornberry-Ehrlich 2006)



Soils of Moores Creek National Battlefield

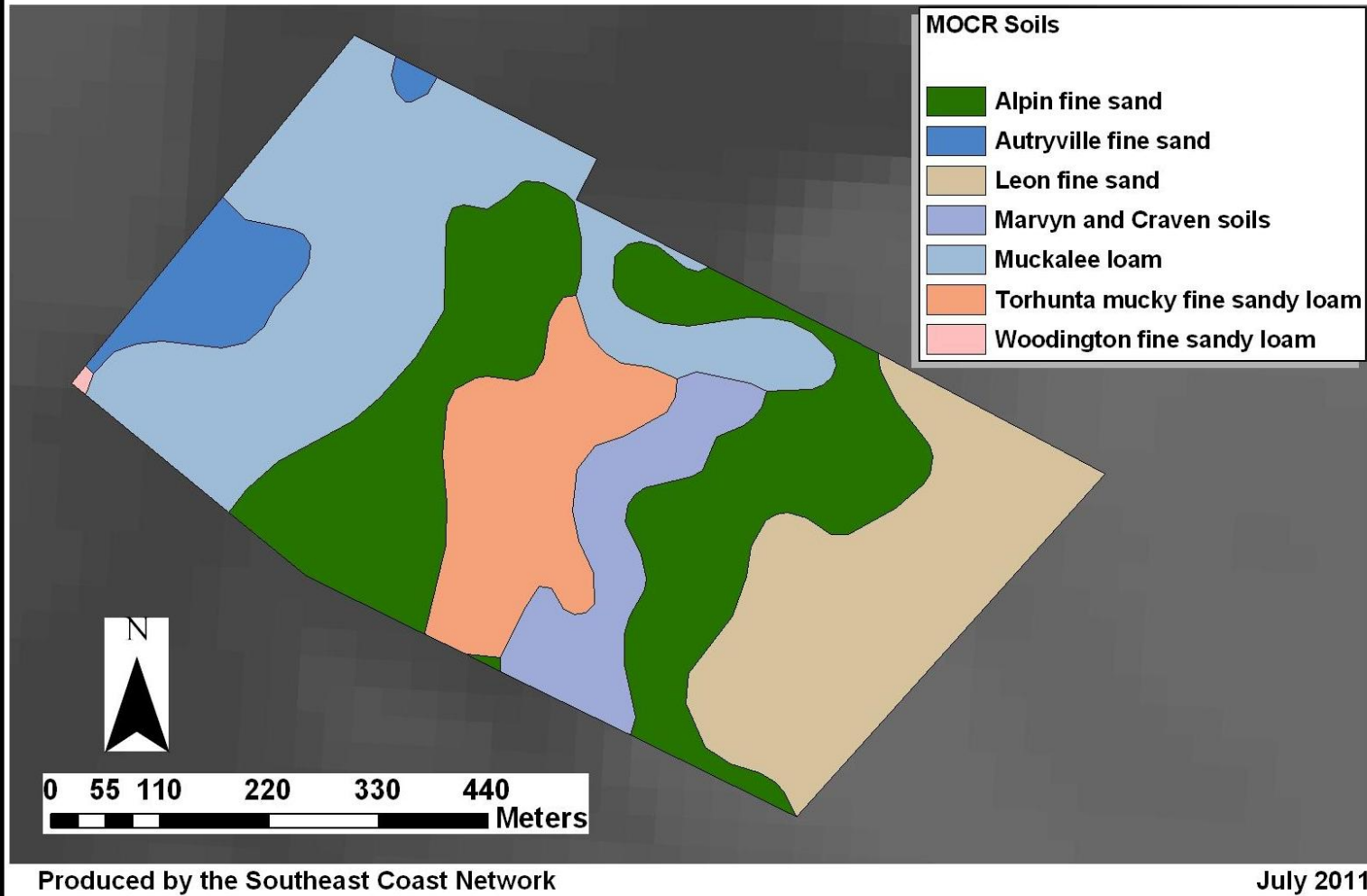


Figure 7. Soils of Moores Creek National Battlefield (Data from SSURGO).

Project Scoping and Planning

In 2005, the SECN proposed to develop vegetation classification and maps for 16 parks: Cape Hatteras National Seashore, Cape Lookout National Seashore, Moores Creek National Battlefield, Fort Sumter National Monument, Fort Pulaski National Monument, Fort Frederica National Monument, Cumberland Island National Seashore, Fort Matanzas National Monument, Timucuan Ecological and Historic Preserve, Fort Caroline National Monument, Castillo de San Marcos National Monument, Canaveral National Seashore, Ocmulgee National Monument, Horseshoe Bend National Military Park, Kennesaw Mountain National Battlefield Park, and Chattahoochee River National Recreation Area. The SECN teamed with the Southeast regional office of NatureServe to complete this project. NatureServe's role was to collect field data and develop the local association descriptions and the field key to map classes for each of the parks. The SECN agreed to complete the photographic interpretation/image analysis, digital map and database development, accuracy assessment, metadata, and final reports in-house.

Project Boundary Extent

The SECN determined that the MOCR vegetation mapping boundary extent should include the entire area within the park plus an additional buffer surrounding the park boundary of 100 meters (328 ft). Therefore, the total map extent is 70.1 ha, with 40.2 ha occurring within park boundaries and the remaining 29.9 ha occurring outside of park boundaries.

Field Survey

Prior to field work, NatureServe compiled a list of preliminary vegetation associations and alliances likely to occur in MOCR. Published floristic information, the plant-species list of MOCR, and expert local knowledge, including NPS staff at MOCR, were used to refine the list. The preliminary list of associations was useful for planning, estimating the amount of field work necessary, and for assigning provisional names to vegetation plots and observation points.

Plots were placed non-randomly in such a way as to sample as many of the vegetation associations as possible given the minimum number of plots for the project (C. Nordman, pers. comm., 21 Feb. 2011). Plots were deliberately placed in certain areas in order to capture the diversity of vegetation communities at the park. Plot size was variable (e.g., 10 m × 30 m, 15 m × 20 m, 20 m × 20 m, 20 m × 40 m, 20 m × 50 m) and decided at the time of sampling based on which dimension would most adequately characterize the vegetation sampled in each plot. Twelve vegetation plots were sampled in MOCR in November 2005 (Figure 8).

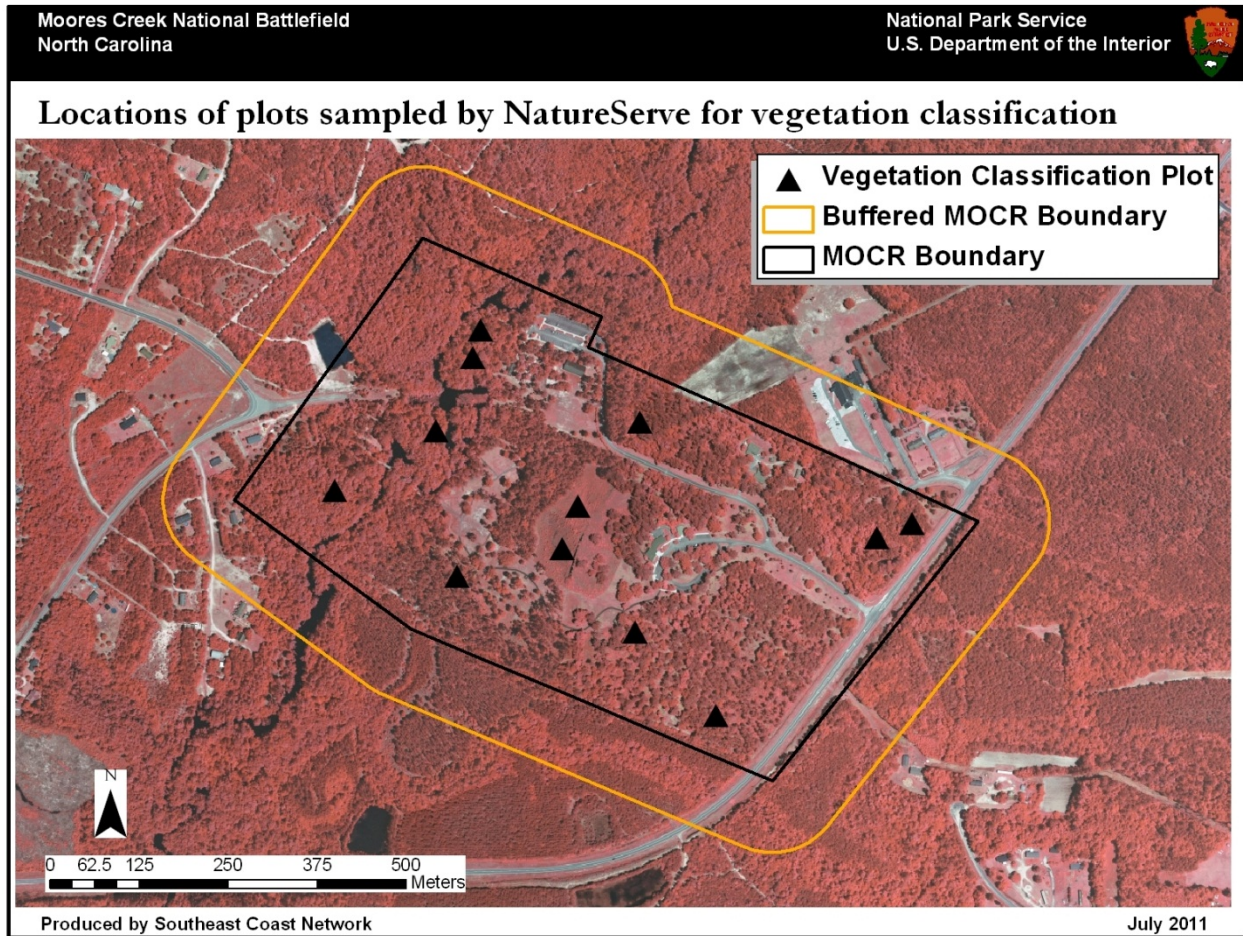


Figure 8. Locations of plots sampled in Moore's Creek National Battlefield used for vegetation classification.

Within each plot, field staff estimated and recorded an array of vegetation and environmental data using the field form featured in Appendix A. The following four categories of data were collected for vegetation plots:

Location and Plot Identifiers

The locations of the vegetation plots were not permanently marked. The bounds of each plot were marked temporarily using measuring tapes (Figure 9). The Universal Transverse Mercator (UTM) coordinates at the center of each lot were recorded (Zone 17, NAD83) on Garmin® hand-held GPS receivers.



Figure 9. Example of a vegetation classification plot for the Moores Creek National Battlefield vegetation mapping project (Photo courtesy of Southeast regional office of NatureServe).

Environmental Description

The physical characteristics of each plot were documented in both categorical and narrative fields. These characteristics included physical site features (elevation, slope, aspect, topography), hydrology, geology, and soils. Description of the ground surface included an estimate of the cover of rocks, sand, litter, bare soil, biological soil crust, moss, and lichen. A narrative field was provided for a general description of the plot setting and the influence of disturbance and hydrology on the vegetation.

Vegetation Description

Every vascular plant was assigned to one of eight physiognomic strata. Within each stratum, the investigator recorded the height class for the most abundant species (Table 2). Percent abundance, based on a cover class percentage, for each species present in the plot was also recorded (Table 2). Field crews also recorded percent canopy cover by species.

Table 2. Vegetation height and cover classes used in the Moores Creek National Battlefield Vegetation Mapping Project.

Code	Height scale (m)	Code	Cover Class %
1	< 0.5	1	Trace
2	0.5 - 1.0	2	0.1 - 1
3	1.0 - 2.0	3	1.0 - 2.0
4	2.0 - 5.0	4	2.0 - 5.0
5	5.0 - 10.0	5	5.0 -10.0
6	10.0- 15.0	6	10.0-25.0
7	15.0 - 20.0	7	25.0 -50.0
8	20.0 - 35.0	8	50.0 - 75.0
9	35.0 - 50.0	9	75.0 -95.0
10	> 50.0	10	> 95

Other Ancillary Information Useful to Classification

Field crews optionally recorded how well the plot represented the vegetation of the surrounding area, site disturbance history, and the overall character of the vegetation features of each plot.

Vegetation Classification

Plot data were manually entered into the NatureServe PLOTS Database Version 3.0, a Microsoft Access database designed for the NPS VIP (NatureServe 2010). The PLOTS database was designed specifically for the NPS vegetation and mapping program so that the electronic data entry fields mirror the standard field form. Data entry was facilitated by assigning each plant taxon a unique, standardized code and name based on the PLANTS database developed by the Natural Resources Conservation Service in cooperation with the Biota of North America Program (USDA and NRCS 2009). Data were thoroughly proofed after entry to minimize errors.

Due to a relatively small sample size, cluster analysis techniques that have been traditionally used in other vegetation mapping projects to generate vegetation classifications were not used for MOCR. Instead, plots were assigned to an existing vegetation association based on a cursory overview of their best fit according to species composition (R.White, pers. comm., 25 March 2011). The vegetation associations and descriptions can be found on the NatureServe Explorer (see <http://www.natureserve.org/explorer/index.htm>; NatureServe 2009).

Revisions to the Vegetation Classifications by SECN

After the field reconnaissance and field verification steps of the photo-interpretation process (see methods in following section), the SECN decided two changes were needed to the natural/semi-natural associations in the NVCS identified by NatureServe. The first change was the decision not to include the Loblolly Pine Plantation (CEGL007179) association within the park boundaries of MOCR but only to areas outside of park boundaries. The second change was to reclassify the Typic Sandhill Hillside Seep (CEGL004468) association to the Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type) (CEGL003660) association. The justification and reasoning behind these decisions is described in further detail below.

Loblolly Pine Plantation (CEGL007179):

The differences in the Loblolly Pine Plantation (CEGL007179) and the Mid- to Late-Successional Loblolly Pine Forest (CEGL006011) identified at MOCR during preliminary vegetation-community assessment and inventory are indeterminable given the current condition

and the progression of land management at the site. Consequently, we are considering the previously identified occurrence of Loblolly Pine Plantation not applicable within park boundaries of MOCR and are henceforth considering it Mid- to Late-Successional Loblolly Pine Forest. Outside of park boundaries (e.g., within the buffered region), we did utilize the Loblolly Pine Plantation association since the reasoning described below is not applicable to these areas.

The Early- to Mid-Successional Loblolly Forest association is the best replacement for the Loblolly Pine Planted Forest association based on similarities in spectral values, qualitative (photo-interpretation) evaluation, species composition, hydrologic processes, successional processes, and soils.

Historic aspect of the occurrence

Prior to 1850, extensive woodlands, mainly composed of longleaf pine (*Pinus palustris*), with scattered individuals of Loblolly pine (*Pinus taeda*), dominated the upland landscape around and east of the Visitor's Center in MOCR (McCrain et al. 1985). After 1850, these woodlands were cut and converted to a loblolly pine plantation. Over the next hundred years, the plantation was timbered repeatedly. Once timber operations ceased, the plantation was left fallow. A seed bank from the loblolly pine allowed for self-regeneration of the species to occur. Since the 1950s, regenerated loblolly pine forests have remained uncut within the park boundaries of MOCR. Only scattered individuals of longleaf pine have been planted in various upland locations in the park, and these plantings have not been actively managed (J. Sutton, pers. comm., 22 June 2011).

The NVCS description of the Loblolly Pine Plantation (CEGL007179) suggests that this association hosts trees that rarely exceed 20–40 years old. Because the area has not been harvested in over 60 years, the mean age of the trees in this area is very likely to approximate or exceed 40 years.

Current land use associated with the occurrence

Management activities that are typically associated with pine plantations, such as thinning and cutting, are not currently performed at MOCR. These stands are treated as successional pine forests. Within the next two years, prescribed fire regimes will be introduced as a management activity for loblolly pine dominated stands (J. Sutton, pers. comm., 22 June 2011).

Ecological properties of the occurrence

Mounded/bedded windrows were not created during the establishment of the loblolly plantation and the soils were not altered. Though the area was ditched, hydrologic processes are beginning to return to what they would have been historically. This is evidenced by the presence of, for example, *Osmunda cinnamomea* and *Arundinaria gigantea*, species considered Facultative Wetland (FACW) and could only persist in areas with unimpeded and normal hydrologic function. Because the plantation has not been harvested for over 50 years, successional processes are evident by observed species composition and natural regeneration of tree species. The area is no longer mono-specific and several native species are now established in the area.

The natural disturbance process in this area is fire; with an estimated fire return-interval of 2–8 years. Natural fires (i.e., lightning caused) were historically suppressed. Recently fire has been reintroduced into the ecosystem for management and restoration purposes. The ultimate goal is

to return many of the park's natural communities to a historic fire-return interval. Fire and other natural processes (selective insect infestation) will thin the trees in this stand gradually over time.

Botanical properties of the occurrence

Herbaceous ground cover in this area is relatively sparse; however, this is due to fire suppression. This area is planned to burn within the next three years, thereby removing the duff layer, exposing mineral soil, releasing the seed bank that currently exists, and providing a seed bed for native species immediately adjacent to the former plantation. Based upon independent data-collection efforts separated by five years by NatureServe and the SECN, the two areas have many characteristic species in common and in relatively similar coverage classes. These species include (a) herbaceous: *Osmunda cinnamomea*, *Arundinaria gigantea*, *Gelsemium sempervirens*, *Tipularia discolor*, several *Smilax* spp. and *Vitis* spp., and *Parthenocissus quinquefolia*; (b) shrubs: *Morella cerifera*, *Vaccinium stamineum*, and *Vaccinium arboretum*, and (c) trees: *Pinus taeda*, *Liquidambar styraciflua*, *Quercus nigra*, *Magnolia virginiana*, and *Acer rubrum*.

Given the small size of the Planted Pine association (~ 5 ac), the spatial arrangement of the occurrence, and the adjacent vegetation community types, the continued movement of native seeds into and throughout the Planted Pine area is very likely.

The Loblolly Pine Planted Forest association most closely resembles this planted pine occurrence botanically, and the planted pine forest is most likely to progress along the same botanical trajectory as Loblolly Pine Planted Forest association.

Mapping Discriminatory ability of the occurrence

We compared both quantitative and qualitative properties of the aerial imagery (color infrared) to determine the differences, if any, that might exist between the Loblolly Pine Planted Forest association and the Early- to Mid-Successional Loblolly association. The Early- to Mid-Successional Loblolly association was chosen as a comparison since its species composition (as per NatureServe vegetation sampling in 2005) most closely resembled that of the Loblolly Pine Planted Forest association. Additionally, these two associations have similar hydrologic regimes (both are considered uplands).

Quantitative Comparison

The aerial imagery was analyzed in ENVI (Version 4.7, ©2009 ITT Visual Information Solutions, Boulder, Colorado). Three regions of interest (ROIs) were extracted in ENVI for both the Loblolly Pine Planted Forest association and for the Early- to Mid-Successional Loblolly association. Pixel radiance values (DN) were averaged across the ROI for each of the bands represented in the imagery: red, green, and blue (or RGB). We used these RGB pixel values to determine whether or not there was a noticeable difference spectrally between these two forested classes. The differences in RGB values between the two classes were negligible (Table 3).

Table 3. Mean values (DN) for each band (red, green, and blue) occurring in three regions of interest (ROIs) selected within the Loblolly Pine Planted Forest and within the Early- to Mid-Successional Loblolly associations.

Band	Loblolly Planted Pine Forest Class Mean DN ^A (SD)	Early- to- Mid-Successional Loblolly Forest Class Mean DN (SD)
1 (Red)		
^B ROI1	149.7 (30.6)	150.1 (38.4)
ROI2	145.9 (17.9)	161.0 (37.8)
ROI3	148.7 (18.7)	151.4 (41.8)
2 (Green)		
ROI1	88.9 (17.9)	86.1 (19.2)
ROI2	85.6 (17.9)	91.6 (19.3)
ROI3	86.4 (18.1)	86.1 (21.7)
3 (Blue)		
ROI1	83.3 (18.7)	81.8 (21.5)
ROI2	80.7 (19.3)	88.0 (22.0)
ROI3	80.7 (19.0)	80.8 (23.3)

^A Digital Number, ^B Region of Interest

Qualitative Comparison

Our qualitative comparison between these two classes involved simply viewing the imagery and noting whether or not any major differences were apparent. The qualitative approach is a very meaningful comparison, since it is through this technique that the vegetation mapping for this project was accomplished. Figure 10 presents a side-by-side comparison of the Early- to Mid-Successional Loblolly Pine Forest and the Loblolly Pine Plantation, as seen on the imagery used to map the vegetation of MOCR. On aerial imagery, a major characteristic of planted forests is the appearance of uniform rows of trees that are indicative of plantings that are actively managed (Philipson 1997). Such uniform tree rows are not obvious on this imagery. Additionally, the color, texture, and tone of these two stands were very similar. Therefore, from a photo-interpretation perspective, the differences between these two classes were not large enough for them to be consistently and accurately differentiated from one another on the imagery.

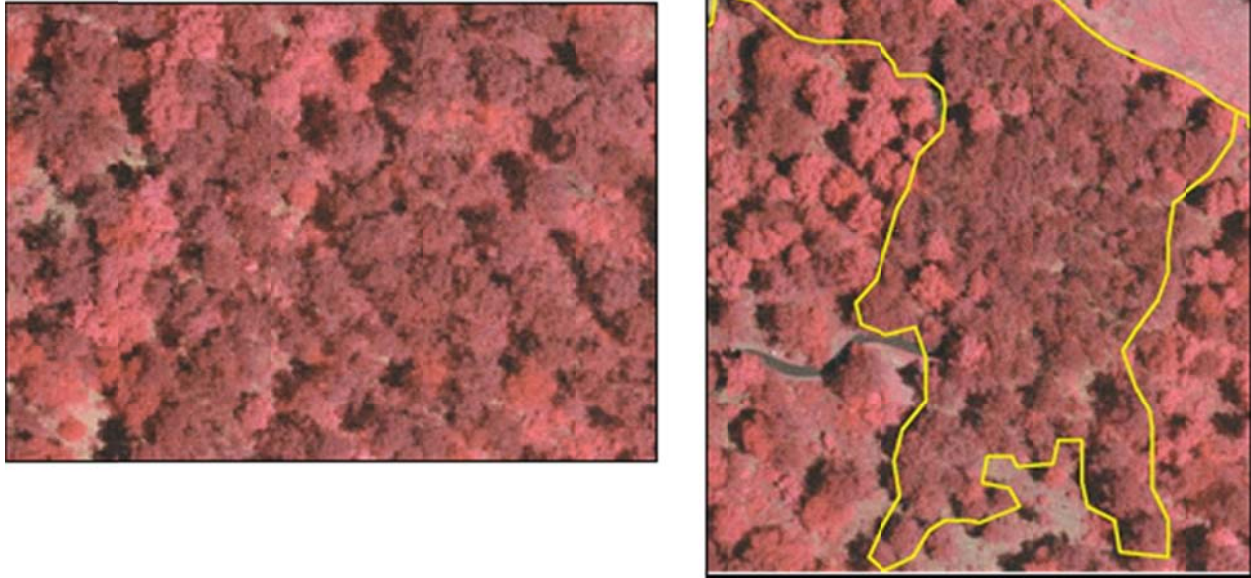


Figure 10. Visual comparison of the Early-to Mid- Successional Loblolly class (left) and the Loblolly Pine Planted Forest class (right) at MOCR in near infrared imagery.

Keying discriminatory ability of the occurrence

The primary difference in discriminating between the two classes (i.e., the Loblolly Pine Plantation [CEGL007179] and the Early- to Mid-Successional Loblolly Pine Forest [CEGL006011]) is whether the trees appear even aged or planted in rows. Even-aged stands commonly occur in natural areas subject to fire suppression; which has occurred and the results of which can be observed throughout the region. While some of the trees appear to be in rows, successional processes and ongoing management will make this pattern much less evident over time. We do not consider these valid differentiating characteristics given that the area has not been managed as a pine plantation in over 60 years.

Typic Sandhill Hillside Seep (CEGL004468):

The center of MOCR is dominated by a distinctive wet savanna. Upon completion of NatureServe's sampling in 2005, they classified this region as a Typic Sandhill Hillside Seep (CEGL004468). Based on species composition, differences in Ecological Systems, and management practices, however, we determined that the most appropriate association for this community is the Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type; CEGL003660).

Species Composition

Because this area has been subject to restoration activities, including numerous plantings and hydrologic alterations, the species composition is variable and complicates the classification of this area into a single natural vegetation association in the NVCS. The classification chosen for this community, consequently, is the current best representation.

The species composition in this area is best described by the Longleaf Pine/Pond Pine Savanna association. The shrub layer is generally absent, with few occurrences of *Morella cerifera* and

Ilex glabra, and does not include some of the most characteristic species of CEG004468, including *Gaylussacia frondosa*, *Clethra alnifolia*, *Arundinaria gigantea*, or *Pteridium aquilinum*. The site does include several characteristic species of CEG003660, including *Ctenium aromaticum*, *Solidago stricta*, and several *Rhynchospora* spp. and *Panicum* spp. The site also includes other less common species exclusive to CEG003660 in comparison to CEG004468, including *Liquidambar styraciflua*, *Saccharum giganteum*, *Hyptis alata*, *Lobelia* spp., *Ludwigia* spp., and *Rhexia mariana*.

Differences in Ecological Systems

The Typic Sandhill Hillside Seep association assigned by NatureServe is classified within the Atlantic Coastal Plain Sandhill Seep Ecological System (CES203.253). The Atlantic Coastal Plain Sandhill Seep Ecological System is found primarily in the Fall-line Sandhills region (although may rarely occur in the Outer Coastal Plain) from east-central North Carolina to central Georgia, typically on slopes where a clay lens or other impermeable layer forces groundwater to the surface as a seepage. The Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type; CEG003660) association is classified within the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System (CES203.265). The Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System ranges from southern Virginia to southern South Carolina, and associations within this system share the common features of wet, seasonally saturated, mineral soils on a wide array of soil textures. This system is found primarily in the Outer Coastal Plain but small patches may occur in atypical landforms in the Fall-line Sandhills. While the Atlantic Coastal Plain Sandhill Seep and the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods are considered similar Ecological Systems (NatureServe 2009), we consider the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System to be a better representation of the vegetation community in question in MOCR because it is located on a relatively flat site within the Outer Coastal Plain region not immediately adjacent to any sandhill communities.

Management Practices

The wetland savanna in question has recently undergone an unfunded, independent restoration effort with the goal being to restore the vegetation and hydrology of the area to what it was around the time of the Battle at Moores Creek (1776). At the time of the battle this area was likely part of a pine-mixed hardwood bottomland forest system that was subject to periodic flooding from the nearby creek during high water flood events. The loam- sandy-loam soils in conjunction with periodic flooding allowed for a high diversity of plant-life to flourish in this region. All indications from battle accounts and other historical records indicate that this was an open savanna with scattered trees, maintained by periodic wildfire and area usage, and was the established community pattern in this area even before the battle took place (McCrain et al. 1985). The savanna area is currently dominated by herbaceous species with a few scattered pines and hardwoods. A low, bog-like community along the northern edge of the savanna supports a variety of insectivorous plants such as *Sarracenia* spp. and *Drosera* spp. As previously mentioned, the savanna received over 25,000 plantings of bunchgrasses (e.g., *Aristida stricta* [wiregrass] and *Ctenium aromaticum* [toothache grass]) between 2003 and 2005. Additionally, *Pinus palustris* (longleaf pine) has been planted in scattered areas throughout the savanna. With the assistance of current management practices this area is transitioning back to what it was historically, which we determined to be best represented by the Longleaf Pine / Pond Pine Savanna (Wet Ultisol Type) association.

Final Map Classifications

Once the associations were finalized, a dichotomous key, that was originally developed by NatureServe and later revised by the SECN (Appendix C), was finalized. The full NVCS hierarchical classification and global descriptions are available in Appendix B. MOCR specific vegetation (i.e., local) descriptions were written based on MOCR plot data. In addition, the final associations were linked to map classes for use in the photo-interpretation and mapping portions of the project. We assigned a map class code merely for ease of assigning information to polygons and for display purposes for the photo-interpreter. The first few letters in the code represent whether a class is a Forest or Woodland, and the following letters are shorthand taken from the classes' common name. An example of a map code is as follows: FORSF which stands for the Sandhills Atlantic White-cedar Streamside Forest.

Vegetation that did not fall into the natural/semi-natural category (e.g., warm season lawn) was assigned to the Cultural Vegetation of the NVCS at the Type level (NVCS Version 2, FGDC 2008).

For non-vegetated features (e.g., open water bodies, structures, etc.), we derived map classes from Level II of the Land Use and Land Cover Classification System (Anderson et al. 1976). We slightly modified two of the land use and land cover classes so they would be more appropriate for this mapping project (e.g., 'Pond' is a modified version of 'Lake' and 'Creek' is a modified version of 'Streams and Canals'). The 'Other Urban or Built-Up Land' category was used to characterize maintained turf grass areas within the park, which also falls under the Cultural Vegetation in the NVCS (Version 2, 2008) as "Warm Season Lawn." One polygon was classified as a "Transitional Area" since it appeared to be an agricultural field that had been cleared, and it was unclear whether agricultural activities would continue there in the future or not. The 'Commercial and Services' category was used to characterize areas of the park containing park buildings and facilities. The 'Residential' category was used for private residences outside of park boundaries within the environs of the project mapping boundary. The 'Transportation, Communications, and Utilities' category was used to characterize roads within the mapping boundaries.

We further classified vegetated wetlands (natural/semi-natural vegetation) to the System Level of the U.S. Fish and Wildlife Service's Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). All the wetlands within MOCR are considered Palustrine systems (Table 4).

Table 4. Map classification codes for wetlands derived from the U.S. Fish and Wildlife Service's Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

Map Class Code from U.S. Fish and Wildlife Wetland Classification	General Explanation of Wetland Systems
Upland	Non-Wetlands
Marine	Open ocean overlying the continental shelf and its associated high energy coastline.
Estuarine	Deepwater tidal habitats and adjacent tidal wetlands in which ocean water is at least occasionally diluted by freshwater runoff from the land.
Riverine	Wetlands and deepwater habitats contained within channels, except where wetlands are dominated by vegetation or where salinity exceeds 0.5%.
Lacustrine	Wetlands and deep water habitats situated in a topographic depression or dammed river channel, lacking vegetation with greater than 30% aerial coverage, total area exceeds 8 ha.
Palustrine	All non-tidal wetlands dominated by vegetation and all such wetlands that occur in tidal areas where salinity is below 0.5%.

Digital Imagery and Interpretation

Aerial Photography Acquisition and Processing

The SECN contracted with Aero-Metric Inc., through the USGS Rolla, Missouri office to provide color infrared aerial photographs. Color infrared imagery was chosen because healthy green vegetation is a very strong reflector of infrared radiation and appears bright red in color infrared imagery, which helps tremendously in vegetation mapping efforts. This set of photography covered the full project boundary extent plus a buffer surrounding the boundary of 500 meters. The flight path and centers of the aerial photo mission were planned with 60% forward-lap and 30% side-lap in order to assure stereo viewing (Figure 11). Airborne GPS data were provided by Aero-Metric, Inc, as were ground check point data. The project was referenced to the North American Datum of 1983/2007 (NAD83/07), Universal Transverse Mercator Zone 17 horizontally and to the North American Vertical Datum of 1988 vertically. The aerial photographs were taken on 31 May 2009 at a scale of 1:12,000. The calibration focal length for the photos was 152.823 mm. Contact prints of the CIR imagery were created for use in the field, and diapositives of the CIR set were created for photo-interpretation. Scanned images (13 micron) were processed to 0.3 meter (1.0 ft) resolution and provided in a digital orthophotograph mosaic. The scanned imagery was rectified through an aerotriangulation process. The scanned images, Airborne Global Positioning System (ABGPS) data, ground check point data, and camera calibration data were used as inputs to the Zeiss/Intergraph ImageStationAutomatic Triangulation (ISAT) softcopy program. ISAT correlated image points are aerotriangulated in a block of images to create the exposure station exterior orientations. Three ground check points were manually measured on the imagery. All of these points had vertical and horizontal coordinates. Statistics associated with the aerotriangulation bundle adjustment are as follows:

1. Four photographs.
2. 108 image points.
3. Three Horizontal and Vertical ground control points.
4. 6.4 microns image sigma.
5. 90 degrees of freedom.
6. Root mean square error of residuals for three ground control points:
 - a. 0.029 meters for horizontal-control eastings
 - b. 0.028 meters for horizontal-control northings
 - c. 0.006 meters for vertical control
7. Root mean square error of residuals for four ABPGS exposure station control points:
 - a. 0.039 meters for horizontal-control eastings
 - b. 0.021 meters for horizontal-control northings
 - c. 0.168 meters for vertical control.



Flight path for aerial photography used in Moore's Creek National Battlefield Vegetation Mapping Project

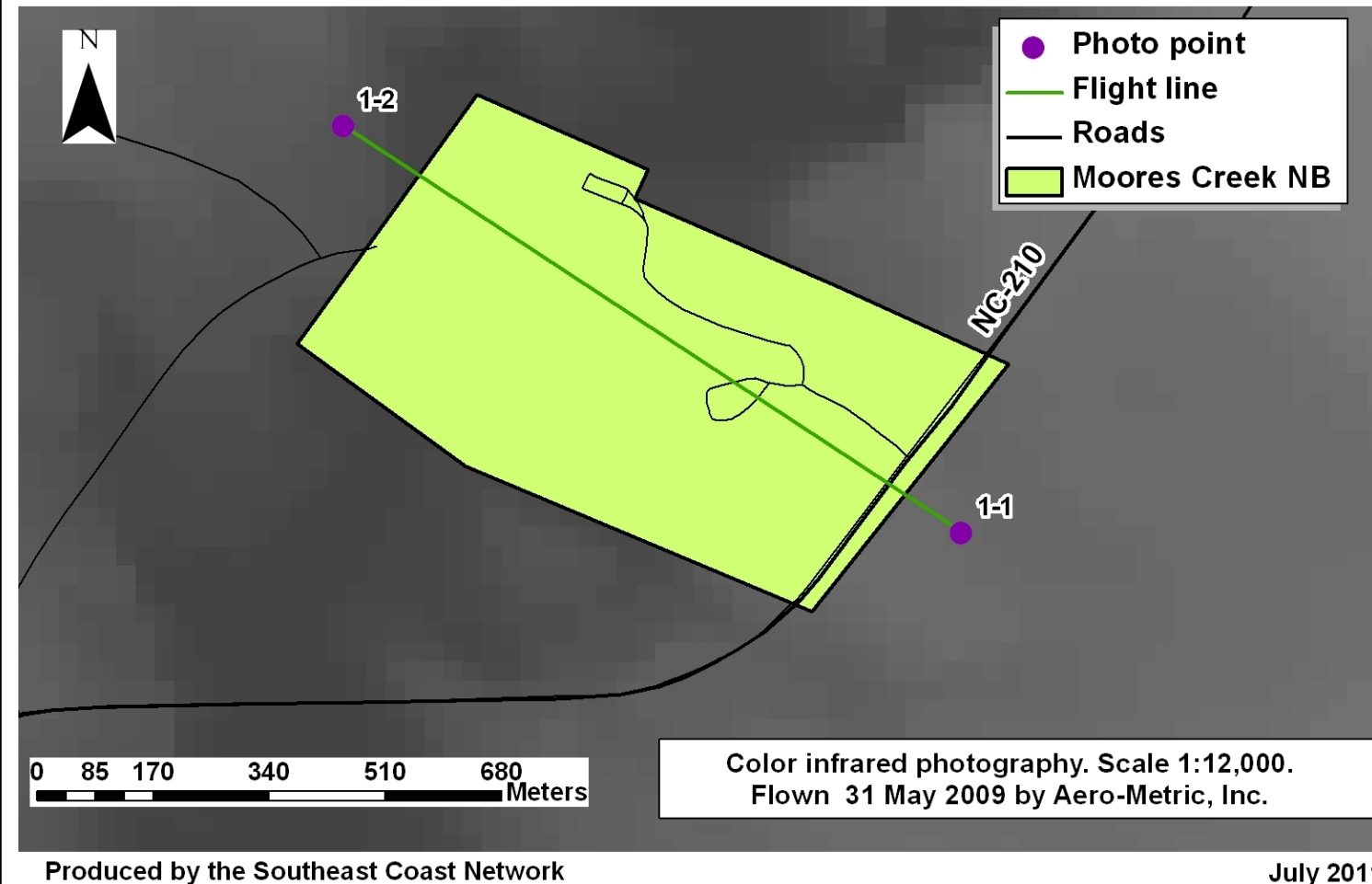


Figure 11. Flight lines for the 2009 color infrared stereo aerial photograph coverage of Moore's Creek National Battlefield.

Preliminary Photo-Interpretation

Prior to field reconnaissance, it is advantageous for the individual(s) interpreting the imagery to become familiar with the project imagery as well as the vegetation types to be mapped. The benefit of this early mapping step is that it allows the interpreters to identify particular areas of interest to visit during the field reconnaissance step. For this preliminary mapping, the SECN remote sensing specialist delineated vegetation polygons on the digital orthophoto mosaics to at least the Formation-level of the NVCS. In addition to vegetation, other features were mapped as well, such as non-vegetated surfaces that were classified according to the Anderson Land Use Level II mapping regime (Anderson et al. 1976). Polygons were digitized on-screen using Arc GIS (Version 9.3, © 2008 Environmental Systems Research Institute, Redlands, California).

Field Reconnaissance

The purpose of this step is to train the photo-interpreter(s) on the correlation of photo-signatures with vegetation associations. A photo-signature is a set of diagnostic characteristics present on the imagery, such as color, tone, shape, size, etc. that represents a particular vegetation association on the imagery (Philipson 1997). During field reconnaissance it is important to explore a variety of locations that represent various images, since color-infrared (CIR) imagery is typically not consistent between photo sets. Even slight differences in sun angle, light intensity, shadow, and even the particular film batch and printing process can affect vegetation's appearance on imagery (Hershey and Befort 1995). The ability of the imagery interpreter(s) to identify diagnostic characteristics on the imagery that can be tied directly to a vegetation association is a key component to successful, consistent, and accurate mapping. For some vegetation types, a set of diagnostic characteristics may not be visible on the imagery (i.e., the understory species may be the ones that are diagnostic). In such cases, the imagery interpreter(s) may be able to rely on an informed understanding of the ecological and environmental settings of the particular vegetation types (e.g., the environmental setting where an association is likely to occur) in order to make a mapping decision.

A field reconnaissance trip was taken to MOCR in late August, 2010. During this trip, the SECN remote sensing specialist spent time investigating ground conditions with copies of the aerial photographs in hand. Notes were taken directly on the copies of the aerial imagery as observations were made. The remote sensing specialist used a Garmin® Rino GPS unit to navigate to a set of predetermined points of interest within the vegetation polygons mapped during the preliminary mapping step. These points of interest were chosen specifically to aid in the identification of vegetation photo-signatures. Upon reaching each point, vegetation at that point was keyed to its association by using the key developed by NatureServe (NatureServe 2008). Difficulties in determining association, if any, were documented on the field sheet (Appendix E). Dominant species found in each vegetation strata were documented. Ground photographs of each point were taken.

Photo-Interpretation and Polygon Attribution

Based on the information gathered from the field reconnaissance trip, the SECN remote sensing specialist was able to develop a photo-interpretation guide that aided the delineation of vegetation classes (see Appendix D). Standard photo-signature characteristics were applied during the photo-interpretation process, including texture, color, pattern, and position in the landscape (Philipson 1997). In addition to photo-signature characteristics, understanding the environmental distribution of the vegetation types helped the remote sensing specialist not only

identify types, but also to properly place polygon boundaries. Polygons were interpreted and digitized on-screen using Arc GIS (Version 9.3, © 2008 Environmental Systems Research Institute, Redlands, California). Features were mapped to a minimum mapping unit (MMU) of 0.5 ha, which is the NPS VIP standard. Exceptions for mapping below the MMU were allowed for map-class units with vegetation unique to the immediate surroundings. For each polygon, the appropriate map-class code along with its NVCS code, alliance, association, and association common name were entered into the fields of the associated attribute table (Table 5).

Table 5. Fields used in the attribute table of the vegetation polygon layer of the Moores Creek Vegetation Mapping Project.

Field in Attribute Table	Description	Polygon Types Field Applies to
Cultural Type	NVCS Cultural Vegetation Type	Cultural Vegetation
Alliance	NVCS Alliance scientific name	Natural/Semi-natural vegetation
Association	NVCS Association scientific name	Natural/Semi-natural vegetation
Common_Name	NVCS Association Common Name	Natural/Semi-natural vegetation
LUC_II	Land Cover and Land Use Level II Codes (Anderson et al. 1976)	Natural/Semi-natural vegetation, Cultural Vegetation, and Non-Vegetated Areas
ELCODE	NVCS Element Code	Natural/Semi-natural vegetation
Map Code	Abbreviated code used by photo-interpreter	Natural/Semi-natural vegetation, Cultural Vegetation, and Non-Vegetated Areas
Wetland	Type of wetland	Natural/Semi-natural vegetation
Acres	Size of polygon in acres	Natural/Semi-natural vegetation, Cultural Vegetation, and Non-Vegetated Areas

Field Verification

A second trip was taken to MOCR in October 2010 for field verification. Field verification allows the photo-interpreter to gauge how accurately the photo-signatures developed during the field reconnaissance step are with respect to consistently mapping vegetation associations on the ground. Specific issues with problem classes can be resolved during this step prior to submitting the map for Accuracy Assessment.

Methodology for the field verification is nearly identical to the field reconnaissance step. The remote sensing specialist navigated via GPS to a predetermined set of points. Vegetation at that point was keyed to its association by using the vegetation key developed by NatureServe (NatureServe 2008). Difficulties in determining association, if any, were documented on the field sheet (same field sheet used during field reconnaissance).

Accuracy Assessment

The main goal of an accuracy assessment (AA) is to measure the probability that a particular location on the map created from the interpreted imagery has been assigned to its correct vegetation class on the ground. A vegetation map is an abstract model of the distribution of vegetation on the ground that is made possible by making some generalizations. These generalizations lead to errors in the map product. These map errors must be quantified so that the map user and the map producer understand the limitations of the map. A formalized accuracy assessment is a way to quantify these errors. In the AA there is “producers’ accuracy,” which is the probability that an AA point has been mapped correctly (also known as error of omission), and there is “users’ accuracy,” which is the probability that the map actually represents what was found on the ground (also known as error of commission). Both the producers’ accuracy and users’ accuracy can be obtained from the same set of data by using different analyses. Overall accuracy of the map is obtained by determining the fraction of accuracy assessment observations within all map classes that were mapped correctly. The Kappa Index is another measure of

overall accuracy, which takes into account the probability that mapped polygons will be correct due to random chance.

There are a number of factors that contribute to error on a vegetation map and some of these are listed below. It is important for the field investigator(s) conducting the AA to be aware of these situations and to take actions to minimize error when at all possible.

- Locational error (when it is not possible to acquire reliable UTM coordinates, the AA point data collected may look like it is in another polygon, or if the polygons are small, narrow and the GPS receiver isn't working well, it may be difficult to know which polygon is supposed to be sampled).
- Field key is difficult to use, leading the investigator to assign the point to the wrong association.
- Field key does not include all the plant associations in the park, also leading to confusion in which association to assign a point.
- Field data error; either by misidentifying diagnostic species, or by not reading the key carefully, resulting in a bad field call when the map attribute is accurate.
- AA point falls within an ecotone, which is impossible to classify but still has to be mapped to something.
- Relationship between plant associations and map units (modeling) are flawed.
- The polygon is heterogeneous, including patches of varying vegetation that are too small to map individually. The AA point may fall in a part of the polygon with a different community than observed by the photo interpreter in the bigger picture.

The formal accuracy assessment consists of several parts. First, a sampling design must be developed that follows methodology which is scientifically sound as well ideally practical and cost effective. The sampling design should cover all vegetation types mapped across the park. Sample sites must be visited in order to determine the vegetation type actually present at that particular ground location. The results of the sampling are used to create a contingency table (confusion matrix) that is used to calculate the per-class and over-all accuracy of the map.

Sampling Design

We used a stratified random sampling approach to select AA sites in MOCR. We included all map classes representing natural/semi-natural vegetation types as defined in the NVCS in sampling selection (FGDC 1997). Cultural vegetation (e.g., warm season lawn) and non-vegetated (e.g., Residential, etc.) polygons were excluded from the AA. Points for the AA were restricted to within park boundaries (i.e., no points were located in the buffered region outside of MOCR boundaries).

We determined the sample size needed for each map class by following guidelines outlined in Thematic Accuracy Assessment Procedures (Lea and Curtis 2010; Table 6).

Table 6. Standard sample size allocations for accuracy assessment, based on map class area (Lea and Curtis 2010).

Map Class Total Area (ha)	Number of observations per map class
>50	30
8.33 to 50	0.6 per hectare
<8.33	5

Eight of the nine vegetation classes within MOCR boundaries covered less than 8.33 hectares, therefore these eight map classes warranted five observations each. The two remaining map classes (Atlantic Coastal Plain Bald-cypress-Blackgum Swamp and Early- to Mid-Successional Loblolly Pine Forest) were between the 8.33 and 50 hectare threshold. Based on the guideline of 0.6 observations per hectare, both of these map classes warranted 10 observations each. Therefore, the total number of observations for the AA of MOCR was 60.

In order to account for positional error due to site location (GPS error), vegetation polygons were buffered internally by 10 meters prior to generation of the AA points, with the exception of the Sandhills Atlantic White-cedar Streamside Forest (FORSF) polygon. Since there was only one FORSF polygon, and it was small in size (0.3 ac) and linear in shape, a 10 m buffer would have eliminated most of the area suitable for sampling. The AA points were generated randomly in ArcGIS using the Create Random Points tool in ArcToolbox (Version 9.3, © 2008 Environmental Systems Research Institute, Redlands, California). Due to the shape and small size of some of the polygons, it was not possible to locate as many random points as specified by the Lea and Curtis (2010) guidelines. Therefore, the final number of AA points was 54 rather than the prescribed 60 (Figure 12).



Locations of accuracy assessment points sampled in April 2011

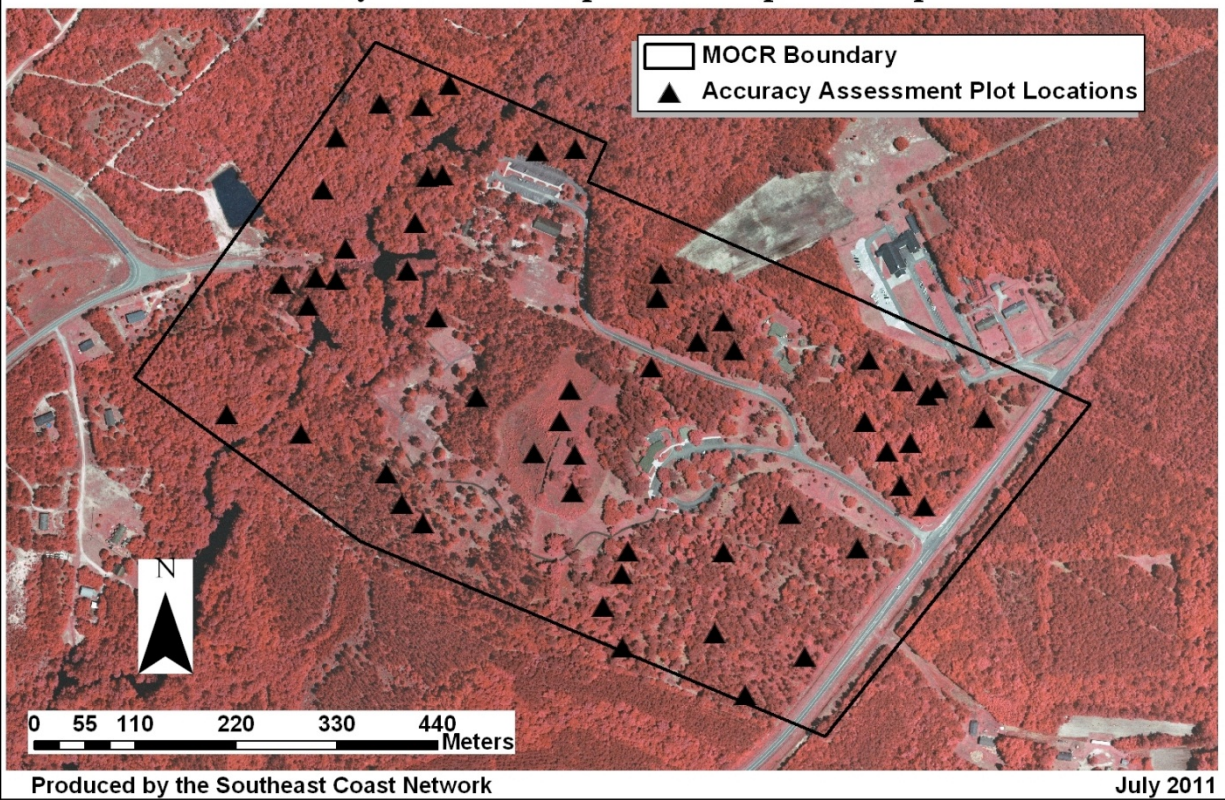


Figure 12. Locations of accuracy assessment points sampled in Moore's Creek National Battlefield.

Field Data Collection

Accuracy assessment point data were collected at MOCR during April 2011. A field crew from the SECN loaded the AA points into a GPS receiver in order to navigate to the points in the field. In addition to the GPS receivers, the field crew used copies of the ortho-photographs overlaid with the AA points (not including any of the lines from the mapped vegetation polygons) as an additional navigation aid. Upon reaching an AA point, the field crew assessed the site within an area of equal size to the minimum ha radius of the observation area following methodology outlined by Lea and Curtis (2010). The field crew collected environmental data, such as hydrology and topography, where meaningful for each AA plot. Vegetation data collected included leaf phenology, leaf type of the dominant stratum, physiognomic class, and vegetation composition in each stratum (see Appendix F for example of AA form). A space was provided for the field crew to make general comments about the classification made for each plot, noting any problems that were encountered (if any). Photographs in each cardinal direction, as well as of the canopy, were taken at each site to provide a visual documentation of each AA site.

Data Analysis

The AA point data were manually entered into the NPS PLOTS Database Version 3.2 (The Nature Conservancy 2010). PLOTS Version 3.2 is a relational database designed to store vegetation inventory field data for taxonomy and accuracy assessment and the data were subjected to a thorough quality assessment/quality check prior to analysis. The analysis of the map accuracy included the following steps:

- Initial comparative analysis of the field and map data.
- Review of all disagreements and correcting for false errors as necessary.
- Final comparative analysis of the field and map data.
- Individual map class analysis.
- Final output of results into a contingency matrix.
- Final output of the analyses and results into a spatial database for use in GIS.

Initial Comparative Analysis

We used the Intersect Tool in Arc Toolbox (ArcGIS Version 9.3, © 2008 Environmental Systems Research Institute, Redlands, California) to combine the AA point layer and the map vegetation polygon layer. The resulting layer from the intersection allowed us to compare each AA field-site call (vegetation type) to the corresponding map-polygon call (map class representing vegetation type). We used Microsoft Excel 2007 (Microsoft Corporation) to compare and tabulate the field-site call to the map-polygon call.

Review of Disagreements

All mismatches (disagreements) were subsequently reviewed for false errors. A false error is defined as a mismatch between the AA field-site call and the map-polygon call if caused by an accuracy error in the GPS field coordinates, a missing or misapplied field call, or a field site assessment of an area smaller than the MMU. We reviewed the AA sites within the context of their corresponding polygons in ArcGIS. We also reviewed the field data sheet to gain a fuller context of the ground data. From this process, we determined whether an initial disagreement was either a true error or indeed a match.

Final Comparison

None of the mismatches were determined to be a result of a false error. Therefore, we used all 54 of the 54 AA field sites for the final comparative analysis of the vegetation map layer.

Individual Map-class Analysis

We looked at the accuracy for each map-class on an individual basis to determine if accuracy requirements of the NPS VIP were met. Based on these individual map class results, we determined whether or not it would be necessary to merge the map classes to gain higher accuracy or to leave the map classes as they were, even if it resulted in lower accuracy.

Final Output

We generated two outputs for the AA results: a sample contingency table and a population contingency table. The sample contingency table provides an initial summary of the AA data by displaying counts of observations, with sample data values (vegetation map classes) as rows and reference data values (vegetation types as identified on the ground) as columns. The values in the shaded cells along the diagonal represent counts for correctly classified observations, where the reference data (column) matches the mapped vegetation type (row; see Appendix G). User's accuracy was calculated by dividing the number of samples that agreed with their corresponding map class by the total number of samples in that class. Producer's accuracy was calculated by dividing the number of samples that agreed with their corresponding map class by the total number of samples whose field call belonged to that category.

Previous NPS VIP guidance (TNC and ESRI 1994) suggested calculating users', producers', and overall accuracies from the sample contingency table of observation counts. However, this practice did not account for the unequal probability sampling imposed by the stratification by map classes. While appropriate for users' accuracies, it will give inaccurate results for producers' accuracies and overall accuracy. Therefore, measures of accuracy for the AA are now defined by the population contingency table. Similar to the sample contingency table, rows in the population contingency table are defined by the sample data values, and the columns are defined by the reference data values. Unlike the sample contingency table, the values in each cell are the proportion of the target area in the corresponding true and mapped vegetation classes, rather than the raw counts of observations. The population and sample contingency tables are reported together as a summary of between-class error relationships and class accuracy statistics (Lea and Curtis 2010; see Appendix G).

AA Spatial Database

For use in GIS, we produced a feature-class layer of the AA site locations, along with supporting tables, and incorporated them into the MOCR vegetation mapping project geodatabase.

Results

Vegetation Classification

The final classification for MOCR (including revisions that the SECN made to the associations developed by NatureServe) resulted in 10 vegetation associations in the NVCS (one of which was applied only outside of park boundaries; see Appendix B for full association descriptions).

Both historical and current land management practices, hydrology, climate, and geology and soils of the area have strongly influenced the types and distributions of vegetation communities throughout MOCR. The low lying, flat land with its nutrient poor soils has contributed greatly to the evolution of diversity and abundance of species within the areas of the park and the region (NPS 2011). Numerous vegetation communities require natural fire and hydrologic regimes for successful regeneration and maintenance. Maintaining natural hydrology and using fire as a management tool will be crucial for the continued success of many vegetation communities. For example, the Sandhills Atlantic White-cedar Streamside Forest is very susceptible to major disruptions in hydrology; rapid prolonged change in water depth kills *Chamaecyparis thyroides* seedlings and stresses or kills mature specimens. Leaf litter and woody debris should not be too dense in order for the shade-intolerant *Chamaecyparis thyroides* seedlings to survive. In the absence of fire and adequate gap regeneration, succession often leads to development of a bay forest dominated by *Magnolia virginiana*, *Persea palustris*, and *Gordonia lasianthus*. The Atlantic Coastal Plain Bald-cypress-Blackgum Swamp is another community particularly sensitive to alterations from sedimentation and hydrologic changes to upstream areas (NatureServe 2008). The Longleaf Pine/Pond Pine Savanna found at the center of the park depends on frequent, low-intensity, growing-season fires to control understory vegetation and for the reproduction of *Pinus palustris* and *Pinus serotina*. Fire suppression and disturbance from the past has led to the development of the Successional Water Oak Forest and the Successional Sweetgum Forest.

Digital Imagery and Interpretation

For MOCR, 10 map units were developed and directly matched to corresponding plant associations in the NVCS (Table 7). One map class representing cultural vegetation in the NVCS (e.g., Warm Season Lawn) was identified. Six map classes representing non-vegetated units (e.g., open water bodies, buildings, roads, etc.) were identified (Table 8).

The relatively small size of the park allowed very thorough examination of subtle vegetation characteristics and photo-signatures on the imagery as well as on the ground. Ancillary data sources such as a digital raster graphic (DRG) and historical aerial photographs provided additional insight into ground conditions. Historical and current land management practices in the park provided details pertinent to classification issues.

Table 7. Final vegetation associations of the NVCS used for vegetation mapping (with their assigned Map Codes) in Moores Creek National Battlefield.

	Association Common Name	NVCS Code	Map Code
Forest			
	Loblolly Pine Plantation ¹	CEGL007179	FORPP
	Early to Mid-Successional Loblolly Pine Forest	CEGL006011	FORPF
	Sandhills Atlantic White-cedar Streamside Forest	CEGL007563	FORSF
	Successional Sweetgum Forest	CEGL007216	FORSF
	Successional Water Oak Forest	CEGL004638	FORWO
	Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest	CEGL004737	FORRF
	Atlantic Coastal Plain Bald-cypress-Blackgum Swamp	CEGL004733	FORBG
	Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest	CEGL004606	FORLS
	Blackwater Bottomland Hardwood-Pine Forest (High Type)	CEGL004736	FORHP
Woodland			
	Longleaf Pine / Pond Pine Savanna (Wet Ultisol Type) ²	CEGL003660	WOODPS

¹ Applied outside of park boundaries only ² Revised from CEGL004468 assigned by NatureServe

Table 8. Map classification codes for non-vegetated areas in Moores Creek National Battlefield, following Land Use and Land Cover Level II (Anderson et al. 1976).

Map Class Code	Anderson Land Use and Land Cover Level II (1976)
11	Residential
12	Commercial and Services
14	Transportation, Communications, and Utilities
17	Other Urban or Built-Up Land
76	Transitional Areas
Creek	Modified 'Streams and Canals'
Pond	Modified 'Lakes'

Vegetation Map

Table 9 provides a summary report of the spatial-data layer (map) of MOCR and summarizes frequency, mean area (in acres), and the sum of areas (in acres) for each map class. Summary areas are provided in acres rather than hectares due to the small sizes of some of the polygons.

Collectively, the MOCR spatial database layer is composed of 83 polygons covering 173.0 acres, with an average polygon size of 5.4 acres. Map classes representing natural/semi-natural types in the NVCS apply to 49 polygons (59.0% of all polygons) covering 128.7 acres (74.4 % of entire area) with an average polygon size of 2.4 acres. Of these natural/semi-natural types, the Early to Mid-Successional Loblolly Pine Forest dominates, both in frequency of polygons (22), and in size (57.6 acres). A close second, in terms of size, is the Atlantic Coastal Plain Bald-cypress-Blackgum Swamp which covers 40.6 acres. The Early to Mid-Successional Loblolly Pine Forest dominates drier upland sites on the eastern section of the park; whereas, the Atlantic Coastal Plain Bald-cypress-Blackgum Swamp is commonly found along the floodplain of Moores Creek.

The single cultural type in the NVCS (warm season lawn) consists of 10 polygons (12.5% of all polygons) and covers 16.6 acres (9.6% of the entire area). This particular type accounts for the monument area of MOCR as well as many locations along the park road.

Non-vegetated areas (including developed areas) consist of 24 polygons (28.9% of all polygons) and cover 27.7 acres (16.0% of the entire area). Developed areas in the park include the NPS Visitor Center and maintenance buildings, roads, and some private residences outside of park boundaries.

Wetlands consist of 23 polygons (27.7% of all polygons) and cover 58 acres (33.5% of entire area). Vegetation associations in the NVCS that are considered wetlands according to the U.S. Fish and Wildlife Service include the following: Sandhills Atlantic White-cedar Streamside Forest, Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest, Atlantic Coastal Plain Bald-cypress-Blackgum Swamp, Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest, and Blackwater Bottomland Hardwood-Pine Forest (High Type).

Considerably more analyses and deductions can be attained from even these simple summary reports. For example, a query could be done to determine the average distance a certain vegetation association occurs from a road or another developed area. Additionally, more complex reports could be derived by introducing additional spatial-data layers (e.g., amphibian distributions, invasive species, etc.) Such analyses provide greater insight into vegetation and its ecology.

Table 9. Summary statistics for the map classes occurring in Moores Creek National Battlefield.

Map Class	Park Boundary and Buffer			Within Park Boundary Only		
	Frequency (# polygons)	Mean (Ac)	Sum (Ac)	Frequency (# Polygons)	Mean (Ac)	Sum (Ac)
Natural/Semi-natural Vegetation						
Loblolly Pine Plantation	7	1.8	12.8	0	0.00	0.0
Early- to Mid-Successional Loblolly Pine Forest	22	2.6	57.6	16	2.47	39.5
Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest	2	1.3	2.7	1	N/A	1.3
Blackwater Bottomland Hardwood-Pine Forest (High Type)	3	0.9	2.8	2	0.83	1.7
Successional Water Oak Forest	3	0.5	1.5	3	0.34	1.0
Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest	3	0.8	2.4	2	0.46	0.9
Sandhills Atlantic White-cedar Streamside Forest	1	N/A	0.3	1	N/A	0.3
Atlantic Coastal Plain Bald-cypress-Blackgum Swamp	4	10.2	40.6	2	10.67	21.3
Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type)	1	N/A	3.7	1	N/A	3.7
Successional Sweetgum Forest	3	1.4	4.3	3	1.10	3.3
Natural/Semi-natural Vegetation subtotal:	49	2.4	128.7	31	2.3	73.1
Cultural Vegetation						
Warm season lawn	10	1.7	16.6	9	1.7	15.6
Cultural vegetation subtotal:	10	1.7	16.6	9	1.7	15.6
Non-Vegetated Areas						
Residential	6	0.8	4.6	1	N/A	0.2
Commercial and Services	5	1.0	5.0	4	0.38	1.5
Transportation, Communications, and Utilities	4	3.0	11.9	2	3.54	7.1
Transitional Areas	4	1.0	4.0	2	0.24	0.5
Creek	4	0.4	1.7	4	0.32	1.3
Pond	1	N/A	0.5	1	N/A	0.1
Non-Vegetated Areas subtotal:	24	1.2	27.7	14	1.1	10.7
Grand Total:	83	5.4	173.0	54	5.1	99.3

Map Layer Presentation

Figure 13 presents the map layer produced for the MOCR vegetation mapping project. The map is shown at its finest level, i.e. vegetation classes are shown at the association level and are labeled by the association common name. The boundary for MOCR and the mapping boundary for the project are both included. Figure 14 presents wetland layer polygons in MOCR.



Vegetation and developed land classes in Moore's Creek National Battlefield



- Buffered MOCR Boundary
- MOCR Boundary
- Loblolly Pine Plantation
- Early to Mid-Successional Loblolly Pine Forest
- Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest
- Blackwater Bottomland Hardwood-Pine Forest (High Type)
- Successional Water Oak Forest
- Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest
- Sandhills Atlantic White-cedar Streamside Forest
- Atlantic Coastal Plain Bald-cypress-Blackgum Swamp
- Longleaf Pine / Pond Pine Savanna (Wet Ultisol Type)
- Successional Sweetgum Forest
- Warm Season Lawn
- Residential
- Commercial and Services
- Transportation, Communications, and Utilities
- Transitional Areas
- Creek
- Pond

0 120 240 480 720 960 Meters



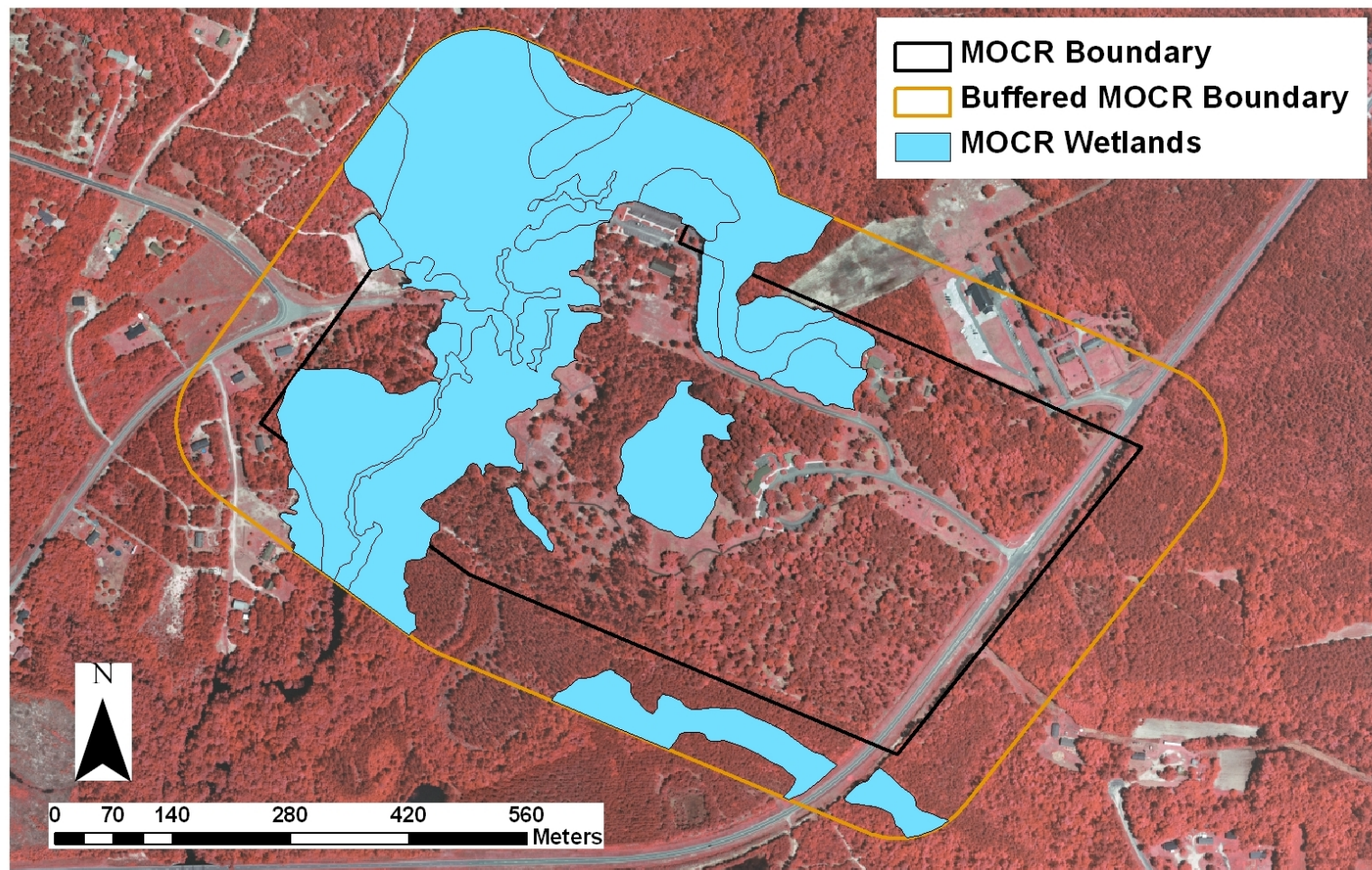
Produced by the Southeast Coast Network

July 2011

Figure 13. Vegetation (NVCS, FGDC 1997) and Land Use (Anderson et al. 1976) map classes for Moore's Creek National Battlefield.



Wetlands in Moore's Creek National Battlefield



Produced by the Southeast Coast Network

July 2011

Figure 14. Distribution of wetland (Cowardin et al. 1979) vegetation map classes in Moore's Creek National Battlefield.

Accuracy Assessment

Overall accuracy is 97.7% (90% confidence interval [CI]: 96.5 – 98.8%) for primary map classes representing natural/semi-natural vegetation floristic types in the NVCS. A kappa adjustment for chance agreements resulted in a final overall accuracy of 86.9% (90% CI: 78.2 – 95.1%). The sample and population contingency matrices for AA results are provided in Appendix G: Accuracy Assessment Contingency Tables. The population contingency matrix shows the accuracy of each map class (along with 90% CIs), with the user's accuracy reflecting errors of inclusion (commission errors) and the producer's accuracy reflecting errors of exclusion (omission errors) present in the mapping. The width of each CI is affected by the sample size used to derive the point estimate.

Our overall AA met the accuracy requirement of 80% established by the NPS VIP. We attribute our accuracy in part to the relatively small size of the park and our ability to visit a large majority of vegetation types represented on the ground during the field reconnaissance portion of the mapping project. Some individual classes, however, did not meet the 80% accuracy requirement. The following are map classes that did not meet the required accuracy, either with the actual percentage or within the confidence intervals.

User's Accuracy (Errors of Commission)

Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest (FORRF): The user's accuracy for FORRF was 75% (90% CI: 26.6 – 100%). Of the four AA sites sampled for FORRF, one site was determined on the ground to be Blackwater Bottomland Hardwood-Pine Forest (High Type) (FORHP). The error came about because this incorrectly mapped AA site occurred next to an FORRF polygon. Since the FORRF forest and the FORHP forest both contain oak species and loblolly pine in the canopy, there was confusion about where the divide between these two polygons should have been made.

Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest (FORLS): The user's accuracy for FORLS was 60% (90% CI: 0.0 – 86.0%). Of the five AA sites sampled for the FORLS, three of the sites were determined on the ground to be Early-to Mid-Successional Loblolly Pine Forest (FORPF). Confusion between these two forest types likely occurred because both FORLS and FORPF have canopies dominated by loblolly pine, and they also share many other similar species throughout the canopy as well as in other strata. One major difference between the two forests is that the FORPF occurs on uplands, whereas the FORLS occurs on wetlands. However, ecotonal areas between these two communities were especially difficult to map because determining where to delineate wetland from upland was often ambiguous. For example, at one of the sites the field crew noted that the species on the ground suggested a wetland forest while the species in the canopy were more characteristic of the upland class. Specifically, the *Taxodium ascendens* and *Nyssa biflora* suggested in the key to be main components of the FORLS forest (indicative of wetlands) were absent in the canopy. Despite the confusion that occurred between these two classes and the resulting error, we determined that pooling them would not be beneficial or practical.

Blackwater Bottomland Hardwood-Pine Forest (High Type; FORHP): The user's accuracy for BBHP was 60% (90% CI: 14.0 – 100%). Of the five AA sites sampled for FORHP, two of the sites were determined on the ground to be Early-to Mid-Successional Loblolly Pine Forest (FORPF). Both the FORHP and FORPF are characterized by canopies dominated by loblolly

pine. The FORPF forests occur on upland sites while the FORHP forests occur on high areas of the bottomlands by Moores Creek. The two errors can be attributed to a single polygon that both AA sites occurred in. From the remote sensing specialist's perspective, the polygon appeared to be in a high area of the bottomlands of MOCR. However, on the ground this polygon was determined to be an upland site.

Producers' Accuracy (Errors of Omission)

None of the producers' accuracies were less than the NPS VIP required 80%.

Literature Cited

- Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964. United States Government Printing Office. Washington, DC. 28 pp.
- Capps, Michail A. and Steven A. Davis. 1999. Moores Creek National Battlefield, an Administrative History. Department of the Interior, National Park Service: http://www.nps.gov/history/history/online_books/mocr/index.htm.
- 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, DC. Jamestown, ND: Northern Prairie Wildlife Research Center Online. <http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm>. (Version 04DEC98).
- Davey, C.A., K.T. Redmond, and D.B. Simeral. 2007. Weather and Climate Inventory, National Park Service, Southeast Coast Network. Natural Resource Technical Report NPS/SECN/NRTR—2007/010. National Park Service, Fort Collins, CO.
- Environmental Systems Research Institute (ESRI), Inc. 2010. Arc GIS 9.3. Environmental Systems Research Institute, Inc. Redlands, CA.
- Environmental Systems Research Institute (ESRI), National Center for Geographic Information and Analysis, and The Nature Conservancy (TNC). 1994. Final Draft for Field Methods for Vegetation Mapping procedures. USGS/NPS Vegetation Mapping Program. Prepared for the United States Department of the Interior, Biological Resources Division and National Park Service.
- Federal Geographic Data Committee (FGDC). 1997. Vegetation classification standard [online]. Available from: <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/vegclass.pdf>.
- Federal Geographic Data Committee (FGDC). 1998a. Spatial data transfer standard, FGDC-STC-002 (modified version ANSI NCITS 20:19998). Web address: <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS>.
- Federal Geographic Data Committee (FGDC). 1998b. Content standard for digital geospatial metadata, FGDC-STD-001-1998. Web address: <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/base-metadata>.
- Federal Geographic Data Committee-Vegetation Subcommittee. 2008. National Vegetation Classification Standard (Version 2). FGDC-STD-005-2008. Available online: <http://www.fgdc.gov/standards/project/FGDC-standards-projects/vegetation>.
- Flahault, C., and C. Schroter. 1910. Rapport sur la nomenclature phytogeographique. Proceedings of the Third International Botanical Congress, Brussels 1:131-164.

- Grossman, D. H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I. The National Classification System: Development, Status, and Applications. The Nature Conservancy, Arlington, VA.
- Hershey, R. R., and W. A. Befort. 1995. Aerial photo guide to New England forest cover types. General Technical Report NE-195. U.S. Forest Service, Radnor, Pennsylvania, USA.
- ITT Visual Information Solutions. Inc. 2009. ENVI 4.7. ITT Visual Information Solutions, Inc. Boulder, Colorado.
- Lea, C. and A.C. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service Vegetation Inventory, version 2.0. Natural Resources Report NPS/2010/NRR-2010/204. National Park Service, Fort Collins, Colorado.
- McCrain, G.R. and B. H. Church. 1985. An analysis of past and present plant community patterns in Moores Creek National Battlefield along with associated impacts affecting distribution and restoration. Resource Management Company. Raleigh, North Carolina.
- National Park Service (NPS). 2011. Fire Management Plan for Moores Creek National Battlefield. Unpublished Report, Atlanta, Georgia.
- NatureServe. 2003. International Ecological Classification Standard: International Vegetation Classification. Natural Heritage Central Databases, NatureServe, Arlington, VA.
- NatureServe. 2008. National Vegetation Classification. Associations and Alliances of Moores Creek National Battlefield. NatureServe Central Databases. Arlington, VA. Data current as of 20 February 2008.
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA, USA. [Available: <http://www.natureserve.org/explorer>].
- NatureServe. 2010. NPS PLOTS Database Version 3.2. NatureServe, Arlington, Virginia, USA.
- Nordman, C. 2011. Personal communication. February 21, 2011. Southeast regional office of NatureServe, Raleigh/Durham, North Carolina.
- Philipson, W. 1997. Manual of Photographic Interpretation, Second Edition. American Society for Photogrammetry and Remote Sensing. Bethesda, MD.
- Reid, M. and P. Comer. 1998. Vegetation Alliance Descriptions of the Western U.S. Available at <http://www.gap.uidaho.edu/bulletins/7/VADWUS.htm>.
- Sutton, James. Personal communication. June 22, 2011. Moores Creek National Battlefield. Currie, North Carolina.

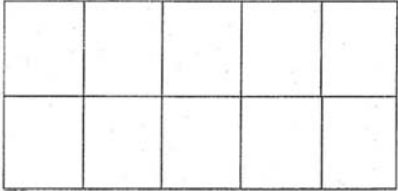
- The Nature Conservancy. 1996. Final Draft, Methodology for Assessing the Utility of Existing Data for Vegetation Mapping. Prepared for Prepared for USDI-National Biological Survey and NPS. Arlington, VA.
- The Nature Conservancy (TNC) and Environmental Systems Research Institute (ESRI). 1994a. NBS/NPS Vegetation Mapping Program: Final Draft, Standardized National Vegetation Classification System. Prepared for USDI-National Biological Survey and NPS. Arlington, VA.
- The Nature Conservancy (TNC) and Environmental Systems Research Institute (ESRI). 1994b. NBS/NPS Vegetation Mapping Program: Final Draft, Field Methods for Vegetation Mapping. Prepared for USDI – National Biological Survey and National Park Service. Arlington, Virginia.
- The Nature Conservancy and Environmental Systems Research Institute. 1994. Final Draft Methodology for Assessing the Utility of Existing Data for Vegetation Mapping. NBS/NPS Vegetation Mapping Program. Prepared for the United States Department of Interior, Biological Sciences Resource Division and National Park Service.
- Thornberry-Ehrlich, T. 2006. Moores Creek National Battlefield Geologic Resource Evaluation Report. Natural Resource Report NPS/NRPC/GRD/NRR—2006/012. National Park Service, Denver, Colorado.
- USDA-NRCS. 2009. The PLANTS Database (<http://plants.usda.gov>, 19 April 2011). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
- USDA-SCS. 1990. Soil Survey of Pender County, North Carolina. 162 p. Available online at <http://soildatamart.nrcs.usda.gov/manuscripts/NC141/0/Pender.pdf>.
- U.S. Geological Survey (USGS). 1999. Map accuracy standards. Fact sheet FS-171-99 (November 1999). Web address: <http://egsc.ugs.gov/isb/pubs/factsheets/fs17199.html>.
- White, R. Personal communication. March 25, 2011. Southeast regional office of NatureServe, Raleigh/Durham, North Carolina.

Appendix A: Field Survey Form

NPS SE COAST PROJECT: Plot Sampling Form

Page 1

County: Pender Park: CAHA - CALO - MOCR Plot Code: MOCL State: NC Location org: NPS

Ecological System
 Provisional community name Central Atlantic Coastal Plain Wet Longleaf Pine Savanna & Flatwoods
Gaylussacia frondosa - Clethra alnifolia - Arundinaria gigantea ssp. tecta / Aristida stricta
 Classified community name Pteridium aquilinum var. pseudocaudatum Herbaceous Vegetation
 Classifier CWN Date 12/1/2007 NVC ELCODE CEGL004468 (LES 203,265)
 Survey date: 11/9/05 time 1:45 Surveyors initials: JG, BOW
declination: 6°
 Directions to plot (including any notes on best access route, and mile marker): (Go NW) from visitor center, turn
ditch
 Time taken to walk to plot: 5 min. from parking lot
 PLOT CONFIGURATION (Depict the plot layout on right with respect to the surrounding area and attempt to draw in points where GPS positions were collected, witness tree, bearing of centerline, locations of pictures taken, and communities near the plot.)
 Plot representativeness - Is the surrounding area all the same? ☒ YES ☐ NO - if not, depict below
 PLOT LOCATION (Below show general plot location)
 Plot dimensions: 30 m X 10 m
bearing center line 53°

 Est. Extent of occurrence of community:
☒ < 1HA ☐ 1-10 HA ☐ 10-100HA ☐ > 100HA
 PIC # 1-4 Description of pictures (N,E,S & W from GPS point at middle of plot): NW, SE, SW
2 photos of sundew
 Select one: UTM / Lat/long (if lat/long, then values are 34.45845 N 78.11080 W
 GPS Techniques/Equipment: 5 Datum (pick one) WGS84 / NAD83 / NAD27 UTM Zone: _____
 GPS Unit ID _____ GPS file name MOCL01 (standard = First letter(s) of park + # of plot (e.g. CH04, CL04, MO04)
 Field UTM X _____ m E Y _____ m N Elevation 411 m (ft)
 Averaging performed (at least 120 observations)? ☒ Coordinate accuracy 13 m (ft) DOP _____ # sats 8
3a-diff

Community Survey
Page 1

NPS SE COAST PROJECT: Plot Sampling Form

Page 2

County: Pender Park: CAHA - CALO MOCR Plot Code: MOCR01 State: NC Location org: NPS

ENVIRONMENTAL / SITE INFORMATION

Measured Slope _____ ° _____ % ☒ Flat 0° 0% ☐ Gentle 0-5° 1-9% ☐ Moderate 6-14° 10-25% ☐ Somewhat steep 15-25° 26-49% ☐ Steep 27-45° 50-100% ☐ Very steep 45-69° 101-275% ☐ Abrupt 70-100° 276-300% ☐ cvrhng/shltd > 100° > 300%	Measured Aspect _____ ° (N = 0°) ☒ Flat SE 113-157° ☐ Variable S 158-202° ☐ N 338-22° SW 203-247° ☐ NE 23-67° W 248-292° ☐ E 68-112° NW 293-337°	Topographic Position ☐ Interfluvial (Ridge/summit/crest) ☐ Toeslope ☐ High Slope (upper/convex slope) ☐ Midslope ☐ Low level (terrace) ☐ Low slope (lower/footslope) ☒ Channel bed Cowardin System ☒ ☐ Upland ☒ Palustrine ☐ Estuarine ☐ Lacustrine ☐ Riverine
Landform (check most applicable) ☐ Alluvial flat ☐ Bottomlands ☐ Interdune Flat ☐ Spit ☐ Alluvial terrace ☐ Carolina Bay ☐ Lagoon ☐ Streambed ☐ Backslope Terrace ☐ Channel ☐ Lowland ☐ Streamhead ☐ Bank ☐ Depression ☐ Mound ☐ Swale ☐ Bar ☐ Draw ☐ Mudflat ☐ Tidal Flat ☐ Barrier Island ☐ Dune ☐ Ravine ☐ Toe slope ☐ Beach ☐ Estuary ☐ Ridge ☐ Washover Fan ☐ Beach Ridge ☐ Floodplain ☒ Seep ☐ Bench ☐ Gap ☐ Slope ☐ Gravel Bar ☐ Slough		
Rock types present: Hydrologic Regime (check only for wetlands) ☐ Not a wetland (Upland: XERIC : DRY - MESIC : MESIC) ☐ Tidally Flooded ☐ Intermittently flooded ☐ Permanently flooded ☐ Semipermanently flooded ☐ Temporarily Flooded (e.g. floodplains) ☐ Seasonally Flooded (e.g. seasonal ponds) ☒ Saturated (e.g. bogs, perennial seeps) ☐ Unknown ☐ Irregularly flooded ☐ Irregularly exposed		
QUALITATIVE ASSESSMENT: A) HYDROLOGY: <u>seepage area altered by drainage ditch</u> B) LANDSCAPE AND LANDUSE HISTORY (including disturbance history and possible threats to sustainability): <u>been mown, burned, ditched maybe plowed?</u>		
Soil Texture: ☐ Sand ☐ Peat ☐ Silt loam ☒ Muck ☐ Sandy loam ☐ Loam ☐ Clay loam ☐ Clay	Drainage: ☐ Rapidly drained ☐ Moderately well drained ☒ Somewhat poorly drained ☐ Well drained ☐ Poorly drained ☐ Very poorly drained	
Ground cover (Exclusive of living plants; adds to 100%) ☐ % Bedrock ☒ 5 % Litter, duff ☐ % Other _____ ☐ % Large rocks (cobbles, boulders > 10cm) ☐ % Wood (> 1 cm) ☐ % Small rocks (gravel, 0.2-10 cm) ☐ % Water ☐ % Loose sand (0.1-2 mm) ☐ % Bare soil		
Leaf type: ☐ Broad-leaved ☐ Mixed ☐ Needle-leaved ☐ Succulent ☐ Microphyllous ☒ Graminoid ☐ Broad-leaved herbaceous ☐ Pteridophyte ☐ Extremely xeromorphic	Leaf phenology (dominant stratum) ☐ Evergreen ☐ Cold-deciduous ☐ Drought-deciduous ☐ Mixed evergreen-cold-deciduous ☐ Mixed evergreen drought deciduous ☐ Herb - Annual ☒ Herb - Perennial	Physiognomic Class ☐ Forest (closed tree canopy) ☐ Woodland (open tree canopy) ☐ Shrubland ☐ Dwarf Shrubland ☒ Herbaceous (less than 25% woody layers) ☐ Nonvascular ☐ Sparse Vegetation
Natural and Anthropogenic Disturbance ☐ logging ☒ fire ☒ Hydrologic ☐ erosion ☐ trails/roads ☐ Agriculture ☐ grazing/browsing ☐ wind/ice damage ☐ Old Growth ☐ pine bark beetle ☐ exotic plants ☐ Fire Suppression ☐ dogwood anthr ☐ ORV		Disturbance and animal use comments:

Community Survey
Page 2

NPS SE COAST PROJECT: Plot Sampling Form

Page 3

County: Pender Park: CAHA - CALO - MOCR Plot Code: 01 State: NC Location org: NPS

QUANTITATIVE VEGETATION SAMPLE

STRATA	STRATA HEIGHT (1 only)	COVER CLASS	DOMINANT/DIAGNOSTIC SPECIES	Height scale (use tallest one for strata)	% cover for strata = top of cover class
Emergent - T1	—			< .5m 1	0-5% 1
Tree Canopy T2	—			.5-1m 2	5-10% 2
Subcanopy T3	—			1-2m 3	10-20% 3
Tall shrub S1	—			2-5m 4	20-30% 4
Short shrub S2	<u>03</u>	<u>2</u>	<u>Liquist; ARONAR</u>	5-10m 5	30-40% 5
Herbaceous	<u>3</u>	<u>90-100</u>	<u>PANIANC CTENRAC</u>	10-15m 6	40-50% 6
Non-vascular				15-20m 7	50-60% 7
Vine/liana				20-35m 8	60-70% 8
Other notable species (indicators of distinctive conditions, e.g. high pH soil, elevation, geographic region, other particularly abundant species):				35-50m 9	70-80% 9
				>50m 10	80-90% 10
					90-100% 11

T1: Emergent | T2: Tree Canopy | T3 Subcanopy | S1 Tall Shrub (>1m; to 5m) | S2 Short Shrub (< 1m) | H Herbaceous | N Nonvascular | V Vines (lianas) | E Epiphytes

SPECIES COMPOSITION AND COVER/ABUNDANCE CLASS BY STRATUM (enter cover values for each stratum AND for Total cover)

T1	T2	T3	S1	S2	H	N	V	E	Total Cover	Name (7 letter code or full name)	Collected? Spec #?	Discarded?	Cover cls
					5				5	Panagr	1	1	1 trace
					2				2	Aster pilosus	1	1	2 0.1-1%
					5				5	Andr tenarius	1	1	3 1-2%
					5				5	Liquist			4 2-5%
					5				5	Sol. pet			5 5-10%
					5				5	Centella erecta			6 10-25%
					4				4	Carex glaucescens			7 25-50%
					2				2	Rhex mar			8 50-75%
					2				2	Sabatia dip			9 75-95%
			4						4	Aronia arbutifolia			10 >95%
					2				2	Rhyn ine	1	1	
					2				2	Plan lan			
					3				3	Eupa rot			
					3				3	Paspalil	1	1	
					2				2	Spir praecox			
					2				2	Rhyn caduca	1	1	
					2				2	Lobe nuttalanthis			

NPS SE COAST PROJECT: Plot Sampling Form

Page 4

County: Pender Park: CAHA - CALO MOCB Plot Code: MOCK01 State: NC Location org: NPS

SPECIES COMPOSITION AND COVER/ABUNDANCE CLASS BY STRATUM

T1	T2	T3	S1	S2	H	N	V	E	Total cover	Name (7 letter acronym or full name)	Collected? Spec #?	Discarded?	Cover classes
					3				3	Scut int			1. trace
					2				2	Heli ang			2. 0.1-1%
					2				2	Soli str			3. 1-2%
					3				3	Robust - recurved thorns			4. 2-5%
					4				4	Ctenium (bottlebrush grass)			5. 5-10%
					4				4	Andro vir			6. 10-25%
					5				5	Agropyrum			7. 25-50%
					3				3	Xyris caroliniana			8. 50-75%
					2				2	Lodw pal			9. 75-95%
					2				2	Lobe gla			10. >95%
					5				5	Eupa cap			
					1				1	Smil rot			
			2						2	Pinu tae			T1: Emergent
			2						2	Cynilla rac			T2: Tree Can
			2						2	Ilex gla			T3 Subcanopy
					3				3	Hype betarum			S1 Tall Shrub (>1m; to 5m)
			1						1	Ilex opaca hybrid ornamental			S2 Short Shrub (< 1m)
					2				2	Diodia teres			H Herbaceous
					2				2	Core ang			N Nonvascular
					3				3	~~For~~ Dich ere			V Vines (lianas)
					2				2	Hype sp. maybe cistifolium			E Epiphytes
					3				3	Viola pap			
					1				1	Mare ceri			
					2				2	Pluchea odor			
					6				6	Pani anceps	1	1	
					2				2	Drac int (pale yellow red fruit)			
					2				2	Lychee			
					2				2	Drac cap			

Use bottom of this sheet or additional pages for other species in plot

Appendix B: Descriptions of Vegetation Types

This subset of the International Ecological Classification Standard covers associations and alliances attributed to Moores Creek National Battlefield. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, Durham, NC <mary_russo@natureserve.org> and Carl W. Nordman, Regional Ecologist, Durham, NC <carl_nordman@natureserve.org>. Some classifications were altered by SECN staff and are detailed in the descriptions below. In those instances, comments should be directed to the authors of this report.

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These vegetation data, descriptions and classifications should be cited as:

NatureServe. 2008. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 20 February 2008.

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Forest (I.)

Planted/cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.x.)

Pinus taeda Planted Forest Alliance (A.99)

Alliance Concept

Summary: This alliance represents young, monospecific plantation stands of *Pinus taeda* (loblolly pine). These are cultivated forests and are not considered natural or near-natural vegetation. They are plantations in the strictest sense, typically managed under a regime in which most of the characteristics and attributes of a natural forest are absent. The core concept of these stands are those which support dense, often perfect rows of planted *Pinus taeda* (loblolly pine) or otherwise dense, young stands which are managed and maintained for the extraction of forest products, especially pulpwood. In most cases these stands support almost no other tree species in the overstory and typically very little understory. This association rarely exceeds 20-40 years of age, and with more intensive management, these rotations may be shortened even further. Stands are typically established with artificial regeneration, often using genetically improved tree stock. Excluded from this alliance are former plantation stands which have "broken up" with age or management to approximate a more natural structure and composition. 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.

Similar Alliances:

- *Pinus taeda* - *Pinus echinata* Forest Alliance (A.129)--natural or semi-natural mix of *Pinus echinata* and *Pinus taeda*.
- *Pinus taeda* Forest Alliance (A.130)--natural or semi-natural stands dominated by *Pinus taeda*.

Related Concepts:

- *Pinus taeda* / *Rhus copallina* planted forest alliance (Hoagland 1998a)
- Loblolly Pine: 81 (Eyre 1980) I

Alliance Description

Environment: In parts of the Southeast, loblolly pine has been widely planted for soil stabilization and rehabilitation of eroding uplands, especially in western Tennessee and northern Mississippi (Ursic 1963).

Vegetation: This alliance represents young, monospecific plantation stands of *Pinus taeda* (loblolly pine). These are cultivated forests and are not considered natural or near-natural vegetation. They are maintained as plantations for the harvest of forest products (usually pulpwood). The core concept of these stands are those which support dense, often perfect rows of planted *Pinus taeda* (loblolly pine) or otherwise dense, young stands which are managed and maintained for the extraction of forest products. In most cases these stands support almost no other tree species in the overstory and typically very little understory.

Dynamics: These stands are typically established with artificial regeneration and genetically improved trees (Farnum et al. 1983) but may also be established through other means. Characteristics of *Pinus taeda* create an ideal erosion control and plantation species, namely

good survival, fast growth, high litter fall, and low maintenance (Ursic 1963). Most such stands are managed for pulpwood, with standard rotations of 20 to 25 years, but these may be further reduced to 12 to 15 years or less, while producing the same fiber volumes (Moorhead et al. 1998). Stands resulting from such management often have impoverished species diversity and structure (Hunter 1990). 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.

Alliance Distribution

Range: This alliance is found throughout the central eastern and southeastern United States from Maryland to Florida and west to Oklahoma and Texas.

Nations: US

Subnations: AL, AR, DC?, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA

TNC Ecoregions: 38:C, 39:C, 40:C, 41:C, 42:P, 43:C, 44:C, 50:C, 51:C, 52:C, 53:C, 56:C, 57:C, 58:C, 62:C

USFS Ecoregions: 221Hc:CCC, 221He:CCC, 221Jb:CCC, 222C:CC, 222Eg:CCC, 231Aa:CCC, 231Ae:CCC, 231Ak:CCC, 231An:CCC, 231Ba:CCC, 231Bg:CCC, 231Bh:CCC, 231Bi:CCC, 231Ca:CPP, 231Cd:CPP, 231E:CC, 232Ac:CCC, 232Bm:CCC, 232Br:CCC, 232Bx:CCC, 232Ca:CCC, 232Cb:CCC, 232Ce:CCC, 234A:CC, M221Cd:CCC, M221D:CC, M222A:CC, M231A:CC

Federal Lands: DOD (Arnold, Fort Benning, Fort Bragg, Fort Gordon, Fort Stewart); DOE (Savannah River Site); NPS (Appomattox Court House, C&O Canal?, Chickamauga-Chattanooga?, Colonial, Fredericksburg-Spotsylvania, George Washington Birthplace, Manassas?, Moores Creek, Natchez Trace, National Capital-East?, Obed, Petersburg, Richmond, Timucuan?, Vicksburg); USFS (Angelina, Bankhead?, Bienville, Cherokee, Conecuh, Croatan, Davy Crockett, De Soto, Delta, Francis Marion, Holly Springs, Kisatchie, Land Between the Lakes, Oconee, Ouachita, Ozark, Sabine, Sam Houston, St. Francis?, Sumter, Talladega, Tombigbee, Tuskegee); USFWS (Blackwater, Chesapeake Marshlands, Eufaula, Prime Hook) (CEGL007179) Loblolly Pine Planted Forest

***Pinus taeda* Planted Forest**

Loblolly Pine Plantation

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Planted/Cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.)
Formation	Planted/cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.x.)
Alliance	<i>Pinus taeda</i> Planted Forest Alliance (A.99)
Alliance (English name)	Loblolly Pine Planted Forest Alliance
Association	<i>Pinus taeda</i> Planted Forest
Association (English name)	Loblolly Pine Planted Forest
Association (Common name)	Loblolly Pine Plantation

After the field reconnaissance and field verification steps of the photo-interpretation, the SECN found it necessary to alter the natural/semi-natural associations in the NVCS identified by

NatureServe. In this classification, Loblolly Pine Plantation (CEGL007179) association was not included within the park boundaries of MOCR but was applied to areas outside of park boundaries.

The differences in the Loblolly Pine Plantation (CEGL007179) and the Mid- to Late-Successional Loblolly Pine Forest (CEGL006011) identified at MOCR during preliminary vegetation-community assessment and inventory are indeterminable given the current condition and the progression of land management at the site. Consequently, we are considering the previously identified occurrence of Loblolly Pine Plantation not applicable within park boundaries of MOCR and are henceforth considering it Mid- to Late-Successional Loblolly Pine Forest. Outside of park boundaries (e.g., within the buffered region), we did utilize the Loblolly Pine Plantation association since the reasoning described below is not applicable to these areas.

The Early- to Mid-Successional Loblolly Forest association is the best replacement for the Loblolly Pine Planted Forest association based on similarities in spectral values, qualitative (photo-interpretation) evaluation, species composition, hydrologic processes, successional processes, and soils.

Historic aspect of the occurrence

Prior to 1850, extensive woodlands, mainly composed of longleaf pine (*Pinus palustris*), with scattered individuals of Loblolly pine (*Pinus taeda*), dominated the upland landscape around and east of the Visitor's Center in MOCR (McCrain et al. 1985). After 1850, these woodlands were cut and converted to a loblolly pine plantation. Over the next hundred years, the plantation was timbered repeatedly. Once timber operations ceased, the plantation was left fallow. A seed bank from the loblolly pine allowed for self-regeneration of the species to occur. Since the 1950s, regenerated loblolly pine forests have remained uncut within the park boundaries of MOCR. Only scattered individuals of longleaf pine have been planted in various upland locations in the park, and these plantings have not been actively managed (J. Sutton, pers. comm., 22 June 2011).

The NVCS description of the Loblolly Pine Plantation (CEGL007179) suggests that this association hosts trees that rarely exceed 20-40 years old. Because the area has not been harvested in over 60 years, the mean age of the trees in this area is very likely to approximate or exceed 40 years.

Current land use associated with the occurrence

Management activities that are typically associated with pine plantations, such as thinning and cutting, are not currently performed at MOCR. These stands are treated as successional pine forests. Within the next two years, prescribed fire regimes will be introduced as a management activity for loblolly pine dominated stands (J. Sutton, pers. comm., 22 June 2011).

Ecological properties of the occurrence

Mounded/bedded windrows were not created during the establishment of the loblolly plantation and the soils were not altered. The area was not ditched, so hydrologic processes continue to occur as they would have historically. This is evidenced by the presence of, for example, *Osmunda cinnamomea* and *Arundinaria gigantea*, species considered Facultative Wetland (FACW) and could only persist in areas with unimpeded and normal hydrologic function. Because the plantation has not been harvested for over 50 years, successional processes are

evident by observed species composition and natural regeneration of tree species. The area is no longer mono-specific and several native species are now established in the area.

The natural disturbance process in this area is fire; with an estimated fire return-interval of 2–8 years. Natural fires (i.e., lightning caused) were historically suppressed. Recently fire been reintroduced into the ecosystem for management and restoration purposes. The ultimate goal is to return many of the park's natural communities to a historic fire-return interval. Fire and other natural processes (selective insect infestation) will thin the trees in this stand gradually over time.

Botanical properties of the occurrence

Herbaceous ground cover in this area is relatively sparse; however, this is due to fire suppression. This area is planned to burn within the next three years, thereby removing the duff layer, exposing mineral soil, releasing the seed bank that currently exists, and providing a seed bed for native species immediately adjacent to the former plantation. Based upon independent data-collection efforts, separated by five years, by NatureServe and the SECN, the two areas have many characteristic species in common, in relatively similar coverage classes. These species include (a) herbaceous: *Osmunda cinnamomea*, *Arundinaria gigantea*, *Gelsemium sempervirens*, *Tipularia discolor*, several *Smilax* spp. and *Vitis* spp., and *Parthenocissus quinquefolia*; (b) shrubs: *Morella cerifera*, *Vaccinium stamineum*, and *Vaccinium arboretum*, and (c) trees: *Pinus taeda*, *Liquidambar styraciflua*, *Quercus nigra*, *Magnolia virginiana*, and *Acer rubrum*.

Given the small size of the Planted Pine association (~ 5 ac), the spatial arrangement of the occurrence, and the adjacent vegetation community types, the continued movement of native seeds into and throughout the Planted Pine area is very likely.

The Loblolly Pine Planted Forest association most closely resembles this planted pine occurrence botanically, and the planted pine forest is most likely to progress along the same botanical trajectory as Loblolly Pine Planted Forest association.

Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)

***Pinus taeda* Forest Alliance (A.130)**

Alliance Concept

Summary: This alliance includes both successional forests, following cropping or site conversion, and natural forests in the Piedmont, Cumberland and Ridge and Valley, and Coastal Plain of the southeastern United States. Other canopy and subcanopy species that may be present in successional stands are *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus virginiana* (Virginia pine), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Ulmus rubra* (slippery elm), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), *Ulmus alata* (winged elm), *Cornus florida* (flowering dogwood), *Prunus serotina* var. *serotina* (black cherry), and *Carya* (hickory) spp. *Vaccinium* (blueberry) spp., especially *Vaccinium stamineum* (deerberry), are common in these forests. One association in this alliance occurs on barrier

islands in the Mid-Atlantic Coastal Plain. Along with the dominant *Pinus taeda* (loblolly pine), canopy associates often include *Quercus falcata* (southern red oak), *Acer rubrum* (red maple), *Prunus serotina* var. *serotina* (black cherry), and *Sassafras albidum* (sassafras). The tall-shrub layer is comprised of *Morella cerifera* (wax myrtle) and *Vaccinium formosum* (southern blueberry). Vines and lianas are always present in abundance; *Vitis rotundifolia* (muscadine) is most commonly present, but *Toxicodendron radicans* (eastern poison ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper) are usually present in abundance as well. The herbaceous layer may be sparse, particularly if shrubs and vines are dense, but *Chasmanthium laxum* (slender woodoats) may be fairly abundant in this community. Other herbs include *Panicum amarum* var. *amarulum* (bitter panicgrass), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), and *Elephantopus nudatus* (smooth elephantsfoot). In southern Virginia and North Carolina, *Quercus virginiana* (live oak) and *Gelsemium sempervirens* (evening trumpetflower) may also be present, but *Quercus virginiana* (live oak) is never abundant and when present is usually restricted to the understory. *Pinus taeda* (loblolly pine) may occur rarely in the Ouachita Mountains and Ozarks of Arkansas where the species is becoming naturalized, expanding from its native range in the Coastal Plain, where it naturally occurs in low, moist areas (e.g., deep, well-drained soils of floodplains). However, a natural *Pinus taeda* (loblolly pine) forest association is not recognized for the Ozark or Ouachita region.

Classification Comments: On the Bankhead National Forest in the Cumberland Plateau of northern Alabama, this alliance includes streamside terraces that are presumed to have been previously farmed. Associations occurring as plantations are classed in *Pinus taeda* Planted Forest Alliance (A.99).

Similar Alliances:

- *Pinus echinata* - *Quercus* (*alba*, *falcata*, *stellata*, *velutina*) Forest Alliance (A.394)
- *Pinus taeda* - *Quercus* (*phellos*, *nigra*, *laurifolia*) Temporarily Flooded Forest Alliance (A.437)--mixed, temporarily flooded.
- *Pinus taeda* - *Quercus nigra* Forest Alliance (A.406)
- *Pinus taeda* Planted Forest Alliance (A.99)--includes monospecific, dense, plantation stands only.
- *Pinus taeda* Woodland Alliance (A.526)

Related Concepts:

- Loblolly Pine: 81 (Eyre 1980) I
- Lowland Pine - Oak Forest (Foti 1994b) ?
- T1A9bII2a. *Pinus taeda* (Foti et al. 1994) ?
- Upland Mixed Forest (FNAI 1992a) ?
- Upland Mixed Forest, Gumbo Loblolly Forest subtype (FNAI 1992b) ?

Alliance Description

Environment: This alliance includes both successional forests, following cropping or site conversion, and natural forests in the Piedmont, Cumberlands and Ridge and Valley, and Coastal Plain of the southeastern United States.

Vegetation: Canopy and subcanopy species that may be present in successional stands are *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus virginiana* (Virginia pine), *Juniperus virginiana* var. *virginiana* (eastern redcedar), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Ulmus rubra* (slippery

elm), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), *Ulmus alata* (winged elm), *Cornus florida* (flowering dogwood), *Prunus serotina* var. *serotina* (black cherry), and *Carya* (hickory) spp. *Vaccinium* (blueberry) spp., especially *Vaccinium stamineum* (deerberry), are common in these forests. One association in this alliance occurs on barrier islands in the Mid-Atlantic Coastal Plain. Along with the dominant *Pinus taeda* (loblolly pine), canopy associates often include *Quercus falcata* (southern red oak), *Acer rubrum* (red maple), *Prunus serotina* var. *serotina* (black cherry), and *Sassafras albidum* (sassafras). The tall-shrub layer is comprised of *Morella cerifera* (wax myrtle) and *Vaccinium formosum* (southern blueberry). Vines and lianas are always present in abundance; *Vitis rotundifolia* (muscadine) is most commonly present, but *Toxicodendron radicans* (eastern poison ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper) are usually present in abundance as well. The herbaceous layer may be sparse, particularly if shrubs and vines are dense, but *Chasmanthium laxum* (slender woodoats) may be fairly abundant in this community. Other herbs include *Panicum amarum* var. *amarulum* (bitter panicgrass), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), and *Elephantopus nudatus* (smooth elephantsfoot). In southern Virginia and North Carolina, *Quercus virginiana* (live oak) and *Gelsemium sempervirens* (evening trumpetflower) may also be present, but *Quercus virginiana* (live oak) is never abundant and when present is usually restricted to the understory. *Pinus taeda* (loblolly pine) forests may occur rarely in the Ouachita Mountains and Ozarks of Arkansas where the species is becoming naturalized, expanding from its native range in the Coastal Plain, where it naturally occurs in low, moist areas (e.g., deep, well-drained soils of floodplains).

Dynamics: The understory of the heavily disturbed examples of this alliance is often dominated by exotic species, to the exclusion of natives. Common invasives are *Lonicera japonica* and *Microstegium vimineum*. Due to the dominance of these species, stand dynamics often shift so that there are less seedlings and saplings in the understory.

Alliance Distribution

Range: This alliance is found in the Cumberland Plateau, Piedmont, Interior Low Plateau, and Coastal Plains of the southeastern United States, from Delaware and Maryland south and west to Texas, and in the interior to Tennessee and possibly West Virginia.

Nations: US

Subnations: AL, AR, DE, FL, GA, LA, MD, MS, NC, OK, SC, TN, TX, VA

TNC Ecoregions: 31:P, 39:C, 40:C, 41:C, 42:P, 43:C, 44:C, 50:C, 52:C, 53:C, 55:?, 56:C, 57:C, 58:C, 59:C, 62:C

USFS Ecoregions: 221D:CC, 221Jb:CCC, 222Cb:CCC, 222Dc:CCC, 222Dd:CCC, 222Eb:CCC, 222Ec:CCC, 222Ef:CCC, 222Eg:CCC, 231Aa:CCC, 231Ab:CCC, 231Ac:CCC, 231Ad:CCC, 231Ae:CCC, 231Af:CCC, 231Ag:CCC, 231Ah:CCC, 231Ai:CCC, 231Aj:CCC, 231Ak:CCC, 231Al:CCC, 231Am:CCC, 231An:CCC, 231Ao:CCP, 231Ba:CCC, 231Bb:CCC, 231Bc:CCP, 231Bd:CCC, 231Be:CCC, 231Bf:CCP, 231Bg:CCC, 231Bh:CCC, 231Bi:CCC, 231Bj:CCC, 231Bk:CCC, 231Bl:CCC, 231Ca:CCP, 231Cb:CCP, 231Cc:CCC, 231Cd:CCC, 231Ce:CCC, 231Cf:CCC, 231Cg:CCP, 231Da:CCP, 231Dc:CCC, 231De:CC?, 231Ea:CCC, 231Eb:CC?, 231Ec:CC?, 231Ed:CC?, 231Ef:CC?, 231Eg:CCP, 231Eh:CCC, 231Ei:CC?, 231Ej:CC?, 231Ek:CCP, 231En:CC?, 231Fa:CPP, 231Fb:CP?, 232Ac:CCC, 232Ad:CCC, 232Ba:CCC, 232Bb:CCC, 232Bc:CC?, 232Bd:CC?, 232Be:CC?, 232Bg:CCC, 232Bh:CC?, 232Bi:CC?, 232Bj:CCC, 232Bk:CC?, 232Bl:CC?, 232Bm:CCC, 232Bn:CC?, 232Bo:CC?, 232Bp:CC?, 232Bq:CCC, 232Br:CCC, 232Bt:CC?, 232Bu:CC?, 232Bv:CC?, 232Bx:CCC, 232Bz:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CC?, 232Ce:CCC, 232Cf:CC?, 232Cg:CC?,

232Ci:CC?, 232Da:CC?, 232Dc:CCC, 232Fa:CC?, 232Fb:CC?, 232Fe:CCC, 255Da:PPP, M221D:??

Federal Lands: DOD (Arnold, Fort Benning, Fort Gordon); NPS (Assateague Island, Cape Hatteras, Chickamauga-Chattanooga, Colonial, Cowpens, Fort Donelson, George Washington Birthplace, Guilford Courthouse, Kennesaw Mountain, Kings Mountain, Little River Canyon, Moores Creek, Natchez Trace, Ninety Six, Petersburg, Richmond, Shiloh); TVA (Tellico); USFS (Angelina, Apalachicola, Bankhead, Bienville, Chattahoochee, Conecuh?, Croatan, Davy Crockett, Kisatchie, Land Between the Lakes?, Oconee, Ouachita, Sabine, Sam Houston, Sumter, Talladega, Tuskegee, Uwharrie); USFWS (Back Bay?, Blackwater, Chesapeake Marshlands, Chincoteague, Prime Hook)

(CEGL006011) Loblolly Pine / Sweetgum - Red Maple / Deerberry Forest

***Pinus taeda* / *Liquidambar styraciflua* - *Acer rubrum* var. *rubrum* / *Vaccinium stamineum* Forest**

Early- to Mid-Successional Loblolly Pine Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)
Alliance	<i>Pinus taeda</i> Forest Alliance (A.130)
Alliance (English name)	Loblolly Pine Forest Alliance
Association	<i>Pinus taeda</i> / <i>Liquidambar styraciflua</i> - <i>Acer rubrum</i> var. <i>rubrum</i> / <i>Vaccinium stamineum</i> Forest
Association (English name)	Loblolly Pine / Sweetgum - Red Maple / Deerberry Forest
Association (Common name)	Early- to Mid-Successional Loblolly Pine Forest

Element Concept

Global Summary: This association represents stands in which *Pinus taeda* (loblolly pine) is the monospecific dominant tree in the overstory. These are generally early- to mid-successional forests where the pines have reached tree size (as opposed to saplings) and have been established for a long enough period to have developed a closed canopy. Below the canopy of *Pinus taeda* (loblolly pine), a well-developed subcanopy of hardwoods is present. *Acer rubrum* var. *rubrum* (red maple) and *Liquidambar styraciflua* (sweetgum) are often the dominant species in the subcanopy. If significant numbers of these species enter the canopy, the stand would be classified as *Pinus taeda* - *Liquidambar styraciflua* Semi-natural Forest (CEGL008462). Although this forest may result from a planted stand [see *Pinus taeda* (loblolly pine) Planted Forest (CEGL007179)], it is distinguished from young pine plantations by tree height and the formation of distinct stratal layers, especially a well-developed subcanopy. This type may also develop following site preparation, with or without site conversion, and also following agriculture. It is a wide-ranging type, most common from the Piedmont of Virginia, through North Carolina, South Carolina, Georgia and Alabama, likely extending throughout the adjacent Coastal Plain. A large amount of variability exists in species composition and density due to geographic and disturbance factors. Stands typically have more-or-less closed canopies, understories dominated by fire-intolerant hardwoods, and shrub-dominated lower strata.

Environmental Description

Moores Creek National Battlefield Environment: This successional loblolly pine forest was sampled once southeast of Slocumb Monument on a flat low-elevation summit. The soil is well-

drained; there is a small ditch nearby that was dry at the time of sampling. The unvegetated surface is dominated by leaf litter (95% cover) with some wood (5%). Evidence of disturbance includes recent thinning of the trees, past fire, the presence of trails, and alteration of the hydrology (ditch).

Global Environment: This forest follows agricultural cropping or silvicultural site preparation on a variety of sites, and presumably is more likely on moderately dissected topography where fire is a rare occurrence. This community usually is not present on steep slopes and does not occur on wet soils. It occurs on well- to moderately well-drained soils, usually Ultisols, on sites that formerly were under hardwood cover or subjected to agriculture.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderately dense (70% cover) tree canopy, 20-35 m tall, is dominated solely by *Pinus taeda* (loblolly pine). *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), and *Quercus nigra* (water oak) form a sparse (30%) subcanopy (5-10 m). The moderate (40%) short-shrub layer (1-2 m) is fairly diverse and dominated by *Clethra alnifolia* (coastal sweetpepperbush), *Gordonia lasianthus* (loblolly bay), *Liquidambar styraciflua* (sweetgum), *Lyonia lucida* (fetterbush lyonia), *Morella cerifera* (wax myrtle), *Nyssa sylvatica* (blackgum), *Persea palustris* (swamp bay), *Quercus margarettiae* (runner oak), *Quercus nigra* (water oak), and *Vaccinium tenellum* (small black blueberry); a total of 26 taxa were recorded in this stratum. The very sparse (10%) herbaceous layer includes *Arundinaria gigantea* (giant cane), *Osmunda cinnamomea* (cinnamon fern), *Vaccinium crassifolium* (creeping blueberry), *Danthonia sericea* (downy danthonia), and *Dichanthelium sphaerocarpon* (roundseed panicgrass), among others. Vines (5%) are diverse and include *Gelsemium sempervirens* (evening trumpetflower), *Lonicera sempervirens* (trumpet honeysuckle), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax herbacea* (smooth carrionflower), *Smilax laurifolia* (laurel greenbrier), *Smilax rotundifolia* (roundleaf greenbrier), and *Vitis rotundifolia* (muscadine). In addition, this community supports state-critically imperiled *Kalmia angustifolia* (sheep laurel) and state-imperiled *Andropogon virginicus* var. *decipiens* (broomsedge bluestem) and *Dichanthelium strigosum* var. *leucoblepharis* (roughhair rosette grass).

Global Vegetation: The tree canopy of *Pinus taeda* (loblolly pine) is at least 60% but may be considerably more dense, up to and including closed canopies. Tree subcanopy density varies with stand disturbance history but generally is <50%. Shrub and herb layer coverages do not exceed 25% and decrease with increasing age of the stand. Other species of pine, especially *Pinus echinata* (shortleaf pine) and *Pinus virginiana* (Virginia pine) may be sparingly present in the canopy. Other species that may be present in the subcanopy in addition to *Liquidambar styraciflua* (sweetgum) and *Acer rubrum* var. *rubrum* (red maple) include *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Nyssa sylvatica* (blackgum), *Carya glabra* (pignut hickory), *Carya alba* (mockernut hickory), *Diospyros virginiana* (common persimmon), *Prunus serotina* (black cherry), *Cornus florida* (flowering dogwood), *Liriodendron tulipifera* (tuliptree), and *Sassafras albidum* (sassafras) (NatureServe Ecology unpubl. data). Other species in addition to *Vaccinium stamineum* (deerberry) that may be present in the shrub stratum include *Juniperus virginiana* (eastern redcedar), *Vaccinium arboreum* (farkleberry), *Rhus copallinum* (flameleaf sumac), *Gaylussacia baccata* (black huckleberry), *Callicarpa americana* (American beautyberry), and probably others. The herbaceous layer usually forms <5% cover and contains such species as *Gelsemium sempervirens* (evening trumpetflower), *Chimaphila maculata* (striped prince's pine),

Polystichum acrostichoides (Christmas fern), and *Potentilla canadensis* (dwarf cinquefoil). An example from Oconee National Forest has a thinned canopy and grassy herbaceous layer.

Most Abundant Species

Moore's Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine)
Tree subcanopy	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum), <i>Quercus nigra</i> (water oak)
Short shrub/sapling	Broad-leaved deciduous tree	<i>Quercus nigra</i> (water oak)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Liquidambar styraciflua</i> (sweetgum), <i>Vaccinium tenellum</i> (small black blueberry)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Clethra alnifolia</i> (coastal sweetpepperbush), <i>Gordonia lasianthus</i> (loblolly bay)
Herb (field)	Vine/Liana	<i>Gelsemium sempervirens</i> (evening trumpetflower), <i>Vitis rotundifolia</i> (muscadine)
Herb (field)	Graminoid	<i>Arundinaria gigantea</i> (giant cane)

Global

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine)
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple), <i>Liquidambar styraciflua</i> (sweetgum)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium stamineum</i> (deerberry)

Other Noteworthy Species

Moore's Creek National Battlefield

Other Plant Species

<u>Other Plant Species</u>	<u>GRank</u>	<u>Note</u>
<i>Andropogon virginicus</i> var. <i>decipiens</i> (broomsedge bluestem)	G5T4	state-imperiled
<i>Dichanthelium strigosum</i> var. <i>leucoblepharis</i> (roughhair rosette grass)	G5T3T5	state-imperiled
<i>Kalmia angustifolia</i> (sheep laurel)	G5	state-critically imperiled

Conservation Status Rank

Global Rank & Reasons: GNA (modified/managed) (8-Aug-2002). This is a successional forest composed of species native to the southeastern United States; it is not of conservation concern and does not receive a conservation status rank.

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Comments: The similarity of this association with *Pinus taeda* - *Liquidambar styraciflua* Semi-natural Forest (CEGL008462) suggests that a merge with that type should be considered.

Global Similar Associations:

- *Pinus echinata* Early-Successional Forest (CEGL006327)--occurs in the same region but is dominated by *Pinus echinata* instead of *Pinus taeda*.
- *Pinus taeda* - *Liquidambar styraciflua* Semi-natural Forest (CEGL008462)--is a related late-successional type with hardwoods in the canopy.
- *Pinus taeda* - *Liriodendron tulipifera* / *Acer saccharum* Successional Forest (CEGL007105)--of the Ridge and Valley.

- *Pinus taeda* - *Quercus (alba, falcata, stellata)* Successional Coastal Plain Forest [Provisional] (CEGL004766)
- *Pinus taeda* - *Quercus (falcata, hemisphaerica, nigra)* - *Liquidambar styraciflua* / *Rhus copallinum* - *Vaccinium stamineum* Forest (CEGL008450)
- *Pinus taeda* / *Rhus copallinum* Managed Forest (CEGL007108)
- *Pinus taeda* Planted Forest (CEGL007179)--applies to young dense monospecific stands with plantation structure.
- *Pinus virginiana* Successional Forest (CEGL002591)

Global Related Concepts:

- *Pinus taeda* / *Liquidambar styraciflua* - *Acer rubrum* var. *rubrum* / *Vaccinium stamineum* Forest (Bartgis 1986) ?
- IF3b. Plantation (Hardwood or Conifer) (Allard 1990) B
- Loblolly Pine (21) (USFS 1988) ?
- Loblolly Pine - Hardwood: 82 (Eyre 1980) B
- Loblolly Pine: 81 (Eyre 1980) B

Element Distribution

Moore's Creek National Battlefield Range: This forest is found on the uplands, mostly in the southeastern part of Moore's Creek National Battlefield.

Global Range: This forest ranges from the Piedmont of Virginia, through North Carolina, South Carolina, Georgia and Alabama, extending into the adjacent eastern end of the Upper East Gulf Coastal Plain (e.g., Talladega National Forest).

Nations: US

States/Provinces: AL, DE, GA, LA, MD, MS, NC, SC, TN, TX, VA

TNC Ecoregions: 40:C, 41:C, 43:C, 44:C, 52:C, 53:C, 56:P, 57:C, 58:C, 62:C

USFS Ecoregions: 221D:CC, 222Ef:CCC, 222Eg:CCC, 231Aa:CCC, 231Ba:CCC, 231Bb:CCC, 231Bd:CCC, 231Be:CCC, 231Bg:CCC, 231Bh:CCC, 231Bi:CCC, 231Bj:CCC, 231Bk:CCC, 231Bl:CCC, 232Ac:CCC, 232Bb:CCC, 232Cb:CCC, M221D:??

Federal Lands: NPS (Cowpens, George Washington Birthplace, Little River Canyon?, Moore's Creek, Natchez Trace, Petersburg, Shiloh); USFS (Land Between the Lakes?, Oconee, Sumter, Sumter (Piedmont), Talladega, Talladega (Oakmulgee), Talladega (Talladega), Uwharrie?); USFWS (Chesapeake Marshlands)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.3.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: S. Landaal, mod. L.A. Sneddon

References: Allard 1990, Bartgis 1986, Coxe 2007, Eyre 1980, Felix et al. 1983, Harrison 2004, McCrain and Church 1985, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, USFS 1988

Saturated temperate or subpolar needle-leaved evergreen forest (I.A.8.N.g.)

Chamaecyparis thyoides Saturated Forest Alliance (A.196)

Alliance Concept

Summary: These *Chamaecyparis thyoides* (Atlantic white cedar)-dominated forests are found on saturated, peaty substrates. *Chamaecyparis thyoides* (Atlantic white cedar) tolerates only brief inundation. The canopy of forests in this alliance may be heavily dominated by *Chamaecyparis thyoides* (Atlantic white cedar), or they may contain pines (*Pinus elliottii* var. *elliottii* (Honduras pine) in Florida basins, *Pinus serotina* (pond pine) in North Carolina peat domes) or hardwoods (for instance *Acer rubrum* (red maple), *Nyssa biflora* (swamp tupelo), and *Persea palustris* (swamp bay), or *Liriodendron tulipifera* (tuliptree) in one rare example). The subcanopy may contain *Acer rubrum* var. *trilobum* (red maple), *Nyssa biflora* (swamp tupelo), *Magnolia virginiana* (sweetbay), *Nyssa biflora* (swamp tupelo), *Persea palustris* (swamp bay), and *Cliftonia monophylla* (buckwheat tree). *Sabal palmetto* (cabbage palmetto) and *Serenoa repens* (saw palmetto) are abundant on hummocks in one Florida association. The shrub stratum ranges from open to dense and may contain *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron viscosum* (swamp azalea), *Ilex laevigata* (smooth winterberry), *Ilex glabra* (inkberry), *Clethra alnifolia* (coastal sweetpepperbush), *Gaylussacia frondosa* (blue huckleberry), and *Ilex coriacea* (large gallberry), *Cyrilla racemiflora* (swamp titi), *Lyonia lucida* (fetterbush lyonia), *Magnolia virginiana* (sweetbay), *Persea palustris* (swamp bay), *Smilax laurifolia* (laurel greenbrier), and *Vaccinium formosum* (southern blueberry) in the southern portion of the range. In some examples, *Rhododendron maximum* (great laurel) forms a nearly impenetrable shrub thicket. The herbaceous stratum is sparse to well-developed and may contain *Osmunda cinnamomea* (cinnamon fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Woodwardia areolata* (netted chainfern), *Thelypteris simulata* (bog fern), *Gaultheria procumbens* (eastern teaberry), *Drosera* (sundew) spp., *Sarracenia purpurea* (purple pitcherplant), *Pogonia ophioglossoides* (snakemouth orchid), *Mitchella repens* (partridgeberry), *Carex striata* (Walter's sedge), *Carex collinsii* (Collins' sedge), *Carex atlantica* (prickly bog sedge), and *Osmunda regalis* var. *spectabilis* (royal fern). *Sphagnum* (sphagnum) spp., other nonvascular plants, and lichens may be common on exposed peat and rotting wood.

Examples of this alliance may be found in poorly-drained basins in the northeastern United States, along small blackwater or spring-fed streams not subject to much flooding or siltation (in Florida and the East Gulf Coastal Plain); along streams or at seepages (in the Fall-line Sandhills); or in Panhandle Florida in large, constantly saturated basins (inundated under several feet of water during the spring) where fire is an infrequent event; as well as peat dome forests of North Carolina and Virginia dominated by *Chamaecyparis* (cedar) and *Pinus serotina* (pond pine). Soils may be acidic peats but are usually circumneutral sands or sands overlain by peat. Soils are generally organic Histosols, composed of sand and peat, are permanently saturated, and include Histosols (Saprists and Hemists); the pH may be circumneutral or slightly acidic. Fires are infrequent and less destructive than in the northern range of *Chamaecyparis thyoides* (Atlantic white cedar).

Gap succession is more important in this community than post-fire regeneration and accounts for the mixed, uneven-aged stands. Lightning strikes are the main cause of mortality in mature white-cedar trees within the range of this association. Atlantic white-cedar communities are early successional but *Chamaecyparis thyoides* is a long-lived species (250+ years); gap regeneration is hypothesized to be the primary means of reproduction. The community often succeeds to itself following fire or other disturbance. In the absence of fire and adequate gap regeneration, Atlantic White-cedar Forests may be replaced by Bay Forest. Known examples are generally neither flood-prone, nor exposed to frequent fire. One association is thought to become established following fire, with a return time of 25-100+ years.

Classification Comments: Clewell and Ward (1987) describe a community along backswamps of larger rivers in Florida and along the Gulf Coast where "flooding is nominal." This could represent an additional association.

Similar Alliances:

- *Chamaecyparis thyoides* Saturated Woodland Alliance (A.575)
- *Chamaecyparis thyoides* Seasonally Flooded Woodland Alliance (A.571)

Similar Alliance Comments: This alliance should be compared to open-canopy woodlands dominated by *Chamaecyparis thyoides*, such as II.A.4.N.f *Chamaecyparis thyoides* Saturated Woodland Alliance (A.575) and II.A.4.N.e *Chamaecyparis thyoides* Seasonally Flooded Woodland Alliance (A.571).

Related Concepts:

- Atlantic White Cedar Swamp (Nelson 1986) ?
- Atlantic White Cedar Swamp Forest (Oberholster 1993) ?
- Atlantic White-Cedar: 97 (Eyre 1980) I
- Bottomland Forest (FNAI 1992a) I
- Coastal Atlantic White Cedar Swamp (Swain and Kearsley 2001) ?
- IIA2b. Atlantic White Cedar Swamp Forest (Allard 1990) I
- Inland Atlantic White Cedar Swamp (Swain and Kearsley 2001) ?
- Mesotrophic Saturated Forest (Rawinski 1992) I
- Northern Atlantic White Cedar Swamp (Swain and Kearsley 2001) ?
- Peatland Atlantic White Cedar Forest (Schafale and Weakley 1990) ?
- Streamhead Atlantic White Cedar Forest (Schafale and Weakley 1990) ?
- White Cedar Swamp Forest (Wieland 1994b) ?

Alliance Description

Environment: These *Chamaecyparis thyoides*-dominated forests are found on saturated, peaty substrates. *Chamaecyparis thyoides* tolerates only brief inundation. Examples of this alliance may be found in poorly-drained basins in the northeastern United States, along small blackwater or spring-fed streams not subject to much flooding or siltation (in Florida and the East Gulf Coastal Plain); along streams or at seepages (in the Fall-line Sandhills); or in Panhandle Florida in large, constantly saturated basins (inundated under several feet of water during the spring) where fire is an infrequent event; as well as peat dome forests of North Carolina and Virginia dominated by *Chamaecyparis* and *Pinus serotina*. Soils may be acidic peats but are usually circumneutral sands or sands overlain by peat. Soils are generally organic Histosols, composed of sand and peat, are permanently saturated, and include Histosols (Saprists and Hemists); the pH may be circumneutral or slightly acidic. Fires are infrequent and less destructive than in the

northern range of *Chamaecyparis thyoides* (Wiseman 1986, Clewell and Ward 1987, Laderman 1989).

Vegetation: The canopy of forests in this alliance may be heavily dominated by *Chamaecyparis thyoides* (Atlantic white cedar), or they may contain hardwoods (for instance *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), *Nyssa sylvatica* (blackgum), *Nyssa biflora* (swamp tupelo), and *Persea palustris* (swamp bay), or *Liriodendron tulipifera* (tuliptree) in one rare example) or conifers (*Tsuga canadensis* (eastern hemlock) and *Pinus strobus* (eastern white pine) in the Northeast, *Pinus elliottii* var. *elliottii* (Honduras pine) in Florida basins, *Pinus serotina* (pond pine) in North Carolina peat domes). The subcanopy may contain *Acer rubrum* var. *trilobum* (red maple), *Nyssa biflora* (swamp tupelo), *Magnolia virginiana* (sweetbay), *Nyssa biflora* (swamp tupelo), *Persea palustris* (swamp bay), and *Cliftonia monophylla* (buckwheat tree). *Sabal palmetto* (cabbage palmetto) and *Serenoa repens* (saw palmetto) are abundant on hummocks in one Florida association. The shrub stratum ranges from open to dense and may contain *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron viscosum* (swamp azalea), *Ilex laevigata* (smooth winterberry), *Ilex glabra* (inkberry), *Clethra alnifolia* (coastal sweetpepperbush), *Ilex glabra* (inkberry), *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (blue huckleberry), *Ilex coriacea* (large gallberry), *Cyrilla racemiflora* (swamp titi), *Lyonia lucida* (fetterbush lyonia), *Magnolia virginiana* (sweetbay), *Persea palustris* (swamp bay), *Smilax laurifolia* (laurel greenbrier), and *Vaccinium formosum* (southern blueberry) in the southern portion of the range. In some examples, *Rhododendron maximum* (great laurel) forms a nearly impenetrable shrub thicket. In some examples, the herbaceous stratum is sparse to well-developed and may contain *Osmunda cinnamomea* (cinnamon fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Woodwardia areolata* (netted chainfern), *Thelypteris simulata* (bog fern), *Gaultheria procumbens* (eastern teaberry), *Drosera* (sundew) spp., *Sarracenia purpurea* (purple pitcherplant), *Pogonia ophioglossoides* (snakemouth orchid), *Mitchella repens* (partridgeberry), *Carex striata* (Walter's sedge), *Carex collinsii* (Collins' sedge), *Carex atlantica* (prickly bog sedge), and *Osmunda regalis* var. *spectabilis* (royal fern). *Sphagnum* (sphagnum) spp., other nonvascular plants, and lichens may be common on exposed peat and rotting wood.

Dynamics: Gap succession is more important in this community than post-fire regeneration and accounts for the mixed, uneven-aged stands. Lightning strikes are the main cause of mortality in mature white-cedar trees within the range of this association. Atlantic white-cedar communities are early successional but *Chamaecyparis thyoides* is a long-lived species (250+ years); gap regeneration is hypothesized to be the primary means of reproduction. The community often succeeds to itself following fire or other disturbance. In the absence of fire and adequate gap regeneration, Atlantic White-cedar Forests may be replaced by Bay Forest. Known examples are generally neither flood-prone, nor exposed to frequent fire. One association is thought to become established following fire, with a return time of 25-100+ years.

Alliance Distribution

Range: This alliance is found along the coast from Maine south to Florida and in the Eastern Gulf states to Mississippi.

Nations: US

Subnations: AL, CT, DE, FL, GA, MA, ME, MS, NC, NH, NJ, NY, RI, SC, VA

TNC Ecoregions: 53:C, 55:C, 56:C, 57:C, 58:?, 60:C, 61:C, 62:C, 63:C

USFS Ecoregions: 212Da:CCC, 212Dc:CCP, 212Fc:CCC, 221Aa:CCP, 221Ab:CCC, 221Ac:CCC, 221Ad:CCC, 221Ae:CCC, 221Af:CCC, 221Ag:CCC, 221Ah:CCC, 221Ai:CCC,

221Ak:CCC, 221Al:CCP, 221Am:CCP, 221Ba:CCC, 221Bc:CCP, 221Bd:CCC, 221Dc:CCC, 232Aa:CCC, 232Ab:CCC, 232Ac:CCC, 232Ba:CCP, 232Bc:CCP, 232Bf:CCC, 232Bg:CCC, 232Bh:CCC, 232Bj:CCC, 232Bp:CCP, 232Bq:CCC, 232Br:CCC, 232Bt:CCC, 232Bu:CCP, 232Ca:CCC, 232Cb:CCC, 232Ch:CCC, 232Dc:CCC, 232Dd:CCP, M212Bb:CC?, M212Bc:CCC, M212Bd:CCC

Federal Lands: DOD (Dare County Bombing Range, Eglin, Fort Bragg, Fort Gordon); NPS (Cape Cod, Fire Island, Moores Creek); USFS (Apalachicola, Conecuh, De Soto, Ocala); USFWS (Alligator River, Great Dismal Swamp, Mississippi Sandhill Crane, Pocosin Lakes, St. Marks)

(CEGL007563) Atlantic White-cedar - (Tuliptree) / Shining Fetterbush Forest

Chamaecyparis thyoides - (*Liriodendron tulipifera*) / *Lyonia lucida* Forest

Sandhills Atlantic White-cedar Streamside Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Saturated temperate or subpolar needle-leaved evergreen forest (I.A.8.N.g.)
Alliance	<i>Chamaecyparis thyoides</i> Saturated Forest Alliance (A.196)
Alliance (English name)	Atlantic White-cedar Saturated Forest Alliance
Association	<i>Chamaecyparis thyoides</i> - (<i>Liriodendron tulipifera</i>) / <i>Lyonia lucida</i> Forest
Association (English name)	Atlantic White-cedar - (Tuliptree) / Shining Fetterbush Forest
Association (Common name)	Sandhills Atlantic White-cedar Streamside Forest
Ecological System(s):	Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin, and Baygall (CES203.252)

Element Concept

Global Summary: This forest, found along streams or at seepages in the Fall-line Sandhills, is usually dominated by *Chamaecyparis thyoides* (Atlantic white cedar), but possesses a mixed-species canopy with *Liriodendron tulipifera* (tuliptree) usually present. It is found in the Sandhills area of North Carolina, South Carolina, and Georgia, but is possible on the outer coastal terraces of North Carolina, South Carolina, and Georgia. The ground surface has little exposed soil. The community is not flood-prone, nor exposed to frequent fire. It occurs at seepage areas where water infiltration is impeded by an impervious clay layer and therefore flows out where the hardpan intersects the soil surface, usually on a slope and often creating a streamhead. The community also occurs at streambanks of small blackwater streams. Soils are generally acidic and saturated throughout the year and often are of the Torhunta (Typic Humaquept) and Johnston (Cumulic Humaquept) series. The canopy contains *Chamaecyparis thyoides* (Atlantic white cedar), with *Liriodendron tulipifera* (tuliptree), *Pinus serotina* (pond pine), *Pinus taeda* (loblolly pine), *Nyssa biflora* (swamp tupelo), and *Acer rubrum* (red maple). The subcanopy contains *Persea palustris* (swamp bay) and *Magnolia virginiana* (sweetbay). The shrub stratum is tall and includes *Cyrilla racemiflora* (swamp titi), *Ilex coriacea* (large gallberry), *Ilex glabra* (inkberry), *Lyonia lucida* (fetterbush lyonia), and *Vaccinium formosum* (southern blueberry). *Toxicodendron radicans* (eastern poison ivy), *Smilax laurifolia* (laurel greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier) are extremely frequent in most occurrences. *Arundinaria gigantea* ssp. *tecta* (switchcane) is common. Herbaceous species that may be present include *Drosera capillaris* (pink sundew), *Drosera rotundifolia* (roundleaf sundew), *Sarracenia flava* (yellow pitcherplant), *Sarracenia rubra* (sweet pitcherplant),

Peltandra virginica (green arrow arum), *Mayaca fluviatilis* (stream bogmoss), and *Orontium aquaticum* (goldenclub). *Sphagnum* (sphagnum) spp. are also present.

Environmental Description

USFWS Wetland System: Palustrine

Moore's Creek National Battlefield Environment: This Atlantic white-cedar forest was sampled once southwest of Grady Monument. The site is a gently sloping draw with saturated, somewhat poorly drained muck soil. The unvegetated surface is dominated by leaf litter (85% cover) with some wood (5%) and bare soil (10%). The site has been thinned to reduce the midstory and fuel load (possibly in 2005).

Global Environment: This forest, found along streams or at seepages in the Fall-line Sandhills, is usually dominated by *Chamaecyparis thyoides*, but possesses a mixed species canopy with *Liriodendron tulipifera* usually present. It is found in the Sandhills area of North Carolina, South Carolina, and Georgia, but is possible on the outer coastal terraces of North Carolina, South Carolina, and Georgia. The ground surface has little exposed soil. The community is not flood-prone, nor exposed to frequent fire. This association occurs at seepage areas where water infiltration is impeded by an impervious clay layer and therefore flows out where the hardpan intersects the soil surface - usually on a slope and often creating a streamhead. The community also occurs at streamsides of small blackwater streams. Soils are generally acidic and saturated throughout the year, and often are of the Torhunta (Typic Humaquept) and Johnston (Cumulic Humaquept) series.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderate (60% cover) tree canopy, 15-20 m tall, is dominated by *Chamaecyparis thyoides* (Atlantic white cedar) (state-vulnerable), as is the sparse (20%) subcanopy. Additional tree species include *Pinus taeda* (loblolly pine) and *Acer rubrum* (red maple). The sparse short-shrub layer contains *Arundinaria gigantea* (giant cane), *Cyrilla racemiflora* (swamp titi), *Ilex opaca* (American holly), *Itea virginica* (Virginia sweetspire), *Lyonia lucida* (fetterbush lyonia), *Morella cerifera* (wax myrtle), *Vaccinium formosum* (southern blueberry), and *Vaccinium tenellum* (small black blueberry). The very sparse (20%) herbaceous layer includes *Carex* (sedge) sp., *Carex glaucescens* (southern waxy sedge), and *Panicum virgatum* (switchgrass). Vines include *Smilax glauca* (cat greenbrier) and *Smilax laurifolia* (laurel greenbrier).

Global Vegetation: This forest is usually dominated by *Chamaecyparis thyoides* (Atlantic white cedar), but possesses a mixed species canopy with *Liriodendron tulipifera* (tuliptree) usually present. The canopy contains *Chamaecyparis thyoides* (Atlantic white cedar), with *Liriodendron tulipifera* (tuliptree), *Pinus serotina* (pond pine), *Pinus taeda* (loblolly pine), *Nyssa biflora* (swamp tupelo), and *Acer rubrum* (red maple). The subcanopy contains *Persea palustris* (swamp bay) and *Magnolia virginiana* (sweetbay). The shrub stratum is tall and includes *Cyrilla racemiflora* (swamp titi), *Ilex coriacea* (large gallberry), *Ilex glabra* (inkberry), *Lyonia lucida* (fetterbush lyonia), and *Vaccinium formosum* (southern blueberry). *Toxicodendron radicans* (eastern poison ivy), *Smilax laurifolia* (laurel greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier) are extremely frequent in most occurrences. *Arundinaria gigantea ssp. tecta* (switchcane) is common. Herbaceous species that may be present include *Drosera capillaris* (pink sundew), *Drosera rotundifolia* (roundleaf sundew), *Sarracenia flava* (yellow pitcherplant), *Sarracenia rubra* (sweet pitcherplant), *Peltandra virginica* (green arrow arum), *Mayaca*

fluviatilis (stream bogmoss) and *Orontium aquaticum* (goldenclub). *Sphagnum* (sphagnum) spp. are also present.

Most Abundant Species

Moores Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>
Tree (canopy & subcanopy)	Needle-leaved tree
Short shrub/sapling	Broad-leaved evergreen shrub
Herb (field)	Graminoid

Species

Chamaecyparis thyoides (Atlantic white cedar)
Cyrilla racemiflora (swamp titi)
Carex glaucescens (southern waxy sedge),
Panicum virgatum (switchgrass)

Global

<u>Stratum</u>	<u>Lifeform</u>
Tree canopy	Needle-leaved tree
Tree canopy	Broad-leaved deciduous tree
Tree subcanopy	Broad-leaved evergreen tree
Tall shrub/sapling	Broad-leaved evergreen tree
Tall shrub/sapling	Broad-leaved deciduous shrub
Tall shrub/sapling	Broad-leaved evergreen shrub

Species

Chamaecyparis thyoides (Atlantic white cedar),
Pinus serotina (pond pine), *Pinus taeda* (loblolly pine)
Acer rubrum (red maple), *Liriodendron tulipifera* (tuliptree), *Nyssa biflora* (swamp tupelo)
Magnolia virginiana (sweetbay), *Persea palustris* (swamp bay)
Cyrilla racemiflora (swamp titi)
Vaccinium corymbosum (highbush blueberry)
Ilex coriacea (large gallberry), *Ilex glabra* (inkberry), *Lyonia lucida* (fetterbush lyonia)

Other Noteworthy Species

Moores Creek National Battlefield

Other Plant Species

Chamaecyparis thyoides (Atlantic white cedar)

GRank

G4

Note

state-vulnerable

Global

Other Plant Species

Carex collinsii (Collins' sedge)
Gaylussacia mosieri (woolly huckleberry)
Lindera subcoriacea (bog spicebush)
Rhynchospora alba (white beaksedge)
Sarracenia rubra (sweet pitcherplant)
Syngonanthus flavidulus (yellow hatpins)
Vaccinium crassifolium ssp. *sempervirens* (creeping blueberry)

GRank

G4
G4
G2G3
G5
G4
G5
G4G5T1

Note

Animal Species

Hyla andersonii (pine barrens treefrog)

GRank

G4

Note

Conservation Status Rank

Global Rank & Reasons: G2 (10-Jan-2008). This saturated forest association is found along the margins of streams or seepages in the Fall-line Sandhills area of North Carolina, South Carolina, and Georgia and on the outer coastal terraces as well; it was never common historically. It has significantly declined from its original extent and is currently threatened by fire exclusion along with the development and agricultural use of adjacent uplands. Natural fire and hydrologic regimes need to be maintained for successful regeneration and maintenance of this community. It is very susceptible to major disruptions in hydrology; rapid, prolonged change in water depth kills *Chamaecyparis thyoides* seedlings and stresses or kills mature specimens. Leaf litter and woody debris should not be too dense in order for the shade-intolerant

Chamaecyparis thyoides seedlings to survive. In the absence of fire and adequate gap regeneration, succession often leads to development of a bay forest dominated by *Magnolia virginiana*, *Persea palustris* and *Gordonia lasianthus*.

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Comments: This community type occurs along the northern and southern forks of the Edisto River in South Carolina.

Global Similar Associations:

- *Chamaecyparis thyoides* / *Persea palustris* / *Lyonia lucida* - *Ilex coriacea* Forest (CEGL006146)--is dominated by *Chamaecyparis thyoides*, but it occurs on flat, non-alluvial peatlands, instead of at seepages or along streams.

Global Related Concepts:

- Atlantic White-Cedar: 97 (Eyre 1980) B
- Atlantic white cedar (66) (USFS 1988) ?
- IIA2b. Atlantic White Cedar Swamp Forest (Allard 1990) B
- Streamhead Atlantic White Cedar Forest (Schafale 2000) ?

Element Distribution

Moore's Creek National Battlefield Range: This forest is found along a draw southwest of Grady Monument, on the south side of Moore's Creek National Battlefield.

Global Range: This forest is found along streams or seepages in the Fall-line Sandhills area and on the outer coastal terraces of North Carolina, South Carolina, and Georgia.

Nations: US

States/Provinces: GA, NC, SC

TNC Ecoregions: 53:C, 56:C, 57:C

USFS Ecoregions: 232Bq:CCC, 232Br:CCC, 232Bu:CC?, 232Cb:CCC

Federal Lands: DOD (Fort Bragg, Fort Gordon); NPS (Moore's Creek)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.7.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: S. Landaal

References: Allard 1990, Burns and Honkala 1990a, Burns and Honkala 1990b, Clewell and Ward 1987, Eyre 1980, Frost 1987, Korstian and Brush 1931, Laderman 1989, Landaal 1978, McCrain and Church 1985, Moore and Carter 1987, Schafale 2000, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d., USFS 1988, Wharton 1978, Wharton et al. 1982, Whitehead 1972, ter Braak and Gremmen 1987

Lowland or submontane cold-deciduous forest (I.B.2.N.a.)

***Liquidambar styraciflua* Forest Alliance (A.234)**

Alliance Concept

Summary: This alliance includes a variety of natural and disturbance-related upland forests dominated by *Liquidambar styraciflua* (sweetgum) and other hardwoods, including *Quercus*

(oak) spp. and *Carya* (hickory) spp. These forests tend to develop after logging, agricultural cropping, or natural disturbance in uplands of the Coastal Plain, Piedmont, and other ecoregions. Some associations may have *Quercus* (oak) spp. and *Carya* (hickory) spp., especially *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Quercus nigra* (water oak), *Quercus phellos* (willow oak), *Quercus velutina* (black oak), and *Carya alba* (mockernut hickory). In addition, *Pinus taeda* (loblolly pine) may be present. Piedmont cove forests (of Alabama and likely other states) codominated by *Liquidambar styraciflua* (sweetgum) and *Liriodendron tulipifera* (tuliptree) are included within this alliance as well (although no association specifically accommodates them). These forests have *Nyssa sylvatica* (blackgum), *Quercus nigra* (water oak), and *Acer rubrum* var. *rubrum* (red maple) as associated canopy species, with *Vitis rotundifolia* (muscadine), *Toxicodendron radicans* (eastern poison ivy), and *Smilax rotundifolia* (roundleaf greenbrier) commonly present.

Similar Alliances:

- *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance (A.287)
- *Liquidambar styraciflua* Saturated Forest Alliance (A.350)

Similar Alliance Comments: This alliance (A.234) is a successional upland forest alliance, in contrast to others with *Liquidambar*, which are various wetland alliances.

Related Concepts:

- T1B4aIV9a. *Liquidambar styraciflua* (Foti et al. 1994) ?

Alliance Description

Environment: Vegetation of this alliance occurs in a variety of environmental situations. At Fort Benning, Georgia, this vegetation tends to be more frequently on finer textured soils, with *Quercus nigra*. In the Ozarks, vegetation in this alliance occurs as riparian strips along intermittent streams. Some Piedmont cove forests are included within this alliance as well.

Vegetation: This alliance includes a variety of natural and disturbance-related forests dominated by *Liquidambar styraciflua* (sweetgum) and other hardwoods, including *Quercus* (oak) spp. and *Carya* (hickory) spp. Included are upland forests, dominated by *Liquidambar styraciflua* (sweetgum), that follow logging, agricultural cropping, or natural disturbance in uplands of the Coastal Plain, Piedmont, and other ecoregions. Some associations may have *Quercus* (oak) spp. and *Carya* (hickory) spp., especially *Quercus alba* (white oak), *Quercus falcata* (southern red oak), *Quercus nigra* (water oak), *Quercus phellos* (willow oak), *Quercus velutina* (black oak), and *Carya alba* (mockernut hickory). In addition, *Pinus taeda* (loblolly pine) may be present. Piedmont cove forests included within this alliance are codominated by *Liquidambar styraciflua* (sweetgum) and *Liriodendron tulipifera* (tuliptree). These forests have *Nyssa sylvatica* (blackgum), *Quercus nigra* (water oak), and *Acer rubrum* var. *rubrum* (red maple) as associated canopy species, with *Vitis rotundifolia* (muscadine), *Toxicodendron radicans* (eastern poison ivy), and *Smilax rotundifolia* (roundleaf greenbrier) commonly present. In some areas (e.g., most of Arkansas) which are outside of the range of *Liriodendron tulipifera* (tuliptree), its niche is partly occupied by *Liquidambar* (sweetgum).

Alliance Distribution

Range: This alliance is distributed throughout the southeastern United States in most physiographic provinces. It is found in Alabama, Arkansas, Georgia, Kentucky, Louisiana,

Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and elsewhere, but not in Florida.

Nations: US

Subnations: AL, AR, DC?, DE, GA, KY, LA, MD, MS, NC, NJ, OK, SC, TN, VA

TNC Ecoregions: 31:P, 32:P, 38:C, 39:C, 40:P, 41:C, 42:P, 43:C, 44:C, 50:C, 51:P, 52:C, 53:P, 56:P, 57:C, 58:P, 62:C

USFS Ecoregions: 221Hc:CCC, 222A:CC, 222Cg:CCC, 222D:CC, 222Eb:CCC, 222Ef:CCC, 222Eg:CCC, 222Fa:CCP, 222Fb:CCC, 222Fe:CCP, 231Aa:CCP, 231Ae:CCP, 231Af:CCP, 231Ag:CCP, 231Ah:CCP, 231Ai:CCP, 231Aj:CCP, 231Ak:CCP, 231Al:CCP, 231Am:CCP, 231An:CCP, 231Ao:CCP, 231Ap:CCP, 231Ba:CCC, 231Bb:CCP, 231Bc:CCC, 231Be:CCP, 231Bh:CCC, 231Bi:CCC, 231Bj:CCP, 231Bk:CCC, 231Ca:CCP, 231Cb:CCP, 231Cc:CCC, 231Cd:CCP, 231Ce:CCP, 231Cf:CC?, 231Cg:CC?, 231Da:C??, 231Db:C??, 231Dc:C??, 231Dd:C??, 231De:C??, 231Eb:CC?, 231Ec:CC?, 231Ed:CC?, 231Ga:CC?, 231Gb:CC?, 231Gc:CC?, 232Ac:CCC, 232Ba:CCP, 232Bb:CCP, 232Bc:CCP, 232Bd:CCC, 232Bj:CCC, 232Bk:CC?, 232Bl:CC?, 232Bm:CC?, 232Bn:CC?, 232Bo:CC?, 232Bp:CCP, 232Bq:CCC, 232Br:CCC, 232Bs:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CCP, 232Cf:CCP, 232Cg:CCP, 232Ch:CC?, 234Aa:CCP, 234Ab:CCC, 234Ac:CCC, 234Ad:CCP, 234Ae:CCP, 234Af:CCP, 234Ag:CCP, 234Ah:CCP, 234Ai:CCP, 234Aj:CCP, 234Ak:CCP, 234Al:CCP, 234Am:CCP, 234An:CCP, M221Dc:CC?, M221Dd:CCC, M222Aa:CCC, M222Ab:CCC, M231Aa:CC?, M231Ab:CC?, M231Ac:CC?, M231Ad:CC?

Federal Lands: DOD (Arnold, Fort Benning); NPS (Big South Fork, Buffalo River?, Chickamauga-Chattanooga, Colonial, Congaree Swamp, Cowpens, Cumberland Gap, Fort Donelson, George Washington Birthplace, Guilford Courthouse, Kings Mountain, Mammoth Cave, Moores Creek, Natchez Trace, National Capital-East?, Ninety Six, Petersburg, Shiloh, Thomas Stone, Vicksburg); TVA (Tellico); USFS (Bienville?, Cherokee?, Conecuh?, De Soto?, Delta?, Francis Marion?, Holly Springs, Homochitto?, Oconee?, Ouachita, Ozark, St. Francis, Talladega, Tombigbee?, Tuskegee); USFWS (Eufaula, Prime Hook)
(CEGL007216) Sweetgum Forest

***Liquidambar styraciflua* Forest**

Successional Sweetgum Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	<i>Liquidambar styraciflua</i> Forest Alliance (A.234)
Alliance (English name)	Sweetgum Forest Alliance
Association	<i>Liquidambar styraciflua</i> Forest
Association (English name)	Sweetgum Forest
Association (Common name)	Successional Sweetgum Forest

Element Concept

Global Summary: This early-successional upland forest of the southeastern U.S. occurs on a variety of environmental settings, resulting from succession following human activities such as logging and clearing or agriculture. Stands are dominated by *Liquidambar styraciflua* (sweetgum), sometimes to the exclusion of other species. *Pinus taeda* (loblolly pine) is a

common associate. Other associated species are highly variable and depend on location and stand history.

Environmental Description

Moore's Creek National Battlefield Environment: This early-successional sweetgum forest was sampled once in the eastern corner of the park north of Highway 210. The site is a gently sloping mesic flatwoods that may flood during extreme rain events (rarely) but not regularly. Soil is a moderately well-drained sand. The stand is about 20 years old, with larger sweetgums achieving about 20 cm dbh. The unvegetated surface is dominated by leaf litter (95% cover) with some wood (5%). Evidence of disturbance includes the successional nature of this community and the presence of exotic plants.

Global Environment: This association is found in uplands that have been heavily impacted by agriculture or other severe disturbances and are recovering.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The dense (80% cover) tree canopy, 15-20 m tall, is dominated by *Liquidambar styraciflua* (sweetgum), as is the moderate (50%) subcanopy (10-15 m). Additional tree species include *Acer rubrum* var. *trilobum* (red maple), *Pinus taeda* (loblolly pine), *Catalpa bignonioides* (southern catalpa), *Juniperus virginiana* var. *virginiana* (eastern redcedar), and *Magnolia grandiflora* (southern magnolia) (state-critically imperiled). The sparse shrub layers are made up of tree species, particularly *Liquidambar styraciflua* (sweetgum), as well as *Cornus florida* (flowering dogwood), *Morella cerifera* (wax myrtle), *Prunus serotina* var. *serotina* (black cherry), *Vaccinium arboreum* (farkleberry), *Hypericum hypericoides* (St. Andrew's cross), *Persea palustris* (swamp bay), and *Rubus trivialis* (southern dewberry) (state-vulnerable). The very sparse (5%) herbaceous layer is dominated by ferns *Asplenium platyneuron* (ebony spleenwort) and *Pteridium aquilinum* (western brackenfern). Vines (20%) include *Gelsemium sempervirens* (evening trumpetflower) and *Smilax rotundifolia* (roundleaf greenbrier).

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

Most Abundant Species

Moore's Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	<i>Acer rubrum</i> var. <i>trilobum</i> (red maple), <i>Liquidambar styraciflua</i> (sweetgum) <i>Pinus taeda</i> (loblolly pine)
Tree canopy	Needle-leaved tree	<i>Acer rubrum</i> var. <i>trilobum</i> (red maple), <i>Liquidambar styraciflua</i> (sweetgum)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Gelsemium sempervirens</i> (evening trumpetflower), <i>Smilax rotundifolia</i> (roundleaf greenbrier)
Herb (field)	Vine/Liana	<i>Asplenium platyneuron</i> (ebony spleenwort)
Herb (field)	Fern or fern ally	

Global

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum)

Other Noteworthy Species

Moore's Creek National Battlefield

Exotic and Invasive Species

Ligustrum sinense (Chinese privet)

I-Rank

High/Medium

Note

exotic

Other Plant Species

Magnolia grandiflora (southern magnolia)

G-Rank

G5

Note

state-critically
imperiled

Rubus trivialis (southern dewberry)

G5

state-vulnerable

Conservation Status Rank

Global Rank & Reasons: 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

Status: Standard

Classification Confidence: 3 - Weak

Global Similar Associations:

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

Global Related Concepts:

- sweet gum successional forest (Collins and Anderson 1994) =

Element Distribution

Moore's Creek National Battlefield Range: Successional Sweetgum Forest was sampled in the eastern corner of the park.

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.

Nations: US

States/Provinces: AL, AR?, DC?, DE, GA, KY, LA, MD, MS, NC, NJ, OK, SC, TN, VA

TNC Ecoregions: 31:P, 32:P, 40:P, 41:C, 42:P, 43:C, 44:C, 50:C, 51:P, 52:P, 53:P, 56:P, 57:C, 62:C

USFS Ecoregions: 221Hc:CCC, 222Ef:CCC, 222Fa:CCP, 222Fb:CCC, 222Fe:CCP, 231Aa:CPP, 231Bh:CCC, 231Bi:CCC, 232Ac:CCC, 232Bd:CCC, 232Cb:CCC, M221Dc:???, M221Dd:???

Federal Lands: NPS (Big South Fork, Chickamauga-Chattanooga?, Colonial, Cowpens, George Washington Birthplace, Guilford Courthouse, Kings Mountain, Mammoth Cave, Moore's Creek, Natchez Trace, National Capital-East?, Ninety Six, Petersburg, Shiloh, Thomas Stone, Vicksburg); USFS (Cherokee?, Oconee?, St. Francis?); USFWS (Prime Hook)

Element Sources

Moore Creek National Battlefield Plots: MOCR.10.

Local Description Authors: M.J. Russo and C.W. Nordman

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

References: Collins and Anderson 1994, McCrain and Church 1985, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

***Quercus nigra* Forest Alliance (A.247)**

Alliance Concept

Summary: Upland forests dominated or codominated by *Quercus nigra* (water oak), in some cases as a result of disturbance and/or fire suppression of more diverse canopied forests. Forests in this alliance occur on mesic or dry-mesic sites, especially on loamy or other fine-textured soils (in contrast to the *Quercus hemisphaerica* (Darlington oak) Forest Alliance (A.53), which occurs primarily on coarse-textured sands in drier situations). One association is found along small streams. Stands of this alliance typically contain other *Quercus* (oak) spp. (e.g., *Quercus falcata* (southern red oak)), *Liquidambar styraciflua* (sweetgum), and *Pinus taeda* (loblolly pine). In the Upper Gulf Coastal Plain of Georgia, some examples may contain *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Carya alba* (mockernut hickory), and *Cornus florida* (flowering dogwood) in the subcanopy. In Texas, *Quercus nigra* (water oak) dominates the canopy, with scattered *Quercus virginiana* (live oak). The subcanopy/shrub stratum is dense (without fire) and contains *Ilex vomitoria* (yaupon), *Vaccinium stamineum* (deerberry), and *Vitis rotundifolia* (muscadine). In small stream forests of the Gulf Coast Prairies and Marshes Ecoregion and possibly adjacent areas, other shrubs and small trees include *Callicarpa americana* (American beautyberry) and *Prunus caroliniana* (Carolina laurelcherry). Woody vines include *Berchemia scandens* (Alabama supplejack), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison ivy), and *Ampelopsis arborea* (peppervine). *Chasmanthium sessiliflorum* (longleaf woodoats) is the dominant herb. Other herbs are *Oplismenus hirtellus* ssp. *setarius* (bristle basketgrass), *Carex cherokeensis* (Cherokee sedge), *Verbesina virginica* (white crownbeard), *Ageratina aromatica* (lesser snakeroot), *Asplenium platyneuron* var. *platyneuron* (ebony spleenwort), *Geum canadense* (white avens), and *Polygonum virginianum* (jumpseed). *Tillandsia usneoides* (Spanish moss) and *Pleopeltis polypodioides* ssp. *michauxiana* (resurrection fern) are common epiphytes. This alliance appears to be more abundantly represented (or more 'natural') towards the western end of the Coastal Plain.

Similar Alliances:

- *Pinus taeda* - *Quercus nigra* Forest Alliance (A.406)
- *Quercus alba* - (*Quercus nigra*) Forest Alliance (A.238)--is more diverse and later-successional.
- *Quercus hemisphaerica* Forest Alliance (A.53)--includes similarly fire-sheltered or fire-suppressed vegetation, but on comparatively sandier or more coarsely textured soils.

Alliance Description

Environment: Forests in this alliance occur especially on mesic or dry-mesic sites, especially on loamy or other fine-textured soils (in contrast to the *Quercus hemisphaerica* Forest Alliance

(A.53), which occurs primarily on coarse-textured sands in drier situations). This alliance appears to be more abundantly represented (or more 'natural') towards the western end of the Coastal Plain.

Vegetation: This alliance consists of upland forests dominated or codominated by *Quercus nigra* (water oak). Stands of this alliance typically contain other *Quercus* (oak) spp. (e.g., *Quercus falcata* (southern red oak)), *Liquidambar styraciflua* (sweetgum), and *Pinus taeda* (loblolly pine). In the Upper Gulf Coastal Plain of Georgia, some examples may contain *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Carya alba* (mockernut hickory), and *Cornus florida* (flowering dogwood) in the subcanopy. In Texas, *Quercus nigra* (water oak) dominates the canopy, with scattered *Quercus virginiana* (live oak). The subcanopy/shrub stratum is dense (without fire) and contains *Ilex vomitoria* (yaupon). In small stream forests of the Gulf Coast Prairies and Marshes Ecoregion and possibly adjacent areas, other shrubs and small trees include *Callicarpa americana* (American beautyberry) and *Prunus caroliniana* (Carolina laurelcherry). Woody vines include *Berchemia scandens* (Alabama supplejack), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison ivy), and *Ampelopsis arborea* (peppervine). *Chasmanthium sessiliflorum* (longleaf woodoats) is the dominant herb. Other herbs are *Oplismenus hirtellus* ssp. *setarius* (bristle basketgrass), *Carex cherokeensis* (Cherokee sedge), *Verbesina virginica* (white crownbeard), *Ageratina aromatica* (lesser snakeroot), *Asplenium platyneuron* var. *platyneuron* (ebony spleenwort), *Geum canadense* (white avens), and *Polygonum virginianum* (jumpseed). *Tillandsia usneoides* (Spanish moss) and *Pleopeltis polypodioides* ssp. *michauxiana* (resurrection fern) are common epiphytes.

Alliance Distribution

Range: This alliance is found throughout the eastern U.S. and Canada, from New Hampshire and Ontario in the north to Virginia and Arkansas in the south and west to North Dakota and Manitoba.

Nations: US

Subnations: AL, FL?, GA, LA, MS, NC, SC, TX

TNC Ecoregions: 31:C, 40:?, 41:P, 42:?, 43:C, 52:C, 53:C, 55:?, 56:C, 57:C

USFS Ecoregions: 221Aa:CCC, 231A:CC, 231Bd:CCC, 231Bi:CCC, 231Ea:CPP, 231Ef:CPP, 231Eh:CPP, 231Ei:CPP, 231Fa:CPP, 232Ba:CCP, 232Bb:CCP, 232Bg:CC?, 232Bh:CCP, 232Bi:CCP, 232Bj:CC?, 232Bk:CCP, 232Bl:CCP, 232Bm:CCC, 232Bn:CCP, 232Bo:CCP, 232Bp:CCP, 232Bq:CCC, 232Br:CCC, 232Bs:CCC, 232Bu:CC?, 232Bv:CC?, 232Ca:CCC, 232Cb:CCC, 232Dc:CPP, 232Ea:CPP, 232Fa:CPP, 232Fb:CPP, 232Fe:CPP, 234Aa:???, 234Ab:???, 234Ac:???, 234Ag:???, 234Ah:???, 234Ak:???, 234Al:???, 234Am:???, 234An:???, 255Db:CCC

Federal Lands: DOD (Fort Benning, Fort Gordon, Fort Stewart); NPS (Cowpens, Moores Creek, Natchez Trace, Ninety Six); USFS (Huron?, Talladega?, Tuskegee?); USFWS (San Bernard)

(CEGL004638) Water Oak Forest

***Quercus nigra* Forest**

Successional Water Oak Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)

Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	<i>Quercus nigra</i> Forest Alliance (A.247)
Alliance (English name)	Water Oak Forest Alliance
Association	<i>Quercus nigra</i> Forest
Association (English name)	Water Oak Forest
Association (Common name)	Successional Water Oak Forest
Ecological System(s):	East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland (CES203.496) Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)

Element Concept

Global Summary: This community is a result of disturbance and/or fire suppression of upland pinelands of the southeastern Coastal Plain and of pinelands and subsequent old fields in the adjacent Piedmont areas. This association occurs on mesic or dry-mesic sites, especially on loamy or other fine-textured soils (in contrast to the *Quercus hemisphaerica* (Darlington oak) Forest Alliance (A.53), which occurs primarily on coarse-textured sands in drier situations). *Quercus nigra* (water oak) dominates the tree canopy. Other oaks (e.g., *Quercus falcata* (southern red oak), *Quercus phellos* (willow oak), *Quercus hemisphaerica* (Darlington oak)) may be intermixed, as well as *Liquidambar styraciflua* (sweetgum), remnant *Pinus palustris* (longleaf pine), weedy *Pinus elliotii* var. *elliottii* (Honduras pine), *Carya* (hickory) spp., or *Pinus taeda* (loblolly pine). In the Upper Gulf Coastal Plain of Georgia, some examples may contain *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Carya alba* (mockernut hickory), and *Cornus florida* (flowering dogwood) in the subcanopy.

Environmental Description

Moore's Creek National Battlefield Environment: This successional water oak forest was sampled once near Slocumb Monument. The site is a gently sloping, dry ridge with well-drained sand soil. The unvegetated surface is dominated by leaf litter (95% cover) with some wood (3%) and bare soil (2%). The site has been thinned to reduce the midstory and fuel load; in addition, longleaf pine have been planted here. Evidence of disturbance includes the successional nature of this community and the presence of exotic plants.

Global Environment: This community is a result of disturbance and/or fire suppression of upland pinelands of the southeastern Coastal Plain and adjacent Piedmont. It occurs on mesic or dry-mesic sites, especially on loamy or other fine-textured soils. In the Piedmont transition of South Carolina, it may have grown out of areas that were heavily farmed or cut over in the past but which did not grow up into *Pinus taeda* forests.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderately dense (70% cover) tree canopy, 15-20 m tall, and sparse (30%) subcanopy (10-15 m) are dominated by *Quercus nigra* (water oak); additional tree species include *Pinus taeda* (loblolly pine) and *Quercus margarettiae* (runner oak). The sparse (20%) short-shrub layer (1-2 m) is made up of small amounts of over 20 species, including *Cornus florida* (flowering dogwood), *Ilex glabra* (inkberry), *Ilex opaca* (American holly), *Magnolia virginiana* (sweetbay), *Persea palustris* (swamp bay), *Symplocos tinctoria* (common sweetleaf), *Vaccinium arboreum* (farkleberry), and *Vaccinium tenellum* (small black blueberry). The very sparse (10%) herbaceous layer includes *Andropogon virginicus* (broomsedge bluestem), *Danthonia sericea* (downy danthonia), *Dichanthelium* (rosette grass) sp., *Eupatorium capillifolium* (dogfennel), *Paspalum setaceum* (thin paspalum), *Schizachyrium*

scoparium (little bluestem), and *Tipularia discolor* (crippled crane fly). Vines, often draped over taller vegetation, include *Gelsemium sempervirens* (evening trumpetflower) and *Smilax rotundifolia* (roundleaf greenbrier); *Tillandsia usneoides* (Spanish moss) is an epiphyte found growing in the trees.

Global Vegetation: The canopy of this association is dominated by *Quercus nigra* (water oak). Other oaks may be intermixed, especially *Quercus phellos* (willow oak), as well as *Quercus falcata* (southern red oak), *Quercus hemisphaerica* (Darlington oak), *Liquidambar styraciflua* (sweetgum), remnant *Pinus palustris* (longleaf pine), weedy *Pinus elliotii* var. *elliotii* (Honduras pine), *Carya* (hickory) spp., or *Pinus taeda* (loblolly pine). In the Upper Gulf Coastal Plain of Georgia, some examples may contain *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Carya alba* (mockernut hickory), and *Cornus florida* (flowering dogwood) in the subcanopy.

Most Abundant Species

Moore's Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	<i>Quercus nigra</i> (water oak)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Ilex glabra</i> (inkberry)
Herb (field)	Vine/Liana	<i>Gelsemium sempervirens</i> (evening trumpetflower)

Global

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Quercus nigra</i> (water oak)

Characteristic Species

Moore's Creek National Battlefield: *Paspalum setaceum* (thin paspalum), *Tillandsia usneoides* (Spanish moss)

Other noteworthy Species

Moore's Creek National Battlefield

<u>Exotic and Invasive Species</u>	<u>I-Rank</u>	<u>Note</u>
<i>Eremochloa ophiuroides</i> (centipede grass)	-	exotic
<i>Lonicera japonica</i> (Japanese honeysuckle)	High/Medium	exotic

Conservation Status Ranks

Global Rank & Reasons: GNA (modified/managed) (17-May-2002). This vegetation is presumed to be either a result of disturbance of more diverse-canopied hardwood forests, and/or a result of lack of fire on sites which would be dominated by *Pinus palustris*. In the Piedmont area of South Carolina, it may occur on areas formerly codominated by *Quercus oglethorpensis*. In these areas, the *Quercus oglethorpensis* still survives, making this modified community of more conservation value in those areas.

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Similar Associations:

- *Pinus taeda* - *Quercus nigra* Southern Coastal Plain Forest [Provisional] (CEGL007531)

Element Distribution

Moore's Creek National Battlefield Range: This successional water oak forest was sampled once near Slocumb Monument. It may be found elsewhere in the southeastern part of Moore's Creek National Battlefield.

Global Range: This community is distributed throughout the traditional range of longleaf pine communities, mainly in the Coastal Plain from Texas up through at least South Carolina. In some parts of its range in South Carolina and Georgia, the community may be found in the Piedmont within 50 miles of the fall-line and may share dominance with other successional pine-dominated communities more common in the Piedmont.

Nations: US

States/Provinces: AL, FL?, GA, LA, MS, NC, SC, TX?

TNC Ecoregions: 41:P, 42:?, 43:C, 52:C, 53:C, 55:?, 56:C, 57:C

USFS Ecoregions: 231A:CC, 231Bd:CCC, 231Bi:CCC, 232Bm:CCC, 232Bq:CCC, 232Br:CCC, 232Ca:CCC, 232Cb:CCC, 234Aa:???, 234Ab:???, 234Ac:???, 234Ag:???, 234Ah:???, 234Ak:???, 234Al:???, 234Am:???, 234An:???

Federal Lands: DOD (Fort Benning, Fort Gordon, Fort Stewart); NPS (Cowpens, Moore's Creek, Natchez Trace, Ninety Six); USFS (Talladega (Oakmulgee)?, Talladega (Talladega)?, Talladega?, Tuskegee?)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.11.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: Southeastern Ecology Group

References: McCrain and Church 1985, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d.

Temporarily flooded cold-deciduous forest (I.B.2.N.d.)

Quercus (phellos, nigra, laurifolia) Temporarily Flooded Forest Alliance (A.292)

Alliance Concept

Summary: Forests in this alliance are typically dominated by some combination of *Quercus phellos* (willow oak), *Quercus nigra* (water oak), and/or *Quercus laurifolia* (laurel oak). They may be found throughout the Coastal Plain and adjacent areas of the lower Piedmont, Arkansas Valley, Interior Low Plateau, and the Ouachita Mountains in temporarily flooded environments. These forests may occur in large, relatively high-gradient floodplains (in which they tend to occur on topographically higher portions of the floodplain, such as ridges or terraces), or in small, relatively low-gradient floodplains (in which the landforms are too small and/or too poorly developed to create much consistent, local topographic relief). In the Atlantic and East Gulf coastal plains, these forests may occur more often in association with blackwater / low-sediment / low-nutrient rivers and streams than brownwater ones. They occur on very acidic to mildly alkaline soils, commonly on Portland, Tensas, and Hebert silt loams. Dominant and associated species vary with geographic location and landscape setting. Associated canopy species include *Quercus texana* (Texas red oak), *Fraxinus pennsylvanica* (green ash), *Pinus taeda* (loblolly pine), *Quercus similis* (bottomland post oak), *Quercus michauxii* (swamp chestnut oak), *Magnolia virginiana* (sweetbay), *Pinus glabra* (spruce pine), *Liquidambar styraciflua*

(sweetgum), *Acer rubrum* (red maple), *Nyssa biflora* (swamp tupelo), *Ulmus alata* (winged elm), *Carya aquatica* (water hickory), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus pagoda* (cherrybark oak), *Taxodium distichum* (bald cypress), and *Celtis laevigata* (sugarberry). Subcanopy and shrub species include *Halesia diptera* (two-wing silverbell), *Carpinus caroliniana* (American hornbeam), *Ilex decidua* (possumhaw), *Sebastiania fruticosa* (Gulf Sebastian-bush), *Ostrya virginiana* (hophornbeam), *Viburnum rufidulum* (rusty blackhaw), *Diospyros virginiana* (common persimmon), *Itea virginica* (Virginia sweetspire), *Symplocos tinctoria* (common sweetleaf), *Rhododendron canescens* (mountain azalea), *Illicium floridanum* (Florida anisetree), *Cyrilla racemiflora* (swamp titi), *Ilex verticillata* (common winterberry), *Crataegus viridis* (green hawthorn), *Vaccinium elliotii* (Elliott's blueberry), and *Ilex opaca* (American holly), among others. Woody vines are an important component of these forests; species include *Toxicodendron radicans* (eastern poison ivy), *Bignonia capreolata* (crossvine), *Smilax rotundifolia* (roundleaf greenbrier), *Vitis rotundifolia* (muscadine), *Parthenocissus quinquefolia* (Virginia creeper), *Trachelospermum difforme* (climbing dogbane), *Berchemia scandens* (Alabama supplejack), *Smilax glauca* (cat greenbrier), *Campsis radicans* (trumpet creeper), *Cocculus carolinus* (Carolina coralbead), *Ampelopsis arborea* (peppervine), and others. This alliance also includes forests of large bottomlands dominated by *Quercus phellos* (willow oak) and *Ulmus crassifolia* (cedar elm) that occur on flat ridges and grade up from forests dominated by *Quercus lyrata* (overcup oak) and *Carya aquatica* (water hickory). Characteristic canopy species include *Pinus taeda* (loblolly pine), *Quercus similis* (bottomland post oak), *Liquidambar styraciflua* (sweetgum), *Gleditsia triacanthos* (honeylocust), and *Carya aquatica* (water hickory), but the wettest sites likely will have only *Quercus phellos* (willow oak) and *Ulmus crassifolia* (cedar elm). Understory species include *Ilex decidua* (possumhaw), *Viburnum dentatum* (southern arrowwood), and *Crataegus* (hawthorn) spp., with *Sabal minor* (dwarf palmetto) in drier sites.

Classification Comments: From Eyre (1980). Water oak - willow oak communities occur in northeastern Texas (Eidson pers. comm.). Some vegetation of the Interior Low Plateau of southern middle Tennessee is tentatively placed here.

Similar Alliances:

- *Pinus taeda* - *Quercus* (*phellos*, *nigra*, *laurifolia*) Temporarily Flooded Forest Alliance (A.437)
- *Quercus* (*michauxii*, *pagoda*, *shumardii*) - *Liquidambar styraciflua* Temporarily Flooded Forest Alliance (A.291)--is more brownwater-oriented with a shorter (?) hydroperiod.
- *Quercus* (*phellos*, *laurifolia*) Seasonally Flooded Forest Alliance (A.327)--includes vegetation occurring in seasonally flooded depressions within active, temporarily flooded floodplains with *Quercus laurifolia* or *Quercus phellos* as a dominant which has a longer hydroperiod and a sparse herbaceous layer.
- *Quercus phellos* Seasonally Flooded Forest Alliance (A.330)--occurs in seasonally flooded ponds that are not located in an active floodplain and do not receive overbank flooding.

Related Concepts:

- *Quercus nigra* forest alliance (Hoagland 1998a) ?
- Cedar Elm - Hackberry / *Justicia* Wet-Mesic Stream Bottoms (Turner et al. 1999) I
- Coastal Plain Bottomland Hardwoods, Blackwater Subtype (Schafale and Weakley 1990) ?
- P1B3cVIII14c. *Quercus phellos* - *Quercus laurifolia* (Foti et al. 1994) ?
- P1B3cVIII14d. *Quercus phellos* - *Quercus nigra* (Foti et al. 1994) ?
- Sweetgum - Willow Oak: 92 (Eyre 1980) I

- Water Oak-Willow Oak Series (Diamond 1993) ?
- Willow Oak - Laurel Oak / *Bignonia* Loamy Wet-Mesic Stream Bottoms (Turner et al. 1999) ?
- Willow Oak - Water Oak - Diamondleaf (Laurel) Oak: 88 (Eyre 1980) I
- Willow Oak Forest (Foti 1994b) ?

Alliance Description

Environment: Forests in this alliance occur primarily along blackwater or low-sediment / low-nutrient rivers and small streams in the Atlantic Coastal Plain, lower Piedmont, Arkansas Valley, East Gulf Coastal Plain, West Gulf Coastal Plain, Interior Low Plateau, and the Ouachita Mountains in temporarily flooded environments. These forests may occur in large, relatively high-gradient floodplains (in which they tend to occur on topographically higher portions of the floodplain, such as ridges or terraces), or in small, relatively low-gradient floodplains (in which the landforms are too small and/or too poorly developed to create much consistent, local topographic relief). They occur on very acidic to mildly alkaline soils, commonly on Portland, Tensas, and Hebert silt loams.

Vegetation: Stands of this alliance are typically dominated by some combination of *Quercus phellos* (willow oak), *Quercus nigra* (water oak), and/or *Quercus laurifolia* (laurel oak). Dominant and associated species vary with geographic location and may include *Quercus texana* (Texas red oak), *Fraxinus pennsylvanica* (green ash), *Pinus taeda* (loblolly pine), *Quercus similis* (bottomland post oak), *Quercus michauxii* (swamp chestnut oak), *Magnolia virginiana* (sweetbay), *Pinus glabra* (spruce pine), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Nyssa biflora* (swamp tupelo), *Halesia diptera* (two-wing silverbell), *Ulmus alata* (winged elm), *Carya aquatica* (water hickory), *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus pagoda* (cherrybark oak), *Taxodium distichum* (bald cypress), and *Celtis laevigata* (sugarberry). Subcanopy and shrub species include *Carpinus caroliniana* (American hornbeam), *Ilex decidua* (possumhaw), *Sebastiania fruticosa* (Gulf Sebastian-bush), *Ostrya virginiana* (hophornbeam), *Viburnum rufidulum* (rusty blackhaw), *Diospyros virginiana* (common persimmon), *Itea virginica* (Virginia sweetspire), *Symplocos tinctoria* (common sweetleaf), *Rhododendron canescens* (mountain azalea), *Illicium floridanum* (Florida anisetree), *Cyrilla racemiflora* (swamp tit), *Ilex verticillata* (common winterberry), *Crataegus viridis* (green hawthorn), *Vaccinium elliotii* (Elliott's blueberry), and *Ilex opaca* (American holly), among others. Woody vines are an important component of these forests; species include *Toxicodendron radicans* (eastern poison ivy), *Bignonia capreolata* (crossvine), *Smilax rotundifolia* (roundleaf greenbrier), *Vitis rotundifolia* (muscadine), *Parthenocissus quinquefolia* (Virginia creeper), *Trachelospermum difforme* (climbing dogbane), *Berchemia scandens* (Alabama supplejack), *Smilax glauca* (cat greenbrier), *Campsis radicans* (trumpet creeper), *Cocculus carolinus* (Carolina coralbead), *Ampelopsis arborea* (peppervine), and others. This alliance also includes forests of large bottomlands dominated by *Quercus phellos* (willow oak) and *Ulmus crassifolia* (cedar elm) that occur on flat ridges and grade up from forests dominated by *Quercus lyrata* (overcup oak) and *Carya aquatica* (water hickory). Characteristic canopy species include *Pinus taeda* (loblolly pine), *Quercus similis* (bottomland post oak), *Liquidambar styraciflua* (sweetgum), *Gleditsia triacanthos* (honeylocust), and *Carya aquatica* (water hickory), but the wettest sites likely will have only *Quercus phellos* (willow oak) and *Ulmus crassifolia* (cedar elm). Understory species include *Ilex decidua* (possumhaw), *Viburnum*

dentatum (southern arrowwood), and *Crataegus* (hawthorn) spp., with *Sabal minor* (dwarf palmetto) in drier sites.

Alliance Distribution

Range: Forests in this alliance occur in the Atlantic Coastal Plain, lower Piedmont, Arkansas Valley, East Gulf Coastal Plain, West Gulf Coastal Plain, and the Ouachita Mountains. It ranges from the District of Columbia, south to Georgia, and west to Oklahoma and Texas.

Nations: US

Subnations: AL, AR, DC, FL, GA, LA, MS, NC, OK, SC, TN, TX, VA?

TNC Ecoregions: 39:C, 40:C, 41:C, 42:C, 43:C, 44:C, 50:?, 52:C, 53:C, 55:P, 56:C, 57:C, 58:?, 61:C

USFS Ecoregions: 221Db:CCC, 222Eb:CCC, 222Ec:CC?, 222Eg:CC?, 231Aa:CCP, 231Ba:CCC, 231Bb:CCC, 231Bc:CCC, 231Bd:CCC, 231Be:CC?, 231Bf:CCP, 231Bg:CCC, 231Bi:CCC, 231Bj:CCP, 231Bl:CCP, 231Cc:C??, 231Cd:C??, 231Da:CC?, 231Db:CC?, 231Dc:CC?, 231Dd:CC?, 231De:CC?, 231Ea:CCP, 231Eb:CCP, 231Ec:CCP, 231Ed:CCP, 231Ee:CCP, 231Ef:CCP, 231Eg:CCC, 231Eh:CCC, 231Ei:CCC, 231Ej:CCP, 231Ek:CCP, 231El:CCC, 231Em:CCP, 231En:CCP, 231Ga:CCC, 231Gb:CCC, 232Ba:CCC, 232Bb:CCC, 232Bc:CCC, 232Bd:CCC, 232Be:CCC, 232Bf:CCC, 232Bg:CCC, 232Bh:CCC, 232Bi:CCC, 232Bj:CCC, 232Bk:CCC, 232Bl:CCC, 232Bm:CCC, 232Bn:CCC, 232Bo:CCC, 232Bp:CCC, 232Bq:CCC, 232Br:CCC, 232Bs:CCC, 232Bt:CCC, 232Bu:CCC, 232Bv:CCC, 232Bx:CCC, 232Bz:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CCC, 232Cd:CCC, 232Ce:CCC, 232Cf:CCC, 232Cg:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Ea:CCC, 232Fa:CCC, 232Fb:CCC, 232Fc:CCC, 232Fd:CCP, 232Fe:CCC, 234Aa:CCC, 234Ab:CCC, 234Ac:CCC, 234Ae:CCP, 234Ag:CCP, 234Ah:CC?, 234Ai:CCC, 234Ak:CC?, 234Al:CC?, 234Am:CCP, 234An:CCP, 255:?, M231Ac:CCC, M231Ad:CCC

Federal Lands: COE (Arkansas River); DOD (Arnold, Fort Benning, Pine Bluff Arsenal); DOE (Savannah River Site); NPS (Big Thicket?, C&O Canal, Congaree Swamp, Gulf Islands, Moores Creek, Natchez Trace); USFS (Angelina, Apalachicola, Bienville, Conecuh, Croatan, Davy Crockett, De Soto, Delta, Francis Marion, Homochitto, Kisatchie, Oconee?, Ouachita, Sabine, Sam Houston, St. Francis, Talladega, Tombigbee, Tuskegee); USFWS (Big Lake?, Eufaula, Hatchie, Lower Hatchie?, Pond Creek)

(CEGL004737) Diamondleaf Oak - Overcup Oak / American Hornbeam - Swampbay / Mayberry Forest

***Quercus laurifolia* - *Quercus lyrata* / *Carpinus caroliniana* - *Persea palustris* / *Vaccinium elliotii* Forest**

Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	<i>Quercus (phellos, nigra, laurifolia)</i> Temporarily Flooded Forest Alliance (A.292)
Alliance (English name)	(Willow Oak, Water Oak, Diamondleaf Oak) Temporarily Flooded Forest Alliance
Association	<i>Quercus laurifolia</i> - <i>Quercus lyrata</i> / <i>Carpinus caroliniana</i> - <i>Persea palustris</i> / <i>Vaccinium elliotii</i> Forest
Association (English name)	Diamondleaf Oak - Overcup Oak / American Hornbeam - Swampbay / Mayberry Forest
Association (Common name)	Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest

Ecological System(s): Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249)
Atlantic Coastal Plain Large River Floodplain Forest (CES203.066)

Element Concept

Global Summary: This community type covers forests of low blackwater bottomland river terraces and ridges, in the Atlantic Coastal Plain of the Carolinas and possibly Virginia. This type may have a somewhat longer hydroperiod than other types in this or other temporarily flooded alliances, but it is not seasonally flooded. It is distinguished from some related types by lacking a significant component of levee species. The canopy is dominated by *Quercus laurifolia* (laurel oak) and *Quercus lyrata* (overcup oak). The subcanopy characteristically contains *Carpinus caroliniana* (American hornbeam) and *Persea palustris* (swamp bay). One prominent shrub is *Vaccinium elliotii* (Elliott's blueberry). Additional floristic information is needed. Stands of this community have a significant component of *Quercus lyrata* (overcup oak) and generally lack a significant component of *Pinus taeda* (loblolly pine).

Environmental Description

USFWS Wetland System: Palustrine

Moore's Creek National Battlefield Environment: This blackwater river terrace forest was sampled once along Moore's Creek. The site is a gently sloping, temporarily flooded low bottomland with somewhat poorly drained loamy sand soil. This community sits higher (1 m) than the adjacent bald-cypress - blackgum forest located to the west. The unvegetated surface is dominated by leaf litter (90% cover) with some wood (5%) and bare soil (5%). The presence of snags and downed trees is evidence of past wind/ice damage.

Global Environment: This community occurs on low blackwater bottomland river terraces and ridges, in the Atlantic Coastal Plain of the Carolinas and possibly Virginia. This type may have a somewhat longer hydroperiod than other types in this or other temporarily flooded alliances, but it is not seasonally flooded.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderately dense (70% cover) tree canopy, 20-35 m tall, is codominated by *Quercus laurifolia* (laurel oak) and *Quercus lyrata* (overcup oak), as is the moderate (50%) subcanopy (10-15 m). Additional tree species include *Acer rubrum* (red maple), *Betula nigra* (river birch), *Liquidambar styraciflua* (sweetgum), *Nyssa biflora* (swamp tupelo), *Pinus taeda* (loblolly pine), and *Taxodium distichum* (bald cypress). The sparse (20%) tall-shrub layer (2-5 m) and moderate (60%) short-shrub layer (1-2 m) are dominated by *Arundinaria gigantea* (giant cane); additional shrubs found in lesser amounts include *Carpinus caroliniana* (American hornbeam), *Ilex verticillata* (common winterberry), *Baccharis halimifolia* (eastern baccharis), *Cyrilla racemiflora* (swamp tit), *Hypericum hypericoides* (St. Andrew's cross), and *Viburnum dentatum* (southern arrowwood). The herbaceous layer is nearly absent (<5%); vines include *Campsis radicans* (trumpet creeper) and *Smilax rotundifolia* (roundleaf greenbrier). The epiphyte *Tillandsia usneoides* (Spanish moss) is found growing in the tree canopies.

Global Vegetation: The canopy of this association is dominated by *Quercus laurifolia* (laurel oak) and *Quercus lyrata* (overcup oak). The subcanopy characteristically contains *Carpinus caroliniana* (American hornbeam) and *Persea palustris* (swamp bay). One prominent shrub is *Vaccinium elliotii* (Elliott's blueberry). Additional floristic information is needed. Stands of this

community have a significant component of *Quercus lyrata* (overcup oak) and generally lack a significant component of *Pinus taeda* (loblolly pine).

Most Abundant Species

Moore's Creek National Battlefield

Stratum

Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Tree (canopy & subcanopy)	Broad-leaved evergreen tree
Tree subcanopy	Broad-leaved deciduous tree
Short shrub/sapling	Graminoid

Lifeform

Species

Quercus lyrata (overcup oak)
Quercus laurifolia (laurel oak)
Nyssa biflora (swamp tupelo)
Arundinaria gigantea (giant cane)

Conservation Status Rank

Global Rank & Reasons: G4? (15-Aug-1997).

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

- Blackwater Bottomland Hardwoods (Low Subtype) (Schafale 2000) ?

Element Distribution

Moore's Creek National Battlefield Range: This community is found along Moore's Creek on the western side of the park.

Global Range: This community type is apparently restricted to the Atlantic Coastal Plain of the Carolinas and possibly Virginia.

Nations: US

States/Provinces: NC, SC, VA?

TNC Ecoregions: 57:C

USFS Ecoregions: 232Ca:CCC, 232Cb:CCC

Federal Lands: NPS (Moore's Creek)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.6.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: M.P. Schafale

References: McCrain and Church 1985, Schafale 2000, Schafale and Weakley 1990, Schafale pers. comm., Sieren 1984, Southeastern Ecology Working Group n.d., Wharton et al. 1982

Seasonally flooded cold-deciduous forest (I.B.2.N.e.)

***Taxodium distichum* - *Nyssa* (*aquatica*, *biflora*, *ogeche*) Seasonally Flooded Forest Alliance (A.337)**

Alliance Concept

Summary: This alliance comprises floodplain forests, with seasonally flooded hydrology. It occurs in the Coastal Plain from Virginia south to Florida, west to eastern Texas, and in the Mississippi River alluvial basin north to southern Illinois. These forests are dominated by *Taxodium distichum* (bald cypress) and usually one or more of the following: *Nyssa aquatica*

(water tupelo), *Nyssa biflora* (swamp tupelo), and/or *Nyssa ogeche* (Ogeechee tupelo). Characteristic woody species include *Quercus lyrata* (overcup oak), *Carya aquatica* (water hickory), *Acer rubrum* (red maple), *Planera aquatica* (planertree), *Fraxinus caroliniana* (Carolina ash), *Liquidambar styraciflua* (sweetgum), *Quercus laurifolia* (laurel oak), *Populus heterophylla* (swamp cottonwood), *Ilex decidua* (possumhaw), and others. The subcanopy, shrub and herbaceous layers of these communities range from sparse to moderate. Herbaceous and vine species that may be present include *Leersia lenticularis* (catchfly grass), *Justicia ovata* (looseflower water-willow), *Carex intumescens* (greater bladder sedge), *Boehmeria cylindrica* (smallspike false nettle), *Onoclea sensibilis* (sensitive fern), *Commelina communis* (Asiatic dayflower), *Hydrocotyle verticillata* (whorled marshpennywort), *Ludwigia palustris* (marsh seedbox), *Carex bromoides* (bromelike sedge), *Saururus cernuus* (lizard's tail), *Pilea pumila* (Canadian clearweed), *Phanopyrum gymnocarpon* (savannah-panicgrass), *Campsis radicans* (trumpet creeper), *Smilax tamnoides* (bristly greenbrier), *Ampelopsis arborea* (peppervine), *Mikania scandens* (climbing hempvine), and others.

Classification Comments: Compare to alliances in I.B.2.N.f with semipermanently flooded hydrology where surface water persists through the growing season in most years. This alliance with seasonal flooding has flooding of long duration, but the water level is below the surface by the end of the growing season. Several communities in Louisiana contain *Taxodium distichum* with various hardwoods (*Quercus nigra* and *Magnolia virginiana*; *Celtis laevigata* and *Acer rubrum* or *Acer negundo*). Assessment is needed regarding their alliance placement.

Similar Alliances:

- *Nyssa aquatica* - (*Taxodium distichum*) Semipermanently Flooded Forest Alliance (A.345)--semipermanently flooded.
- *Taxodium distichum* Semipermanently Flooded Forest Alliance (A.346)--semipermanently flooded and lacking *Nyssa* component.

Related Concepts:

- Bald Cypress - Water Tupelo Swamp (Wieland 1994b) ?
- Baldcypress - Tupelo: 102 (Eyre 1980) I
- Baldcypress / *Ceratophyllum* Semi-Permanently Flooded Swamps (Turner et al. 1999) I
- Baldcypress-Water Tupelo Series (Diamond 1993) I
- Cypress - Tupelo Swamp (Foti 1994b) ?
- Cypress swamp (Evans 1991) I
- Cypress/Cypress-Tupelo Swamp (Smith 1996a) I
- Floodplain swamp (FNAI 1992a) I
- IIA4b. Bald Cypress - Water Tupelo Swamp (Allard 1990) I
- P1B3dI1b. *Taxodium distichum* - *Nyssa aquatica* (Foti et al. 1994) ?
- Palustrine *Taxodium distichum*-*Nyssa* spp. Series (Pyne 1994) I

Alliance Description

Environment: This alliance includes floodplain forests with seasonally flooded hydrology.

Vegetation: These floodplain forests are dominated by *Taxodium distichum* (bald cypress) and usually one or more of the following: *Nyssa aquatica* (water tupelo), *Nyssa biflora* (swamp tupelo), and/or *Nyssa ogeche* (Ogeechee tupelo). Characteristic woody species include *Quercus lyrata* (overcup oak), *Carya aquatica* (water hickory), *Acer rubrum* (red maple), *Planera aquatica* (planertree), *Fraxinus caroliniana* (Carolina ash), *Liquidambar styraciflua* (sweetgum), *Quercus laurifolia* (laurel oak), *Populus heterophylla* (swamp cottonwood), *Ilex decidua*

(possumhaw), and others. The subcanopy, shrub and herbaceous layers of these communities range from sparse to moderate. Herbaceous and vine species that may be present include *Leersia lenticularis* (catchfly grass), *Justicia ovata* (looseflower water-willow), *Carex intumescens* (greater bladder sedge), *Boehmeria cylindrica* (smallspike false nettle), *Onoclea sensibilis* (sensitive fern), *Commelina communis* (Asiatic dayflower), *Hydrocotyle verticillata* (whorled marshpennywort), *Ludwigia palustris* (marsh seedbox), *Carex bromoides* (bromelike sedge), *Saururus cernuus* (lizard's tail), *Pilea pumila* (Canadian clearweed), *Phanopyrum gymnocarpon* (savannah-panicgrass), *Campsis radicans* (trumpet creeper), *Smilax tamnoides* (bristly greenbrier), *Ampelopsis arborea* (peppervine), *Mikania scandens* (climbing hempvine), and others.

Alliance Distribution

Range: Forests in this alliance occur in the Coastal Plain from Delaware south to Florida and west to eastern Texas and in the Mississippi River alluvial basin north to Kentucky.

Nations: US

Subnations: AL, AR, DE, FL, GA?, KY, LA, MD, MS, NC, SC, TN, TX, VA?

TNC Ecoregions: 40:P, 41:C, 42:C, 43:C, 53:C, 55:C, 56:C, 57:C, 58:C

USFS Ecoregions: 231B:C?, 231E:CP, 231Gc:CCC, 232Ac:CCC, 232Ad:CCC, 232Ba:CCC, 232Bb:CCC, 232Bc:CCC, 232Bd:CCC, 232Be:CCC, 232Bf:CCC, 232Bg:CCC, 232Bh:CCC, 232Bi:CCC, 232Bj:CCC, 232Bk:CCC, 232Bl:CCC, 232Bm:CCC, 232Bn:CCC, 232Bo:CCC, 232Bp:CCC, 232Bq:CCC, 232Br:CCC, 232Bs:CCC, 232Bt:CCC, 232Bu:CCC, 232Bv:CCC, 232Bx:CCC, 232Bz:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CCC, 232Cd:CCC, 232Ce:CCC, 232Cf:CCC, 232Cg:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Dc:CCC, 232Fa:CCC, 232Fb:CCC, 232Fc:CCC, 232Fd:CCC, 232Fe:CCC, 234Aa:CCC, 234Ac:CCC, 234Ad:CCC, 234Ae:CCC, 234Af:CCC, 234Ag:CCC, 234Ah:CCC, 234Ai:CCC, 234Aj:CCC, 234Ak:CCC, 234Al:CCC, 234Am:CCC, 234An:CCC

Federal Lands: DOD (Camp Lejeune, Camp MacKall); DOE (Savannah River Site); NPS (Congaree Swamp, Moores Creek); USFS (Angelina, Apalachicola, Croatan, Davy Crockett, De Soto, Delta, Francis Marion, Holly Springs, Kisatchie, Ocala, Osceola, Sabine, Sam Houston, Tuskegee); USFWS (Okefenokee?)

(CEGL004733) Bald-cypress - Swamp Blackgum / Water Ash / Shining Fetterbush Forest

Taxodium distichum - *Nyssa biflora* / *Fraxinus caroliniana* / *Lyonia lucida* Forest

Atlantic Coastal Plain Bald-cypress - Blackgum Swamp

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Seasonally flooded cold-deciduous forest (I.B.2.N.e.)
Alliance	<i>Taxodium distichum</i> - <i>Nyssa (aquatica, biflora, ogeche)</i> Seasonally Flooded Forest Alliance (A.337)
Alliance (English name)	Bald-cypress - (Water Tupelo, Swamp Blackgum, Ogeechee Tupelo) Seasonally Flooded Forest Alliance
Association	<i>Taxodium distichum</i> - <i>Nyssa biflora</i> / <i>Fraxinus caroliniana</i> / <i>Lyonia lucida</i> Forest
Association (English name)	Bald-cypress - Swamp Blackgum / Water Ash / Shining Fetterbush Forest
Association (Common name)	Atlantic Coastal Plain Bald-cypress - Blackgum Swamp
Ecological System(s):	Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249)
	Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)
	Atlantic Coastal Plain Large River Floodplain Forest (CES203.066)

Element Concept

Global Summary: This association includes very wet forests of the southeastern Coastal Plain in North Carolina and South Carolina that are flooded by river overbank flow for long periods. It occurs along Coastal Plain streams which lack clay sediment, where *Nyssa aquatica* (water tupelo) is not a significant component of the canopy. This community occupies the most acidic and clay-free streams and consequently is found within coarse-sandy landscapes. Forests are dominated by combinations of *Nyssa biflora* (swamp tupelo), *Taxodium distichum* (bald cypress), and *Taxodium ascendens* (pond cypress).

Environmental Description

USFWS Wetland System: Palustrine

Moore's Creek National Battlefield Environment: This bald-cypress - blackgum swamp was sampled twice along Moore's Creek. Both sites are seasonally flooded flat floodplains with very poorly drained muck soil. These sites are prone to inundation for extended periods in normal winters. However, at the time of sampling, the sites were merely moist or saturated at the surface with no standing water due to drought conditions. The unvegetated surface is dominated by leaf litter (90-94% cover) with some wood (3-4%) and bare soil (2-7%). At least one site was logged long ago; still, there are some large bald-cypress present.

Global Environment: This community occurs along Coastal Plain streams which lack clay sediment, where *Nyssa aquatica* is not a significant component of the canopy. It occupies the most acidic and clay-free streams and consequently is found within coarse-sandy landscapes.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The dense (70-80% cover) tree canopy, 15-35 m tall, is codominated exclusively by *Nyssa biflora* (swamp tupelo) and *Taxodium distichum* (bald cypress). *Nyssa biflora* (swamp tupelo) also dominates the moderately sparse (30-40%) subcanopy (10-15 m) along with lesser amounts of *Acer rubrum* var. *trilobum* (red maple), *Betula nigra* (river birch), *Liquidambar styraciflua* (sweetgum), *Quercus laurifolia* (laurel oak), *Quercus lyrata* (overcup oak), and/or *Ulmus americana* (American elm). The moderately sparse (30-40%) tall-shrub layer (2-5 m) is codominated by *Fraxinus caroliniana* (Carolina ash) and *Itea virginica* (Virginia sweetspire); additional tall shrubs may include *Acer rubrum* var. *trilobum* (red maple), *Cyrilla racemiflora* (swamp titi), *Ilex opaca* (American holly), *Ilex verticillata* (common winterberry), and *Ilex amelanchier* (sarvis holly) (state-vulnerable). The sparse (10-20%) short-shrub layer (1-2 m) is dominated by *Itea virginica* (Virginia sweetspire). The very sparse (<5%) herbaceous layer includes *Carex glaucescens* (southern waxy sedge), *Mikania scandens* (climbing hempvine), *Osmunda regalis* (royal fern), *Saururus cernuus* (lizard's tail), and *Woodwardia areolata* (netted chainfern). Vines (20%) are dominated by *Smilax laurifolia* (laurel greenbrier) and *Smilax walteri* (coral greenbrier), which may climb up into taller vegetation; the state-critically imperiled vine *Gelsemium rankinii* (Rankin's trumpetflower) has also been found in this habitat at Moore's Creek National Battlefield (Sieren 1984). The epiphyte *Tillandsia usneoides* (Spanish moss) can be found growing in the tree canopy. This community supports two additional state-vulnerable plants, *Ilex myrtifolia* (myrtle dahoon) and *Mayaca fluviatilis* (stream bogmoss).

Global Vegetation: Stands are dominated by combinations of *Nyssa biflora* (swamp tupelo), *Taxodium distichum* (bald cypress), and *Taxodium ascendens* (pond cypress). *Nyssa aquatica* (water tupelo) is not a significant component of the canopy.

Most Abundant Species

Moore's Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	<i>Nyssa biflora</i> (swamp tupelo)
Tree canopy	Needle-leaved tree	<i>Taxodium distichum</i> (bald cypress)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Itea virginica</i> (Virginia sweetspire)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Fraxinus caroliniana</i> (Carolina ash)
Herb (field)	Vine/Liana	<i>Smilax walteri</i> (coral greenbrier)
Herb (field)	Graminoid	<i>Carex glaucescens</i> (southern waxy sedge)

Characteristic Species

Moore's Creek National Battlefield: *Acer rubrum* var. *trilobum* (red maple), *Cyrilla racemiflora* (swamp tit), *Mikania scandens* (climbing hemipine), *Osmunda regalis* (royal fern), *Tillandsia usneoides* (Spanish moss)

Other Noteworthy Species

Moore's Creek National Battlefield

<u>Other Plant Species</u>	<u>GRank</u>	<u>Note</u>
<i>Gelsemium rankinii</i> (Rankin's trumpetflower)	G5	state-critically imperiled
<i>Ilex amelanchier</i> (sarvis holly)	G4	state-vulnerable
<i>Ilex myrtifolia</i> (myrtle dahoon)	G5?	state-vulnerable
<i>Mayaca fluviatilis</i> (stream bogmoss)	G5	state-vulnerable

Conservation Status Rank

Global Rank & Reasons: G3G4 (31-Jan-2001). This cypress-gum swamp occurs in the most acidic landscapes of the southeastern Coastal Plain in North Carolina and South Carolina. There are over 20 occurrences recorded in North Carolina, totaling less than 10,000 acres, though additional occurrences exist. Nearly all examples have been altered by timber harvest, and many have also been altered by sedimentation and hydrologic changes to upstream areas in the watershed.

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

- Cypress--Gum Swamp (Acid Blackwater Subtype) (Schafale 2000) ?

Element Distribution

Moore's Creek National Battlefield Range: This swamp forest is found in the floodplains along both sides of Moore's Creek.

Global Range: This cypress-gum swamp occurs in the most acidic landscapes of the southeastern Coastal Plain in North Carolina and South Carolina.

Nations: US

States/Provinces: NC, SC

TNC Ecoregions: 57:C

USFS Ecoregions: 232Bq:CCC, 232Bv:CCP, 232Ca:CCC, 232Cb:CCC, 232Ce:CCC

Federal Lands: DOD (Camp Lejeune, Camp MacKall); NPS (Moore's Creek); USFS (Croatan, Francis Marion)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.5, MOCR.12.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: M.P. Schafale

References: McCrain and Church 1985, Peet et al. unpubl. data 2002, Schafale 2000, Schafale and Weakley 1990, Schafale pers. comm., Sieren 1984, Southeastern Ecology Working Group n.d.

Temporarily flooded mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.b.)

***Pinus taeda* - *Liquidambar styraciflua* - *Nyssa biflora* Temporarily Flooded Forest Alliance (A.433)**

Alliance Concept

Summary: Forests in this alliance occur on slightly elevated ridges of floodplains primarily in the Atlantic Coastal Plain and the adjacent East Gulf Coastal Plain. The canopy is typically dominated by some combination of *Pinus taeda* (loblolly pine), *Liquidambar styraciflua* (sweetgum), and *Nyssa biflora* (swamp tupelo). Other canopy species which may be present are a mixture of bottomland hardwood species that includes *Diospyros virginiana* (common persimmon), *Quercus nigra* (water oak), *Acer rubrum* (red maple), *Quercus michauxii* (swamp chestnut oak), *Quercus laurifolia* (laurel oak), *Ulmus alata* (winged elm), *Carya cordiformis* (bitternut hickory), *Ulmus americana* (American elm), *Quercus pagoda* (cherrybark oak), *Celtis laevigata* (sugarberry), *Quercus phellos* (willow oak), *Fagus grandifolia* (American beech), *Carya alba* (mockernut hickory), and more. *Asimina triloba* (pawpaw) may be prominent in the understory with *Ilex decidua* (possumhaw), *Carpinus caroliniana* (American hornbeam), *Crataegus viridis* (green hawthorn), *Crataegus spathulata* (littlehip hawthorn), *Ilex opaca* (American holly), and other species. These forests develop following disturbance, natural and artificial, and may persist.

Classification Comments: The West Gulf Coastal Plain component of this alliance (CEGL004911) was moved to a pine-oak seasonally flooded alliance (A.437).

Similar Alliances:

- *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance (A.287)
- *Pinus taeda* - *Liriodendron tulipifera* Temporarily Flooded Forest Alliance (A.434)--also a successional forest alliance, with some distributional and floristic overlaps.

Related Concepts:

- IIA8c. Lowland Pine - Oak Forest (Allard 1990) I
- Loblolly Pine - Hardwood: 82 (Eyre 1980) I

Alliance Description

Environment: These forests are found on slightly elevated ridges of floodplains primarily in the Atlantic Coastal Plain.

Vegetation: The canopy is typically dominated by some combination of *Pinus taeda* (loblolly pine), *Liquidambar styraciflua* (sweetgum), and *Nyssa biflora* (swamp tupelo). Other canopy species which may be present are a mixture of bottomland hardwood species that includes *Diospyros virginiana* (common persimmon), *Quercus nigra* (water oak), *Acer rubrum* (red maple), *Quercus michauxii* (swamp chestnut oak), *Quercus laurifolia* (laurel oak), *Ulmus alata* (winged elm), *Carya cordiformis* (bitternut hickory), *Ulmus americana* (American elm), *Quercus pagoda* (cherrybark oak), *Celtis laevigata* (sugarberry), *Quercus phellos* (willow oak), *Fagus grandifolia* (American beech), *Carya alba* (mockernut hickory), and more. *Asimina triloba* (pawpaw) may be prominent in the understory with *Ilex decidua* (possumhaw), *Carpinus caroliniana* (American hornbeam), *Crataegus viridis* (green hawthorn), *Crataegus spathulata* (littlehip hawthorn), *Ilex opaca* (American holly), and other species.

Dynamics: These forests develop following disturbance, natural and artificial, and may persist.

Alliance Distribution

Range: This alliance is found primarily in the Atlantic Coastal Plain of Georgia, North Carolina and South Carolina, and may possibly occur in the adjacent East Gulf Coastal Plain of Florida, Louisiana, and Mississippi, and in Virginia.

Nations: US

Subnations: FL?, GA, LA?, MS?, NC, SC, VA?

TNC Ecoregions: 53:C, 56:C, 57:C, 58:P

USFS Ecoregions: 232Br:CCC, 232Bs:CCC, 232Cb:CCC

Federal Lands: DOD (Fort Benning); DOE (Savannah River Site); NPS (Congaree Swamp, Moores Creek)

(CEGL004606) Loblolly Pine - Sweetgum - Swamp Blackgum Temporarily Flooded Forest

Pinus taeda - *Liquidambar styraciflua* - *Nyssa biflora* Temporarily Flooded Forest

Loblolly Pine - Sweetgum - Swamp Blackgum Successional Swamp Forest

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Mixed evergreen-deciduous forest (I.C.)
Physiognomic Group	Mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.)
Physiognomic Subgroup	Natural/Semi-natural mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.)
Formation	Temporarily flooded mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.b.)
Alliance	<i>Pinus taeda</i> - <i>Liquidambar styraciflua</i> - <i>Nyssa biflora</i> Temporarily Flooded Forest Alliance (A.433)
Alliance (English name)	Loblolly Pine - Sweetgum - Swamp Blackgum Temporarily Flooded Forest Alliance
Association	<i>Pinus taeda</i> - <i>Liquidambar styraciflua</i> - <i>Nyssa biflora</i> Temporarily Flooded Forest
Association (English name)	Loblolly Pine - Sweetgum - Swamp Blackgum Temporarily Flooded Forest
Association (Common name)	Loblolly Pine - Sweetgum - Swamp Blackgum Successional Swamp Forest
Ecological System(s):	East Gulf Coastal Plain Small Stream and River Floodplain Forest (CES203.559)
	Atlantic Coastal Plain Large River Floodplain Forest (CES203.066)

Element Concept

Global Summary: This association includes forests dominated by the nominal species on slightly elevated ridges of floodplains primarily in the Atlantic Coastal Plain and the adjacent East Gulf Coastal Plain. The canopy of this successional forest is typically dominated by some combination of *Pinus taeda* (loblolly pine), *Liquidambar styraciflua* (sweetgum), and *Nyssa biflora* (swamp tupelo). A mixture of other bottomland hardwood species may be present which

includes *Diospyros virginiana* (common persimmon), *Quercus nigra* (water oak), *Acer rubrum* (red maple), *Quercus michauxii* (swamp chestnut oak), *Quercus laurifolia* (laurel oak), *Ulmus alata* (winged elm), *Carya cordiformis* (bitternut hickory), *Ulmus americana* (American elm), *Quercus pagoda* (cherrybark oak), *Celtis laevigata* (sugarberry), *Quercus phellos* (willow oak), *Fagus grandifolia* (American beech), *Carya alba* (mockernut hickory), and others. *Asimina triloba* (pawpaw) may be prominent in the understory with *Ilex decidua* (possumhaw), *Carpinus caroliniana* (American hornbeam), *Crataegus viridis* (green hawthorn), *Crataegus spathulata* (littlehip hawthorn), *Ilex opaca* (American holly), and other species. These forests develop following disturbance and may persist.

Environmental Description

USFWS Wetland System: Palustrine

Moore's Creek National Battlefield Environment: This successional swamp forest was sampled once just north of the main entrance road, near the eastern bend in Moore's Creek. The site is a flat, intermittently flooded creekbed with muck soil. Due to drought conditions at the time of sampling, the creek was mainly dry with some scattered pools of standing water. The unvegetated surface is dominated by leaf litter (75% cover) with some wood (15%), bare soil (5%), and standing water (5%). Evidence of disturbance includes downed trees, including bald-cypress (probably the result of hurricane damage), possible pine bark beetle damage, and the presence of exotic plants.

Global Environment: These are forests dominated by the nominal species on slightly elevated ridges of floodplains primarily in the Atlantic Coastal Plain, ranging into the adjacent East Gulf Coastal Plain.

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderately dense (70% cover) tree canopy, 20-35 m tall, is dominated by *Taxodium ascendens* (pond cypress) and *Pinus taeda* (loblolly pine) and includes lesser amounts of *Liquidambar styraciflua* (sweetgum) and *Quercus nigra* (water oak). The moderate (50%) subcanopy (15-20 m) is dominated by *Liquidambar styraciflua* (sweetgum) and *Quercus nigra* (water oak) along with lesser amounts of *Acer rubrum* (red maple) and *Nyssa biflora* (swamp tupelo). *Acer rubrum* (red maple) dominates the moderate (40%) tall-shrub layer (5-10 m), and *Itea virginica* (Virginia sweetspire) dominates the sparse (20%) short-shrub layer (1-2 m). Additional short shrubs include *Clethra alnifolia* (coastal sweetpepperbush), *Cornus foemina* (stiff dogwood), *Lyonia lucida* (fetterbush lyonia), and *Vaccinium corymbosum* (highbush blueberry). The moderately dense (70%) herbaceous layer is dominated by *Saururus cernuus* (lizard's tail) and *Woodwardia areolata* (netted chainfern) and includes *Hydrocotyle* (hydrocotyle) sp., *Woodwardia virginica* (Virginia chainfern), *Arundinaria gigantea* (giant cane), *Duchesnea indica* (Indian strawberry), and *Osmunda regalis* (royal fern), among others. Eight species of vine (20%) were recorded from a single plot; *Parthenocissus quinquefolia* (Virginia creeper) and *Smilax rotundifolia* (roundleaf greenbrier) are dominant. In addition, this community supports state-critically imperiled *Bacopa caroliniana* (blue waterhyssop).

Global Vegetation: The canopy is dominated by some combination of *Pinus taeda* (loblolly pine), *Liquidambar styraciflua* (sweetgum), and *Nyssa biflora* (swamp tupelo). A mixture of other bottomland hardwood species may be present which includes *Diospyros virginiana* (common persimmon), *Quercus nigra* (water oak), *Acer rubrum* (red maple), *Quercus michauxii* (swamp chestnut oak), *Quercus laurifolia* (laurel oak), *Ulmus alata* (winged elm), *Carya*

cordiformis (bitternut hickory), *Ulmus americana* (American elm), *Quercus pagoda* (cherrybark oak), *Celtis laevigata* (sugarberry), *Quercus phellos* (willow oak), *Fagus grandifolia* (American beech), *Carya alba* (mockernut hickory), and others. *Asimina triloba* (pawpaw) may be prominent in the understory with *Ilex decidua* (possumhaw), *Carpinus caroliniana* (American hornbeam), *Crataegus viridis* (green hawthorn), *Crataegus spathulata* (littlehip hawthorn), *Ilex opaca* (American holly), and other species.

Most Abundant Species

Moores Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine), <i>Taxodium ascendens</i> (pond cypress)
Tree subcanopy	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum), <i>Quercus nigra</i> (water oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Acer rubrum</i> (red maple)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Itea virginica</i> (Virginia sweetspire)
Herb (field)	Vine/Liana	<i>Smilax rotundifolia</i> (roundleaf greenbrier)
Herb (field)	Forb	<i>Saururus cernuus</i> (lizard's tail)
Herb (field)	Fern or fern ally	<i>Woodwardia areolata</i> (netted chainfern), <i>Woodwardia virginica</i> (Virginia chainfern)

Other Noteworthy Species

Moores Creek National Battlefield

Exotic and Invasive Species

Cardamine hirsuta (hairy bittercress)
Duchesnea indica (Indian strawberry)
Ligustrum sinense (Chinese privet)
Polygonum hydropiper (marshpepper knotweed)

I-Rank

- exotic
Low/Insignificant exotic
High/Medium exotic
- exotic

Note

Other Plant Species

Bacopa caroliniana (blue waterhyssop)

GRank

G4G5

Note

state-critically imperiled

Conservation Status Rank

Global Rank & Reasons: G4 (8-Dec-2000). These forests develop following disturbance and may persist. This is not an inherently rare forest type and is widely distributed. Older or higher quality examples could be significant to conservation, particularly if they are interspersed with, and serve as buffer for, rarer types. Grank changed from G3G5 to G4 2000-11-22.

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Comments: Pederson et al. (1997) report old stands at Congaree Swamp National Monument dominated by *Pinus taeda*, *Liquidambar styraciflua*, *Carpinus caroliniana*, and *Ilex opaca*. This vegetation is apparently accommodated in the USNVC as a *Pinus taeda*-containing "phase" of *Liquidambar styraciflua* - *Quercus (laurifolia, nigra)* - (*Pinus taeda*) / *Arundinaria gigantea* / *Carex abscondita* Forest (CEGL007732).

Global Similar Associations:

- *Liquidambar styraciflua* - *Liriodendron tulipifera* / *Onoclea sensibilis* Forest (CEGL007329)-- a related deciduous type.

Element Distribution

Moore's Creek National Battlefield Range: This community is found in a wetland tributary of Moore's Creek, in the northern part of Moore's Creek National Battlefield, between the picnic area and NPS residences, north of the road to the picnic area.

Global Range: These forests are primarily found in the Atlantic Coastal Plain and the adjacent East Gulf Coastal Plain of the United States.

Nations: US

States/Provinces: FL?, GA, LA?, MS?, NC, SC, VA?

TNC Ecoregions: 53:C, 56:C, 57:C

USFS Ecoregions: 232Br:CCC, 232Bs:CCC, 232Cb:CCC

Federal Lands: DOD (Fort Benning); DOE (Savannah River Site); NPS (Congaree Swamp, Moore's Creek)

Element Sources

Moore's Creek National Battlefield Plots: MOCR.4.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: S. Landaal

References: Allard 1990, Eyre 1980, Jones and Churchill 1987, Jones et al. 1981b, McCrain and Church 1985, Pederson and Jones 1994, Southeastern Ecology Working Group n.d.

***Pinus taeda* - *Quercus (phellos, nigra, laurifolia)* Temporarily Flooded Forest Alliance (A.437)**

Alliance Concept

Summary: This alliance covers mixed loblolly pine - hardwood forests of primarily blackwater rivers of the southeastern Coastal Plain of the United States and related small stream floodplains west of the Mississippi River. Stands are dominated by *Pinus taeda* (loblolly pine) with any combination of *Quercus laurifolia* (laurel oak), *Quercus nigra* (water oak), and/or *Quercus phellos* (willow oak), with *Liquidambar styraciflua* (sweetgum). Some stands could originate as *Pinus taeda* (loblolly pine) plantations, with subsequent ingrowth of hardwoods. These situations confound the status of this alliance as distinct from its deciduous equivalent *Quercus (phellos, nigra, laurifolia)* Temporarily Flooded Forest Alliance (A.292), which is very similar but lacks a significant component of *Pinus taeda* (loblolly pine). This alliance perhaps uncomfortably combines natural, ecologically restricted situations (e.g., *Pinus taeda* - *Quercus laurifolia* - *Chamaecyparis thyoides* - (*Quercus virginiana*) / *Vaccinium elliottii* Forest (CEGL007548) of "sandy blackwater streams and on low, sandy terraces and levees in the Atlantic Coastal Plain") as well as more semi-natural or successional situations under less restricted or clearly defined conditions.

Classification Comments: This vegetation may occur along small streams and rivers at the northern periphery of the Gulf Coast Prairies and Marshes Ecoregion in eastern Texas in the vicinity of Beaumont.

Similar Alliances:

- *Pinus taeda* - *Liriodendron tulipifera* Temporarily Flooded Forest Alliance (A.434)
- *Pinus taeda* Forest Alliance (A.130)
- *Quercus (phellos, nigra, laurifolia)* Temporarily Flooded Forest Alliance (A.292)--is very similar, but lacks a significant component of *Pinus taeda*.

Related Concepts:

- Coastal Plain Bottomland Hardwoods, Blackwater Subtype (Schafale and Weakley 1990) ?
- IIA8c. Lowland Pine - Oak Forest (Allard 1990) I
- Loblolly Pine - Hardwood: 82 (Eyre 1980) I
- Loblolly Pine-Lowland Hardwoods Type (?) (Beckett and Golden 1982) ?
- Loblolly Pine: 81 (Eyre 1980) I
- Lowland Pine - Oak Forest (Foti 1994b) I
- T1B3aIII5b. *Pinus taeda* - *Quercus phellos* - *Quercus stellata* (Foti et al. 1994) ?
- White Oak - Loblolly Pine / *Callicarpa* Loamy Infrequently Flooded Levees and Bottomland Ridges (Turner et al. 1999) I

Alliance Description

Environment: The best, most natural examples of vegetation attributed to this alliance are mixed loblolly pine - hardwood forests primarily of blackwater rivers of the southeastern Coastal Plain. It also includes small stream floodplains in the Coastal Plain west of the Mississippi River and parts of the East Gulf Coastal Plain.

Vegetation: These mixed loblolly pine - hardwood forests are dominated by *Pinus taeda* (loblolly pine) with any combination of *Quercus laurifolia* (laurel oak), *Quercus nigra* (water oak), and/or *Quercus phellos* (willow oak), with *Liquidambar styraciflua* (sweetgum). Some of the vegetation placed here may have had its composition affected by the planting or spread from plantings of *Pinus taeda* (loblolly pine).

Dynamics: Some stands could originate as *Pinus taeda* plantations, with subsequent ingrowth of the hardwoods. These situations confound the status of this alliance as distinct from its deciduous equivalent (A.292). In addition, some of the vegetation placed here may have had its composition affected by the planting or spread from plantings of *Pinus taeda*.

Alliance Distribution

Range: This alliance is found throughout the southeastern United States.

Nations: US

Subnations: AL, AR, FL, GA, LA, MS, NC, OK, SC, TX, VA?

TNC Ecoregions: 31:C, 40:C, 41:C, 42:C, 43:P, 50:P, 52:P, 53:C, 55:P, 56:C, 57:C, 58:C, 62:C

USFS Ecoregions: 231Aa:CCC, 231Ab:CC?, 231Ac:CC?, 231Ad:CC?, 231Ae:CCP, 231Af:CCC, 231Ag:CCC, 231Ah:CC?, 231Ai:CC?, 231Aj:CC?, 231Am:CC?, 231Ao:CCC, 231Ba:CCP, 231Bb:CCP, 231Bc:CCC, 231Bd:CCP, 231Be:CC?, 231Bf:CCP, 231Bg:CC?, 231Bi:CCP, 231Bj:CCP, 231Bl:CCP, 231Da:CC?, 231Db:CC?, 231Dc:CC?, 231Dd:CC?, 231De:CC?, 231Ea:CCP, 231Eb:CCP, 231Ec:CCP, 231Ed:CCP, 231Ee:CCP, 231Ef:CCP, 231Eg:CCP, 231Eh:CCC, 231Ei:CCP, 231Ej:CCC, 231Ek:CCP, 231El:CCP, 231Em:CCP, 231En:CCP, 231Fa:CPP, 232A:CP, 232Ba:CCC, 232Bb:CCC, 232Bc:CCC, 232Bd:CCC, 232Be:CCC, 232Bf:CCC, 232Bg:CCC, 232Bh:CCC, 232Bi:CCC, 232Bj:CCC, 232Bk:CCC, 232Bl:CCC, 232Bm:CCC, 232Bn:CCC, 232Bo:CCC, 232Bp:CCC, 232Bq:CCC, 232Br:CCC, 232Bs:CCC, 232Bt:CCC, 232Bu:CCC, 232Bv:CCC, 232Bx:CCC, 232Bz:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CCC, 232Cd:CCC, 232Ce:CCC, 232Cf:CCC, 232Cg:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Dc:C??, 232Ea:CCC, 232Fa:CCP, 232Fb:CCP, 232Fc:CCP, 232Fd:CCP, 232Fe:CCC, 234Ac:CCP, 234Ah:CC?, 234Ak:CC?

Federal Lands: DOD (Fort Bragg); NPS (Moores Creek); USFS (Angelina, Apalachicola, Bienville?, Croatan?, Davy Crockett, De Soto, Francis Marion?, Holly Springs, Homochitto?,

Kisatchie, Oconee, Osceola, Sabine, Sam Houston, St. Francis, Sumter, Talladega?, Tombigbee, Tuskegee)

(CEGL004736) Loblolly Pine - Diamondleaf Oak / Mayberry - Giant Cane Forest

Pinus taeda - *Quercus laurifolia* / *Vaccinium elliotii* - *Arundinaria gigantea* Forest

Blackwater Bottomland Hardwood - Pine Forest (High Type)

NVC Classification

Physiognomic Class	Forest (I)
Physiognomic Subclass	Mixed evergreen-deciduous forest (I.C.)
Physiognomic Group	Mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.)
Physiognomic Subgroup	Natural/Semi-natural mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.)
Formation	Temporarily flooded mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.b.)
Alliance	<i>Pinus taeda</i> - <i>Quercus (phellos, nigra, laurifolia)</i> Temporarily Flooded Forest Alliance (A.437)
Alliance (English name)	Loblolly Pine - (Willow Oak, Water Oak, Diamondleaf Oak) Temporarily Flooded Forest Alliance
Association	<i>Pinus taeda</i> - <i>Quercus laurifolia</i> / <i>Vaccinium elliotii</i> - <i>Arundinaria gigantea</i> Forest
Association (English name)	Loblolly Pine - Diamondleaf Oak / Mayberry - Giant Cane Forest
Association (Common name)	Blackwater Bottomland Hardwood - Pine Forest (High Type)
Ecological System(s):	Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249)

Element Concept

Global Summary: This association is apparently a "high subtype" of blackwater bottomland hardwood-pine forest of the sandhills of the Atlantic Coastal Plain of North Carolina, South Carolina, Georgia, and possibly other states. The canopy would be expected to be dominated by *Pinus taeda* (loblolly pine) and *Quercus laurifolia* (laurel oak), with an understory characterized by *Vaccinium elliotii* (Elliott's blueberry) and *Arundinaria gigantea* (giant cane). More detailed information is needed.

Environmental Description

USFWS Wetland System: Palustrine

Moore's Creek National Battlefield Environment: This blackwater bottomland hardwood-pine forest was sampled once along Moore's Creek on slightly higher ground than the adjacent bald-cypress floodplain. The site is a gently sloping, low bottomland that is prone to short-term temporary flooding of Moore's Creek. The soil is somewhat poorly drained loamy sand, and the unvegetated surface is dominated by leaf litter (90% cover) with some wood (6%) and bare soil (4%). Evidence of disturbance includes past logging (removal of bald-cypress and loblolly pine).

Vegetation Description

Moore's Creek National Battlefield Vegetation: The moderately dense (70% cover) tree canopy, 20-35 m tall, is dominated exclusively by *Pinus taeda* (loblolly pine). The moderate (40%) subcanopy (10-15 m) is codominated by *Quercus laurifolia* (laurel oak) and *Quercus nigra* (water oak) and includes small amounts of *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Nyssa biflora* (swamp tupelo), *Pinus taeda* (loblolly pine), and *Taxodium distichum* (bald cypress). The very sparse (10%) tall-shrub layer (2-5 m) includes *Vaccinium arboreum* (farkleberry), *Vaccinium elliotii* (Elliott's blueberry), and *Vaccinium fuscum* (black highbush blueberry), and the sparse (30%) short-shrub layer (0.5-1 m) includes small amounts of *Arundinaria gigantea* (giant cane), *Cyrilla racemiflora* (swamp titi),

Hypericum hypericoides (St. Andrew's cross), and *Ilex verticillata* (common winterberry). The herbaceous layer is very sparse (10%). Vines include *Smilax glauca* (cat greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier), often found climbing into the shrub layer.

Global Vegetation: The canopy of stands of this type would be expected to be dominated by *Pinus taeda* (loblolly pine) and *Quercus laurifolia* (laurel oak), with an understory characterized by *Vaccinium elliottii* (Elliott's blueberry) and *Arundinaria gigantea* (giant cane). More detailed information is needed.

Most Abundant Species

Moores Creek National Battlefield

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine)
Tree subcanopy	Broad-leaved deciduous tree	<i>Quercus nigra</i> (water oak)
Tree subcanopy	Broad-leaved evergreen tree	<i>Quercus laurifolia</i> (laurel oak)
Short shrub/sapling	Vine/Liana	<i>Smilax rotundifolia</i> (roundleaf greenbrier)

Characteristic Species

Moores Creek National Battlefield: *Arundinaria gigantea* (giant cane), *Vaccinium elliottii* (Elliott's blueberry)

Conservation Status Rank

Global Rank & Reasons: G3G4 (15-Aug-1997).

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Similar Associations:

- *Pinus taeda* - *Quercus laurifolia* - *Chamaecyparis thyoides* - (*Quercus virginiana*) / *Vaccinium elliottii* Forest (CEGL007548)

Global Related Concepts:

- Blackwater Bottomland Hardwoods (High Subtype) (Schafale 2000) ?
- Willow Oak - Water Oak - Diamondleaf (Laurel) Oak: 88 (Eyre 1980) B

Element Distribution

Moores Creek National Battlefield Range: This community is found along Moores Creek on slightly higher ground than the adjacent bald-cypress floodplain, generally near the banks of Moores Creek.

Global Range: This type is restricted to blackwater streams in the sandhills and related areas of the Atlantic Coastal Plain of North Carolina and adjacent states, ranging south to Georgia and possibly northeastern Florida.

Nations: US

States/Provinces: FL?, GA, NC, SC, VA?

TNC Ecoregions: 56:C, 57:C

USFS Ecoregions: 232Cb:CCC

Federal Lands: DOD (Fort Bragg?); NPS (Moores Creek); USFS (Francis Marion?, Osceola?)

Element Sources

Moores Creek National Battlefield Plots: MOCR.8.

Local Description Authors: M.J. Russo and C.W. Nordman

Global Description Authors: M.P. Schafale

References: Eyre 1980, McCrain and Church 1985, Schafale 2000, Schafale and Weakley 1990, Schafale pers. comm., Southeastern Ecology Working Group n.d.

Herbaceous Vegetation (V.)

Saturated temperate or subpolar grassland (V.A.5.N.m.)

***Rhynchospora oligantha* - *Sarracenia* spp. - (*Aristida beyrichiana*, *Ctenium aromaticum*) - *Osmunda cinnamomea* / *Sphagnum* spp. Saturated Herbaceous Alliance (A.1463)**

Alliance Concept

Summary: This alliance includes herbaceous bogs and wetland savannas of the southeastern Coastal Plain ranging from Texas and Oklahoma eastward to North Carolina. Such communities have been variously called hillside seepage bogs, wet prairies, muck bogs, poor fens, sandhill seeps, and other names. Examples are influenced by groundwater seepage and/or seasonally high water tables. Given the large geographic range and extensive species turnover within the Coastal Plain, associations found in this alliance are quite floristically variable. Most types are heavily dominated by wetland herbaceous species. Woody species may occur in scattered clumps and patches in most examples, with density dependent largely on fire frequency and seasonality. In some parts of the distribution of this alliance, especially the Atlantic Coastal Plain, shrubs can be very prominent, even when fire is relatively frequent. *Rhynchospora* (beaksedge) spp. are especially prominent and diverse in most examples; many associations may have as many as ten *Rhynchospora* (beaksedge) spp. present. Carnivorous taxa are also usually present and diagnostic, especially *Sarracenia* (pitcherplant) spp. *Sarracenia* (pitcherplant) spp. range from dominant or codominant to sparse but diagnostic, and from a single species to several present. The range of species include *Sarracenia alata* (yellow trumpets), *Sarracenia leucophylla* (crimson pitcherplant), *Sarracenia psittacina* (parrot pitcherplant), *Sarracenia flava* (yellow pitcherplant), *Sarracenia purpurea* (purple pitcherplant), and *Sarracenia rubra* (sweet pitcherplant). Woody species are *Magnolia virginiana* (sweetbay), *Smilax laurifolia* (laurel greenbrier), *Morella cerifera* (wax myrtle), *Morella caroliniensis* (southern bayberry), *Morella inodora* (scentless bayberry), *Cliftonia monophylla* (buckwheat tree), *Cyrilla racemiflora* (swamp titi), *Clethra alnifolia* (coastal sweetpepperbush), *Arundinaria gigantea* ssp. *tracta* (switchcane), and *Toxicodendron vernix* (poison sumac).

Related Concepts:

- *Drosera* Sandy/Loamy Wet Herbaceous Seeps (Turner et al. 1999) I
- Eastern Hillside Seepage Bog (Smith 1996a) ?
- Hillside Herb Bog (Nelson 1986) I
- Quaking Bog (Wieland 1994b) ?
- Sandhill Seep (Schafale and Weakley 1990) I
- Seepage Slope (FNAI 1992a) I
- Sphagnum-Beakrush Series (Diamond 1993) I
- Western Hillside Seepage Bog (Smith 1996a) ?
- Wet Prairie (FNAI 1992a) I
- Wet Prairie, Pitcher Plant Prairie subtype (FNAI 1992b) I
- Wet Prairie, Wiregrass Prairie subtype (FNAI 1992b) ?

Alliance Description

Environment: Soils can be peats or wet mineral soils, though generally this alliance occurs in sites wet enough to result in some organic accumulation. In Florida, wetland savanna soils are

poorly drained Ultisols with argillic horizons, or Aquults. A seasonally high water table is perched near the soil surface during periods of heavy rainfall due to the presence of this argillic horizon which is slowly permeable to downward percolating water. A combination of high clay content and standing water contributes to sparse overstories.

Vegetation: All but the wettest associations are dominated or codominated by *Ctenium aromaticum* (toothache grass), *Rhynchospora* (beaksedge) spp., and *Aristida beyrichiana* (Beyrich threeawn) (from southeastern Mississippi eastwards). *Rhynchospora* (beaksedge) spp. are prominent and diverse in all associations of this alliance, with *Rhynchospora oligantha* (featherbristle beaksedge) and *Rhynchospora stenophylla* (coastalplain beaksedge) being character species; many associations may have as many as ten *Rhynchospora* (beaksedge) spp. The genus *Sarracenia* (pitcherplant) is generally present, ranging from dominant or codominant to sparse, and from a single species to several. Species include *Sarracenia alata* (yellow trumpets), *Sarracenia leucophylla* (crimson pitcherplant), *Sarracenia psittacina* (parrot pitcherplant), *Sarracenia flava* (yellow pitcherplant), *Sarracenia purpurea* (purple pitcherplant), and *Sarracenia rubra* (sweet pitcherplant). Other characteristic species that are widespread in the alliance include *Aristida palustris* (longleaf threeawn), *Aristida stricta* (pineland threeawn) (Atlantic Coastal Plain only), *Carphephorus pseudoliatris* (bristleleaf chaffhead) (East Gulf Coastal Plain only), *Chaptalia tomentosa* (woolly sunbonnets), *Coreopsis linifolia* (Texas tickseed), *Helianthus heterophyllus* (variableleaf sunflower), *Lilium catesbaei* (pine lily), *Lophiola aurea* (goldencrest) (East Gulf Coastal Plain only), *Lycopodiella alopecuroides* (foxtail clubmoss), *Lycopodiella prostrata* (featherstem clubmoss), *Macranthera flammea* (flameflower) (East Gulf Coastal Plain only), *Muhlenbergia expansa* (cutover muhly), *Pinguicula* (butterwort) spp., *Polygala* (milkwort) spp., *Pteridium aquilinum* var. *pseudocaudatum* (western brackenfern), *Rhynchospora macra* (large beaksedge), *Scleria baldwinii* (Baldwin's nutrush), *Scleria muehlenbergii* (Muehlenberg's nutrush), *Sphagnum* (sphagnum) spp., *Triantha racemosa* (coastal false asphodel), *Utricularia subulata* (zigzag bladderwort), *Xyris baldwiniana* (Baldwin's yelloweyed grass), *Xyris* (yelloweyed grass) spp., and *Zigadenus* (deathcamas) spp. Scattered *Pinus elliottii* var. *elliottii* (Honduras pine) may occur and in some cases have been augmented in abundance by planting across the bog. Other typical woody species, occurring in scattered clumps and patches, are *Magnolia virginiana* (sweetbay), *Smilax laurifolia* (laurel greenbrier), *Morella cerifera* (wax myrtle), *Morella caroliniensis* (southern bayberry), *Morella inodora* (scentless bayberry), *Cliftonia monophylla* (buckwheat tree), *Cyrilla racemiflora* (swamp titi), *Clethra alnifolia* (coastal sweetpepperbush), *Arundinaria gigantea* ssp. *tecta* (switchcane), and *Toxicodendron vernix* (poison sumac). In some parts of the distribution of this alliance, especially the Atlantic Coastal Plain, shrubs can be very prominent, even when fire is relatively frequent.

Alliance Distribution

Range: This alliance is found in the southeastern Coastal Plain from North Carolina to Texas.

Nations: US

Subnations: AL, FL, LA, MS, NC, SC, TX

TNC Ecoregions: 32:C, 40:C, 41:C, 43:C, 53:C, 55:P, 56:P, 57:C

USFS Ecoregions: 231Bc:CCC, 231Ea:CCC, 231Ef:CC?, 231Eh:CC?, 231Ei:CC?, 231Fa:C??, 231Fb:C??, 232Ba:CCC, 232Be:CCP, 232Bg:CCC, 232Bh:CCC, 232Bi:CCP, 232Bj:CCC, 232Bk:CCP, 232Bl:CC?, 232Bm:CC?, 232Bn:CC?, 232Bo:CCP, 232Bp:CCP, 232Bq:CCC, 232Cc:CP?, 232Cf:CP?, 232Dc:CCC, 232Ea:C??, 232Eb:C??, 232Fa:CCC, 232Fb:CCC, 232Fe:CCP, 234Ad:???, 255Ca:CCC

Federal Lands: DOD (Eglin, Fort Bragg); NPS (Big Thicket?, Moores Creek); USFS (Angelina, Apalachicola, Conecuh, De Soto, Kisatchie, Sabine, Talladega); USFWS (Grand Bay, Mississippi Sandhill Crane)

(CEGL004468) Dangleberry - Coastal Sweet-pepperbush - Switch Cane / Carolina Wiregrass - Southern Bracken Herbaceous Vegetation

***Gaylussacia frondosa* - *Clethra alnifolia* - *Arundinaria gigantea* ssp. *tecta* / *Aristida stricta* - *Pteridium aquilinum* var. *pseudocaudatum* Herbaceous Vegetation**

Typic Sandhill Hillside Seep

NVC Classification

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Saturated temperate or subpolar grassland (V.A.5.N.m.)
Alliance	<i>Rhynchospora oligantha</i> - <i>Sarracenia</i> spp. - (<i>Aristida beyrichiana</i> , <i>Ctenium aromaticum</i>) - <i>Osmunda cinnamomea</i> / <i>Sphagnum</i> spp. Saturated

Herbaceous Alliance (A.1463)

Alliance (English name)	Feather-bristle Beaksedge - Pitcherplant species - (Southern Wiregrass, Toothache Grass) - Cinnamon Fern / Peatmoss species Saturated Herbaceous Alliance
Association	<i>Gaylussacia frondosa</i> - <i>Clethra alnifolia</i> - <i>Arundinaria gigantea</i> ssp. <i>tecta</i> / <i>Aristida stricta</i> - <i>Pteridium aquilinum</i> var. <i>pseudocaudatum</i> Herbaceous

Vegetation

Association (English name)	Dangleberry - Coastal Sweet-pepperbush - Switch Cane / Carolina Wiregrass - Southern Bracken Herbaceous Vegetation
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Association (Common name) Typic Sandhill Hillside Seep

Ecological System(s): Atlantic Coastal Plain Sandhill Seep (CES203.253)

After the field reconnaissance and field verification steps of the photo-interpretation, the SECN found it necessary to alter the natural/semi-natural associations in the NVCS identified by NatureServe. In this classification, the Typic Sandhill Hillside Seep (CEGL004468) association was changed to the Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type) (CEGL003660) association.

The center of MOCR is dominated by a distinctive wet savanna. Upon completion of NatureServe's sampling in 2005, they classified this region as a Typic Sandhill Hillside Seep (CEGL004468). Based on species composition, differences in Ecological Systems, and management practices, however, we determined that the most appropriate association for this community is the Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type; CEGL003660).

Species Composition

Because this area has been subject to restoration activities, including numerous plantings and hydrologic alterations, the species composition is variable and complicates the classification of this area into a single natural vegetation association in the NVCS. The classification chosen for this community, consequently, is the current best representation.

The species composition in this area is best described by the Longleaf Pine/Pond Pine Savanna association. The shrub layer is generally absent, with few occurrences of *Morella cerifera* and *Ilex glabra*, and does not include some of the most characteristic species of CEGL004468,

including *Gaylussacia frondosa*, *Clethra alnifolia*, *Arundinaria gigantea*, or *Pteridium aquilinum*. The site does include several characteristic species of CEG003660, including *Ctenium aromaticum*, *Solidago stricta*, and several *Rhynchospora* spp. and *Panicum* spp. The site also includes other less common species exclusive to CEG003660 in comparison to CEG004468, including *Liquidambar styraciflua*, *Saccharum giganteum*, *Hyptis alata*, *Lobelia* spp., *Ludwigia* spp., and *Rhexia mariana*.

Differences in Ecological Systems

The Typic Sandhill Hillside Seep association assigned by NatureServe is classified within the Atlantic Coastal Plain Sandhill Seep Ecological System (CES203.253). The Atlantic Coastal Plain Sandhill Seep Ecological System is found primarily in the Fall-line Sandhills region (although may rarely occur in the Outer Coastal Plain) from east-central North Carolina to central Georgia, typically on slopes where a clay lens or other impermeable layer forces groundwater to the surface as a seepage. The Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type; CEG003660) association is classified within the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System (CES203.265). The Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System ranges from southern Virginia to southern South Carolina, and associations within this system share the common features of wet, seasonally saturated, mineral soils on a wide array of soil textures. This system is found primarily in the Outer Coastal Plain but small patches may occur in atypical landforms in the Fall-line Sandhills. While the Atlantic Coastal Plain Sandhill Seep and the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods are considered similar Ecological Systems (NatureServe 2009), we consider the Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods Ecological System to be a better representation of the vegetation community in question in MOCR because it is located on a relatively flat site within the Outer Coastal Plain region not immediately adjacent to any sandhill communities.

Management Practices

The wetland savanna in question has recently undergone an unfunded, independent restoration effort with the goal being to restore the vegetation and hydrology of the area to what it was around the time of the Battle at Moores Creek (1776). At the time of the battle this area was likely part of a pine-mixed hardwood bottomland forest system that was subject to periodic flooding from the nearby creek during high water flood events. The loam- sandy-loam soils in conjunction with periodic flooding allowed for a high diversity of plant-life to flourish in this region. All indications from battle accounts and other historical records indicate that this was an open savanna with scattered trees, maintained by periodic wildfire and area usage, and was the established community pattern in this area even before the battle took place (McCrain et al. 1985). The savanna area is currently dominated by herbaceous species with a few scattered pines and hardwoods. A low, bog-like community along the northern edge of the savanna supports a variety of insectivorous plants such as *Sarracenia* spp. and *Drosera* spp. As previously mentioned, the savanna received over 25,000 plantings of bunchgrasses (e.g., *Aristida stricta* [wiregrass] and *Ctenium aromaticum* [toothache grass]) between 2003 and 2005. Additionally, *Pinus palustris* (longleaf pine) has been planted in scattered areas throughout the savanna. With the assistance of current management practices this area is transitioning back to what it was historically, which we determined to be best represented by the Longleaf Pine / Pond Pine Savanna (Wet Ultisol Type) association.

Woodland (II.)

Saturated temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.f.)

***Pinus taeda* / *Pinus (elliottii, serotina)* Saturated Woodland Alliance (A.578)**
(CEGL003660) Longleaf Pine – Pond pine / Toothache Grass – Savanna Hairgrass – Sand-swamp Whitetop Woodland

Alliance Concept

Summary: This alliance consists of wet pinelands (often termed pine flatwoods, wet pine flatwoods, and pine savannas) of the Outer Coastal Plain or "coastal flatlands" typically dominated by *Pinus palustris*, with or without the presence of the other nominals. *Pinus elliottii* var. *elliottii* and *Pinus serotina* are more restricted geographically and edaphically than is *Pinus palustris*. *Pinus serotina* may be present within its natural range (from southeastern Virginia south to panhandle Florida) but tends to be codominant only on the wettest, often organic soils. *Pinus elliottii* var. *elliottii* may be present or codominant within its natural range from South Carolina to eastern Louisiana, as well as in limited areas of the West Gulf Coastal Plain (which are outside the natural range of *Pinus elliottii* var. *elliottii*). Both *Pinus elliottii* and *Pinus serotina* may replace *Pinus palustris* on wetter sites. Both species are less tolerant of frequent fire than is *Pinus palustris*. While *Pinus elliottii* can survive reasonably frequent fire, it has been estimated that natural fire frequencies are less than half that of longleaf pine, while typical regimes for *Pinus serotina* may be less than one-third as frequent. Thus, it is often believed that these species were confined historically to wetter flatwoods sites with lower burn frequencies than those typical of *Pinus palustris*-dominated communities. With fire suppression, alteration of fire regimes, and widespread logging of *Pinus palustris*, *Pinus elliottii* has invaded many flatwoods sites historically dominated almost exclusively by *Pinus palustris*. To a lesser extent this phenomenon may also have occurred with *Pinus serotina*. As presently defined, this alliance includes both naturally mixed *Pinus palustris* - *Pinus elliottii* stands, as well as those originally dominated by *Pinus palustris* into which *Pinus elliottii* has invaded, as well as silviculturally managed stands outside of the natural range of *Pinus elliottii* var. *elliottii* in Louisiana and Texas. Across the range of this alliance, pine densities vary from low with widely spaced trees giving an open savanna-like aspect, to high with dense, nearly closed canopies. Nevertheless, even the densest stands have discontinuous canopies which allow considerable light to penetrate to the forest floor. Probably the most significant factor affecting community composition is fire. In fire-suppressed examples, an understory of *Acer rubrum*, *Liquidambar styraciflua*, and *Morella cerifera* (= *Myrica cerifera*) is likely to develop. Understory composition is variable, and includes both shrub- and shrub/graminoid-dominated systems. Heavily shrubby examples may be indicative of lower fire frequencies than are more herbaceous-dominated examples. Appreciable herb layers typically exist only where the canopy and shrub layers are relatively open, and where there has been relatively frequent fire history. Grasses usually make up the majority of total cover. This alliance also includes silviculturally managed stands from the West Gulf Coastal Plain of Louisiana and Texas.

Classification Comments: More information needs to be integrated on the expression of vegetation of this alliance in Texas (e.g., in the Big Thicket); existing associations as of November 2000 may not be entirely adequate, although one is positively attributed to Texas (MP 2000-12-04). REE 2000-12-01: "the so called wet savannas or flatwoods which may or may not have pitcher plants present are crudely covered by associations. These are the ones which

basically come from LA and haven't been worked up enough to specifically incorporate examples in TX . The types from the WGCP were all defined by Latimore Smith from LA examples; their occurrence and distribution are poorly understood west of the Sabine River." There are some stands at Fort Benning, Georgia, which contain *Pinus serotina* with *Pinus palustris* over either *Arundinaria gigantea* or a mix of other evergreen shrubs. This is near the northern limit of the distribution of *Pinus serotina*, and these stands have been placed either as *Arundinaria gigantea* Saturated Shrubland Alliance (A.801) or *Lyonia lucida* - *Ilex glabra* Saturated Wooded Shrubland Alliance (A.805) with scattered, stunted *Pinus serotina*.

Similar Alliances:

- *Pinus palustris* (A.123)
- *Pinus elliotii* Saturated Temperate Woodland Alliance (A.574)
- *Pinus serotina* Saturated Woodland Alliance (A.581)

Similar Alliance Comments: Defining the differences between this alliance and the *Pinus elliotii* Saturated Temperate Woodland Alliance (A.574) will require additional work. Silviculturally managed *Pinus palustris* - *Pinus elliotii* forests, including those outside of the natural range of *Pinus elliotii*, are treated in the *Pinus palustris* - (*Pinus elliotii*) Forest Alliance (A.123).

Related Concepts:

- IIB1b. Wet Longleaf Pine Flatwoods Atlantic (Allard, D.J. 1990)
- IIB1c. Wet Longleaf Pine - Slash Pine Flatwoods (Allard, D.J. 1990)
- IIB1d. Atlantic Coastal Plain Wet Longleaf Pine Savanna (Allard, D.J. 1990)
- IIB1g. Atlantic Coastal Plain Wet-Mesic Longleaf Pine Savanna (Allard, D.J. 1990)
- IIB1h. East Gulf Coastal Plain Wet Longleaf Pine Savanna (Allard, D.J. 1990)
- IIB1i. West Gulf Coastal Plain Wet Longleaf Pine Savanna (Allard, D.J. 1990)
- Longleaf Pine - Slash Pine: 83 (Eyre, F.H. 1980)
- Longleaf Pine / *Schizachyrium* - *Drosera* Fine-Sandy Wet Flatwoods (Turner et al. 1999)
- Longleaf Pine-Beakrush Series (Diamond, D.D. 1993)
- Longleaf Pine: 70 (Eyre, F.H. 1980)
- Mesic Flatwoods (FNAI, 1992a)
- Piedmont Longleaf Pine Forest, Wet Variant (Schafale, M.P. 1994)
- Pine Savanna (Schafale, M.P. and A.S. Weakley 1990)
- Pine Savanna, Lumbee Variant (Schafale, M.P. 1994)
- Pine Savanna, Very Wet Clay Variant (Schafale, M.P. 1994)
- Pine Savanna, Wet Spodosol Variant (Schafale, M.P. 1994)
- Pond Pine: 98 (Eyre, F.H. 1980)
- Western Wet/Mesic Longleaf Pine Savannah/Flatwoods (Smith, L.M. compiler. 1996a)
- Western Wet/Mesic Longleaf Pine Savannah/Flatwoods, saline variant (Smith, L.M. compiler. 1996a)
- Wet Pine Flatwoods (Schafale, M.P. and A.S. Weakley 1990)
- Wet Pine Flatwoods, Leiophyllum Variant (Schafale, M.P. 1994)
- Wet Pine Flatwoods, Wet Spodosol Variant (Schafale, M.P. 1994)
- Wet Slash Pine Savannah (Wieland, R.B. 1994b)

Alliance Description

Environment: Stands of this alliance consist of wet pinelands (often termed "pine flatwoods," "wet pine flatwoods," and "pine savannas") of the Outer Coastal Plain or "coastal flatlands." Many soils contain a spodic horizon occasionally underlain by a clay hardpan, which additionally restricts drainage. Soils include Alfisols, Spodosols, and Ultisols. Sites vary in the presence or absence of a hardpan, in soil pH (range from 3.1-7.8), and in drainage. *Pinus serotina* may be present within its natural range (from southeastern Virginia south to panhandle Florida) but tends to be codominant only on the wettest, often organic soils.

Vegetation: This alliance consists of wet pinelands typically dominated by *Pinus palustris*, with a geographically and edaphically determined admixture of *Pinus elliottii* var. *elliottii* and *Pinus serotina* with or without another pine. *Pinus serotina* may be present or codominant from southeastern Virginia south to panhandle Florida. *Pinus elliottii* var. *elliottii* may be present or codominant from South Carolina south to Florida, and west to eastern Louisiana. *Pinus elliottii* is less tolerant of fire than *Pinus palustris* and may originally have been confined to wet flatwoods sites with lower burn frequencies than those typical of *Pinus palustris*-dominated communities. With fire suppression and widespread logging of *Pinus palustris*, *Pinus elliottii* has probably invaded flatwoods sites historically dominated by *Pinus palustris*. In addition, in parts of the range, *Pinus taeda* may also be present, and may represent a substantial component of the stand. This species is presumed to be a natural component of this vegetation type (Glitzenstein and Streng 2004). As presently defined, this alliance includes both naturally mixed *Pinus palustris* - *Pinus elliottii* stands, as well as those originally dominated by *Pinus palustris* into which *Pinus elliottii* has invaded. Pine densities vary from low with widely spaced trees giving an open savanna-like aspect, to high with dense, nearly closed canopies. Nevertheless, even the densest stands have discontinuous canopies which allow considerable light to penetrate to the forest floor. Probably the most significant factor affecting community composition is fire. In areas protected from fire, an understory of *Acer rubrum*, *Liquidambar styraciflua*, and *Morella cerifera* (= *Myrica cerifera*) is likely to develop. Understory composition is variable, and includes both shrub- and shrub/graminoid-dominated systems. Typical shrubs may include *Gaylussacia* spp., *Ilex coriacea*, *Ilex glabra*, *Ilex vomitoria*, *Morella cerifera*, *Osmanthus americanus* var. *americanus*, *Serenoa repens*, *Symplocos tinctoria*, and *Vaccinium* spp. Appreciable herb layers typically exist only where the canopy and shrub layers are relatively open. Grasses usually make up the majority of total cover. Graminoids typical in various associations of this alliance include *Aristida beyrichiana*, *Aristida palustris*, *Aristida stricta*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Sporobolus curtissii*, *Sporobolus floridanus*, *Sporobolus pinetorum*, *Sporobolus silveanus*, *Sporobolus teretifolius*, *Andropogon capillipes*, *Andropogon glaucopsis*, *Andropogon glomeratus*, *Rhynchospora* spp., *Dichanthelium* spp., *Fimbristylis puberula*, *Gymnopogon chapmanianus*, *Panicum* spp., *Schizachyrium* spp., *Scleria* spp., and *Sorghastrum* spp. Forbs typical of this alliance include *Carphephorus odoratissimus*, *Chaptalia tomentosa*, *Eupatorium* spp., *Helianthus* spp., *Lachnanthes carolina*, *Lachnocaulon* spp., *Liatris* spp., *Lobelia* spp., *Pinguicula* spp., *Pityopsis* spp., *Polygala* spp., *Sabatia* spp., and *Solidago* spp.

Dynamics: Both *Pinus elliottii* and *Pinus serotina* are less tolerant of frequent fire than is *Pinus palustris*. While *Pinus elliottii* can survive reasonably frequent fire, it has been estimated that natural fire frequencies are less than half that of longleaf pine, while typical regimes for *Pinus*

serotina may be less than one-third as frequent (Landers 1989). Thus, it is often believed that these species were confined historically to wetter flatwoods sites with lower burn frequencies than those typical of *Pinus palustris*-dominated communities. With fire suppression, alteration of fire regimes, and widespread logging of *Pinus palustris*, *Pinus elliottii* has invaded many flatwoods sites historically dominated almost exclusively by *Pinus palustris*. To a lesser extent this phenomenon may also have occurred with *Pinus serotina*. Across the range of this alliance, pine densities vary from low with widely spaced trees giving an open savanna-like aspect, to high with dense, nearly closed canopies. Nevertheless, even the densest stands have discontinuous canopies which allow considerable light to penetrate to the forest floor. Probably the most significant factor affecting community composition is fire.

Alliance Distribution

Range: This alliance is found in the southeastern U.S. from Virginia to Florida and west to Texas.

Nations: US

Subnations: AL, FL, GA, LA, MS, NC, SC, TX, VA

(CEGL003660) Longleaf Pine – Pond Pine / Toothache Grass – Savanna Hairgrass – Sand-swamp Whitetop Woodland

Pinus palustris – *Pinus serotina* / *Ctenium aromaticum* – *Muhlenbergia expansa* – *Rhynchospora latifolia* Woodland

NVC Classification

Physiognomic Class	Woodland (II)
Physiognomic Subclass	Evergreen woodland (II.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen woodland (I.A.4.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (II.A.4.N.)
Formation	Saturated temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.f.)
Alliance	<i>Pinus palustris</i> – <i>Pinus (elliottii, serotina)</i> Saturated Woodland Alliance (A.578)
Alliance (English name)	Longleaf Pine – (Slash Pine, Pond Pine) Saturated Forest Alliance
Association	<i>Pinus palustris</i> – <i>Pinus serotina</i> / <i>Ctenium aromaticum</i> – <i>Muhlenbergia expansa</i> – <i>Rhynchospora latifolia</i> Woodland
Association (English name)	Longleaf Pine – Pond Pine / Toothache Grass – Savanna Hairgrass – Sand-swamp Whitetop Woodland
Association (Common name)	Longleaf Pine / Pond Pine Savanna (Wet Ultisol Type)
Ecological System(s):	Central Atlantic Coastal Plain Longleaf Pine Savanna and Flatwoods (CES203.247)

Element Concept

Global Summary: This association is a saturated longleaf pine - pond pine woodland which is found on wet Ultisols of the Atlantic Coastal Plain. The open canopy is dominated by a mixture of *Pinus palustris* and *Pinus serotina*. The shrub layer is sparse to absent. Some characteristic components of the herbaceous stratum include *Ctenium aromaticum*, *Muhlenbergia expansa*, and *Rhynchospora latifolia*.

Environmental Description

USFWS Wetland System: Palustrine

Global Environment: This saturated longleaf pine - pond pine woodland association is restricted to wet Ultisols of the Atlantic Coastal Plain from North Carolina to Florida. This association is found on very silty soils (R. Peet pers. comm. 2009). Examples are found in the Green Swamp TNC Preserve, North Carolina.

Vegetation Description

Global Vegetation: The open canopy of this association is dominated by a mixture of *Pinus palustris* and *Pinus serotina*. The shrub layer is sparse to absent. Some characteristic components of the herbaceous stratum include *Ctenium aromaticum*, *Muhlenbergia expansa*, *Rhexia alifanus*, *Sarracenia flava*, and *Rhynchospora latifolia*.

Conservation Status Rank

Global Status: G1 (10Oct1997)

Rounded Global Status: G1 - Critically Imperiled

Reasons: This saturated longleaf pine - pond pine woodland association is naturally rare, restricted both in range and in the substrate on which it occurs. It is only found in the Atlantic Coastal Plain from North Carolina to Florida, on wet Ultisols. It is part of the endangered Longleaf Pine Ecosystem, which once dominated the Coastal Plain landscape of the southeastern United States, and depends on frequent, low-intensity, growing-season fires to control understory vegetation and for the reproduction of *Pinus palustris* and *Pinus serotina*. Saturated pine woodlands are susceptible to the effects of fire suppression, over-grazing, hydrologic alteration, or conversion to commercial forest plantations or agriculture. Remaining examples are highly threatened by development, conversion, and alteration of fire regimes. Most of those occurrences which have not been destroyed are severely degraded.

Status: Standard

Classification Confidence: 1 - Strong

Global Similar Associations:

- *Pinus palustris* – *Pinus serotina* / *Ctenium aromaticum* – *Muhlenbergia expansa* – *Carphephorus odoratissimus* Woodland (CEGL003658)
- *Pinus palustris* / *Schizachyrium scoparium* - *Muhlenbergia expansa* - *Arnoglossum ovatum* Woodland (CEGL004086)
- *Pinus palustris* - *Pinus serotina* / *Ctenium aromaticum* - *Scleria pauciflora* - *Sarracenia flava* Woodland (CEGL004499)
- *Pinus palustris* - *Pinus serotina* / *Sporobolus pinetorum* - (*Aristida stricta*) - *Eryngium integrifolium* Woodland (CEGL004501)

Global Related Concepts:

- Atlantic Coastal Plain Wet Longleaf Pine Savanna (Allard, D.J. 1990)
- Pine Savanna (Schafale, M.P. and A.S. Weakley. 1990)
- Pine Savanna, Wet Ultisol Variant (Schafale, M.P. 1994)
- Wet Loamy Pine Savanna (Schafale, M.P. 2000)

Element Distribution

Global Range: This saturated longleaf pine - pond pine woodland association is found only in the Atlantic Coastal Plain from North Carolina to Florida. It ranges from Camp Lejeune south into South Carolina, to the Francis Marion National Forest.

Nations: US

States/Provinces: GA, NC, SC

Element Sources

Concept Author(s): M.P. Schafale and A.S. Weakley, mod. R.K. Peet and A.S. Weakley

Element Description Edition Date: 22Oct2009

Global Description Author(s): M.P. Schafale and A.S. Weakley, mod. R.K. Peet and A.S. Weakley

NatureServe Conservation Status Factors Edition Date: 10Oct1997

NatureServe Conservation Status Factors Author(s): Southeastern Ecology Group

References: Allard, D.J. 1990, Peet, Dr. Robert, person. Comm., Schafale, M.P. 2000, Schafale, M.P. 1994, Schafale, M.P. and A.S. Weakley. 1990. Southeastern Ecology Working Group of NatureServe. No date., Taggart, J.B. 1990.

Bibliography

- ALNHP [Alabama Natural Heritage Program]. 2002. Eufaula National Wildlife Refuge: Natural community and rare plant survey. Alabama Natural Heritage Program, The Nature Conservancy, Montgomery.
- Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.
- Allen, W. H. 1993a. The rise of the botanical database. *BioScience* 43:274-280.
- Beckett, S., and M. S. Golden. 1982. Forest vegetation and vascular flora of Reed Brake Research Natural Area, Alabama. *Castanea* 48:368-392.
- Breden, T. F., Y. R. Alger, K. S. Walz, and A. G. Windisch. 2001. Classification of vegetation communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry, New Jersey Department of Environmental Protection, Trenton.
- Bridges, E. L., and S. L. Orzell. 1989a. Longleaf pine communities of the West Gulf Coastal Plain. *Natural Areas Journal* 9:246-263.
- Burns, R. M., and B. H. Honkala, technical coordinators. 1990a. *Silvics of North America: Volume 1. Conifers*. USDA Forest Service. Agriculture Handbook 654. Washington, DC. 675 pp.
- Burns, R. M., and B. H. Honkala, technical coordinators. 1990b. *Silvics of North America. Volume 2: Hardwoods*. Agriculture Handbook 654. USDA Forest Service, Washington, DC. 877 pp.
- Cain, M. D., and M. G. Shelton. 1994. Indigenous vegetation in a southern Arkansas pine-hardwood forest after a half century without catastrophic disturbances. *Natural Areas Journal* 14:165-174.
- Clewell, A. F. 1971. The vegetation of the Apalachicola National Forest: An ecological perspective. Unpublished document. USDA Forest Service, Tallahassee, FL. 152 pp.
- Clewell, A. F., and D. B. Ward. 1987. White cedar in Florida and along the northern Gulf Coast. Pages 69-81 in: A. D. Laderman, editor. *Atlantic white cedar wetlands*. Westview Press, Boulder, CO. 401 pp.
- Collins, B. R., and K. H. Anderson. 1994. *Plant communities of New Jersey*. Rutgers University Press, New Brunswick, NJ. 287 pp.

- Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.
- Conner, W. H., J. G. Gosselink, and R. T. Parrondo. 1981. Comparison of the vegetation of three Louisiana swamp sites with different flooding regimes. *American Journal of Botany* 68:320-331.
- Conner, W. H., and J. W. Day, Jr. 1976. Productivity and composition of a baldcypress-water tupelo site and a bottomland hardwood site in a Louisiana swamp. *American Journal of Botany* 63:1354-1364.
- Coxe, R. 2007. Guide to Delaware vegetation communities. Unpublished document. Delaware Natural Heritage Program, Smyrna.
- Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin. 25 pp.
- Doyle, K. M., and D. J. Allard. 1990. Applying an ecosystem classification on national forest land in the southeastern United States: A pilot study. 108 pp. plus appendices.
- Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boston, MA.
- Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero, editors. 2002. Ecological communities of New York state. Second edition. A revised and expanded edition of Carol Reschke's ecological communities of New York state. (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.
- Eidson, Jim. Personal communication. The Nature Conservancy, Texas Program Office, San Antonio.
- Enser, R. 1999. Natural communities of Rhode Island. Unpublished draft, December 1999. 22 pp.
- Evans, M. 1991. Kentucky ecological communities. Draft report to the Kentucky Nature Preserves Commission. 19 pp.
- Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.
- FNAI [Florida Natural Areas Inventory]. 1992a. Natural communities. Unpublished document. The Nature Conservancy, Florida Natural Areas Inventory, Tallahassee. 6 pp.

- FNAI [Florida Natural Areas Inventory]. 1992b. Natural community classification. Unpublished document. The Nature Conservancy, Florida Natural Areas Inventory, Tallahassee. 16 pp.
- Farnum, P., R. Timmis, and J. L. Kulp. 1983. Biotechnology of forest yield. *Science* 219:694-702.
- Felix, A. C., III, T. L. Sharik, B. S. McGinnes, and W. C. Johnson. 1983. Succession in loblolly pine plantations converted from second growth forest in the central Piedmont of Virginia. *The American Midland Naturalist* 110:365-380.
- Fleming, G. P. 1998. Virginia natural community framework, version January 30, 1998. Unpublished document. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 6 pp.
- Folkerts, G. W. 1982. The Gulf Coast pitcher plant bogs. *American Scientist* 70:260-267.
- Foti, T., M. Blaney, X. Li, and K. G. Smith. 1994. A classification system for the natural vegetation of Arkansas. *Proceedings of the Arkansas Academy of Science* 48:50-53.
- Foti, T., compiler. 1994b. Natural vegetation classification system of Arkansas, draft five. Unpublished document. Arkansas Natural Heritage Commission, Little Rock. 8 pp.
- Frost, C. C. 1987. Historical overview of Atlantic white cedar in the Carolinas. Pages 257-263 in: A. D. Laderman, editor. *Atlantic white cedar wetlands*. Westview Press, Boulder, CO. 401 pp.
- Frost, C. C., and L. J. Musselman. 1987. History and vegetation of the Blackwater Ecologic Preserve. *Castanea* 52:16-46.
- Gallyoun, M., G. Meyer, A. Andreu, and W. Slocumb. 1996. Mapping vegetation communities with The Nature Conservancy's vegetation classification system on five small national parks in the southeastern USA. Unpublished report. The Nature Conservancy, Southeast Regional Office, Conservation Science Department, Chapel Hill, NC.
- Gawler, S. C. 2002. Natural landscapes of Maine: A guide to vegetated natural communities and ecosystems. Maine Natural Areas Program, Department of Conservation, Augusta, ME. [in press]
- Gemborys, S. R., and E. J. Hodgkins. 1971. Forests of small stream bottoms in the coastal plain of southwestern Alabama. *Ecology* 52:70-84.
- Glascok, S., and S. Ware. 1979. Forests of small stream bottoms in the peninsula of Virginia. *Virginia Journal of Science* 30:17-21.
- Golden, M. S. 1979. Forest vegetation of the lower Alabama Piedmont. *Ecology* 60:770-782.

- Harrison, J. W., compiler. 2004. Classification of vegetation communities of Maryland: First iteration. A subset of the International Classification of Ecological Communities: Terrestrial Vegetation of the United States, NatureServe. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis. 243 pp.
- Hermann, S. M. 1991. Pitcher plant habitats of the Southeast: A community profile. Tall Timbers Research Station, Tallahassee, FL.
- 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. 43 pp.
- Hunter, M. L., Jr. 1990. Wildlife, forests, and forestry: Principles of managing forests for biological diversity. Prentice Hall Career & Technology, Englewood Cliffs, NJ. 370 pp.
- Jones, S. M., D. H. Van Lear, and S. K. Cox. 1981b. 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. 79 pp. plus 24 illustrations.
- Jones, S. M., and L. A. Churchill. 1987. The use of vegetation in assessing site potential within the upper coastal plain of South Carolina. *Castanea* 52:1-8.
- Korstian, C. F., and W. D. Brush. 1931. Southern white cedar. USDA Forest Service. Technical Bulletin 251. Washington, DC. 76 pp.
- LNHP [Louisiana Natural Heritage Program]. 1992. Survey of threatened and endangered plants and animals on U.S. Army Fort Polk Military Reservation, Louisiana. Unpublished report. Louisiana Natural Heritage Program, Baton Rouge. 32 pp.
- Laderman, A. D. 1989. The ecology of the Atlantic white cedar wetlands: A community profile. USDI Fish and Wildlife Service. Biological Report 85(7.21). 114 pp.
- Landaal, S. 1978. Plant successional trends in selected Dismal Swamp stands of *Chamaecyparis thyoides* (L.) BSP (Atlantic white cedar.) Unpublished report to USDI Fish & Wildlife Service, Great Dismal Swamp National Wildlife Refuge.
- MacRoberts, B. R., and M. H. MacRoberts. 1988. Floristic composition of two west Louisiana pitcher plant bogs. *Phytologia* 65:184-190.
- MacRoberts, B. R., and M. H. MacRoberts. 1991. Floristics of three bogs in western Louisiana. *Phytologia* 70:135-141.

- Martin, D. L., and L. M. Smith. 1991. A survey and description of the natural plant communities of the Kisatchie National Forest, Winn and Kisatchie districts. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA. 372 pp.
- Martin, D. L., and L. M. Smith. 1993. A survey and description of the natural plant communities of the Kisatchie National Forest, Evangeline and Catahoula districts. Louisiana Department of Wildlife and Fisheries, Baton Rouge. 274 pp.
- McCrain, G. R., and B. H. Church. 1985. An analysis of past and present plant community patterns in Moores Creek National Battlefield along with associated impacts affecting distribution and restoration. Prepared by Resource Management Co., Raleigh, NC, under Purchase Order Number PX-5550-3-0062 for the USDI, National Park Service, Southeast Regional Office, Atlanta, GA.
- Monk, C. D., D. W. Imm, R. L. Potter, and G. G. Parker. 1989. A classification of the deciduous forest of eastern North America. *Vegetatio* 80:167-181.
- Moore, J. H., and J. H. Carter, III. 1987. Habitats of white cedar in North Carolina. Pages 177-190 in: A. D. Laderman, editor. *Atlantic white cedar wetlands*. Westview Press, Boulder, CO.
- Moorhead, D. J., C. W. Dangerfield, Jr., and J. R. Beckwith, III. 1998. Opportunities for intensive pine plantation management. The Entomology and Forest Resources Digital Information Work Group, College of Agricultural and Environmental Sciences and Warnell School of Forest Resources, The University of Georgia, Tifton.
[<http://www.bugwood.caes.uga.edu/>]
- Motzkin, G. 1991. *Atlantic white cedar wetlands of Massachusetts*. Massachusetts Agricultural Experiment Station, University of Massachusetts. Research Bulletin 731. 53 pp.
- NatureServe Ecology - Southeastern United States. No date. Unpublished data. NatureServe, Durham, NC.
- Nelson, J. B. 1986. The natural communities of South Carolina: Initial classification and description. South Carolina Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries, Columbia, SC. 55 pp.
- Nixon, E. S., and J. A. Raines. 1976. Woody vegetation of Nacogdoches County, Texas. *Texas Journal of Science* 27:443-452.
- Oberholster, C. 1993. Preliminary list of natural communities of Alabama. Unpublished document. Alabama Department Conservation and Natural Resources, Natural Heritage Section, Montgomery, AL. 6 pp.

- Pederson, N., and R. H. Jones. 1994. Disturbance history and establishment of loblolly pine in the Congaree Swamp. Unpublished report. USDI National Park Service, Congaree Swamp National Monument. 42 pp.
- Peet, R. K., T. R. Wentworth, M. P. Schafale, and A.S. Weakley. 2002. Unpublished data of the North Carolina Vegetation Survey. University of North Carolina, Chapel Hill.
- Pyne, M. 1994. Tennessee natural communities. Unpublished document. Tennessee Department of Conservation, Ecology Service Division, Nashville. 7 pp.
- Rawinski, T. J. 1992. A classification of Virginia's indigenous biotic communities: Vegetated terrestrial, palustrine, and estuarine community classes. Unpublished document. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report No. 92-21. Richmond, VA. 25 pp.
- Schafale, M.P. 1994. Inventory of longleaf pine natural communities. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh. 230 pp.
- Schafale, M. 2000. Fourth approximation guide. Coastal Plain. January 2000 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina. Third approximation. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh. 325 pp.
- Schafale, Mike P. Personal communication. Ecologist, North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh.
- Schneider, R. L., N. E. Martin, and R. R. Sharitz. 1989. Impact of dam operations on hydrology and associated floodplain forests of southeastern rivers. Pages 1113-1122 in: R. R. Sharitz and J. W. Gibbons, editors. Freshwater wetlands and wildlife. U.S. Department of Energy. Symposium Series 61. Oak Ridge, TN.
- Schotz, Al. Personal communication. Community Ecologist. Alabama Natural Heritage Program. Huntingdon College, Massey Hall, 1500 East Fairview Avenue, Montgomery, AL 36106-2148.
- Sieren, D. J. 1984. A floristic study of the vascular plants on 11.77 acres of Moores Creek National Battlefield. Prepared under Purchase Order Number PX-5550-3-0062 for the USDI, National Park Service, Southeast Regional Office, Atlanta, GA.
- Smith, B. S., and H. Patti. 1995. A floristic study of the meadow habitat at Moores Creek National Battlefield. Prepared under Contract Number 1443PX5550-94-006 for the USDI, National Park Service, Southeast Regional Office, Atlanta, GA.

- Smith, E. B. 1994c. Keys to the flora of Arkansas. University of Arkansas Press, Fayetteville. 363 pp.
- Smith, L. M., compiler. 1996a. 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. 2 pp.
- Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC.
- Sperduto, D. A., and K. F. Crowley. 2002b. Atlantic white cedar in New England: Analysis and proposed classification. New Hampshire Natural Heritage Inventory. DRED Division of Forests & Lands and The Nature Conservancy, Concord, NH.
- Sperduto, D. D. 2000b. A classification of wetland natural communities in New Hampshire. New Hampshire Natural Heritage Inventory, Department of Resources and Economic Development, Division of Forests and Lands. Concord, NH. 156 pp.
- Sperduto, D. D., and N. Ritter. 1994. Atlantic cedar wetlands of New Hampshire. Environmental Protection Agency, Boston, MA.
- Swain, P. C., and J. B. Kearsley. 2001. Classification of natural communities of Massachusetts. September 2001 draft. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- TDNH [Tennessee Division of Natural Heritage] Unpublished data. Tennessee Division of Natural Heritage, 14th Floor, L&C Tower, 401 Church Street, Nashville, TN 37243-0447. 615-532-0431
- TNC [The Nature Conservancy]. 1998a. An investigation and assessment of the vegetation of Arnold Air Force Base. Coffee and Franklin counties, Tennessee. The Nature Conservancy, Tennessee Field Office, Nashville. 37 pp. plus appendices.
- TNC and NCNHP [The Nature Conservancy and North Carolina Natural Heritage Program]. 1993. Rare and endangered plant survey and natural area inventory for Fort Bragg and Camp MacKall military reservations, North Carolina. Unpublished report by M. J. Russo, B. A. Sorrie, B. van Eerden, and T. Hippensteel, The Nature Conservancy and North Carolina Division of Parks and Recreation, Department of Environment, Health, and Natural Resources, Raleigh, NC.
- Terwilliger, K. 1987. Breeding birds of two Atlantic white cedar (*Chamaecyparis thyoides*) stands in Great Dismal Swamp. Pages 215-230 in: A. D. Laderman, editor. Atlantic white cedar wetlands. Westview Press, Boulder, CO.

- Turner, R. L., J. E. Van Kley, L. S. Smith, and R. E. Evans. 1999. Ecological classification system for the national forests and adjacent areas of the West Gulf Coastal Plain. The Nature Conservancy, Nacogdoches, TX. 95 pp. plus appendices.
- USFS [U.S. Forest Service]. 1988. Silvicultural examination and prescription field book. USDA Forest Service, Southern Region. Atlanta, GA. 35 pp.
- Ursic, S. J. 1963. Planting loblolly pine for erosion control in north Mississippi. USDA Forest Service Research Paper SO-3. Southern Forest Experiment Station, New Orleans, LA. 21 pp.
- Wharton, C. H. 1978. The natural environments of Georgia. Georgia Department of Natural Resources, Atlanta. 227 pp.
- 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.
- Whipple, S. A., L. H. Wellman, and B. J. Good. 1981. A classification of hardwood and swamp forests on the Savannah River Plant, SC. USDE Savannah River Plant National Environmental Research Park Program. SRO-NERP-6. 36 pp.
- Whitehead, D. R. 1972. Developmental and environmental history of the Dismal Swamp. *Ecological Monographs* 42:301-315.
- Wieland, R. G. 1994b. Mississippi Natural Heritage Program: Ecological communities. Unpublished document. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson, MS. 7 pp.
- Wiseman, J. 1986. Mississippi Natural Heritage Program community classification. Second draft. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson. 11 pp.
- Woods, S. W., and J. Wagner. 2001. Hydrologic restoration of a wet pine savanna at Moores Creek National Battlefield, North Carolina. Technical Report NPS/NRWRD/NRTR-2001/293. NPS Water Resources Division, Fort Collins, CO. 49 pp.
- ter Braak, C. J. F., and N. J. M. Gremmen. 1987. Ecological amplitudes of plant species and the internal consistency of Ellenberg's indicator values for moisture. *Vegetatio* 69:79-87.

Appendix C: Field Key to Vegetation Types

Key to the National Vegetation Classification (NVCS) Associations that occur at Moores Creek National Battlefield

December 2007

NatureServe, Durham, NC

Revised by Southeast Coast Inventory and Monitoring Network February 2011

Associations which are documented from Moores Creek National Battlefield are in **bold type**. This key does not include regularly mowed areas with turf grass vegetation. For each association, the common name is given, with the Element Code in parentheses (CEGL00####) and the Alliance Code in brackets [A.###].

1. Vegetation dominated by herbaceous plants, in wet meadow restoration area west of the Visitors Center, Longleaf Pine (*Pinus palustris*) may or may not be present (tree and shrub cover is less than 25%)...

Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type) (CEGL003660) [A.578]

1. Vegetation dominated by trees; forests (tree and shrub cover is 60-100% cover) or woodlands (tree and shrub cover is 25-60%) 2

2. Forest dominated or codominated by the evergreen conifers Loblolly Pine (*Pinus taeda*) or Atlantic White-cedar (*Chamaecyparis thyoides*), canopy may or may not have broadleaf trees 3

2. Forest dominated or codominated by deciduous trees, such as Bald-cypress or Pond cypress (*Taxodium distichum* or *Taxodium ascendens*) and/or broadleaf trees 7

3. Forest dominated or codominated by Atlantic White-cedar (*Chamaecyparis thyoides*). With *Liriodendron tulipifera*, *Cyrilla racemiflora*, *Acer rubrum*, *Magnolia virginiana*, *Vaccinium corymbosum*, *Ilex coriacea*.....
.....**Fall-line Sandhills Atlantic White-cedar Streamside Forest (CEGL007563) [A.196]**

3. Forest dominated or codominated by Loblolly Pine (*Pinus taeda*) 4

4. Upland forest with canopy dominated by Loblolly Pine (*Pinus taeda*)..... 5

4. Riparian or bottomland forest, canopy codominated by Loblolly Pine (*Pinus taeda*) and usually mixed with broadleaf hardwood trees..... 6

5. Loblolly Pine (*Pinus taeda*) dominated stand (>50%), not planted or in rows, generally not even aged. May co-occur with *Liriodendron tulipifera*, *Acer rubrum*, *Liquidambar styraciflua*, *Quercus* spp., *Carya* spp., *Vaccinium stamineum*, and/or *Prunus serotina*
.....**Early- to Mid-Successional Loblolly Pine Forest (CEGL006011) [A.130]**

6. Loblolly Pine (*Pinus taeda*), not planted or in rows, with Bald-cypress or Pond cypress (*Taxodium distichum* or *Taxodium ascendens*), Swamp Blackgum (*Nyssa biflora*), and/or Sweetgum (*Liquidambar styraciflua*) and occurring in floodplain areas.....
..**Loblolly Pine - Sweetgum - Swamp Blackgum Successional Swamp Forest (CEGL004606)**

[A.433]

6. Loblolly Pine (*Pinus taeda*), not planted or in rows, with Diamondleaf Oak (*Quercus laurifolia*), Water Oak (*Quercus nigra*), and Giant Cane (*Arundinaria gigantea*) in high areas of the bottomlands by Moores Creek.....

..... **Blackwater Bottomland Hardwood - Pine Forest (High Type) (CEGL004736) [A.437]**

7. Forest dominated by Bald-cypress or Pond cypress (*Taxodium distichum* or *Taxodium ascendens*) and Swamp Blackgum (*Nyssa biflora*), and sometimes with Sweetgum (*Liquidambar styraciflua*), occurring in the floodplain

.....**Atlantic Coastal Plain Bald-cypress - Gum Swamp (CEGL004733) [337]**

7. Forest not dominated by Bald-cypress (*Taxodium distichum*) and Swamp Blackgum (*Nyssa biflora*).... **8**

8. Upland forest dominated by Water Oak (*Quercus nigra*).....

.....**Successional Water Oak Forest (CEGL004638) [A.247]**

8. Upland or wetland forest not dominated by Water Oak (*Quercus nigra*)..... **9**

9. Forest dominated by Diamondleaf Oak (*Quercus laurifolia*), Overcup Oak (*Quercus lyrata*), possibly with Bald-cypress (*Taxodium distichum*), Swamp Blackgum (*Nyssa biflora*) and/or Sweetgum (*Liquidambar styraciflua*), occurring in the floodplain or riparian bottomlands.....

.**Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest (CEGL004737) [A.292]**

9. Forest dominated by Sweetgum (*Liquidambar styraciflua*)

.....***Liquidambar styraciflua* Forest Alliance [A.234]**

Appendix D: Photo-Interpretation Guide

Photo-Interpretation Guide to the Vegetated Map Classes of Moores Creek National Battlefield

Upland Forest

Loblolly Pine Plantation

Early to Mid-Successional Loblolly Pine Forest

Successional Sweetgum Forest

Successional Water Oak Forest

Wetland Forest

Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest

Blackwater Bottomland Hardwood-Pine Forest (High Type)

Sandhills Atlantic White-cedar Streamside Forest

Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest

Atlantic Coastal Plain Bald-cypress-Blackgum Swamp

Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type)

I. Upland Forest:

MAP CLASS 1

Loblolly Pine Plantation:



Abundant species:

- *Pinus taeda*
- *Liquidambar styraciflua*
- *Morella cerifera*
- *Acer rubrum*

Map Class Statistics:

Frequency: 7

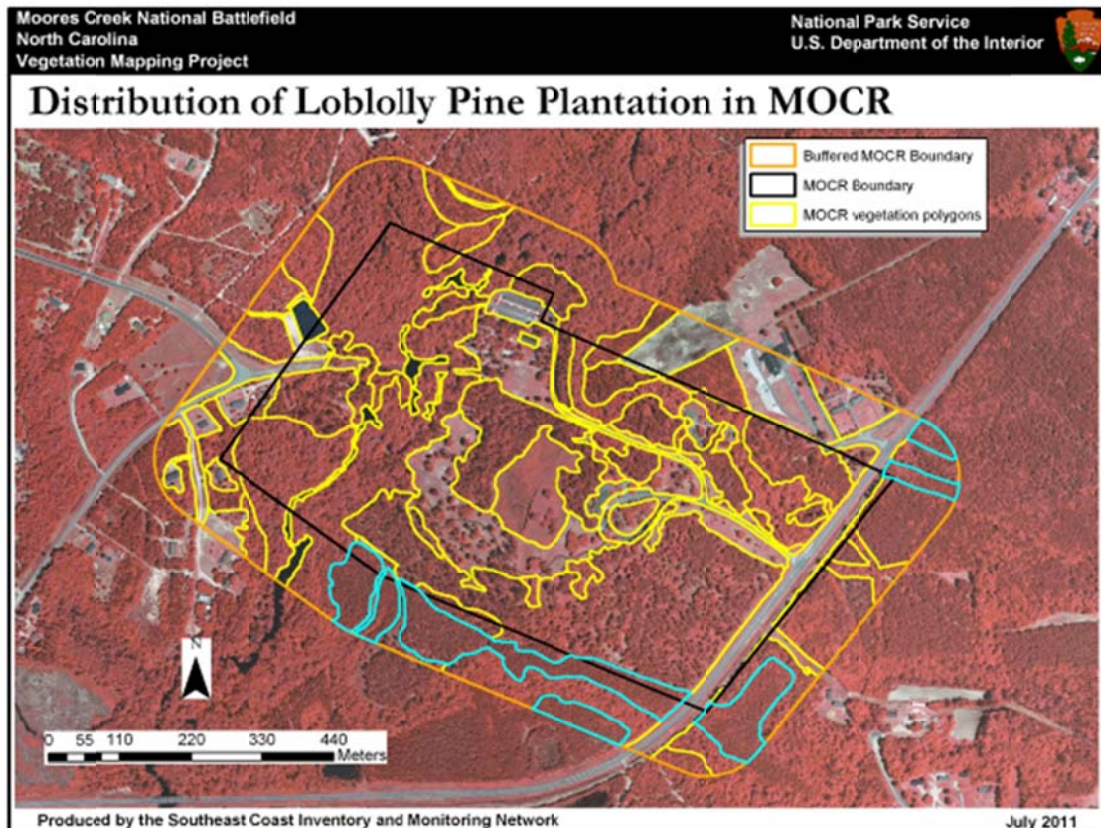
Total area: 12.8 Ac

Average polygon size: 1.8 Ac

Producer's accuracy: N/A

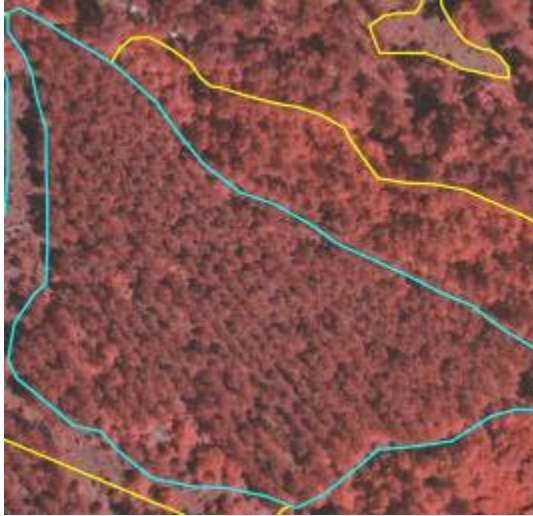
User's accuracy: N/A

Distribution in Mapping Area:



Interpretation:

Loblolly pine appears dark red to brown on the imagery, with moderate or small crown sizes, and a coarse texture. Trees are oriented in a linear, evenly spaced pattern. Historical aerial photographs were beneficial in some cases by providing evidence of an area having been previously cleared. As described in the body of this report, only loblolly stands outside of park boundaries were considered for this forest type.



Example of photo-signature for Loblolly Pine Plantation

MAP CLASS 2

Early to Mid-Successional Loblolly Pine Forest:



Abundant species:

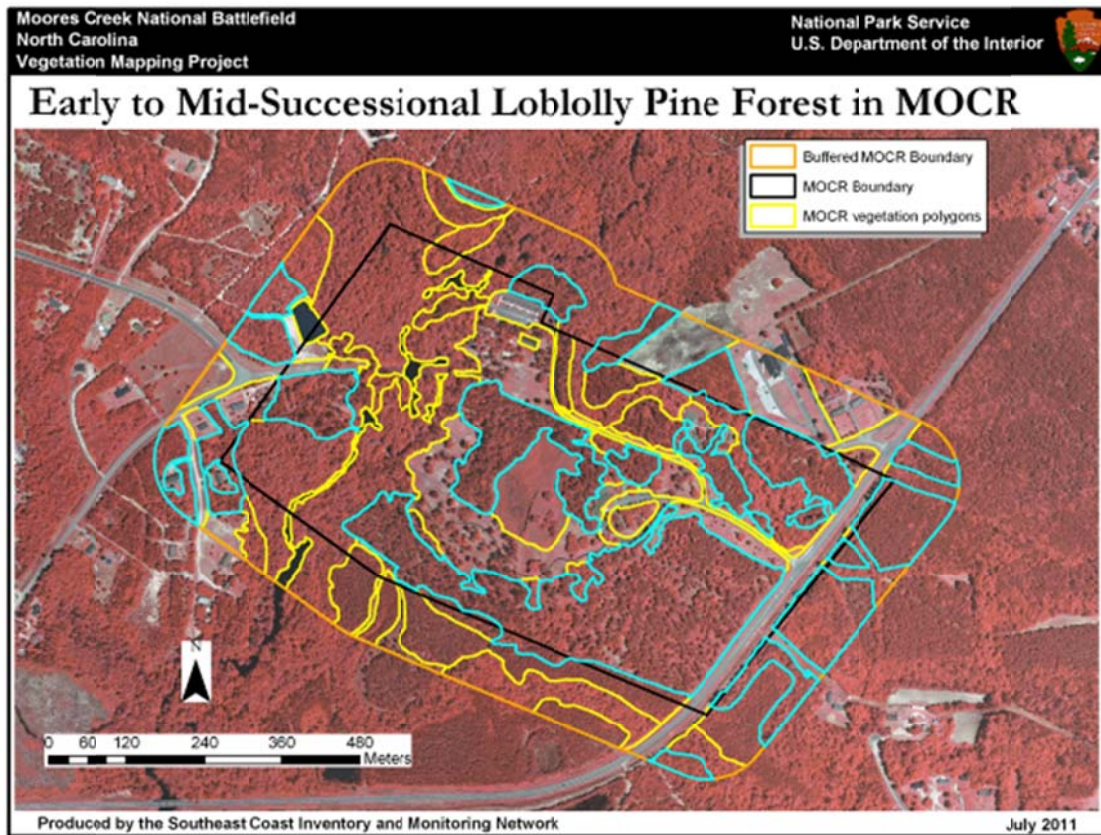
- *Pinus taeda*
- *Liquidambar styraciflua*
- *Quercus nigra*
- *Clethra alnifolia*
- *Gelsemium sempervirens*
- *Arundinaria gigantea*

Map Class Statistics:

Frequency: 22

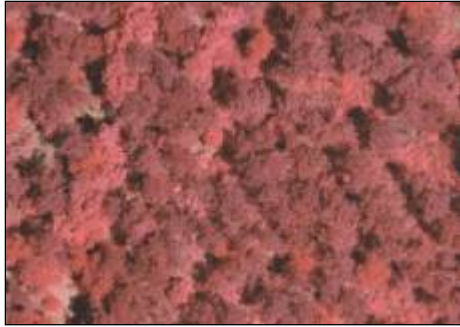
Total area: 57.6 Ac
Average polygon size: 2.6 Ac
Producer's accuracy: 100%
User's accuracy: 75%

Distribution in Mapping Area:



Interpretation:

Loblolly pine appears dark red to brown on the imagery, with moderate or small crown sizes, and a coarse texture. Sweetgum (pink, large canopy, coarse texture) and water oak (red/orange color, various sized canopies depending on size of tree) are typically visible as well as other deciduous species that appear as various shades of pink to red. The ground, when visible, appears gray.



Example of photo-signature for Early to Mid-Successional Loblolly Pine

MAP CLASS 3

Successional Sweetgum Forest:



Abundant species:

- *Liquidambar styraciflua*
- *Acer rubrum* var. *trilobum*
- *Pinus taeda*
- *Gelsemium sempervirens*
- *Smilax rotundifolia*
- *Asplenium platyneuron*

Map Class Statistics:

Frequency: 3

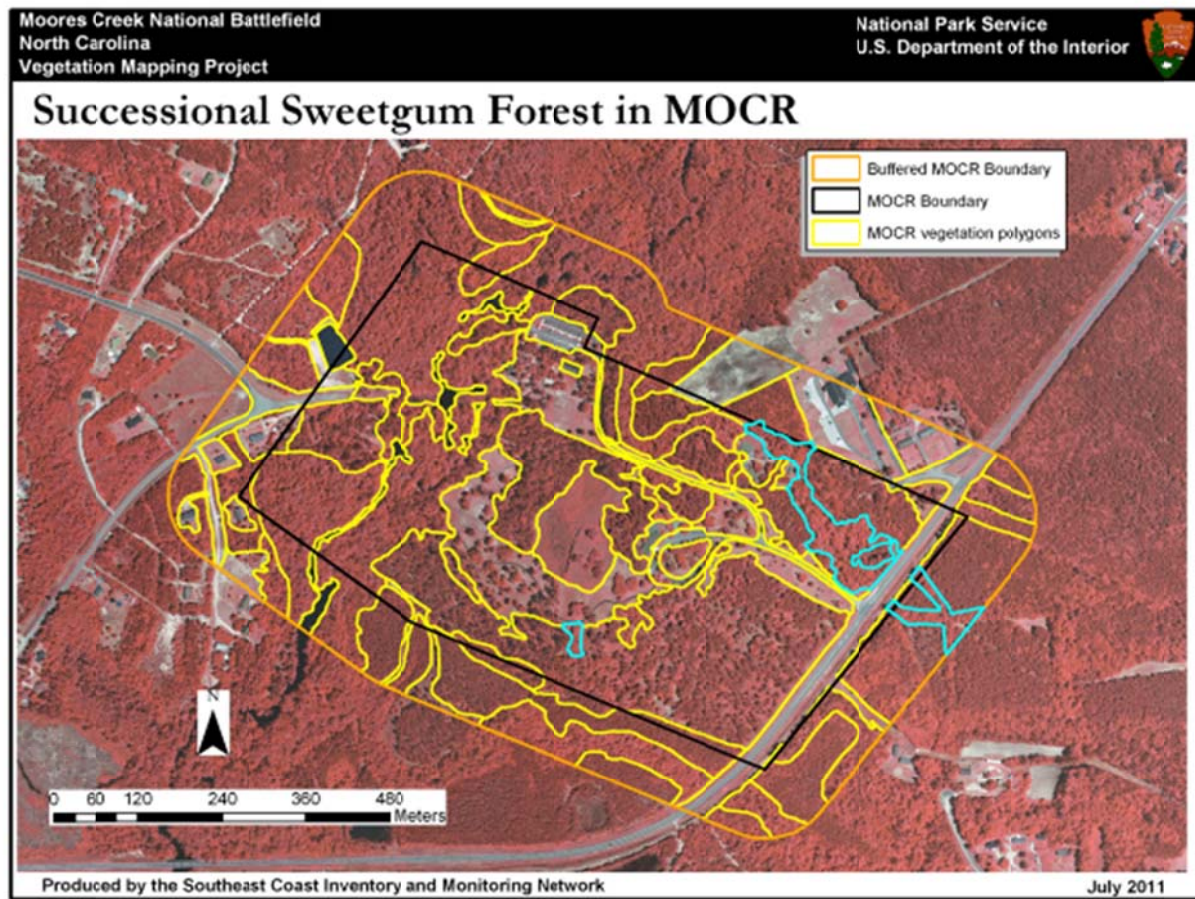
Total area: 4.3 Ac

Average polygon size: 1.4 Ac

Producer's accuracy: 100%

User's accuracy: 100%

Distribution in Mapping Area:



Interpretation:

Sweetgum appears pink, and typically has large, asymmetric crowns. The subcanopy, when visible, appears as a variety of red and pink hues due to a number of deciduous species present such as red maple, catalpa, and magnolia. Magnolia has a particularly distinct photo-signature of white/gray speckles throughout the tree crown.



Example of photo-signature for Successional Sweet Gum Forest

MAP CLASS 4

Successional Water Oak Forest:



Abundant species:

- *Quercus nigra*
- *Ilex glabra*
- *Gelsemium sempervirens*

Map Class Statistics:

Frequency: 3

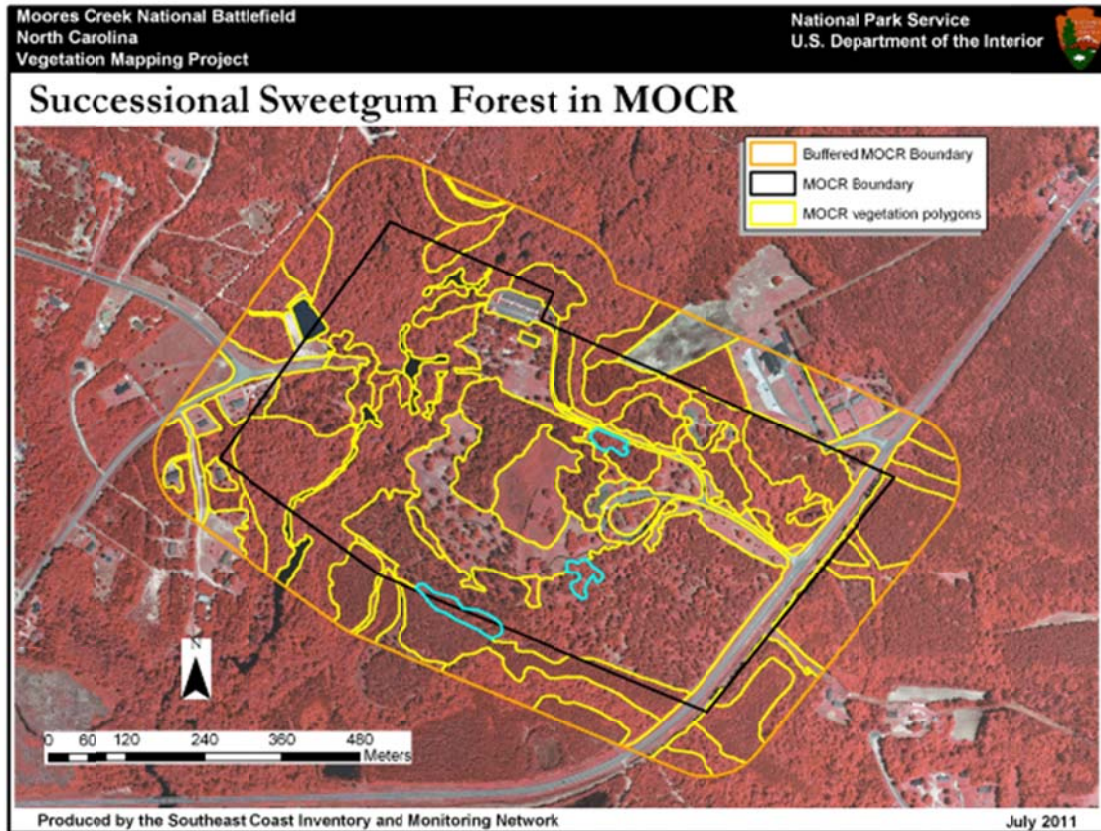
Total area: 1.5 Ac

Average polygon size: 0.5 Ac

Producer's accuracy: 100%

User's accuracy: 100%

Distribution in Mapping Area:



Interpretation:

Water oak appears red/orange with various sizes and shapes of crowns (some more symmetrical than others). The Successional Water Oak Forest can be distinguished from the Successional Sweetgum Forest because the canopy of the Successional Water Oak Forest appears much more orange/red, whereas the Successional Sweetgum Forest canopy appears pink.



Example of photo-signature for Successional Water Oak Forest

II. Wetland Forest:

MAP CLASS 5

Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest



Abundant species:

- *Pinus taeda*
- *Taxodium ascendens*
- *Liquidambar styraciflua*
- *Quercus nigra*
- *Acer rubrum*
- *Itea virginica*

- *Smilax rotundifolia*
- *Saururus cernuus*
- *Woodwardia aerolata*, *Woodwardia virginica*

Map Class Statistics:

Frequency: 2

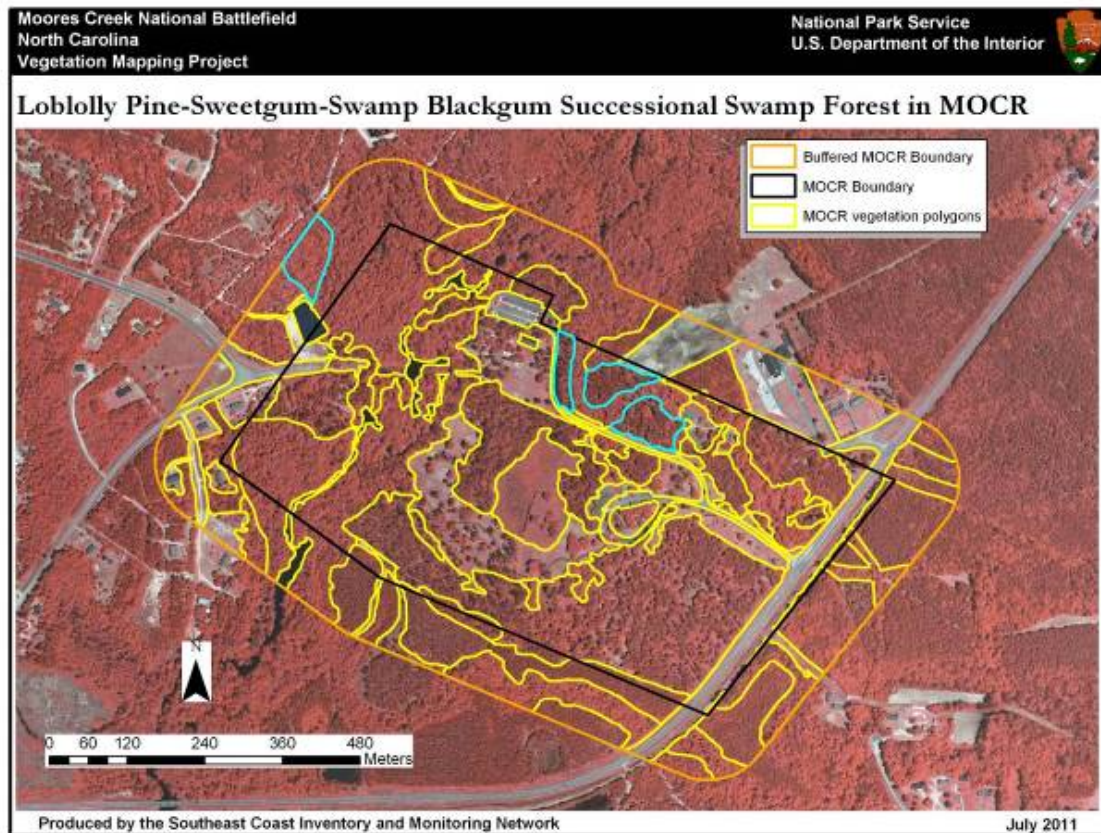
Total area: 2.7 Ac

Average polygon size: 1.3 Ac

Producer's accuracy: 40%

User's accuracy: 100%

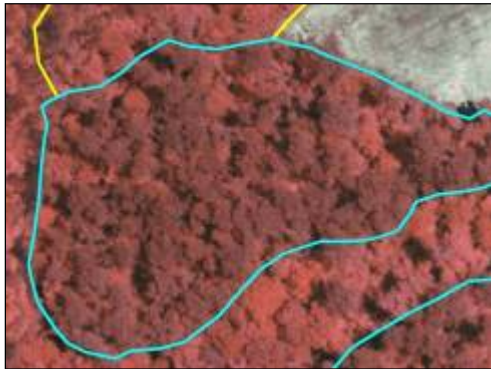
Distribution in Mapping Area:



Interpretation:

Loblolly pine appears dark red to brown, with small to moderate crowns, and a coarse texture. Sometimes Pond Cypress mixing in with the Loblolly pine gives the canopy a slightly purple tint in addition to the over-all brown color. In the subcanopy, a variety of deciduous species may or may not be visible, such as sweetgum (pink color, large canopy, coarse texture), water oak (red/orange color, various sized and shaped crowns (some more symmetrical than others), tupelo (red/orange color, moderate to large crown size, coarse texture.) If ground is visible, it is dark

gray in color. This map class's location on wetlands rather than uplands is one main distinguishing factor from the Early to Mid-Successional Loblolly Pine Forest.



Example of photo-signature for Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest

MAP CLASS 6

Blackwater Bottomland Hardwood-Pine Forest (High Type)



Abundant species:

- *Pinus taeda*
- *Quercus nigra*
- *Quercus laurifolia*
- *Smilax rotundifolia*

Map Class Statistics:

Frequency: 3

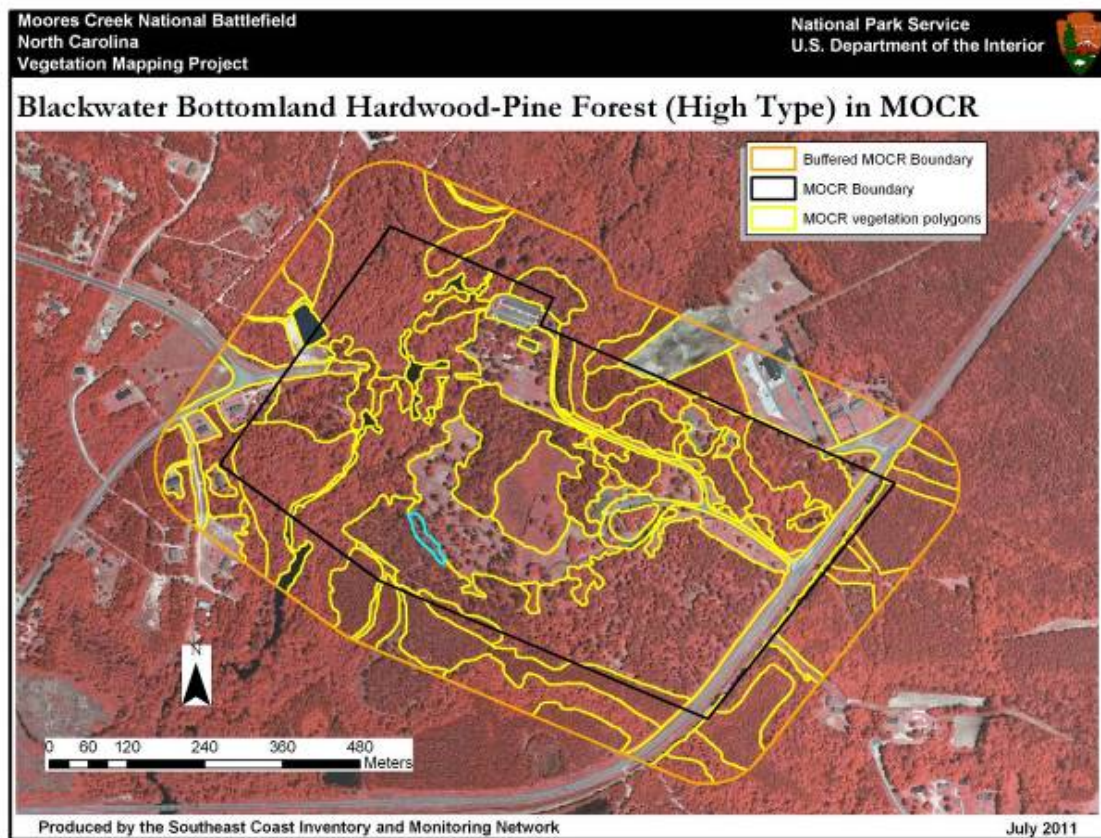
Total area: 2.8 Ac

Average polygon size: 0.9 Ac

Producer's accuracy: 60%

User's accuracy: 75%

Distribution in Mapping Area:



Interpretation:

Loblolly pine appears dark red to brown, with small to moderate crowns, and a coarse texture. The subcanopy contains water oak (red/orange color, various sized and shaped crowns (some more symmetrical than others) and laurel oak (red/orange color). If ground is visible, it is typically dark gray to black. This map class is distinguished from the other Loblolly dominated classes by an abundance of red/orange in the understory from the two prominent oak species present.



Example of photo-signature for Blackwater Bottomland Hardwood-Pine Forest (High Type)

MAP CLASS 7

Sandhills Atlantic White-cedar Streamside Forest



Abundant species:

- *Chamaecyparis thyroides*
- *Cyrilla racemiflora*
- *Carex glaucescens*
- *Panicum virgatum*

Map Class Statistics:

Frequency: 1

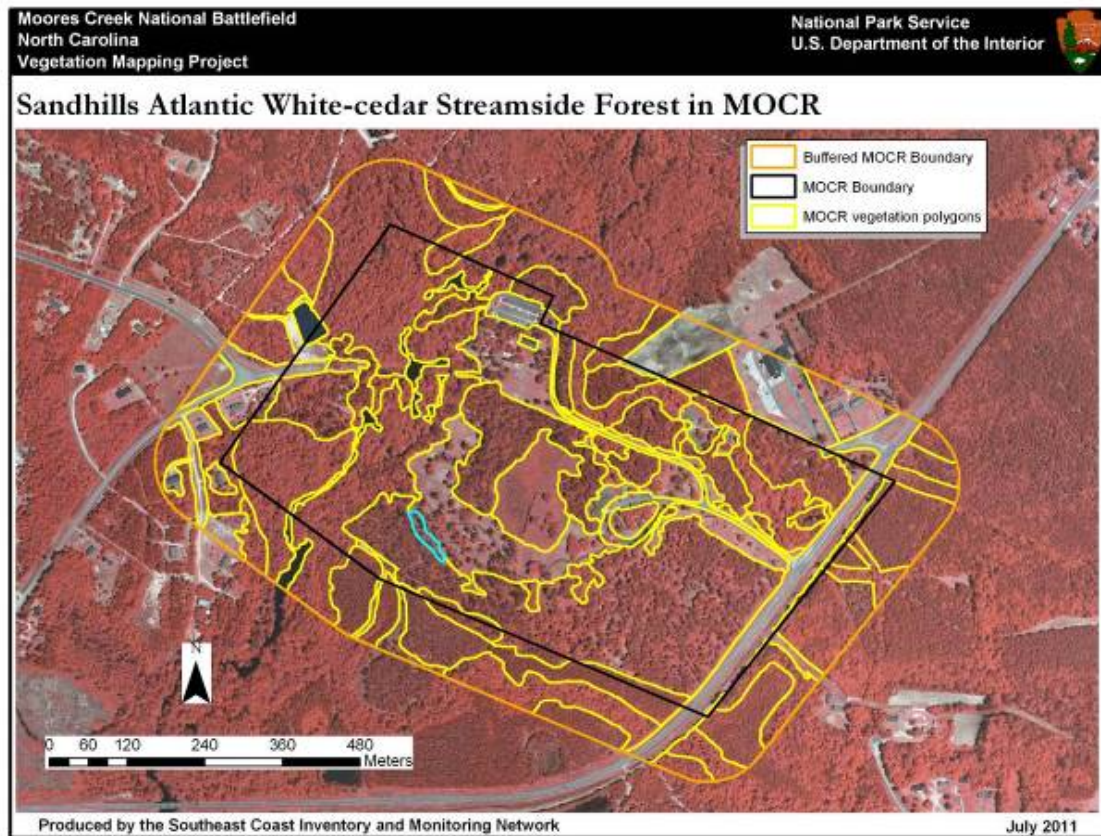
Total area: 0.3 Ac

Average polygon size: N/A

Producer's accuracy: 100%

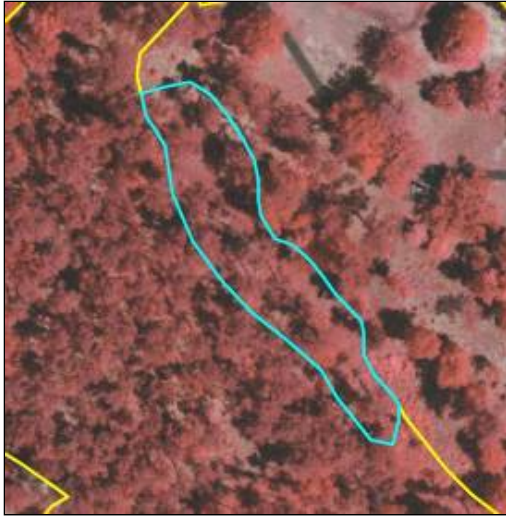
User's accuracy: 100%

Distribution in Mapping Area:



Interpretation:

Atlantic white cedar appears brown, similar to loblolly pine, but the main difference is that the Atlantic white cedar canopy is less dense than the loblolly pine canopy. Red maple mixes in with the Atlantic white cedar, which appears light red. This map class only occurs in a narrow sliver within the park, which simplifies the mapping of this class.



Example of photo-signature for Sandhills Atlantic White-cedar Streamside Forest

MAP CLASS 8

Atlantic Coastal Plain Bald-cypress-Blackgum Swamp



Abundant species:

- *Nyssa biflora*
- *Taxodium distichum*
- *Itea virginica*
- *Fraxinus caroliniana*
- *Smilax walteri*
- *Carex glaucescens*

Map Class Statistics:

Frequency: 4

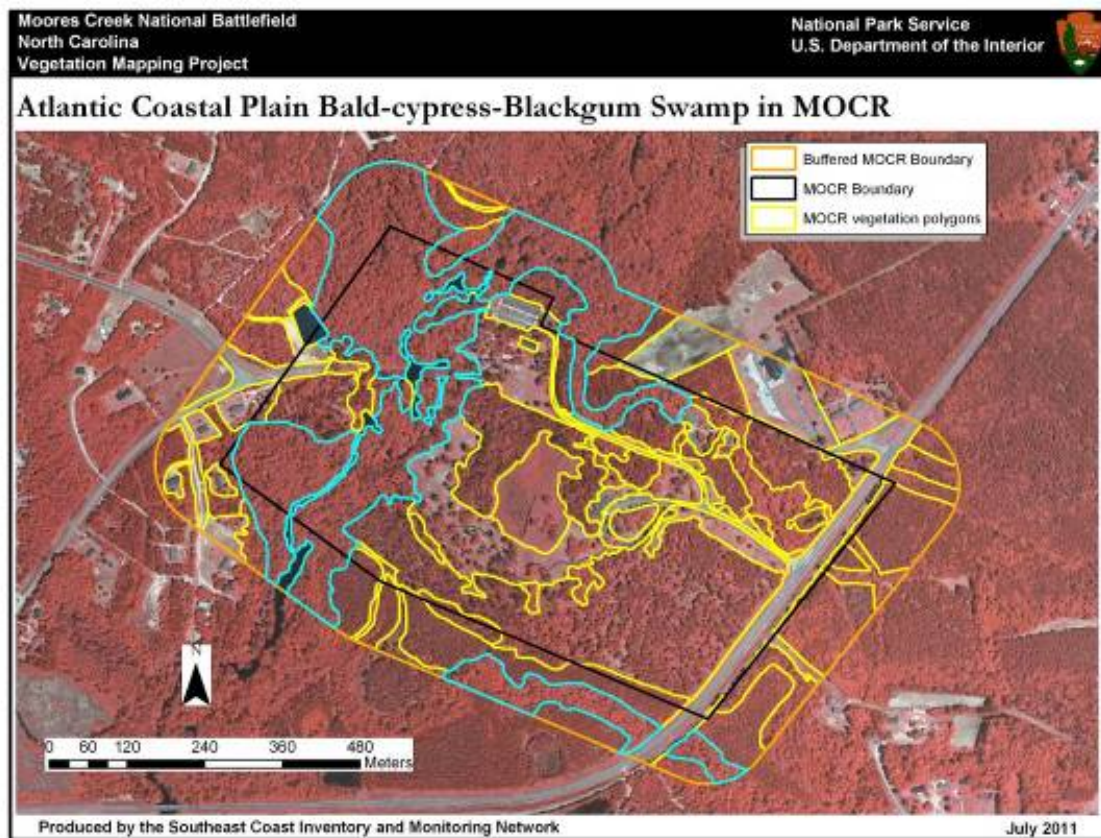
Total area: 40.6 Ac

Average polygon size: 10.2 Ac

Producer's accuracy: 100%

User's accuracy: 100%

Distribution in Mapping Area:



Interpretation

The canopy is mainly composed of Bald cypress (characteristic lavender color with a fluffy texture and small, circular, distinct crowns) and swamp blackgum (red/orange with moderate to large crown size and coarse texture). The subcanopy contains a variety of deciduous species which appear red/pink with various canopy sizes. This forest type occurs mainly along the floodplain of Moores Creek



Example of photo-signature for Atlantic Coastal Plain Bald-cypress-Blackgum Swamp

MAP CLASS 9

Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest



Abundant species:

- *Quercus lyrata*
- *Quercus laurifolia*
- *Nyssa biflora*
- *Arundinaria gigantea*

Map Class Statistics:

Frequency: 3

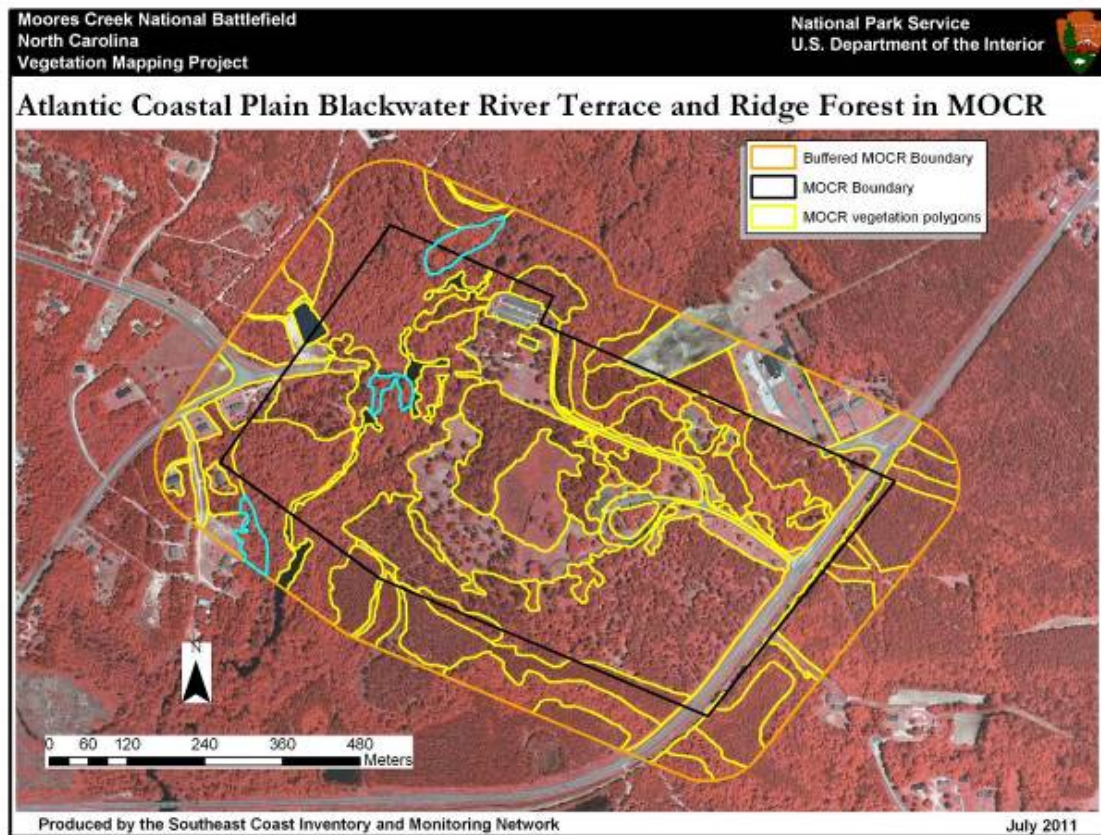
Total area: 2.4Ac

Average polygon size: 0.8 Ac

Producer's accuracy: 75%

User's accuracy: 100%

Distribution in Mapping Area:



Interpretation:

The canopy is dominated by oak species which are red/orange, have asymmetric crown shape, and a moderate to large crown size. This forest type can be distinguished from the Successional Water Oak forest because it occurs in wetland sites in the park, whereas the Successional Water oak Forest occurs in upland sites in the park.



Example of photo-signature for the Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest.

MAP CLASS 10

Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type)



Abundant species:

- *Pinus palustris*
- *Pinus elliottii*
- *Ctenium aromaticum*
- *Muhlenbergia expansa*
- *Rhexia alifanus*
- *Sarracenia flava*
- *Rhynchospora latifolia*

Map Class Statistics:

Frequency: 1

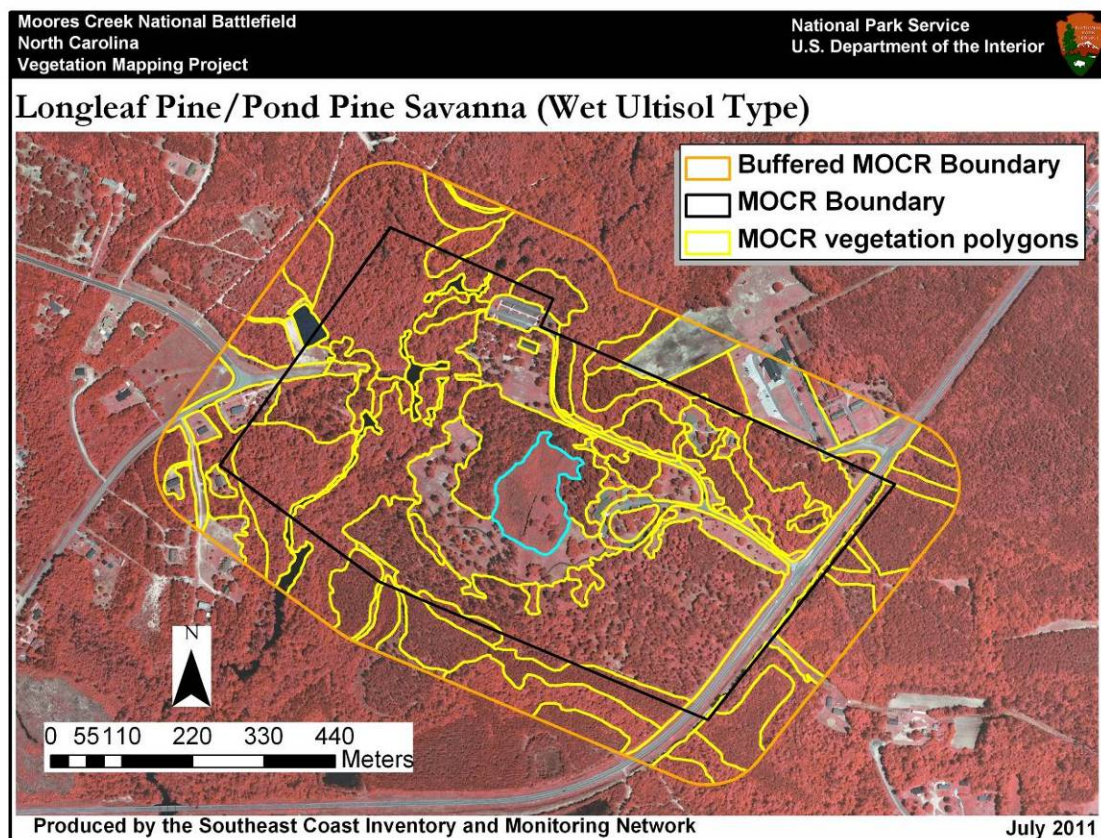
Total area: 3.7 Ac

Average polygon size: N/A

Producer's accuracy: 100%

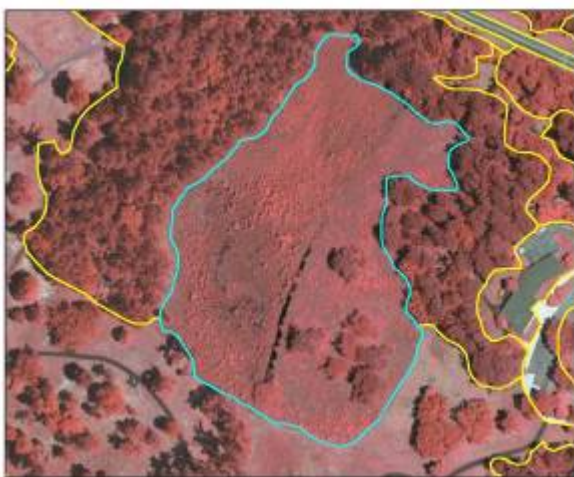
User's accuracy: 100%

Distribution in Mapping Area:



Interpretation:

The ground appears pink and gray with patches of pink that are larger grasses and small trees. This is a very conspicuous open area in the center of the park.



Example of photo-signature of Longleaf Pine/Pond Pine Savanna (Wet Ultisol Type)

Appendix E: Field Reconnaissance Form

MOORES CREEK NATIONAL BATTLEFIELD FIELD RECONNAISSANCE SHEET

I. LOCATION DATA

1. Point #: _____ 2. Date: _____ 3. Observers: _____
4. Photo (s) #: _____
5. Coordinates: X: _____ Y: _____
6. GPS Error: _____ (m) 7. Number of satellites: _____ 8. Elevation: _____

II. ENVIRONMENTAL/ SITE DESCRIPTION

1. Environmental Comments *(site specific information (if applicable) such as hydrology, topographic position, unvegetated surfaces, recent disturbances, etc.)*

III. VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)

Trees and Shrubs
☐ Evergreen
☐ Cold-deciduous
☐ Drought-deciduous
☐ Mixed evergreen - cold-deciduous
☐ Mixed evergreen - drought-deciduous

Herbs
☐ Annual
☐ Perennial

Leaf Type (of dominant stratum)

☐ Broad-leaved
☐ Needle-leaved
☐ Mixed broad-leaved/Needle leaved
☐ Microphyllous
☐ Graminoid
☐ Forb
☐ Pteridophyte

Physiognomic class

☐ Forest
☐ Woodland
☐ Shrubland
☐ Dwarf Shrubland
☐ Herbaceous
☐ Nonvascular
☐ Sparsely Vegetated

IV. VEGETATION COMPOSITION (list **dominant species only** and indicate which stratum it occurs in by checking the appropriate stratum next to the species name)

[illegible]

V. VEGETATION ASSOCIATION

1. Primary and secondary (if there is a close call or multiple associations within the same polygon) vegetation classification(s) within radius of observation point, based on field key:

Appendix F: Accuracy Assessment Form

ACCURACY ASSESSMENT (AA) FORM FOR VEGETATION MAPPING IN SECN PARKS

I. LOCATION DATA

1. AA Point Code: _____ 2. Park: _____ 3. Date: _____
4. Observers: _____
5. Photo (s) #: _____
5. GPS Unit: _____ 6. Projection: _____ 7. Map Datum: _____ 8. Zone: _____
9. Easting _____ E 10. Northing _____ N
11. Estimated Accuracy (m): _____

II. ENVIRONMENTAL/ SITE DESCRIPTION

1. Environmental Comments *(site specific information (if applicable) such as hydrology, topographic position, unvegetated surfaces, recent disturbances, etc.)*

III. VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class
Trees and Shrubs	____ Broad-leaved	____ Forest
____ Evergreen	____ Needle-leaved	____ Woodland
____ Cold-deciduous	____ Mixed broad-leaved/Needle leaved	____ Shrubland
____ Drought-deciduous	____ Microphyllous	____ Dwarf Shrubland
____ Mixed evergreen - cold-deciduous	____ Graminoid	____ Herbaceous
____ Mixed evergreen - drought-deciduous	____ Forb	____ Nonvascular
	____ Pteridophyte	____ Sparsely Vegetated
Herbs		
____ Annual		
____ Perennial		

IV. VEGETATION COMPOSITION (list **dominant species only** and indicate which stratum it occurs in by checking the appropriate stratum next to the species name)

[illegible]

V. VEGETATION ASSOCIATION

1. Primary and secondary (if there is a close call or multiple associations within the same polygon) vegetation classification(s) within radius of observation point, based on field key:

2. Are there any other vegetation associations present within the radius observation area in addition to what was listed above?

3. Representativeness: Does the assigned association represent the vegetation well? If not, why? Please rank the fit as “Good” “Fair” or “Poor.”

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

Appendix G: Accuracy Assessment Contingency Table

Explanation of the Contingency Matrices

The accuracy assessment contingency matrix for the Moores Creek National Battlefield vegetation map layer is designed in a row and column format so as to compare the results of the vegetation types represented on the map layer to the vegetation types as verified on the ground. Map-class codes are used to identify vegetation types for ease of comparison during the analysis. (A crosswalk between map classes and vegetation types is provided.)

The sample contingency table provides an initial summary of the AA data by displaying counts of observations, with sample data values (vegetation map classes) as rows and reference data values (vegetation types as identified on the ground) as columns. The values in the shaded cells along the diagonal represent counts for correctly classified observations, where the reference data (column) matches the mapped vegetation type (row). User's accuracy was calculated by dividing the number of samples that agreed with their corresponding map class by the total number of samples in that class. Producer's accuracy was calculated by dividing the number of samples that agreed with their corresponding map class by the total number of samples whose field call belonged to that category.

Measures of accuracy for the AA are defined on the population contingency table. Similar to the sample contingency table, rows in the population contingency table are defined by the sample data values, and the columns are defined by the reference data values. Unlike the sample contingency table, the values in each cell are the proportion of the target area in the corresponding true and mapped vegetation classes, rather than the raw counts of observations. The population and sample contingency tables are reported together as a summary of between-class error relationships and class accuracy statistics (Lea and Curtis 2010).

Sample Contingency Table

Field Determination												User's Accuracy	90% Confidence Interval	
Map Units		A	B	C	D	E	F	G	H	I	Totals		-	+
Photointerpreter's Determination	A	15									15	100%	97%	103%
	B		3								3	100%	83%	117%
	C			5							5	100%	90%	110%
	D				3						3	100%	83%	117%
	E					3			1		4	75%	27%	123%
	F						9				9	100%	94%	106%
	G	3						2			5	40%	-6%	86%
	H	2							3		5	60%	14%	106%
	I									5	5	100%	90%	110%
	Totals	20	3	5	3	3	9	2	4	5				
Producer's Accuracy		75%	100%	100%	100%	100%	100%	100%	75%	100%	48 Total Correct Points			
90% Confidence Interval		-	57%	83%	90%	83%	83%	94%	75%	27%	90%	54 Total Points		
		+	93%	117%	110%	117%	117%	106%	125%	123%	110%			

Key to Map Class Codes

A= Early- to Mid-Successional Loblolly Pine Forest
 B= Sandhills Atlantic White-cedar Streamside Forest
 C= Successional Sweetgum Forest
 D= Successional Water Oak Forest

E= Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest
 F= Atlantic Coastal Plain Bald-cypress-Blackgum Swamp
 G= Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest
 H= Blackwater Bottomland Hardwood-Pine Forest (High Type)
 I= Longleaf Pine / Pond Pine Savanna

Population Contingency Table

Reference Data (Observations Classified as Vegetation Type on Ground)														
Sample Data (Observations Selected Within the Map Class)										Map Class	Point Estimate (Users' Accuracy)	Lower Limit, 90% Conf Int.	Upper Limit, 90% Conf. Int.	
	A	B	C	D	E	F	G	H	I					Row Total
A	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	15.98	100%	96.7%	100.0%
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	100%	83.3%	100.0%
C	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.34	100%	90.0%	100.0%
D	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.41	100%	83.3%	100.0%
E	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.36	75%	26.9%	100.0%
F	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.29	8.62	100%	94.4%	100%
G	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.53	60%	0.0%	86.0%
H	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.69	60%	14.0%	100.0%
I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	1.50	100%	90.0%	100.0%
Column Total	0.56	0.00	0.05	0.01	0.01	0.29	0.01	0.02	0.05	1.00	29.54	Point Estimate, Overall Accuracy (with 90% Confidence Interval): 97.7%(96.5% - 98.8%) Point Estimate, Overall Accuracy Kappa Statistic (with 90% Confidence Interval): 86.6%(78.2% - 95.1%)		
Estimated True Map Class Area (Ha)	16.57	0.12	1.34	0.41	0.27	8.62	0.21	0.50	1.50					
Point Estimate, Mean Producers' Accuracy	96%	100%	100%	100%	100%	100%	100%	82%	100%					
Lower Limit, 90% Conf. Int.	96%	100%	100%	100%	100%	100%	99%	81%	100%					
Upper Limit, 90% Conf. Int.	97%	100%	100%	100%	100%	100%	100%	83%	100%					

Key to Map Class Codes

A= Early- to Mid-Successional Loblolly Pine Forest	E= Atlantic Coastal Plain Blackwater River Terrace and Ridge Forest
B= Sandhills Atlantic White-cedar Streamside Forest	F= Atlantic Coastal Plain Bald-cypress-Blackgum Swamp
C= Successional Sweetgum Forest	G= Loblolly Pine-Sweetgum-Swamp Blackgum Successional Swamp Forest
D= Successional Water Oak Forest	H= Blackwater Bottomland Hardwood-Pine Forest (High Type)
	I= Longleaf Pine/ Pond Pine Savanna