



Vegetation Mapping at Fort Caroline National Memorial

Photointerpretation Key and Final Vegetation Map

Natural Resource Report NPS/SECN/NRR—2019/2008



ON THE COVER

Saltmarsh and Sabal Palm Forest, Fort Caroline National Memorial, November 11, 2014

Photo Credit: David L. Cotten

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This report received formal peer review by subject-matter experts who were not directly involved in the development or pilot implementation of the project. Peer review was conducted by highly qualified individuals with subject area technical expertise and was overseen by a peer review manager.

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Executive Summary

The University of Georgia Department of Geography's Center for Geospatial Research (CGR), with the support of the National Park Service (NPS) Vegetation Mapping Inventory (VMI) Program, described and mapped vegetation at Fort Caroline National Memorial (FOCA). Mapping was accomplished through collaboration with the NPS Southeast Coast Network (SECN), the North Carolina office of NatureServe (Durham, N.C.), and Amec-Foster-Wheeler Environmental & Infrastructure, Inc.

A final vegetation map for Fort Caroline National Memorial was created to represent the vegetation occurring within the park during 2012. This product represents the final of four steps necessary to produce an accurate vegetation map based upon aerial photographs. This includes the determination of the community element global (CEGL) codes (2008) and acquisition of aerial imagery (2012), using the aerial imagery, with five ground truthing points (2014), to create a draft vegetation map, performing an accuracy assessment (2015), and then using all the available information to create a final vegetation map (2018).

Using dominant vegetation classes and secondary vegetation classes, detailed vegetation maps were created for Fort Caroline National Memorial. Polygons and attributes within the 500-meter (1,640-foot [ft]) buffer were created on a broader scale using a system based on the Anderson Level II classification scheme which includes anthropogenic and land use/land cover (LULC) classes. Within the memorial, the more detailed National Vegetation Classification System (NVCS) was used.

The most common class found in Fort Caroline National Memorial is the combination class 11007 (3564—Southeastern Coastal Plain Xeric Hammock, 7020—Southeastern Florida Maritime Hammock, and 7032—Maritime Live Oak Hammock), covering approximately 64% of the Memorial. All non-NVCS classes combined to cover less than 5% of the total area of the park. A rigorous accuracy assessment was conducted on the 11 map classes within the boundary of Fort Caroline National Memorial representing floristic types within the National Vegetation Classification System. Results showed a 75% map accuracy and a kappa rating of 67% using 36 accuracy assessment points.

The products generated from this project include vegetation maps, a photointerpretation key, summary statistics of each vegetation class, and a detailed geodatabase with digital maps.

Introduction

Fort Caroline National Memorial Vegetation Mapping Project

As part of the National Park Service (NPS) Vegetation Inventory Program (Schmoldt et al. 1994; Fancy et al. 2009), the University of Georgia Center for Geospatial Research (CGR) in the Department of Geography was asked to produce vegetation maps of eight park units in the NPS Southeast Coast Inventory and Monitoring Network (SECN) using mapping standards defined under the National Vegetation Classification System (NVCS; Jennings et al. 2009). Under Task Agreement # P13AC01319, the University of Georgia Center for Geospatial Research agreed to analyze existing leaf-on color infrared (CIR) aerial photography to develop photointerpretation keys, accuracy assessment study plans, final digital maps of vegetation, geodatabases and associated metadata in accordance with NPS vegetation mapping standards, and field verification surveys in accordance with standard mapping practices. The Fort Caroline National Memorial (FOCA) Vegetation Mapping project was coordinated by the University of Georgia Center for Geospatial Research in the Department of Geography between 2014 and 2018, with assistance from the National Park Service (NPS) Southeast Coast Network, the North Carolina (Durham) office of NatureServe (for the vegetation classification portion of the project), and Amec-Foster-Wheeler Environmental & Infrastructure, Inc. (for accuracy assessment).

While the National Vegetation Classification System intends to capture stable vegetation categories, either man-made or natural disturbances may change some areas during the seven years required to produce a vegetation map. For example, changes in non-tree dominated areas, which are typically wetlands in this region, may shift annually depending upon local weather, or cover by invasive exotics may change rapidly. More importantly, both of these natural and anthropogenic changes will likely continue in the future. Therefore, the vegetation map should be evaluated as a snapshot of the park in 2012.

Vegetation Mapping Inventory Program

The Vegetation Mapping Inventory (VMI) Program is an effort by the National Park Service to classify, describe, inventory, and map vegetation communities in more than 280 national park units across the United States. The primary objective of the Vegetation Mapping Inventory Program 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 Mapping Inventory Program, visit the program website (see NPS 2015a).

NPS Southeast Coast Inventory and Monitoring Network

National Park managers across the country need a broad-based understanding about the status and trends of park natural resources. The NPS Inventory & Monitoring Division (IMD) systematically gathers and analyzes information on the plants, animals, and ecosystems within the parks. Parks use this information for planning, research, education, and to help guide decisions related to park

management. Results are also shared with other agencies, researchers, and scientists. The IMD staff and networks share a set of common goals, established when the division was first launched:

Inventory the natural resources under National Park Service stewardship to determine their nature and status.

- Monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments.
- Establish natural resource inventory and monitoring as a standard practice throughout the National Park system that transcends traditional program, activity, and funding boundaries.
- Integrate natural resource inventory and monitoring information into National Park Service planning, management, and decision making.
- Share National Park Service accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

To accomplish these goals, more than 280 parks with significant natural resources were grouped into the 32 IMD networks, which were determined based on geography and shared natural resource characteristics. The network organization increases collaboration among parks, information sharing, and economies of scale in natural resource inventory and monitoring (NPS 2018a).

The Southeast Coast Network (SECN) includes 17 parks with significant natural resources, in 15 administrative units. The network extends along the Atlantic Coast from the North Carolina-Virginia border southward to Cape Canaveral, Florida and inland to Atlanta, Georgia and the Alabama Coastal Plain. The network's purpose is to provide parks with data and information about their natural resources, and to help with information sharing in natural resource monitoring (NPS 2018b).

Location of Fort Caroline National Memorial

Fort Caroline National Memorial covers roughly 60 hectares (148 acres [ac]) in Duval County, Florida. It is located along the St. Johns River northeast of Jacksonville about seven river miles from the mouth of the river (Figure 1).

Fort Caroline National Memorial has a long history and is the site of one of the earliest North American settlements. The original settlement was named La Caroline and built on the banks of the St. Johns River, by French settlers in 1564 (NPS 2015b). It was short lived – the inhabitants faced near starvation and mutinies within their colony. Close to abandoning the settlement, they stayed on after a successful relief expedition in 1565. Sadly, staying in the settlement proved to be a deadly decision as shortly afterwards an attack led by Spanish Admiral Pedro Menendez spared only about 60 women and children out of the remaining 200 inhabitants. (NPS 2017).

It is now part of the Timucuan Ecological and Historic Preserve and is nearby to the Castillo de San Marcos National Monument. As part of the National Park System, it is open to the public.



Fort Caroline National Memorial Park Boundary

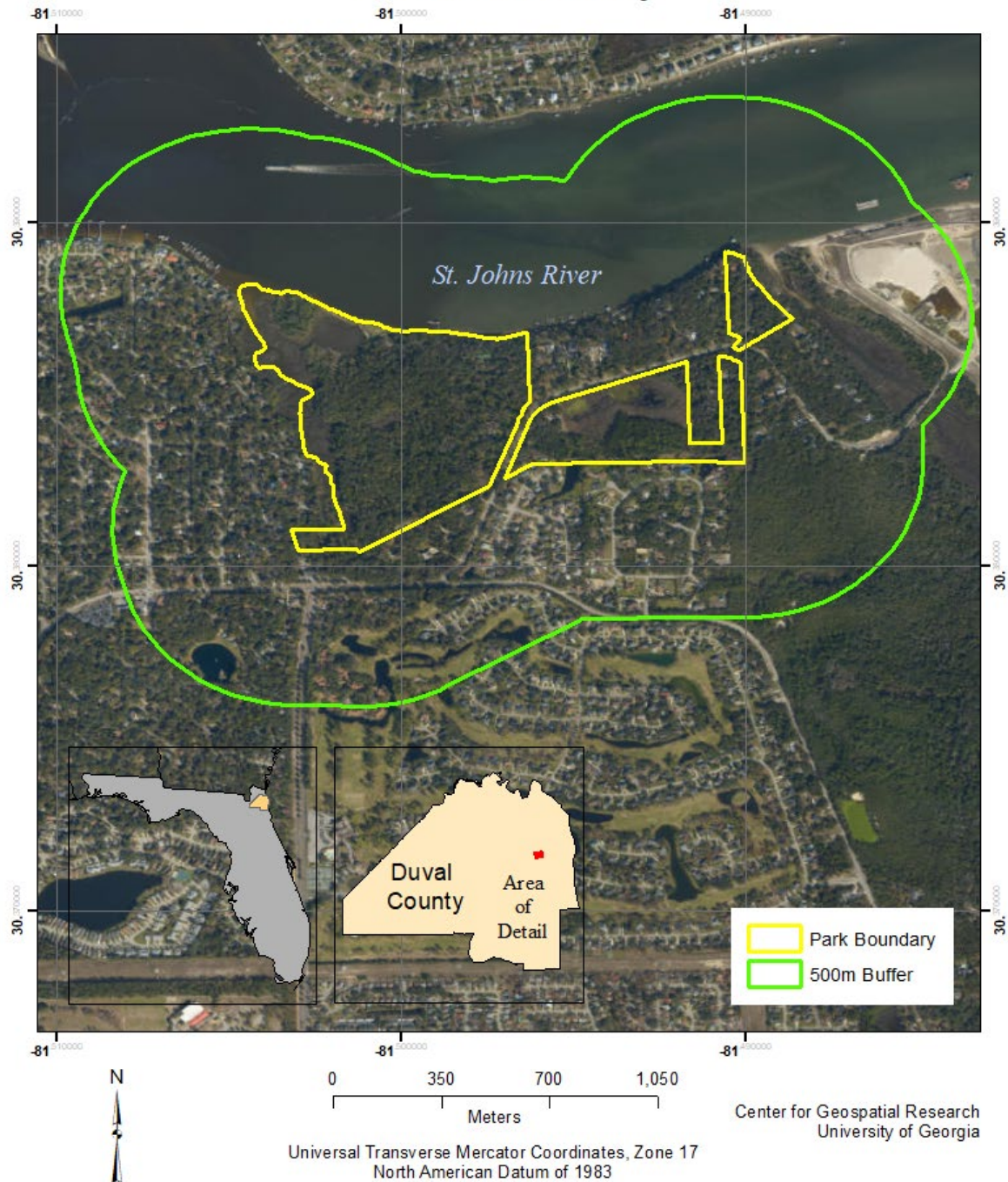


Figure 1. Location of Fort Caroline National Memorial with buffer area and its position relative to the State of Florida and Duval County.

Vegetation Classification System

The task agreement for mapping required using the National Vegetation Classification System (NVCS) for areas inside each park. The National Vegetation Classification System was developed by the Nature Conservancy (Anderson et al. 1998; Grossman et al. 1998). It is primarily based upon vegetation rather than climatic or edaphic factors. It emphasizes the existing natural vegetation and recognizes that vegetation communities form a continuum. The system has seven hierarchical levels so that vegetation can be described at multiple scales, depending upon the amount of information available. Higher levels can be broken down to lower levels as more information is available; conversely, lower levels can be aggregated to upper levels. The five upper levels (formation class, formation subclass, formation group, formation subgroup, and formation) describe vegetation physiognomy rather than actual species composition and are a modification of the UNESCO World Physiognomic Classification of Vegetation (UNESCO 1973). The two lowest levels (the alliance and association) are determined by floristic composition. The alliance level is determined by the species composition of the dominant or diagnostic species in the most prevalent stratum. A diagnostic species does not have to be dominant. For example, *Nyssa biflora* (swamp tupelo) is a characteristic species found in the Sweetgum–Tuliptree Brownwater Floodplain Forest but is not a dominant species.

The association level is determined by diagnostic species in all strata (tree canopy, subcanopy, tall-shrub, short-shrub, herbaceous, non-vascular, vine/liana, and epiphyte), recognizing that each of these strata may not occur in every association. The tallest stratum may not be the diagnostic/dominant stratum. The association level is assigned a unique community element global code (CEGL). The CEGL code for the vegetation association is the target vegetation classification specified in the task agreement.

The dominant species in the tallest stratum are always visible in leaf-on aerial photographs. If the tallest stratum is dense, with a closed canopy, then the shorter subcanopy and understory layers are obstructed from the camera's view and are not visible. In vegetation communities where the tallest stratum is open, other strata will be visible in the aerial photograph. In some cases, a CEGL code can be determined solely by identifying its location (e.g., along a ridge or on the south slope) and viewing the uppermost stratum. In other cases, a lower stratum (or strata) not visible in the aerial photography must be used to determine CEGL code. In such cases, it is impossible to use only aerial photographs recorded during leaf-on conditions to accurately determine the NVCS code at the association level. If it was not possible to determine the association-level class, a second vegetation was assigned as a supplement to the dominant vegetation code.

Prior to the University of Georgia Center for Geospatial Research's photointerpretation, NatureServe conducted field surveys in accordance with standard practices (Jennings et al. 2009) to create a list of NVCS CEGL codes as a combined reference and key for the following national monuments and Preserve: Timucuan Ecological and Historic Preserve, Fort Caroline National Monument, Castillo de San Marcos National Monument and Fort Matanzas National Monument (see Table 1; NatureServe 2009). Their detailed report includes a dichotomous key for separating the CEGL codes described for

the Memorial (see Appendix A). Many of the couplets in the dichotomous key relied upon differences in the dominant vegetation in the tallest stratum or the presence or absence of diagnostic species. However, some couplets relied upon lower strata which may not be evident in the aerial photographs and/or edaphic factors¹ (e.g. soil pH) which would not be evident in leaf-on CIR photographs. The NatureServe report also includes comprehensive descriptions of diagnostic species for each CEG code, and additional information on both the global and local expressions of the vegetation community type.

Table 1: Land cover classes found within the park area of Fort Caroline National Memorial during the initial assessment based on the National Vegetation Classification System.

Code	Description
3564*	Southeastern Coastal Plain Xeric Hammock
3643*	Slash Pine Flatwoods
4178*	Tidal Sawgrass Marsh
4191	Southern Atlantic Coast Salt Marsh
4423*	Central Florida Willow Thicket
4883	St. Augustine Grass Herbaceous Vegetation
7020*	Southeastern Florida Maritime Hammock
7032*	Maritime Live Oak Hammock
7044*	Loblolly-bay Forest
7049*	Outer Coastal Plain Sweetbay Swamp Forest
7694*	Saltgrass - (Saltmarsh Dropseed) Herbaceous Vegetation

* Vegetation classes found within 10 NatureServe plots contained within Fort Caroline National Memorial.

In general, the National Vegetation Classification System is best suited to natural or semi-natural vegetation communities that have been relatively undisturbed long enough for vegetation communities to develop in accordance with the environmental and climatic conditions of the site (Anderson et al. 1998; Grossman et al. 1998;). Areas that are regularly or extensively disturbed by logging, fire, wind damage, exotic insects, exotic vegetation, and human activities are not easily classified with the National Vegetation Classification System. For this reason, the University of Georgia Department of Geography's Center for Geospatial Research augmented the NVCS classes identified by NatureServe as occurring in Fort Caroline National Memorial to include additional disturbed, managed, successional, and modified classes, along with alphanumeric modifiers to provide detailed information to users of the vegetation databases and maps. Modifiers to the NVCS

¹ Vegetation tends to reflect edaphic factors. Yet if the indicator vegetation is not visible in the aerial photograph, edaphic factors cannot be inferred.

classes reflected variations of a particular NVCS class that are characteristic for the local site, but atypical of the global NVCS description.

The task agreement also required mapping a 500-meter (1,640-ft) buffer around each park. The buffer area contained extensive areas of human influence; consequently, the National Vegetation Classification System was not applicable. Buffer areas were therefore mapped using guidelines derived from the Anderson Level II classification system, which includes human influences and water categories (Anderson et al. 1976). Modifiers were also greatly utilized within the buffer to increase the knowledge base about what LULC categories surround Fort Caroline National Memorial.

In summary, the Memorial was initially mapped to the association (CEGL) level of the National Vegetation Classification System, (Table 1), while the buffer area was more appropriately mapped using Anderson Level II guidelines (Table 2). Modifiers to these classification systems were used, as appropriate, to ensure a meaningful classification system for this park (Table 3). The complete vegetation classification system used for Fort Caroline National Memorial is provided in the Final Vegetation Mapping and Summary Statistics section of this report.

Table 2. Land cover/land use classes found within the buffer of Fort Caroline National Memorial.

Code	Description
11	Residential
12	Commercial and Services
14	Transportation, Communications, and Utilities
41	Deciduous Forest Land
43	Mixed Forest Land
51	Streams and Canals
53	Bays and Estuaries
62	Nonforested Wetlands
77	Mixed Barren Land

Table 3. Modifiers used throughout the park area and buffer of Fort Caroline National Memorial.

Code	Description
Res	Residential
dwarf	Dwarf vegetation

Vegetation Mapping Workflow

The general workflow for this vegetation mapping followed a series of steps, including:

1. Define CEGL codes within the study area based upon plot-level ground data (completed by NatureServe)
2. Contact park staff to discuss their needs and concerns as applicable to the final vegetation map, obtain any existing background information on management activities to include in a GIS database (see below), and arrange access
3. Collect base data and construct a GIS foundation geodatabase
 - a. Collect and inventory the aerial photographs
 - b. If needed, scan and orthorectify the aerial photographs
 - c. Obtain available GIS layers on exotic plant removal or prescribed burns that may affect vegetation communities
4. Create an initial photointerpretation key
 - a. Overlay NatureServe Vegetation Survey points on photos
 - b. Examine photos to understand signatures of vegetation communities as identified by ELCodes or CEGL number
5. Perform initial delineation of vegetation communities on CIR aerial photographs, supplemented by other leaf-off imagery (see Table 4) using photointerpretation from both stereo-pairs and 2D imagery by heads-up GIS methods
 - a. Identify spectral signatures dissimilar to the example spectral signatures around the NatureServe ground plots so that vegetation can be evaluated in field visits
6. Field visits
 - a. Schedule field trips to the site to visit specific areas where questions exist
 - b. Verify vegetation communities present
 - c. Reconcile photo signature with NatureServe CEGL code
 - d. Refine classification as necessary with reference to field work and ongoing communication with park staff regarding results
 - e. If needed, assign additional CEGL numbers or combine certain CEGL numbers if specific classes exist within the park that were not discovered by the NatureServe Vegetation Survey or were indiscernible through aerial interpretation
7. Refine and extend photointerpretation key and delineation of polygons
 - a. As needed, print photos and vegetation polygons for review and refinement

8. Prepare draft deliverable products
 - a. Prepare draft GIS files
 - b. Clean up line work and attribute tables
 - c. Compute statistics for vegetation polygons
 - d. Prepare metadata for vegetation polygon files
 - e. Finalize photointerpretation keys
9. Accuracy Assessment
 - a. Using accuracy assessment guidelines points are chosen for a separate team to visit and quantify
 - b. Overlay Accuracy Assessment data points on photos and draft vegetation maps
 - c. Calculate percent accuracy and kappa for the polygons
10. Prepare final deliverable products
 - a. Prepare final GIS files
 - b. Clean up line work and attribute tables using accuracy assessment data as a guide
 - c. Compute statistics for vegetation polygons
 - d. Prepare metadata for vegetation polygon files
 - e. Finalize photointerpretation keys

Note that steps 4–7 reflect an iterative, rather than a linear, process. Steps 1, 2, and 3 are self-explanatory; the detailed workflow for the other steps, as pertains to the mapping of Fort Caroline National Memorial, is described below.

Table 4. Data sets, descriptions, source, date, and scale imported into the Geodatabase.

Dataset	Description	Source	Date	Scale/Resolution
County Boundary	Outline of Duval	US Census Bureau via FGDL	2011	n/a
Park Boundary	Outline of FOCA	NPS via FGDL	2012	n/a
Parcels	Florida Parcel Data by County	FDOR via FGDL	2014	n/a
Vegetation Plots	Sample Vegetation Locations	NatureServe	2006-07	n/a
NAIP Imagery	National Agriculture Imagery Program	USDA via FGDL	2010	1 meter (3.3 ft)
DEM	30-m resolution USGS Digital Elevation Model	University of Florida GeoPlan Center via FGDL	2012	15 meters (49.2 ft)
High Resolution True Color Imagery	True Color Imagery	FDOT	2014	6 inches (15.2 centimeters [cm])
Color Infrared Imagery	Color Infrared Imagery	Aero-Metrics via NPS	2012	1 foot (0.3 meter)

Base Data and GIS Geodatabase Construction

Relevant publicly available GIS data sets that cover the study area were downloaded and archived on a local server in the University of Georgia Center for Geospatial Research. Data sets include roads, hydrology, boundary files (political and NPS), digital elevation models (DEMs), and additional aerial photographs. These data are available from sources such as the NPS Integrated Resource Management Applications (IRMA) portal, the Florida Geographic Data Library, the U.S. Geological Survey National Map, and the National Oceanic and Atmospheric Administration Digital Coast websites. Trail network and exotic plant removal data sets were also obtained. These layers are not publicly available and were obtained through NPS contacts.

The data sets used to populate the foundation GIS database were from different sources, compiled for different reasons, and may not be in the same map projection. The task agreement specified that the spatial data be projected to the Universal Transverse Mercator (UTM) Coordinate System, North American Datum of 1983 (NAD83). Where necessary, data sets were projected to UTM Zone 17. Finally, a geodatabase in ArcGIS 10.2 format was created as a container to store and organize the data. Details of this database are presented in Table 4 and Figure 2.

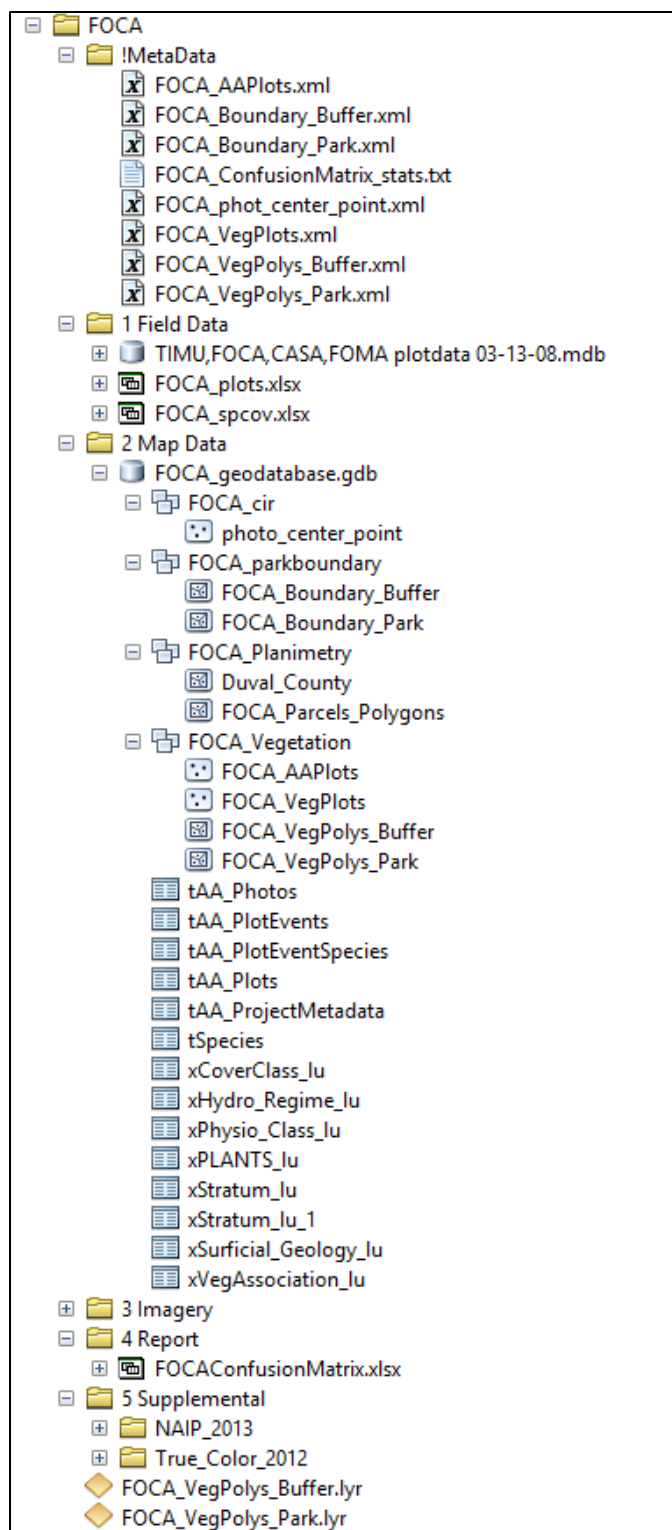


Figure 2. Foundation Geodatabase created for Fort Caroline National Memorial.

Color infrared (CIR) aerial photographs of the park at 1:12,000 scale were acquired by Aero-Metric, Inc. on May 11, 2011. These photos were scanned and converted to digital orthophotographs at 0.3-meter (1ft) resolution before they were delivered to the National Park Service. Digital orthophotographs and hardcopy photographs in both film transparency and paper print formats were provided to the University of Georgia Center for Geospatial Research. Six photos in two flight lines were required to cover Fort Caroline National Memorial (Figure 3 and Appendix B).

The mapping area was split in two sections: park and buffer. The park was defined as the area within the prescribed Memorial boundaries while the buffer pertained to the region within 500 meters (1,640 ft) outside of the Memorial boundary. Detailed vegetation mapping using CEG codes was performed within the park whereas more general mapping using a revised Anderson-type II hierarchical classification scheme was used in the buffer area.



FOCA Photo Center Points and Vegetation Plots



Figure 3. NatureServe vegetation plots and aerial photo center points for Fort Caroline National Memorial.

Initial Photointerpretation Key and Vegetation Delineation

Classifying the different vegetation communities within the park was aided by the use of a photointerpretation key. The initial photointerpretation key was based upon the NCVS vegetation classes at the association level. These associates were determined by NatureServe through independent plot level vegetation surveys in accordance with standard NVCS field methods (Jennings et al. 2009). Plot sizes ranged in size between 100 and 1,000 square meters (1,076 and 10,764 square miles [m^2]). Plot level species presence or abundance was used to assign a four-digit CEGL number. The results of the survey are reported as a list of point locations and CEGL codes, as well as descriptions and field notes (Appendix A). The vegetation associations for Fort Caroline National Memorial were determined by NatureServe from 10 plots. The University of Georgia Center for Geospatial Research visited 21 points to interpret the CIR signatures of these vegetation associations to delineate vegetation. The accuracy assessment of CGR's vegetation map included 54 accuracy assessment points, 35 of which were used for analysis of the park.

The NatureServe vegetation plots were overlaid on the CIR aerial photographs and the photo signature was examined. Many CEGL codes are not represented in Fort Caroline National Memorial, as the key combined four parks (Timucuan Ecological and Historic Preserve, Fort Caroline National Memorial, Castillo de San Marcos National Monument and Fort Matanzas National Monument) into one key, with the acknowledgement not all vegetation classes would be represented in each park (NatureServe 2008). The National Vegetation Classification System recognizes that vegetation communities form a continuum both within and between CEGL codes; spectral signatures are also likely to reflect this natural variation.

The photointerpretation key was developed to assist in the extension of the signatures at the plot level to the remainder of the park. The key noted color, tree crown shapes and sizes, texture, context, and any other characteristics that could help to differentiate one community from the others on the spectral signature of the leaf-on CIR aerial photography. The orthophotographs were examined on-screen in heads-up mode using the ArcGIS software. Where needed, the hardcopy photographs were viewed in stereo/3D using a light table and a mirror stereoscope. This method is excellent for using relative heights of the trees and terrain to assist in determining the vegetation community and to delineate the boundaries of the individual features.

This key was later expanded to include more detailed descriptions of each class. The strength and intensity of the image were described using color (varying from green to pink to purple), tone (light to dark), and texture (fine to coarse). Other categories were based on canopy structure such as pattern (open to dense canopy) and height (short to tall). The remaining categories were used to express how the different codes are interrelated. These include shape (elongated to broad), size (based on total area, average size, and standard deviations of the polygons in a given class), location (relative to specific areas in the park), association (communities typically found near the specific class), and comments (to express any hints or issues that may arise). Also included are images taken from the field in order to provide a ground level perspective that can be compared to the sample image chips taken from the airborne CIR images. The NatureServe summary of the vegetation association and its

distribution both globally and within the park are included for each class following the visual cue description.

The CEGL codes are listed in ascending numerical order in the key. While the National Vegetation Classification System is hierarchical, the numbering system for the codes is not hierarchical. Thus, it is impossible to determine physiognomy, species composition, or edaphic factors (e.g. soil saturation or inundation, soil pH, slope) from the CEGL code alone.

Using ArcGIS software, standard GIS methods, and a minimum mapping unit (MMU) of 0.5 hectares (1.2 ac), preliminary lines were drawn to delineate areas of uniform signature. Where the vegetation communities were clearly identifiable, polygons were tagged with the appropriate CEGL code. Where confusion existed, the polygons were tagged with an ‘unknown’ code until field visits could determine the appropriate CEGL code.

Field Surveys and Ground Truth

In developing the photointerpretation keys and delineating vegetation communities based upon their CIR signatures, several signatures were found that did not easily match the signatures from the NatureServe survey of 10 ground plots. These areas required field visits to clarify vegetation communities.

Field work and ground truthing for Fort Caroline National Memorial took place on November 4, 2014 and February 12, 2015. Field visits were aimed at giving specific attention to representative habitats, rare and important communities, areas that have been managed, disturbed, or invaded, and plots previously surveyed by NatureServe to collect data on canopy species composition, diagnostic species for the National Vegetation Classification System, and terrain, similar to NatureServe’s “Quick Plot” surveys.

Field crews carried paper field maps with the UTM grid coordinates, elevations, roads, rivers, initial vegetation polygons with CEGL codes, and points of interest superimposed on CIR photographs. They also used a Trimble Geo 6000 Xh Global Positioning System (GPS) handheld receiver loaded with similar GIS layers. On some trips, an Apple iPad 4 with a geoPDF (Wuthrich 2006; Pardue 2008) replaced paper field maps. The geoPDF gave the user both a higher level of detail of the original CIR compared paper maps, along with the ability to determine location in real-time using the device’s internal GPS relative to the overlay of the line work.

At each sampling site, researchers recorded GPS position, species data, canopy cover, and topography (e.g. relative slope and aspect) inside an area between 250 and 1,000 square meters (2,691 and 10,764 square feet [ft²]), based upon visual uniformity. Also noted were the presence of exotics, evidence of past or present human influence (e.g., agriculture, grazing, logging, mowing, exotic vegetation removal, old home sites), damage by insects, wild hogs, blow down, or fire. Prior to leaving a sampling location, researchers determined the primary association type, i.e. CEGL code (Grossman et al. 1994; Anderson et al. 1998; Grossman et al. 1998). Some sites were located in a mixed area indicative of an ecotone or an area of successional recovery. In such cases, secondary associations were determined in addition to dominant associations. Tertiary modifiers were often

determined as well. For this reason, all polygons have the possibility of having a secondary association and a modifier in addition to the required dominate association. In cases where researchers were unable to determine a clear match to a NVCS CEGL in the field, more detailed notes were taken in order to assign an appropriate CEGL or CGR-created class (e.g., a managed, damaged, human influence, or successional class) after further review of CIR signatures. The dominate associations used in Fort Caroline National Memorial can be found in Table 1 and the modifiers can be found in Table 3.

The GPS points collected in the field were superimposed on CIR images in ArcMap. Field points were used in conjunction with the aerial photographs to refine vegetation delineation and assigned classification attributes (dominant CEGL, secondary CEGL, and modifiers, as appropriate). Additional field visits were conducted during the iterative interpretation process on an as-needed basis in order to refine interpretations, identify communities with unusual signatures, and resolve any questions. Maps were updated between field visits to reflect the ongoing process of photointerpretation of vegetation communities. Any areas visited that were already classified were checked for accuracy throughout the mapping process.

Two field visits/investigations and 21 discrete point locations were collected at Fort Caroline National Memorial (Table 5 and Figure 4).

Table 5. Field visits and number of data points collected for Fort Caroline National Memorial.

Date	Team Member(s)	Number of Data Points
November 4, 2014	N. K. O'Hare, D. L. Cotten, B. P. Adams	12
February 12, 2015	D. L. Cotten, B. P. Adams	7
Total	–	21



FOCA Data Collection Points

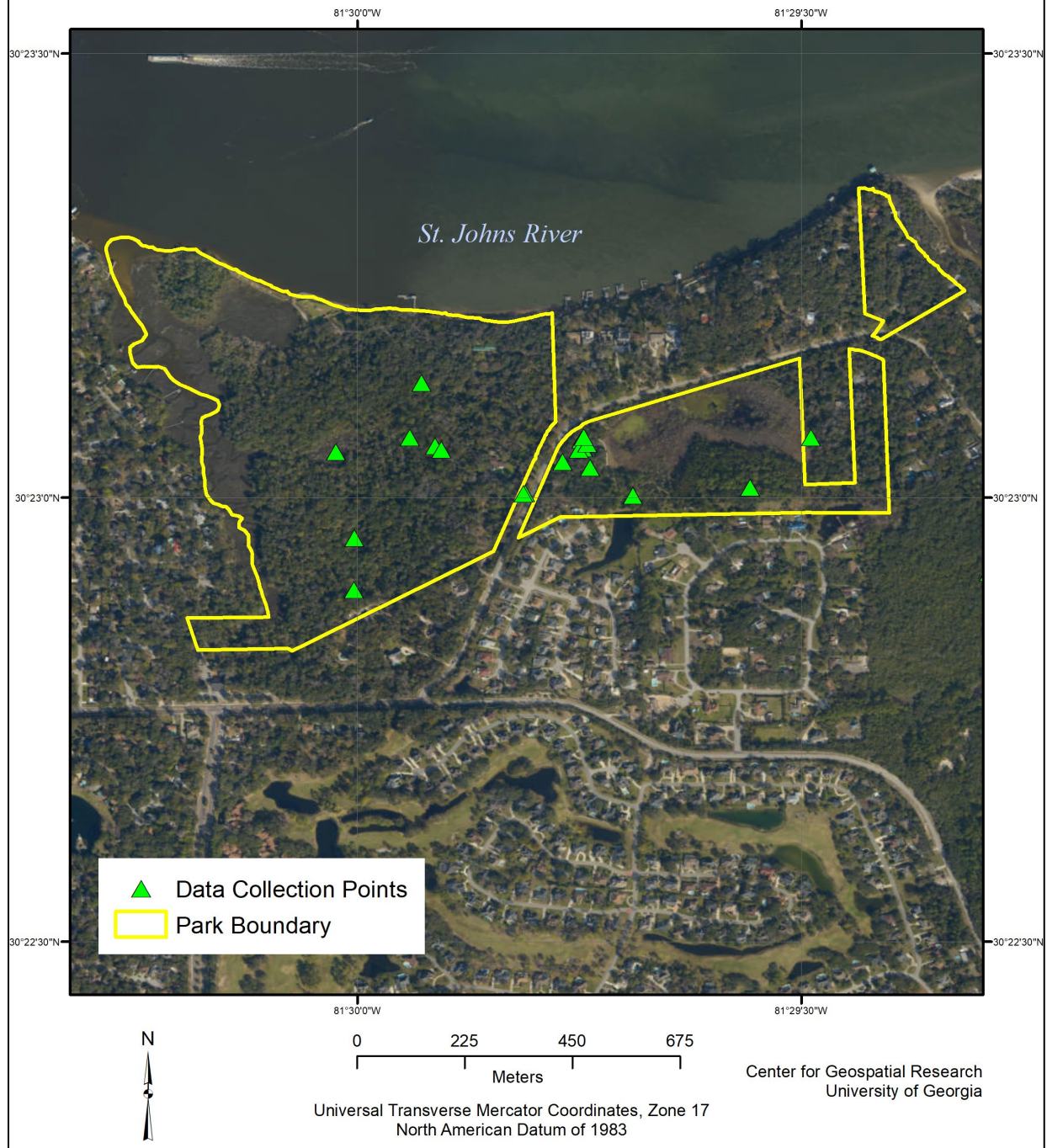


Figure 4. Field data collection locations from Fort Caroline National Memorial overlaid on visual imagery.

Photointerpretation and GIS Methods

The industry-standard GIS software, ArcGIS, offers a variety of methods and procedures to do most common mapping tasks. For the purposes of this project, photointerpretation was performed using heads-up digitizing methods in ArcGIS 10.2 using the CIR digital orthophotographs as the primary source material. Lines were drawn on-screen delineating the boundaries between different classes of vegetation. Where ecotones between features were broad, the line was drawn in the middle of the transition area. While the minimum mapping unit for this project was one half of a hectare (1.2 ac), features smaller than this threshold that were distinct and could be easily mapped were delineated.

As vegetation areas were delineated with vector lines, points were digitized within each delineated area. These points were assigned attribute information such as the dominate vegetation (a CEGL value if located within the park or an Anderson-type code for the buffer), secondary vegetation, a modifier, the interpreter's initials, the date, the confidence of the classification, and other relevant information.

After the line work was completed and points attributed, the lines were converted to polygons and the attributes assigned to each polygon by joining the tables of the point features and polygons based on spatial location. In this operation, the attributes of the point closest to the polygon were assigned to that polygon. A 'distance' field was also assigned which indicates the distance of the point location from the polygon. If the distance was zero, the point was inside the polygon. Any other value greater than zero meant that the point used to populate the attribute fields was outside of the polygon. Consequently, the 'distance > 0' values were used as flags to select and examine polygons that were not properly attributed. Where necessary, additional points were added to the database to complete the map. The process was repeated until all polygons were properly attributed.

The initial draft maps were plotted at large scale on 'E-size' (34 × 48 inches [86.4 × 121.9 centimeters {cm}]) paper such that the hollow polygons with their respective CEGL labels were overlaid on the original aerial photographs. Each polygon was individually inspected by a person not directly involved in the original mapping to make sure that the line work followed the vegetation feature properly, and that the CEGL codes were consistent with spectral signature. Edits were marked on the hardcopy maps and then applied to the database within ArcGIS. This review process was repeated to ensure completeness.

Additional editing and refinement were performed as necessary using information collected during the field surveys.

Final Vegetation Mapping and Summary Statistics

A total of 11 NVCS CEGL association level vegetation communities were found in Fort Caroline National Memorial; three of them were combined to create a separate combination classes due to lack of differentiation in aerial imagery and spectral signature. Five non-CEGL codes were used to describe areas of human influence or non-vegetation (Table 6).

In the buffer zone, there were nine distinct Anderson level II codes (Table 2). The park and buffer were further classified using modifiers (Table 3). These modifiers were generated by the University of Georgia Center for Geospatial Research to provide additional information regarding species content or areas with a large human influence. These classes and modifiers were used to create the final vegetation map (Figure 5).

Table 6. Land cover classes found within the park area of Fort Caroline National Memorial based on the National Vegetation Classification System.

Code	Class	Description
3643	Woodlands	Slash Pine Flatwoods
4178	Marsh	Tidal Sawgrass Marsh
4191	Marsh	Southern Atlantic Coast Salt Marsh
4423	Shrubland	Central Florida Willow Thicket
4883	Herbaceous and Graminoid Vegetation	St. Augustine Grass Herbaceous Vegetation
7044	Forest	Loblolly-bay Forest
7049	Forest	Outer Coastal Plain Sweetbay Swamp Forest
7694	Herbaceous and Graminoid Vegetation	Saltgrass - (Saltmarsh Dropseed) Herbaceous Vegetation
11007 ^a	Forest	3564 Southeastern Coastal Plain Xeric Hammock 7020 Southeastern Florida Maritime Hammock 7032 Maritime Live Oak Hammock
9994 ^b	Nonvegetated Cover	Cultural
9996 ^b	Nonvegetated Cover	Sand
9997 ^b	Nonvegetated Cover	Park Road
9998 ^b	Nonvegetated Cover	Park Structure or Building or Parking
9999 ^b	Nonvegetated Cover	Open Water

^a Not an NVCS Code. This value is a combination of two or more NVCS codes.

^b Not an NVCS Code.



FOCA Park Vegetation and Buffer Classes

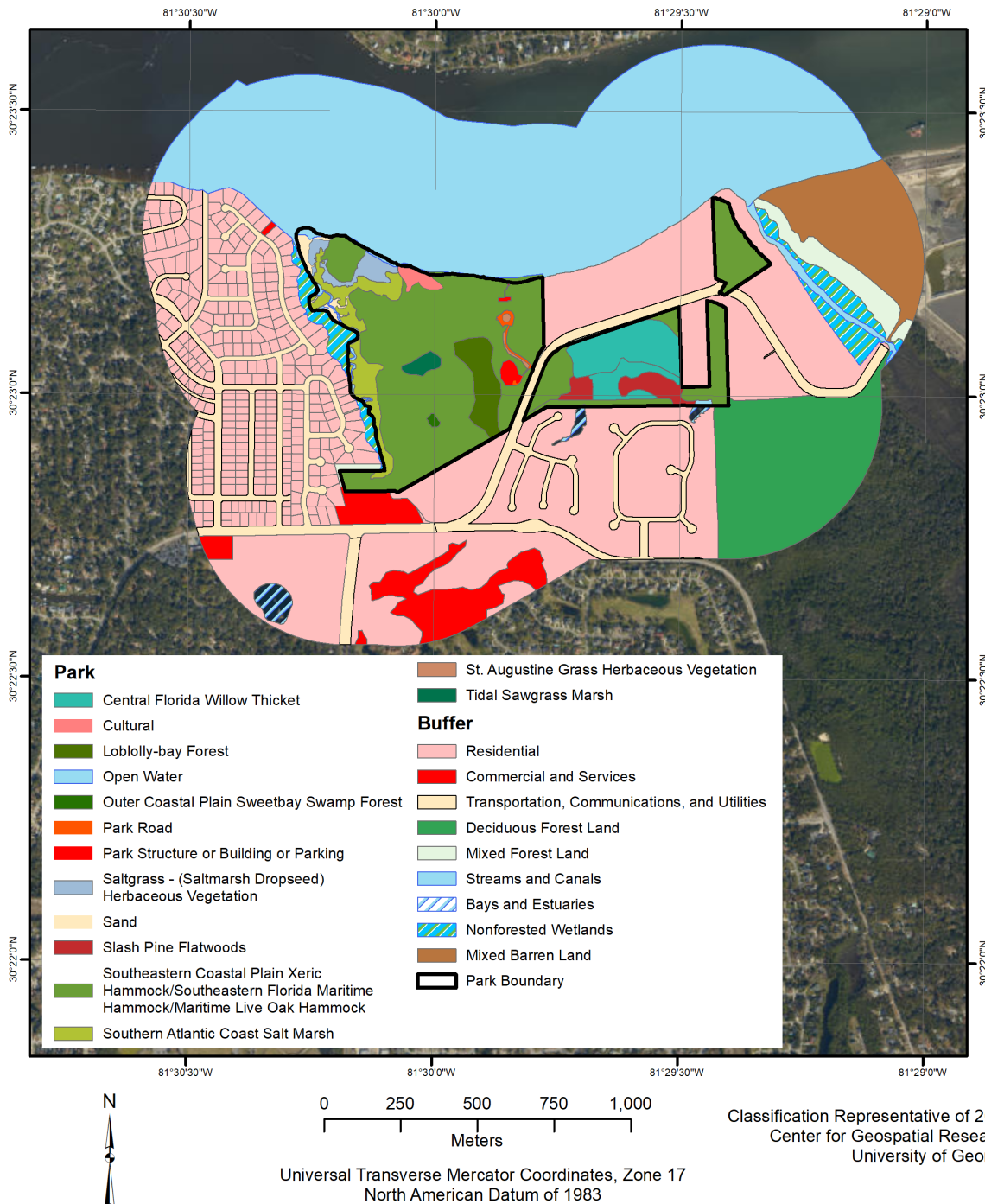


Figure 5. Vegetation map of Fort Caroline National Memorial.

The most common class found in Fort Caroline National Memorial is the combination class 11007 (3564—Southeastern Coastal Plain Xeric Hammock, 7020—Southeastern Florida Maritime Hammock, and 7032—Maritime Live Oak Hammock), covering approximately 64% of the Memorial (Table 7, Figure 6). The second most common class is 4423—Central Florida Willow Thicket, covering slightly over 11% of the park. All non-NVCS classes combined cover less than 5% of the total area of the park.

Table 7. Community element global code (CEGL) classes, frequency of occurrence, mean area, total area, and percentage of total area within the park boundary of Fort Caroline National Memorial [ha—hectares].

CEGL	Description	Frequency	Mean Area (ha)	Total Area (ha)	Percentage of Total Area
11007 ^a	3564 Southeastern Coastal Plain Xeric Hammock 7020 Southeastern Florida Maritime Hammock 7032 Maritime Live Oak Hammock	7	5.24	36.70	63.9%
4423	Central Florida Willow Thicket	2	3.24	6.48	11.3%
4191	Southern Atlantic Coast Salt Marsh	7	0.60	4.21	7.3%
7044	Loblolly-bay Forest	1	2.81	2.81	4.9%
3643	Slash Pine Flatwoods	2	1.00	1.99	3.5%
7694	Saltgrass - (Saltmarsh Dropseed) Herbaceous Vegetation	2	0.75	1.50	2.6%
9994 ^b	Cultural	1	0.70	0.70	1.2%
9996 ^b	Sand	5	0.13	0.67	1.2%
9999 ^b	Open Water	9	0.07	0.67	1.2%
4178	Tidal Sawgrass Marsh	1	0.60	0.60	1.1%
9998 ^b	Park Structure or Building or Parking	2	0.24	0.48	0.8%
9997 ^b	Park Road	1	0.31	0.31	0.5%
4883	St. Augustine Grass Herbaceous Vegetation	2	0.09	0.18	0.3%
7049	Outer Coastal Plain Sweetbay Swamp Forest	1	0.13	0.13	0.2%
Total	—	43	—	57.43	100.0%

^a Not an NVCS Code. This value is a combination of two or more NVCS codes.

^b Not an NVCS Code.

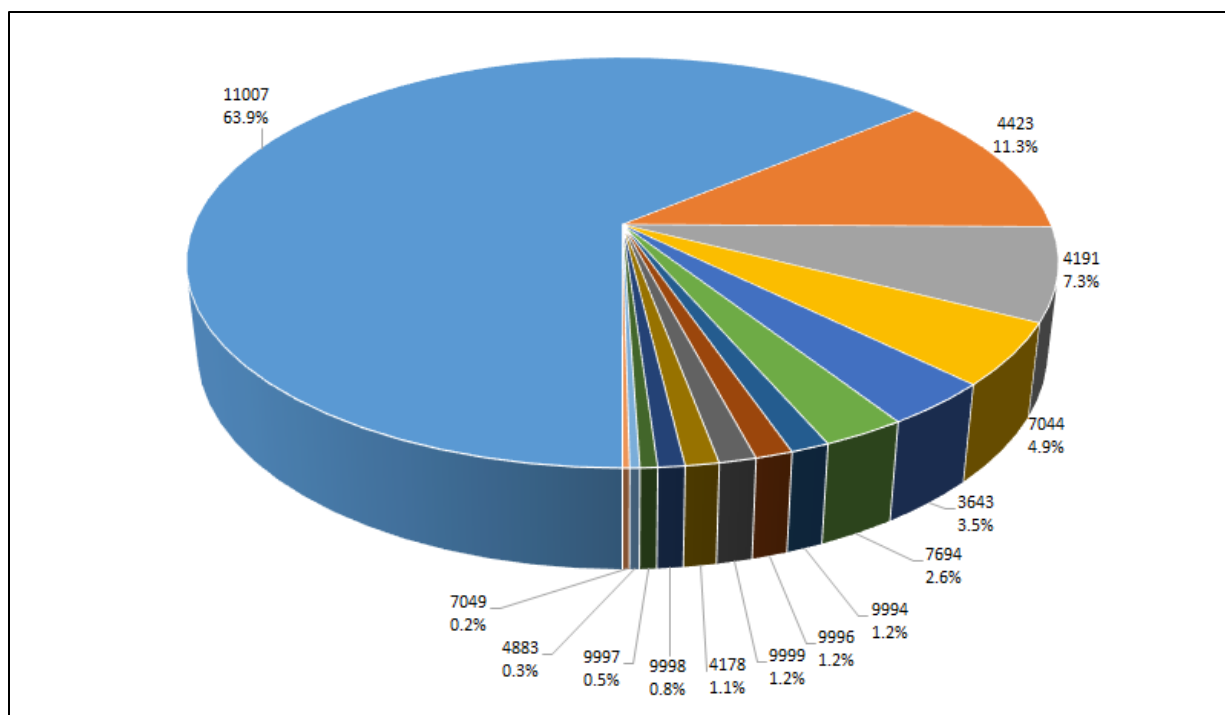


Figure 6. Park vegetation classes as a percentage of total area.

Within the buffer region of Fort Caroline National Memorial, the dominating class is Residential areas encompassing 40% of the total buffer area. Streams and Canals is the second most common class covering 33% of the buffer. Seven other classes cover the remaining 27% (Table 8, Figure 7).

Table 8. Land use/land cover class, frequency of occurrence, mean area, total area, and percentage of total area within the buffer area of Fort Caroline National Memorial [ha—hectares].

Class	Frequency	Mean Area (ha)	Total Area (ha)	Percentage of Total Area
Residential	347	0.37	127.84	39.56%
Streams and Canals	2	53.29	106.58	32.98%
Transportation, Communications, and Utilities	4	6.85	27.40	8.48%
Deciduous Forest Land	1	23.40	23.40	7.24%
Mixed Barren Land	1	13.99	13.99	4.33%
Commercial and Services	5	2.15	10.75	3.33%
Nonforested Wetlands	6	1.11	6.64	2.06%
Mixed Forest Land	5	0.96	4.80	1.49%
Bays and Estuaries	3	0.58	1.75	0.54%
Total	374	—	323.16	100.0

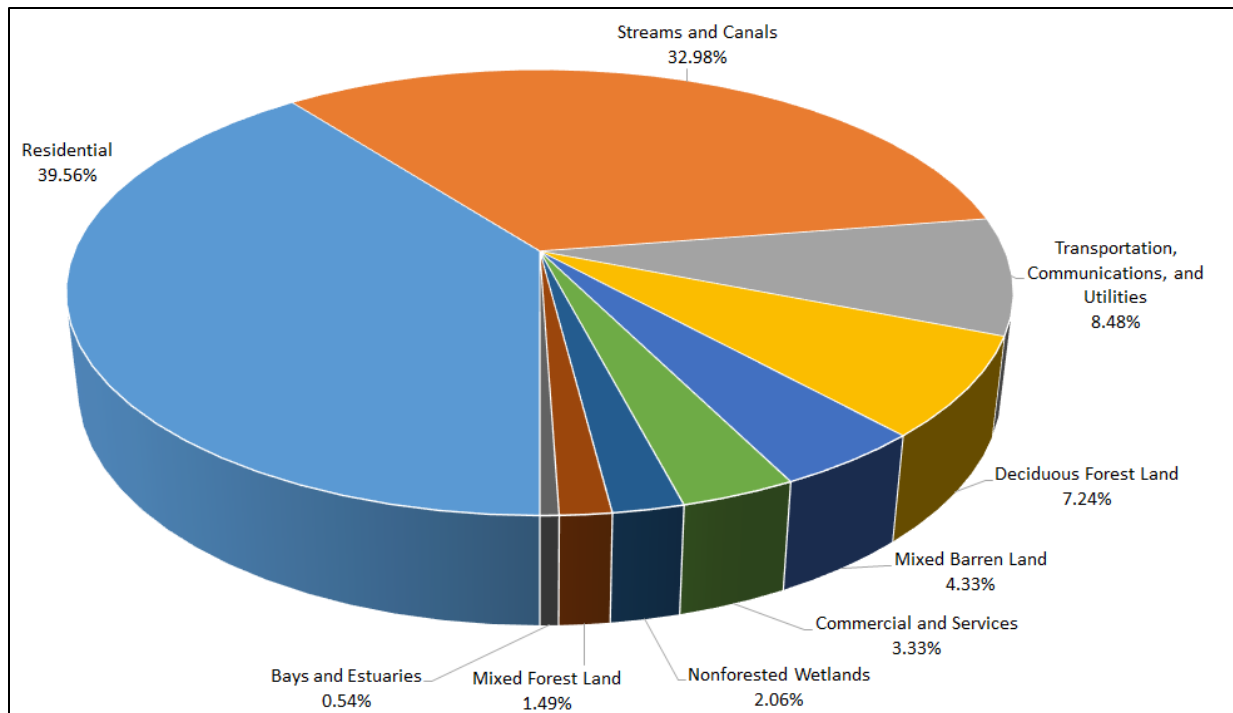


Figure 7. Buffer classes organized by relative size found in Fort Caroline National Memorial.

Modifiers were utilized throughout the park to further enhance the classification system. The modifier system was based on whether the area was heavily influenced by residential areas (Res) or if the area had emergent dwarf vegetation (dwarf; Table 9).

Table 9. Modifiers used throughout the park, including frequency of occurrence, mean area, and total area [ha—hectares].

Code	Description	Frequency	Mean Area (ha)	Total Area (ha)
Res	Residential	3	1.90	5.70
dwarf	Dwarf vegetation	1	4.70	4.70
Total	—	4	—	10.40

Accuracy Assessment

Point Selection

As a part of the total mapping effort, a separate accuracy analysis of the thematic contents of the vegetation maps is required. Only classes with CEGLE codes assigned and only polygons that fall within the prescribed park boundary are evaluated. To accomplish this, a set of points is selected to represent the distribution and rarity of the mapped vegetation classes. The number of accuracy assessment (AA) sample points per class depends on the total area (in hectares) of the particular vegetation class within the map area, according to the rule set established by the NPS for this purpose (Lea and Curtis 2010):

- Classes with < 8.33 ha
 - 5 points per class
- Classes with ≥ 8.33 AND < 50 ha
 - number of points is $0.6 \times$ the area in ha
- Classes with ≥ 50 ha
 - 30 points per class

Protocol dictates that the points be randomly distributed and stratified by class. For example, if 30 points are required for a particular class, those 30 points should be randomly distributed within all of the polygons of that particular class. The distribution of classes, the number of polygons, and the areas of each class is given in Table 7.

Point Acquisition

The Accuracy Assessment points were collected on February 2, 3, 4, 5, and 8, 2016 by J. Ryan and I. Weber. Figure 8 shows the locations of these points and Appendix C has the detailed information gathered at each of the 54 half of a hectare (1.2 ac) accuracy assessment plot locations.

Accuracy of Vegetation Map

Once the accuracy assessment plot data were received, they were overlaid on top of the draft vegetation maps to determine the accuracy of the map. This process entailed determining whether predicted vegetation classes matched observed accuracy assessment plots. To ensure the most accurate assessment was made, all the AA plots went through a series of quality assurance and quality control (QA/QC) processes that considered numerous factors in determining if the accuracy assessment plots were placed in locations representative of their polygons. Plots that were deemed unrepresentative of the polygons in question were removed from the final analysis. The different QA/QC categories are presented in Table 10, and the final accuracy assessment is presented in Table 11a–b.



FOCA Accuracy Assessment Plots

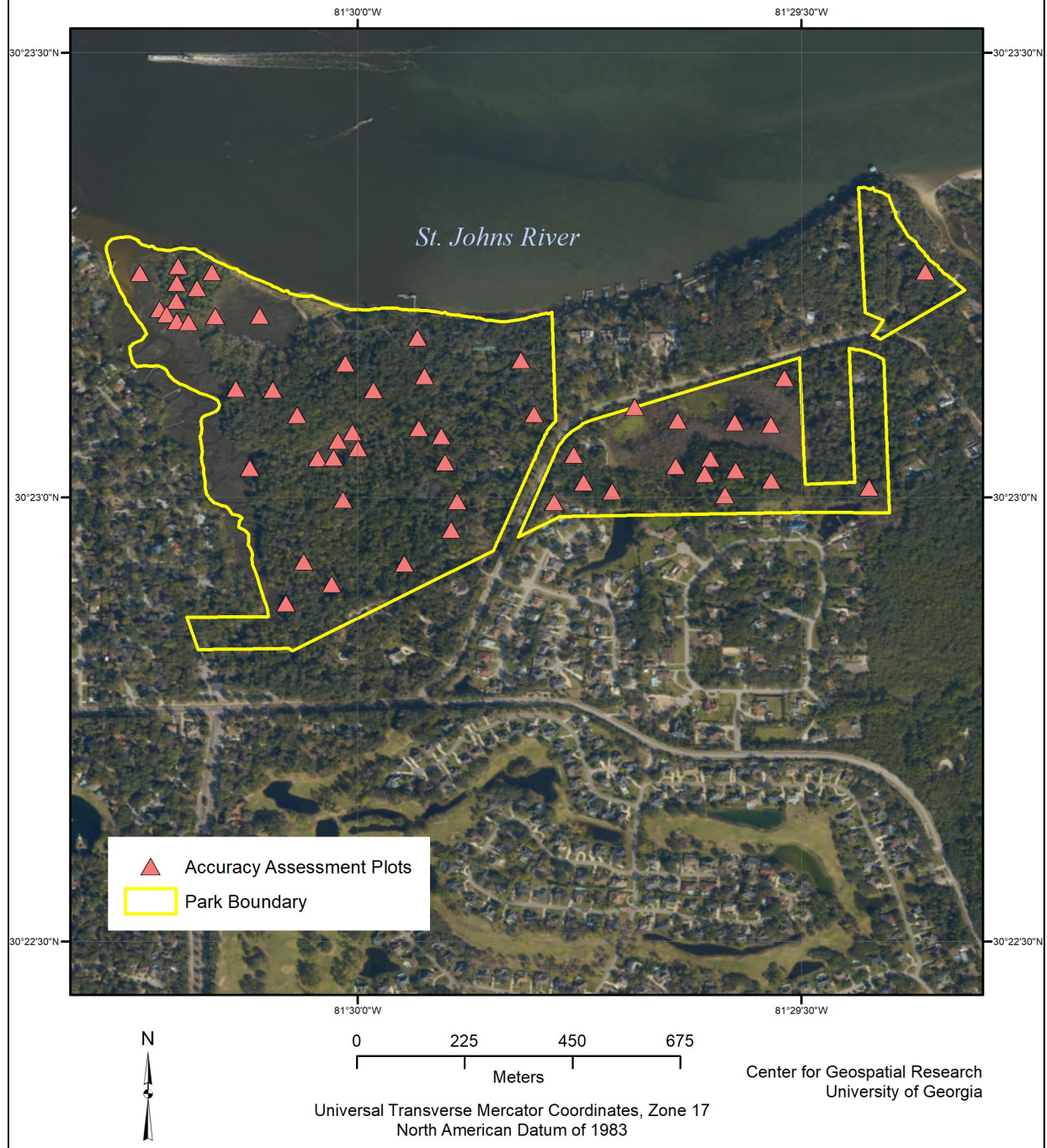


Figure 8. Accuracy Assessment plot locations in Fort Caroline National Memorial.

Table 10. Breakdown of how the AA plots are related to the vegetation polygons and 2012 imagery.

Type	Code	Number	Status for Final Analysis
Perfect match – primary codes matched	L1	12	Retained
Alternate/Secondary Code match	L2	1	Retained
Merged class with an existing vegetation class	M1	14	Retained (4 polygons with merged classes)
Incorrect match	C1	9	Retained
Key discrepancies – disagreements, with nearby NatureServe vegetation plot	N1	6	Kicked Out
Plot surveyed outside of the park	O1	1	Kicked Out
Spatial Error – plots were within an ecotone	S1	3	Kicked Out
Spatial Error – smaller than minimum mapping unit	S2	2	Kicked Out
Temporal Error – changes since images were acquired	T1	6	Kicked Out
Total	–	54	36 used for analysis

Table 11a. Confusion matrix for the accuracy assessment. The rows are the expected vegetation class as predicted by the photo interpretation conducted by the UGA Center for Geospatial Research, and the columns are the observed vegetation class at the AA point.

Vegetation Class	3643	3825	4178	4186	4191	4423	4788	7032	7044	7848	11007	Total
3643	3	0	0	0	0	0	0	0	0	0	0	3
3825	0	0	0	0	0	0	0	0	0	0	0	0
4178	0	0	3	0	0	0	0	0	0	0	0	3
4186	0	0	0	0	0	0	0	0	0	0	0	0
4191²	0	0	0	1	1	0	0	0	0	0	0	2
4423	1	1	0	0	0	3	0	0	0	0	0	5
4788	0	0	0	0	0	0	0	0	0	0	0	0
7032	0	0	0	0	0	0	0	3	0	0	0	3
7044	0	0	0	0	0	0	0	2	0	0	0	2
7848	0	0	0	0	0	0	0	0	0	0	0	0
11007	0	0	0	0	0	0	3	0	0	1	14	18
Total	4	1	3	1	1	3	3	5	0	1	14	36

Table 11b. Accuracy and error for the confusion matrix. Overall accuracy is 75. Kappa is 67.

Accuracy / error type	3643	3825	4178	4186	4191	4423	4788	7032	7044	7848	11007
Producer Accuracy	75 ^a	0 ^b	100 ^a	0 ^b	100 ^a	100 ^a	0 ^b	60 ^b	0 ^b	0 ^b	100 ^a
Omission Error	25	100	0	100	0	0	100	40	0	100	0
User Accuracy	100 ^a	0 ^b	100 ^a	0 ^b	50 ^b	60 ^b	0 ^b	100 ^a	0 ^b	0 ^b	78 ^a
Commission Error	0	0	0	0	50	40	0	0	100	0	22

^a Green represents accuracy greater than or equal to 70%

^b Red represents accuracy less than 70%

Quality Assurance of AA Plots

The AA plots were divided into nine categories to better understand issues regarding representativeness of accuracy assessment plot locations within Fort Caroline National Memorial (Table 10): “perfect match” (L1) if AA plots were assigned the same CEGLE code as the polygon that they fell in, if a secondary class determined by photo interpretation method matched the accuracy assessment point (L2), if the AA plot description was indistinguishable from other vegetation classes and therefore merged with those classes (M1), incorrect matches between the University of Georgia Center for Geospatial Research and the AA plots (C1), if the AA plot description greatly differed from an overlapping NatureServe plot (N1), if the plot was located outside of the park boundary (O1), if the plot was located within an ecotone of adjacent polygons, e.g. less than 20 meters (65.6 ft) from a border (S1), if the plot was located within an area smaller than the minimum mapping unit (MMU; S2), and if successional areas influenced the AA plot, since the imagery and AA plots differed by four years (T1).

The AA plot locations were randomly selected within a given polygon, therefore, there was no guarantee that they landed in a location representative of either the polygon or of the plant associations included within the polygon’s map unit. For example, an AA point could easily land in a small gully, an inclusion that is too small to map, i.e. less than the minimum mapping unit (0.5 hectare [1.2 ac]), or an ecotone where trees are invading a shrub land. To account for these situations, field observers were tasked with determining not only the vegetation within the AA sample area, but the surrounding area as well. These instances included AA plots that fell inside of an ecotone or inclusion, or in an anomalous situation such as in a gully or sandy area (McManamay et al. 2012).

The AA plots labeled as merged classes refer to those that were indistinguishable from other classes. All these locations involved the 7032—Maritime Live Oak Hammock 7032 and 7020—Southeastern Florida Maritime Hammock, thus these classes were merged, and the accompanying AA plots were labeled M1.

Discrepancies between plot locations that disagreed with a nearby NatureServe (within 40 m) vegetation plot were labeled “key discrepancies” (N1). Discrepancies such as these were expected since the park has many successional classes and wetland regions. For instance, AA plots 30 and 31 were labeled 4658—Maritime Slash Pine Upland Flatwoods but were within 35 meters (114.8 ft) of

NatureServe plot labeled TIMU13 7044—Loblolly-bay Forest. A total of six plots were removed due to this reason.

The AA plots that were found to overlap ecotones between polygons or were within an area smaller than minimum mapping unit were labeled “spatial error” (S1 and S2). Plots that fall in these regions are difficult to classify and can be easily misinterpreted therefore those five points were removed accordingly.

Discrepancies between what could be seen from an aerial perspective versus the ground perspective were also considered. These AA plots were labeled “temporal error” (T1). Those six instances were removed since the accuracy assessment was done four years after the aerial imagery was flown and some areas in the park changed vegetation classes over that time. Discrepancies such as these were expected, due to vegetation changes over time. These only occurred in AA plots labeled 4191—Southern Atlantic Coast Salt Marsh but were identified through the imagery as 7694—Saltgrass - (Saltmarsh Dropseed) Herbaceous Vegetation. These are two very dynamic classes that can change in just one or two seasons.

All available data was used to create a final vegetation classification for Fort Caroline National Monument and the confusion matrix for the park is show in Table 11a–b. Overall, 18 AA points were removed (N1, O1, S1, S2, and T1) based on the points lying in locations that were deemed unrepresentative of the polygon or imagery from 2012. This left 36 AA plots were used to assess the map based on the 2012 imagery. The overall assessment showed a 75% accuracy and a kappa rating of 67% using the 36 AA plots.

Potential Improvements

During the analysis of this park a few key issues were identified that could increase the efficiency and effectiveness of this process. These issues, which will be described in more detail below, involve supplying the AA surveyors with basic data, including the CIR imagery used for photointerpretation, polygon boundaries (unlabeled), and NatureServe plot information.

The largest errors associated with the AA plots in Fort Caroline National Memorial were based on key discrepancies (N1; Table 10). Accuracy assessment surveyors should have access to the NatureServe plot locations and information, this would allow them to better understand the system the photo interpretation was based upon. There were six instances that have a NatureServe and AA point within 40 meters (131.2 ft) of each other that assign conflicting classes.

Spatial and temporal mismatches also contributed to errors associated with the AA plots in the Memorial. If the AA surveyors were provided digital copies of the aerial photographs, in GeoPDF form, they could see the vegetation from an aerial perspective, thus providing a broader context of the area in question. Using the GeoPDF format, blank polygon files could be provided to reduce errors caused by AA plots that are within 20 meters (65.6 ft; or many times even less) to a polygon boundary (S1), or located in areas that have drastically changed since the imagery was acquired (T1). These areas are very difficult to classify and typically represent a very gradual change between

vegetation classes that could span tens of meters. By utilizing this technique even more errors can be reduced: 11 of 54 for Fort Caroline National Memorial were attributed to these errors.

Overall, using these simple additions, 31% more points could have been used in the accuracy assessment of the park.

Conclusion

A final vegetation map for Fort Caroline National Memorial was created to represent the vegetation occurring within the park during 2012. This product represents the final of four steps necessary to produce an accurate vegetation map based upon aerial photographs. This includes the determination of the CEGLE codes (2008) and acquisition of aerial imagery (2012), using aerial imagery, with ground truthing (2014), to create a draft vegetation map, performing an accuracy assessment (2016), and then using all the available information to create a final vegetation map (2018).

The most common class found in the Memorial is the combination class 11007 (3564—Southeastern Coastal Plain Xeric Hammock, 7020—Southeastern Florida Maritime Hammock, and 7032—Maritime Live Oak Hammock) covers roughly 64% of the park. In the 500-meter (1,640-ft) buffer zone surrounding the park, almost three-quarters (73%) of the area is Residential (40%) or Streams and Canals (33%). The third largest class, Transportation, Communications, and Utilities, covers eight percent.

Producing an accurate vegetation map based on color infrared imagery is a lengthy process and can take three to seven years to complete. During this time, disturbances may change some areas significantly. As a result, conclusions made from ground observations conducted during the middle or end of the overall process may be different from conclusions made from interpreting aerial photographs that were collected at the onset of the project.

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Appendix A. NatureServe Vegetation Plot Locations and Notes

Table A-1. Field data acquired by G. Shultz on November 7, 8, 9, and 30 and December 5 and 6, 2006.

Plot Code	Field X	Field Y	Provisional	Classified Community Name	ELCODE	Leaf Phenology	Leaf Type	Physiological Class
TIMU11	451825	3361775	Tidal Marsh	Distichlis spicata - (Sporobolus virginicus) Herbaceous Vegetation	7694	Perennial herb	Graminoid	Herbaceous vegetation
TIMU12	451683	3361843	Maritime Hammock	Quercus virginiana - (Pinus elliottii var. elliottii, Sabal palmetto) / Persea borbonia - Callicarpa americana Forest	7032	Evergreen	Broad-leaved	Forest
TIMU13	452101	3361465	Baygall	Gordonia lasianthus - Magnolia virginiana - Persea palustris / Sphagnum spp. Forest	7044	Evergreen	Mixed broad-leaved	Forest
TIMU14	451909	3361140	Mesic Hammock	Quercus geminata / Vaccinium arboreum Forest	3564	Mixed evergreen - cold-deciduous	Broad-leaved	Forest
TIMU15	451956	3361282	Baygall	Magnolia virginiana - Persea palustris / Lyonia lucida Forest	7049	Evergreen	Broad-leaved	Shrubland
TIMU16	451753	3361641	Mesic Flatwoods	Quercus geminata - (Quercus virginiana) / Serenoa repens - Lyonia fruticosa Forest	7020	Evergreen	Mixed broad-leaved	Forest
TIMU21	452736	3361502	Depression Marsh	Salix caroliniana / Decodon verticillatus / Typha latifolia Forest	4423	Cold-deciduous	Mixed broad-leaved	Shrubland
TIMU25	452498	3361374	Depression Marsh	Salix caroliniana / Decodon verticillatus / Typha latifolia Forest	4423	Cold-deciduous	Broad-leaved	Shrubland
TIMU26	452680	3361399	Mesic Flatwoods	Pinus elliottii var. elliottii / Serenoa repens - Ilex glabra Woodland	3643	Evergreen	Needle-leaved	Forest
TIMU27	451945	3361470	Tidal Marsh	Cladium mariscus ssp. jamaicense Tidal Herbaceous Vegetation	4178	Perennial herb	Graminoid	Herbaceous vegetation

Appendix B. Flight Line Information

Table B-1. Fort Caroline National Memorial flight line and photo numbers and photo center coordinates (UTM Zone 17, NAD83). Photos were acquired by Aero-Metric at 1:12,000 scale on May 11, 2012.

Flight line	Photo	Easting	Northing
1	1-172	451213.0353	3362830.9989
1	1-173	451187.6353	3361713.3967
1	1-174	451124.1351	3360608.4945
2	1-133	453079.939	3360449.7441
2	1-134	453111.6891	3361554.6464
2	1-135	453162.4892	3362640.4985

Appendix C. Accuracy Assessment

Table C-1. Data points acquired by J. Ryan and I. Weber, November 11, 2015.

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_000100	2/2/2016 0:00	ryan + 3	-81.49886803	30.38632234	on a slope, probably relic sand dune.	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000200	2/2/2016 0:00	Ryan + 3	-81.50158476	30.38534623	–	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000400	2/3/2016 0:00	JR KB	-81.500477	30.38169405	PRIMARILY OAK. On downslope of sand dune off of park trail.	TRUE	CEGL007032	CABBAGE PALM NOT OBSERVED, but this is best fit	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000500	2/2/2016 0:00	Weber +3	-81.50022052	30.38583965	old dune	TRUE	CEGL007032	few pinus sp at edge of poly	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000600	2/5/2016 0:00	jr kb	-81.49692626	30.38589438	pt is on utility ROW so moved field pt approx 5 meters SW of ROW	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000700	2/5/2016 0:00	jr kb	-81.49668169	30.38488921	forested area btweenpark entrance road and utility ROW	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000800	2/5/2016 0:00	jr kb	-81.49874163	30.38559855	park trail is approx 4 meters N of pt	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_000900	2/2/2016 0:00	ryan + 3	-81.49970021	30.38533548	on downslope from water, likely relic dune	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_001000	2/2/2016 0:00	Ryan + 3	-81.50112494	30.38487046	–	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001100	2/8/2016 0:00	jr kb	-81.50026951	30.38328054	–	TRUE	CEGL004788	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001200	2/3/2016 0:00	JR KB	-81.50100949	30.3821193	FORESTED HARDWOODS	TRUE	CEGL007032	only 2 Magnolia grandiflora observed in polygon	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001300	2/3/2016 0:00	JR KB	-81.49911435	30.38208336	park trail located SE edge of 0.5 ha polygon	TRUE	CEGL004788	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001400	2/2/2016 0:00	ryan + 3	-81.50183062	30.38672994	SALT MARSH	TRUE	CEGL004191	marsh a patchwork of these 2 types	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001500	2/2/2016 0:00	Ryan + 3	-81.50228176	30.38535805	pt 15 is approx 200 meters west of GPS pt. Could not access due to high water. Referring to nps pt - could not access. Observed from high bank on creek. 3 photos taken from high bank. Is tidal marsh.	TRUE	CEGL004191	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001600	2/3/2016 0:00	JR KB	-81.50201578	30.3838813	TIDAL MARSH. NPS pt is 25 meters W of field point.	TRUE	CEGL004186	JUNCUS AND SPARTINA INTERMIXED IN THIS LOCATION	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_001700	2/3/2016 0:00	JR KB	-81.5013437	30.38133617	OBSERVED FROM SHORE OF MARSH. NPS PT IS 19 meters W of field pt.	TRUE	CEGL004186	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001800	2/2/2016 0:00	ryan + 3	-81.50408524	30.38753429	marsh, tidal	TRUE	CEGL004186	salt marsh with dominant vegetation segregated, i.e not intermixed, is mosaic	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_001900	2/8/2016 0:00	jr kb	-81.49479236	30.38501623	NPS PT is meters W of Trimble field point due to deep water. Ground photo at Trimble field pt location.	TRUE	CEGL004178	best fit. Few clumps of sawgrass in polygon, and dense sawgeass nearby in polygon pt 20	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_002000	2/8/2016 0:00	JR KB	-81.49401787	30.38391101	and graminoid leaf type. NPS pt is approx 30 meters WSW of Trimble field pt. Dense saw grass and very mucky soil. But then Walked to SE side of polygon pt 20 from park trail. Observed dog fennel primarily.	TRUE	CEGL004178	dense high sawgrass, could not see far into marsh, so 0.25 ha. Then walked on park trail to SW side of polygon, observed dog fennel as dominant.	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA _002100	2/8/2016 0:00	jr kb	-81.49291559	30.38472972	deep open water marsh. NPS point is 46 meters NW of Trimble field point.	TRUE	CEGL004423	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _002200	2/8/2016 0:00	jr kb	-81.49223427	30.38468234	stagnant sulfur odor	TRUE	CEGL004423	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _002300	2/8/2016 0:00	jr kb	-81.49398467	30.38476471	and graminoid leaf type. Marsh.freshwater	TRUE	CEGL004423	Double check with photos. Giant plume grass possibly Arundo donax	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _002500	2/8/2016 0:00	jr kb	-81.48934163	30.38755659	residential driveway and residence to S and SE of Trimble field pt. Paved park road to W of Trimble field pt. Moved Trimble field point approx 50 meters NNW of NPS point to obtain more representative view of community. NPS pt was on park fenceline imm	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _002600	2/8/2016 0:00	jr kb	-81.49198302	30.38556527	paved road nearby	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_002800	2/5/2016 0:00	jr kb	-81.49039618	30.38351128	nps and field pt are S of park trail. Possible mature tallow near red maple this location. No leaves but looks like popcorn.	TRUE	CEGL007848	2 communities one at lower elev dominated by red maple the most south area. Other area dominated by cherry, laurel and palms and saw palmetto in north area.	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_002900	2/3/2016 0:00	JR KB	-81.49884905	30.38462389	FORESTED MIXED, water control structure - concrete culvert - on edge of polygon, and associated small "creek" to the E of gps pt (both). 2 photos of culvert, 1 photo of creek.	TRUE	CEGL007049	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003000	2/3/2016 0:00	JR KB	-81.49841952	30.38447642	TO THE E AND N of 0.25 ha is park trail and raised berm. Appears similar - community - to n of berm (outside of polygon). 2 PHOTOS FROM NE corner of polygon to show trail and berm.	TRUE	CEGL004658	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_003100	2/3/2016 0:00	JR KB	-81.49835131	30.38397838	FORESTED mixed	TRUE	CEGL004658	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003200	2/3/2016 0:00	JR KB	-81.49812126	30.38325501	NPS 32 PT IS approx 20 m W of field pt. Because nps ptr 32 was on park trail. Same trail as SEEN IN photo at pt 30.	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003300	2/3/2016 0:00	JR KB	-81.49824209	30.38271663	–	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003400	2/5/2016 0:00	jr kb	-81.49337136	30.38404858	pine duff layer. Saturated soil beneath duff. Heavy rain last evening.	TRUE	CEGL003643	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003500	2/5/2016 0:00	jr kb	-81.49347666	30.38376285	nps pt 3 was on trail so moved N into woods to record data	TRUE	CEGL003812	ck key. No cabbage palm no ilex vomit. Saw palmetto is dense next to park trail (SE edge of polygon). Northern area of polygon the understory is more open, similar to pt 34.	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003600	2/5/2016 0:00	jr kb	-81.49289317	30.38383565	nps pt 36 approx 4 meters N of trail	TRUE	CEGL003643	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA_003700	2/5/2016 0:00	jr kb	-81.49223094	30.38364197	very dense saw palmetto	TRUE	CEGL003643	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003800	2/5/2016 0:00	jr kb	-81.49310276	30.38337015	walked S from park trail thru dense high saw palmetto to reach nps pt 38. Pine tree are on very edge of community	TRUE	CEGL003825	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_003900	2/5/2016 0:00	jr kb	-81.49593745	30.38412588	maintained (mowed) area encircled by asphalt at the Spanish Pond NPS parking area. Mature hardwoods present.	TRUE	CEGL004788	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_004000	2/5/2016 0:00	jr kb	-81.49574856	30.38360057	–	TRUE	CEGL007032	best fit but will CHECK KE	3/30/2016 0:00	Daniel Gwartney
FOCA_AA_004100	2/5/2016 0:00	jr kb	-81.49630641	30.38323894	small area standing water within polygon on ESE area of polygon, then fence, then residential	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA _004200	2/5/2016 0:00	JR KB	-81.49521777	30.38343508	0.25 HA since polygon is approx 10 meters from park trail. Standing water observed and saturated soil in area. Heavy rain last night.	TRUE	CEGL003643	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004300	2/2/2016 0:00	Ryan +3	-81.50335798	30.38766501	–	TRUE	CEGL003525	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004400	2/2/2016 0:00	Ryan + 3	-81.50338926	30.38734531	–	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004500	2/2/2016 0:00	Ryan + 3	-81.5033914	30.38701306	upland near marsh	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004600	2/2/2016 0:00	Ryan + 3	-81.50300579	30.38725485	–	TRUE	CEGL004674	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004700	2/2/2016 0:00	ryan + 3	-81.50272397	30.38755105	–	TRUE	CEGL007032	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _004800	2/8/2016 0:00	jr kb	-81.50009018	30.38454168	marsh. Herbaceous and shrub. PINE AND OAK ON EDGE OF POLYGON	TRUE	CEGL004191	–	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA _004900	2/4/2016 0:00	jr kb	-81.49998709	30.3842428	standing on small mound of higher ground where cedar is growing. Graminoid leaves too. Palm trees: many in marsh are dead, have woodpecker holes in dead palm trunk. Minimal living sabal palmetto present.	TRUE	CEGL004178	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005000	2/8/2016 0:00	jr kb	-81.50036737	30.38438796	marsh. Nps pt is 20 meters S of trimble field pt. Water depth and mucky sediment prevented access to nps pt location but have clear view fr trimble pt.	TRUE	CEGL004178	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005100	2/4/2016 0:00	jr kb	-81.50073806	30.3840655	marsh. Nps pt is 30 meters W of tablet field pt.	TRUE	CEGL004186	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005200	2/4/2016 0:00	jr kb	-81.50044258	30.38407001	marsh. Subcanopy trees listed are along edge of marsh, edge of polygon	TRUE	CEGL004178	typha and black rush mosaic.	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005300	2/2/2016 0:00	Ryan + 3	-81.50371406	30.38685637	very similar to 54. 50 50 sporobolus and juncus	TRUE	CEGL004186	2 communities are mosaic within polygon	3/30/2016 0:00	Daniel Gwartney

AA_Event	Event Date	Surveyors	X	Y	Environment	AA Photos	Primary_co	General_Co	AA Update	AA User
FOCA_AA _005400	2/2/2016 0:00	Ryan + 3	-81.50358448	30.38675917	tidal marsh	TRUE	CEGL004186	2 communities are a mosaic within polygon	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005500	2/2/2016 0:00	Ryan +3	-81.50338768	30.38663031	identical to 56 except forested edge further from nps/gps point, so did not list forest edge veg. Graminoid leaf type present too.	TRUE	CEGL004186	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005600	2/2/2016 0:00	Ryan + 3	-81.50316811	30.38660882	tidal marsh with forested edge. Broad leaved in forested area.	TRUE	CEGL004186	–	3/30/2016 0:00	Daniel Gwartney
FOCA_AA _005700	2/2/2016 0:00	Ryan + 3	-81.5026657	30.38671996	tidal marsh	TRUE	CEGL004186	–	3/30/2016 0:00	Daniel Gwartney

Appendix D. Photointerpretation Key

The photointerpretation key describes the attributes of the color infrared (CIR) images used to delineate the vegetation association CEGl codes found within the park. For each CEGl code, a CIR image chip from within the park is included. For most CEGl codes, we also included a ground based digital photo of the vegetation, taken within the park. The standard visual cues to interpret and distinguish vegetation are described, including color, tone, texture, and pattern. When applicable, we also include comments on location within the park or topographic position. If there were other vegetation associations within the park that appeared similar on the CIR photographs, traits used to distinguish between similar vegetation associations are described.

The Vegetation Description for the CEGl codes within the park was copied directly from NatureServe (2009) to provide plot level information on species composition, dominance, characteristic species, and percent estimate of vegetation cover in understory, midstory, or canopy. It also includes the Global Description and geographic distribution. A separate literature cited section of the references from NatureServe (2009) text that was directly copied into the photointerpretation key is included at the end of this appendix.

Slash Pine Flatwoods

Attributes, descriptions, and a map are shown in Table D-1 and Figure D-1.

Table D-1. Attributes and Descriptions for Slash Pine Flatwoods.

Attribute	Description
CEGL Code	3643
Community Name	Slash Pine Flatwoods
Color	Red to purple
Tone	Medium
Texture	Coarse
Pattern	Patchy, uneven
Height	Tall
Shape	Dense coverage
Size	Small
Comments	Near of high human influence

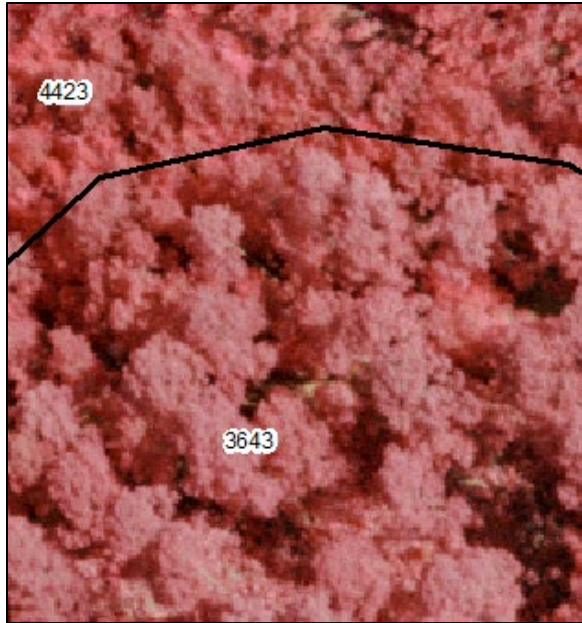


Figure D-1. Map showing Cultivated Meadow Light (3643).

Summary

Fort Caroline National Memorial Vegetation:

The moderate to dense (60–80% cover) tree canopy, 15–35 meters (49.2–114.8 feet [ft]) tall, is dominated by *Pinus elliottii* (slash pine); one plot (much wetter than the others) is codominated by *Pinus serotina* (pond pine). The very sparse to moderate (5–50%) subcanopy (5–15 meters [16.4–49.2 ft]) is dominated by *Persea palustris* (swamp bay) and may include *Ilex cassine* (dahoon), *Quercus nigra* (water oak), and *Quercus virginiana* (live oak), among others. The sparse to moderate (10–60%) tall-shrub layer (2–5 meters [6.6–16.4 ft]) is dominated by *Ilex glabra* (inkberry), while the sparse to closed (20–100%) short-shrub layer (1–2 meters [3.3–6.6 ft]) is dominated by *Serenoa repens* (saw palmetto). Additional shrubs may include *Lyonia fruticosa* (coastalplain staggerbush), *Morella cerifera* (wax myrtle), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium myrsinites* (shiny blueberry), and saplings of species from the upper layers. The variable (0–50%) herbaceous layer is dominated by the fern *Pteridium aquilinum* (western brackenfern). *Smilax glauca* (cat greenbrier) is the dominant vine (5–20%); others may include *Gelsemium sempervirens* (evening trumpetflower), *Smilax auriculata* (earleaf greenbrier), and *Vitis rotundifolia* (muscadine).

Global Vegetation:

Pinus elliottii var. *elliottii* (Honduras pine) dominates the generally open canopy. *Pinus palustris* (longleaf pine) or *Gordonia lasianthus* (loblolly bay) and *Pinus serotina* (pond pine) can be present, even codominant. The dense shrub stratum consists primarily of *Ilex glabra* (inkberry) and *Serenoa repens* (saw palmetto). Other common shrubs include *Persea palustris* (swamp bay), *Gaylussacia nana* (Confederate huckleberry), *Gaylussacia dumosa* (dwarf huckleberry), *Gaylussacia tomentosa* (hairytwig huckleberry), *Photinia pyrifolia* (red chokeberry), *Quercus minima* (dwarf live oak), *Ilex coriacea* (large gallberry), *Vaccinium elliottii* (Elliott's blueberry), *Acer rubrum* (red maple),

Vaccinium formosum (southern blueberry), *Befaria racemose* (tarflower), *Lyonia ferruginea* (rusty staggerbush), *Lyonia fruticosa* (coastalplain staggerbush), *Morella cerifera* (wax myrtle), *Kalmia hirsuta* (hairy laurel), *Vaccinium myrsinites* (shiny blueberry), and *Lyonia lucida* (fetterbush lyonia) (NatureServe Ecology unpublished data). The most common vine is *Smilax laurifolia* (laurel greenbrier); other vines are *Smilax auriculata* (earleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Vitis rotundifolia* (muscadine). The herbaceous flora is generally sparse or patchy, including *Aristida beyrichiana* (Beyrich threeawn), *Aristida spiciformis* (bottlebrush threeawn), *Woodwardia virginica* (Virginia chainfern), *Pteridium aquilinum* (western brackenfern), *Andropogon glomeratus* (bushy bluestem), *Andropogon capillipes* (chalky bluestem), *Andropogon virginicus* (broomsedge bluestem), *Sporobolus curtissii* (Curtis' dropseed), *Sporobolus floridanus* (Florida dropseed), *Schizachyrium scoparium* (little bluestem), *Dichanthelium* (rosette grass) spp., *Gratiola hispida* (rough hedgehyssop), *Pityopsis graminifolia* (narrowleaf silkgrass), and *Xyris* (yelloweyed grass) spp.

Sawgrass Tidal Marsh

Attributes, descriptions, and a map are shown in Table D-2 and Figure D-2.

Table D-2. Attributes and Descriptions for Sawgrass Tidal Marsh.

Attribute	Description
CEGL Code	4178
Community Name	Sawgrass Tidal Marsh
Color	Light pink to brown
Tone	Light to medium
Texture	Smooth
Pattern	Patchy, uneven
Height	Short
Shape	Sparse Coverage
Size	Very small, only one area represented in park
Comments	Surrounded by forest

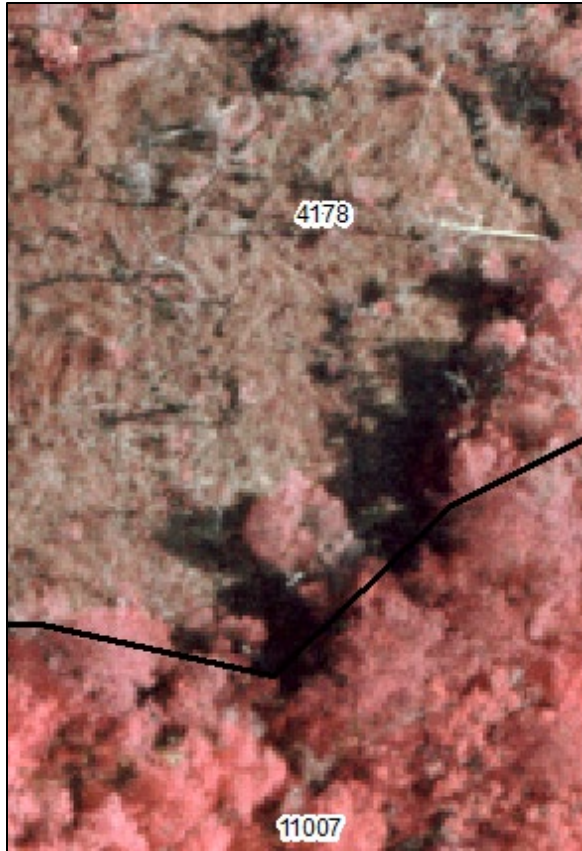


Figure D-2. Map showing of Sawgrass Tidal Marsh (4178).

Summary

Fort Caroline National Memorial Vegetation:

Vegetation is dominated by a very dense to total (100% cover) herbaceous layer of *Cladium mariscus* ssp. *jamaicense* (Jamaica swamp sawgrass). Additional species in lesser amounts may include *Juncus roemerianus* (needlegrass rush), *Osmunda regalis* (royal fern), *Polygonum hydropiperoides* (swamp smartweed), *Spartina alterniflora* (smooth cordgrass), *Spartina bakeri* (sand cordgrass), *Typha domingensis* (southern cattail), and *Woodwardia virginica* (Virginia chainfern), among others. In addition, there may be a sparse (10–20%) tree layer (10–15 meters [32.8–49.2 ft] tall) of *Acer rubrum* (red maple), *Juniperus virginiana* var. *silicicola* (southern redcedar), and *Sabal palmetto* (cabbage palmetto). There may also be a very sparse to moderate (5–50%) shrub layer (2–5 meters [6.6–16.4 ft]) of *Acer rubrum* (red maple), *Baccharis angustifolia* (saltwater false willow), *Morella cerifera* (wax myrtle), and *Salix caroliniana* (coastal plain willow), among others. In addition, the noxious exotic *Triadica sebifera* (tallowtree) is present in one of the sampled plots.

Global Vegetation:

Stands are typically dominated by a very dense herbaceous layer of *Cladium mariscus* ssp. *jamaicense* (Jamaica swamp sawgrass). Additional species may include *Juncus roemerianus* (needlegrass rush), *Osmunda regalis* (royal fern), *Polygonum hydropiperoides* (swamp smartweed), *Spartina alterniflora* (smooth cordgrass), *Spartina bakeri* (sand cordgrass), *Typha domingensis*

(southern cattail), *Amaranthus australis* (southern amaranth), *Amaranthus cannabinus* (tidalmarsh amaranth), *Hibiscus* (rosemallow) sp., *Solidago sempervirens* var. *mexicana* (seaside goldenrod), and *Woodwardia virginica* (Virginia chainfern), among others. In addition, there may be a sparse tree layer (10–15 meters [32.8–49.3 ft] tall) of *Acer rubrum* (red maple), *Juniperus virginiana* var. *silicicola* (southern redcedar), and *Sabal palmetto* (cabbage palmetto). There may also be a very sparse to moderate shrub layer (2–5 meters [6.6–16.4 ft]) of *Acer rubrum* (red maple), *Baccharis angustifolia* (saltwater false willow), *Morella cerifera* (wax myrtle), and *Salix caroliniana* (coastal plain willow), among others. In addition, the noxious exotic *Triadica sebifera* (tallowtree) could be present.

Southern Atlantic Coast Salt Marsh

Attributes, descriptions, and a map are shown in Table D-3 and Figure D-3.

Table D-3. Attributes and Descriptions for Southern Atlantic Coast Salt Marsh.

Attribute	Description
CEGL Code	4191
Community Name	Southern Atlantic Coast Salt Marsh
Color	Brown to reddish-brown
Tone	Medium
Texture	Coarse
Pattern	Consistent, patchy
Height	Short
Shape	Dense coverage
Size	Large areas following waterways
Comments	Near water

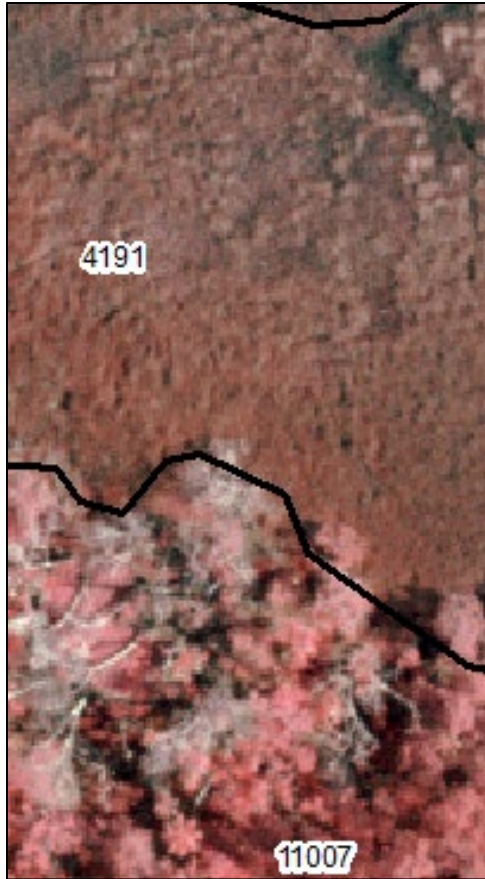


Figure D-3. Map showing Southern Atlantic Coast Salt Marsh (4191).

Summary

Fort Caroline National Memorial Vegetation:

Vegetation is a closed (100% cover) herbaceous layer made up almost exclusively of *Spartina alterniflora* (smooth cordgrass). Additional species in very small amounts include *Borrichia frutescens* (bushy seaside tansy), *Iva frutescens* (Jesuit's bark), *Distichlis spicata* (inland saltgrass), *Fimbristylis thermalis* (hot springs fimbry), *Juncus roemerianus* (needlegrass rush), *Limonium carolinianum* (Carolina sealavender), and *Sarcocornia perennis* (chickenclaws).

Global Vegetation:

This community is commonly known as "low salt marsh," occurring as a tall grassland strongly dominated by *Spartina alterniflora* (smooth cordgrass). There is little variation in vascular plant species composition across the range. *Spartina alterniflora* (smooth cordgrass) occurs in nearly pure stands, occasionally with other low-stature species. *Salicornia* (pickleweed) sp. can be quite common mixed in with the *Spartina* (cordgrass), often becoming more apparent later in the growing season. *Limonium carolinianum* (Carolina sealavender) is another characteristic herb, but only as scattered individuals. More detailed information is needed on the composition of this vegetation and how it differs floristically from its northern equivalent, *Spartina alterniflora* / (*Ascophyllum nodosum*) Acadian/Virginian Zone Herbaceous Vegetation (CEGL004192).

Central Florida Willow Thicket

Attributes, descriptions, and a map are shown in Table D-4 and Figure D-4.

Table D-4. Attributes and Descriptions for Central Florida Willow Thicket.

Attribute	Description
CEGL Code	4423
Community Name	Central Florida Willow Thicket
Color	Light pink to soft red
Tone	Light
Texture	Coarse
Pattern	Patchy, uneven
Height	Short to medium
Shape	Sparse to dense coverage
Size	Large
Comments	Black line in image delineates where dwarf modifier (above line) is used in this class as compared to no modifier (below line).

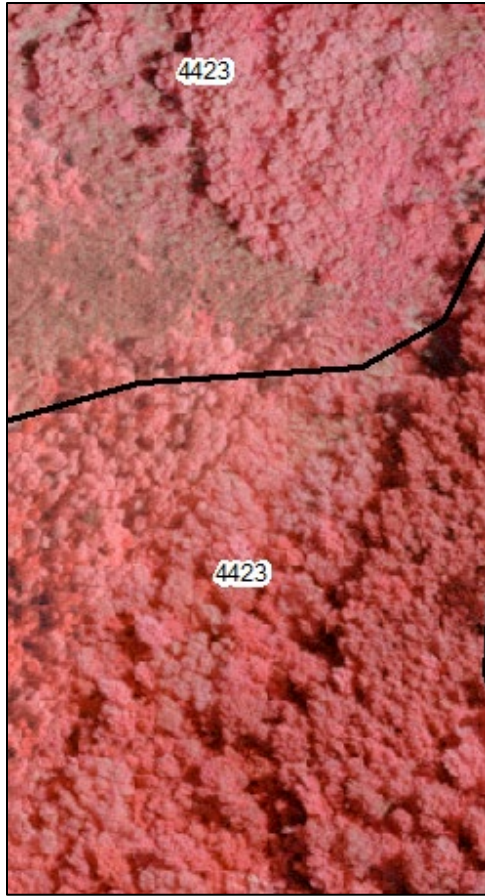


Figure D-4. Map showing Central Florida Willow Thicket (4423).

Summary

Fort Caroline National Memorial Vegetation:

Vegetation is typically dominated by a moderate to dense (70–90% cover) tall-shrub layer (2–10 meters [6.6–32.8 ft] tall) of *Salix caroliniana* (coastal plain willow) and may include *Baccharis halimifolia* (eastern baccharis), *Cephalanthus occidentalis* (common buttonbush), *Ilex cassine*, *Morella cerifera* (wax myrtle), and *Sambucus canadensis* (common elderberry). One example also has a moderate (70%) emergent tree canopy (5–15 meters [16.4–49.2 ft]) of *Salix caroliniana* (coastal plain willow). There may also be a sparse (5–20%) short-shrub layer (1–2 meters [3.3–6.6 ft]) that may include tall-shrub species as well as *Cinnamomum camphora* (camphortree), *Persea palustris* (swamp bay), *Rubus argutus* (sawtooth blackberry), and *Sabal palmetto* (cabbage palmetto). The moderate (40–50%) herbaceous layer may include *Boehmeria cylindrica*, *Eupatorium capillifolium* (dogfennel), *Hydrocotyle bonariensis*, *Juncus effusus* (common rush), *Mikania scandens* (climbing hempvine), *Polygonum densiflorum* (denseflower knotweed), *Polygonum hydropiperoides* (swamp smartweed), *Sacciolepis striata* (American cupscale), and *Setaria magna* (giant bristlegrass), among others. Ferns may be abundant and include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Thelypteris dentata* (downy maiden fern), *Thelypteris hispidula* (roughhaired maiden fern), *Woodwardia areolata* (netted chainfern), and *Woodwardia*

virginica (Virginia chainfern). Vines (0–40%) may include *Ampelopsis arborea* (peppervine), *Smilax auriculata* (earleaf greenbrier), and *Toxicodendron radicans* (eastern poison ivy).

Global Vegetation:

An example of this community at Canaveral National Seashore occurs along the edge of a larger, linear marsh and is dominated by *Salix caroliniana* (coastal plain willow) in both the canopy and tall-shrub layers, with a sparse herb layer of *Cladium mariscus ssp. jamaicense* (Jamaica swamp sawgrass), *Sagittaria lancifolia* (bulltongue arrowhead), and *Acrostichum danaeifolium* (inland leatherfern).

St. Augustine Grass Herbaceous Vegetation

Attributes, descriptions, and a map are shown in Table D-5 and Figure D-5.

Table D-5. Attributes and Descriptions for St. Augustine Grass Herbaceous Vegetation.

Attribute	Description
CEGL Code	4883
Community Name	St. Augustine Grass Herbaceous Vegetation
Color	Red
Tone	Light
Texture	Coarse
Pattern	Patchy, uneven
Height	Short
Shape	Full coverage
Size	Very small
Comments	In areas of high human influence, adjacent to park road

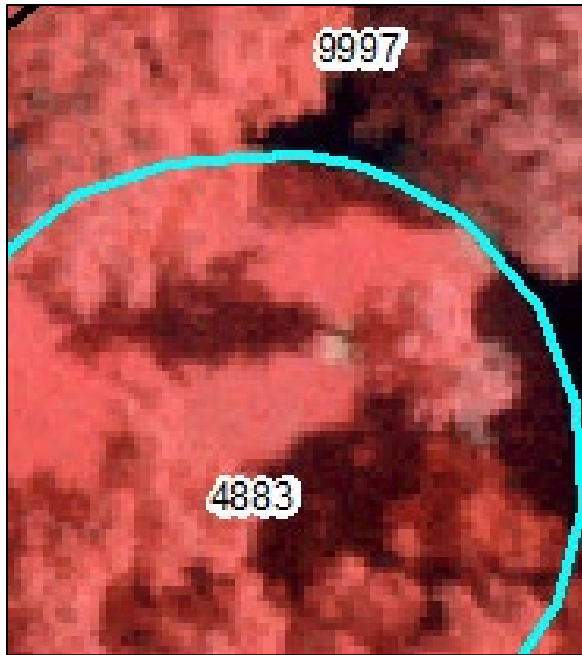


Figure D-5. Map showing St. Augustine Grass Herbaceous Vegetation (4883).

Summary

Fort Caroline National Memorial Vegetation:

The continuous herbaceous layer (100% cover) is clearly dominated by *Stenotaphrum secundatum* (St. Augustine grass). Additional species include native species *Ambrosia artemisiifolia* (annual ragweed), *Drymaria cordata* (whitesnow), and *Hydrocotyle umbellata* (manyflower marshpennywort), and exotic species *Cynodon dactylon* (Bermudagrass), *Medicago lupulina* (black medick), *Oxalis corniculata* (creeping woodsorrel), *Paspalum notatum* (bahiagrass), and *Poa annua* (annual bluegrass). A total of 24 species were recorded from one sampled plot.

Global Vegetation:

This association is dominated by *Stenotaphrum secundatum* (St. Augustine grass) occurring either as a monoculture or with a mix of native and non-native species, including the native species *Ambrosia artemisiifolia* (annual ragweed), *Drymaria cordata* (whitesnow), and *Hydrocotyle umbellata* (manyflower marshpennywort), and exotic species *Cynodon dactylon* (Bermudagrass), *Medicago lupulina* (black medick), *Oxalis corniculata* (creeping woodsorrel), *Paspalum notatum* (bahiagrass), and *Poa annua* (annual bluegrass).

Loblolly-bay Forest

Attributes, descriptions, and a map are shown in Table D-6 and Figure D-6.

Table D-6. Attributes and Descriptions for Loblolly-bay Forest.

Attribute	Description
CEGL Code	7044
Community Name	Loblolly-bay Forest
Color	Purple-pink to red
Tone	Light to medium
Texture	Coarse
Pattern	Consistent
Height	Tall
Shape	Dense and full coverage
Size	Only representation in park is large
Comments	Surrounded entirely by 11007

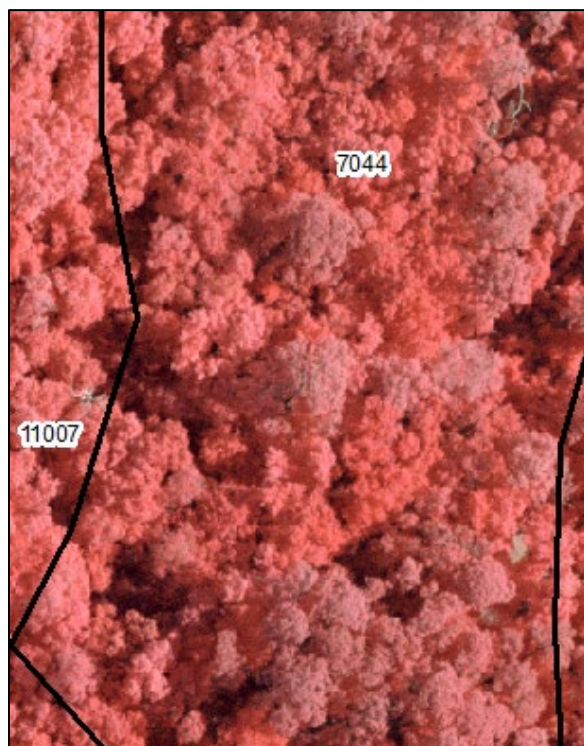


Figure D-6. Map showing Loblolly-bay Forest (7044).

Summary

Fort Caroline National Memorial Vegetation:

The moderate to closed (70–100% cover) tree canopy, 20–35 meters [65.6–114.8 ft] tall, is made up of various combinations of *Gordonia lasianthus* (loblolly bay), *Magnolia virginiana* (sweetbay), and

Persea palustris (swamp bay); additional canopy species may include *Liquidambar styraciflua* (sweetgum), *Nyssa biflora* (swamp tupelo), *Pinus elliottii* (slash pine), *Quercus laurifolia* (laurel oak), and *Quercus nigra* (water oak). The moderate (40–50%) subcanopy (10–15 meters [32.8–49.2 ft]) is dominated by canopy species and may also include *Acer rubrum* (red maple) and *Ilex cassine* (dahoon). The highly variable (10–90%) tall-shrub layer (2–5 meters [6.6–16.4 ft]) again contains substantial amounts of the canopy dominants and may include *Ilex coriacea* (large gallberry), *Itea virginica* (Virginia sweetspire), *Lyonia lucida* (fetterbush lyonia), *Morella cerifera* (wax myrtle), and *Vaccinium corymbosum* (highbush blueberry). The highly variable short-shrub layer (1–2 meters [3.3–6.6 ft]) which may be absent or closed (0–100%) is made up of species from the upper layers along with possible *Sabal palmetto* (cabbage palmetto) and *Serenoa repens* (saw palmetto). The very sparse (0–5%) herbaceous layer is dominated by ferns, including *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Pteridium aquilinum* (western brackenfern), and *Woodwardia virginica* (Virginia chainfern). Nonvascular species (up to 20%) include *Sphagnum* (sphagnum) spp. Vines (5%) are quite common and include *Gelsemium sempervirens* (evening trumpetflower), *Smilax auriculata* (earleaf greenbrier), *Smilax glauca* (cat greenbrier), *Smilax laurifolia* (laurel greenbrier), and *Vitis rotundifolia* (muscadine). Epiphytes present in small amounts are *Phoradendron leucarpum* (oak mistletoe), *Pleopeltis polypodioides* (resurrection fern), and *Tillandsia usneoides* (Spanish moss).

Global Vegetation:

The closed, broad-leaved evergreen canopy is composed of *Magnolia virginiana* (sweetbay), *Persea palustris* (swamp bay), and *Gordonia lasianthus* (loblolly bay). A patchy understory of shrubs *Cyrilla racemiflora* (swamp titi), *Clethra alnifolia* (coastal sweetpepperbush), *Itea virginica* (Virginia sweetspire), *Lyonia lucida* (fetterbush lyonia), and *Ilex glabra* (inkberry) and vines *Smilax laurifolia* (laurel greenbrier), *Smilax glauca* (cat greenbrier), and *Vitis rotundifolia* (muscadine) occurs with an abundant to sparse layer of ferns *Woodwardia areolata* (netted chainfern) and *Osmunda cinnamomea* (cinnamon fern). *Sphagnum* (sphagnum) mats are interlaced with exposed tree roots. Additional species found on Ocala National Forest include *Quercus nigra* (water oak), *Pinus serotina* (pond pine), *Vaccinium fuscatum* (black highbush blueberry), *Gelsemium sempervirens* (evening trumpetflower), *Morella cerifera* (wax myrtle), *Nyssa biflora* (swamp tupelo), *Serenoa repens* (saw palmetto), *Ilex cassine* (dahoon), *Smilax smallii* (lanceleaf greenbrier), and *Viburnum nudum* (possumhaw).

Outer Coastal Plain Sweetbay Swamp Forest

Attributes, descriptions, and a map are shown in Table D-7 and Figure D-7.

Table D-7. Attributes and Descriptions for Outer Coastal Plain Sweetbay Swamp Forest.

Attribute	Description
CEGL Code	7049
Community Name	Outer Coastal Plain Sweetbay Swamp Forest
Color	Pink to light red
Tone	Light
Texture	Coarse
Pattern	Patchy, uneven
Height	Short
Shape	Full coverage
Size	Very small, only one area represented in park
Comments	Surrounded entirely by 11007

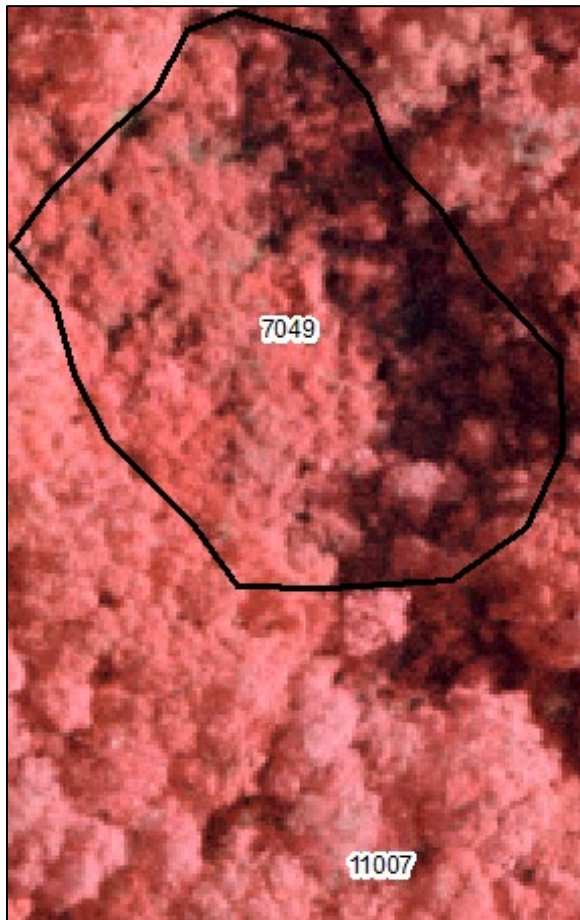


Figure D-7. Map showing Outer Coastal Plain Sweetbay Swamp Forest (7049).

Summary

Fort Caroline National Memorial Vegetation:

Although the vegetation is very thick, species diversity is low. The sparse (30% cover) tree canopy (10–15 meters [32.8–49.2 ft] tall) is dominated by *Persea palustris* (swamp bay), many of which are dead and dying. The closed (100%) tall-shrub layer (2–5 meters [6.6–16.4 ft]) is dominated by *Lyonia lucida* (fetterbush lyonia); additional shrubs found in trace amounts are *Nyssa biflora* (swamp tupelo), *Sabal palmetto* (cabbage palmetto), and *Vaccinium corymbosum* (highbush blueberry). There is a very sparse (5%) herbaceous layer of the fern *Woodwardia virginica* (Virginia chainfern) and the vine *Vitis rotundifolia* (muscadine).

Global Vegetation:

The canopy of stands is dominated by *Magnolia virginiana* (sweetbay) and/or *Persea palustris* (swamp bay) (and rarely also *Gordonia lasianthus* (loblolly bay)). Additional less important components of the canopy are *Nyssa biflora* (swamp tupelo), *Taxodium ascendens* (pond cypress), *Ilex cassine* (dahoon), *Acer rubrum* (red maple), and *Cliftonia monophylla* (buckwheat tree). Sometimes there is a very sparse canopy emergent component of *Pinus elliottii* (slash pine) or *Pinus serotina* (pond pine). The shrub layer is dominated by *Lyonia lucida* (fetterbush lyonia), and can also include *Ilex coriacea* (large gallberry), *Morella cerifera* (wax myrtle), *Clethra alnifolia* (coastal sweetpepperbush), *Serenoa repens* (saw palmetto), *Gaylussacia mosieri* (woolly huckleberry), *Ilex coriacea* (large gallberry), *Rhododendron viscosum* (swamp azalea), *Ilex glabra* (inkberry), *Hamamelis virginiana* (American witchhazel), and *Leucothoe racemosa* (swamp doghobble). Vines are mainly *Smilax laurifolia* (laurel greenbrier), but also *Vitis rotundifolia* (muscadine) and *Toxicodendron radicans* (eastern poison ivy). Herbaceous flora is sparse to absent, but can include *Osmunda cinnamomea* (cinnamon fern) and *Woodwardia virginica* (Virginia chainfern). *Tillandsia usneoides* (Spanish moss) can be present as an epiphyte. Scattered *Sphagnum* (sphagnum) patches occur. Stands of this forest typically have a low diversity of vascular plants. A site in Bradwell Bay, Apalachicola National Forest, burned in a high-intensity wildfire in 1998. It was a regenerating stand of *Magnolia virginiana* (sweetbay) with some *Pinus elliottii* (slash pine) and *Pinus serotina* (pond pine). *Lyonia lucida* (fetterbush lyonia) was a dominant shrub. The herbaceous flora was sparse but somewhat more diverse than other examples of this association.

Saltgrass—(Saltmarsh Dropseed) Herbaceous Vegetation

Attributes, descriptions, and a map are shown in Table D-8 and Figure D-8.

Table D-8. Attributes and Descriptions for Saltgrass—(Saltmarsh Dropseed) Herbaceous Vegetation.

Attribute	Description
CEGL Code	7694
Community Name	Saltgrass – (Saltmarsh Dropseed) Herbaceous Vegetation
Color	Light pink to reddish-brown
Tone	Medium to dark
Texture	Smooth
Pattern	Consistent
Height	Short
Shape	Full coverage
Size	Medium
Comments	Occurs near water and near 4191

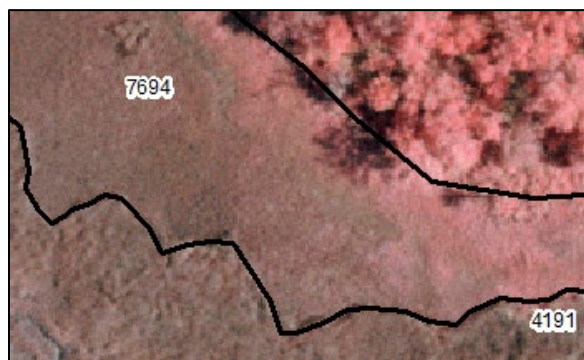


Figure D-8. Map showing Cultivated Meadow Light (7694).

Summary

Fort Caroline National Memorial Vegetation:

Vegetation is a closed (100% cover) herbaceous layer made up almost exclusively of *Distichlis spicata* (inland saltgrass). Additional species in very small amounts include *Borrichia frutescens* (bushy seaside tansy), *Iva frutescens* (Jesuit's bark), *Juncus roemerianus* (needlegrass rush), *Spartina patens* (saltmeadow cordgrass), and *Sarcocornia perennis* (chickenclaws).

Global Vegetation:

This association is dominated by *Distichlis spicata* (inland saltgrass), often mixed with other halophytic grasses and succulents such as *Sporobolus virginicus* (seashore dropseed), *Sarcocornia perennis* (chickenclaws), *Batis maritima* (turtleweed), *Lycium carolinianum* (Carolina desert-thorn), *Heliotropium curassavicum* (salt heliotrope), and others. In some Florida high marshes this type may occur in distinct monotypic zones with *Paspalum vaginatum* (seashore paspalum), *Batis maritima*

(turtleweed), and *Salicornia* (pickleweed) spp., and in other cases these species intermingle (Montague and Wiegert 1990).

Southeastern Coastal Plain Xeric Hammock/Southeastern Florida Maritime Hammock/Maritime Live Oak Hammock

Attributes, descriptions, and a map are shown in Table D-9 and Figure D-9.

Table D-9. Attributes and Descriptions for Southeastern Coastal Plain Xeric Hammock/Southeastern Florida Maritime Hammock/Maritime Live Oak Hammock.

Attribute	Description
CEGL Code	11007 (3564, 7020, 7032)
Community Name	Southeastern Coastal Plain Xeric Hammock/Southeastern Florida Maritime Hammock/Maritime Live Oak Hammock
Color	Light pink to red
Tone	Light
Texture	Coarse
Pattern	Expansive
Height	Tall
Shape	Dense and full coverage
Size	Large areas
Comments	Covers majority of Fort Caroline National Memorial

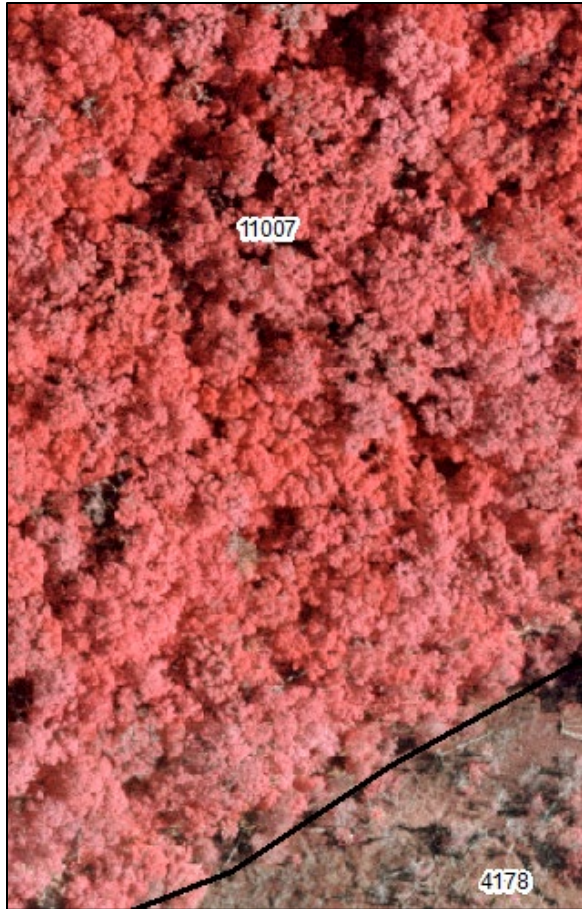


Figure D-9. Map showing Southeastern Coastal Plain Xeric Hammock/Southeastern Florida Maritime Hammock/Maritime Live Oak Hammock (11007).

Summary

Fort Caroline National Memorial Vegetation:

(3564) The very dense to closed (80–100% cover) tree canopy, 15–35 meters (49.2–114.8 ft) tall, is codominated by *Quercus geminata* (sand live oak) and *Quercus hemisphaerica* (Darlington oak). The moderate (40–60%) subcanopy (5–15 meters [16.4–49.2 ft]) includes *Ilex opaca* (American holly), *Magnolia grandiflora* (southern magnolia), *Osmanthus americanus* (devilwood), *Persea borbonia* (redbay), and the dominant canopy species. The sparse to dense (20–80%) tall-shrub layer (2–5 meters [6.6–16.4 ft]) will commonly contain *Ilex ambigua* (Carolina holly), *Ilex opaca* (American holly), *Lyonia ferruginea* (rusty staggerbush), *Osmanthus americanus* (devilwood), *Persea borbonia* (redbay), *Serenoa repens* (saw palmetto), and *Vaccinium arboreum* (farkleberry), among others. The moderate to very dense (40–90%) short-shrub layer (1–2 meters [3.3–6.6 ft]) is dominated by *Serenoa repens* (saw palmetto) and may include other tall-shrub species along with *Morella cerifera* (wax myrtle), *Sabal palmetto* (cabbage palmetto), *Vaccinium corymbosum* (highbush blueberry), and *Vaccinium stamineum* (deerberry). The very sparse (5–20%) herbaceous layer may include *Galactia elliotii* (Elliott's milkpea), *Mitchella repens* (partridgeberry), *Rhynchospora megalocarpa* (sandyfield beaksedge), *Scleria triglomerata* (whip nutrush), and *Smilax pumila* (sarsparilla vine).

Epiphytes include small amounts of *Phoradendron leucarpum* (oak mistletoe), *Pleopeltis polypodioides* (resurrection fern), *Tillandsia recurvata* (small ballmoss), and *Tillandsia usneoides* (Spanish moss). Vines (5%) are *Gelsemium sempervirens* (evening trumpetflower), *Smilax auriculata* (earleaf greenbrier), *Vitis aestivalis* (summer grape), and *Vitis rotundifolia* (muscadine). This community also supports the state vulnerable *Monotropa uniflora* (Indianpipe).

(7020) The structure of this community is variable among the sampled plots. The very dense to closed canopy (80–100% cover) ranges in height from 5 to 20 meters (16.4 to 65.6 ft). In addition, one plot has a sparse (20%) emergent layer 20–35 meters (65.6–114.8 ft) tall. *Quercus geminata* (sand live oak) dominates; additional species may include *Pinus elliottii* (slash pine), *Quercus nigra* (water oak), *Quercus hemisphaerica* (Darlington oak), and *Quercus myrtifolia* (myrtle oak). The sparse (10–40%) tall-shrub layer (2–10 meters [6.6–32.8 ft]) is made up of canopy tree saplings along with *Lyonia ferruginea* (rusty staggerbush), *Morella cerifera* (wax myrtle), *Osmanthus americanus* (devilwood), *Persea borbonia* (redbay), *Quercus chapmanii* (Chapman oak), *Vaccinium arboreum* (farkleberry), and *Vaccinium stamineum* (deerberry). The very dense to closed (90–100%) short-shrub layer (1–2 meters [3.3–6.6 ft]) is dominated by *Serenoa repens* (saw palmetto) and includes saplings of species from the upper layers, as well as *Gaylussacia tomentosa* (hairytwig huckleberry), *Ilex glabra* (inkberry), *Lyonia lucida* (fetterbush lyonia), and *Vaccinium myrsinites* (shiny blueberry). The very sparse (5%) herbaceous layer may contain small amounts of *Galactia elliottii* (Elliott's milkpea), *Pteridium aquilinum* (western brackenfern), and *Rhynchospora megalocarpa* (sandyfield beaksedge). Nonvascular species (5%) found here are *Cladina evansii* (Evans' reindeer lichen) and *Cladina subtenuis* (reindeer lichen). Vines (5%) include *Smilax auriculata* (earleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Vitis rotundifolia* (muscadine), and epiphytes include *Pleopeltis polypodioides* (resurrection fern), *Tillandsia recurvata* (small ballmoss), and *Tillandsia usneoides* (Spanish moss).

(7032) The very dense to closed (90–100% cover) tree canopy, 15–35 meters [49.2–114.8 ft] tall, is dominated by *Quercus virginiana* (live oak); additional canopy species may include *Carya glabra* (pignut hickory), *Juniperus virginiana* var. *silicicola* (southern redcedar), *Magnolia grandiflora* (southern magnolia), *Quercus hemisphaerica* (Darlington oak), and *Sabal palmetto* (cabbage palmetto). The sparse to dense (20–80%) subcanopy (5–15 meters [16.4–49.2 ft]) is made up of canopy species and may include *Celtis laevigata* (sugarberry), *Fraxinus americana* (white ash), *Ilex opaca* (American holly), *Ostrya virginiana* (hophornbeam), and *Persea borbonia* (redbay). The sparse to dense (20–80%) tall-shrub layer (2–5 meters [6.6–16.4 ft]) is dominated by *Ilex vomitoria* (yaupon) and may include *Cornus foemina* (stiff dogwood), *Forestiera ligustrina* (upland swampprivet), *Forestiera segregata* (Florida swampprivet), *Osmanthus americanus* (devilwood), *Prunus caroliniana* (Carolina laurelcherry), and *Ximenia americana* (tallow wood), among others. The sparse to very dense (30–90%) short-shrub layer (1–2 meters [3.3–6.6 ft]) is dominated by *Ilex vomitoria* (yaupon) and *Sabal palmetto* (cabbage palmetto) and may include other tall-shrub species as well as *Psychotria nervosa* (Seminole balsamo), *Ptelea trifoliata* (common hoptree), and *Serenoa repens* (saw palmetto). The very sparse to moderate (5–50%) herbaceous layer may be dominated by *Chasmanthium sessiliflorum* (longleaf woodoats), *Pteridium aquilinum* (western brackenfern), or *Toxicodendron radicans* (eastern poison ivy). Additionally, this community supports state-imperiled

Peperomia humilis (Polynesian peperomia) and state-vulnerable *Monotropa uniflora* (Indianpipe). Vines (5–40%) are dominated by *Cynanchum scoparium* (leafless swallow-wort). Epiphytes include *Pleopeltis polypodioides* (resurrection fern) and *Tillandsia usneoides* (Spanish moss). Stands of this community can be rather diverse with up to 70 species recorded from a single plot.

Global Vegetation:

(3564) This forest is dominated by *Quercus geminata* (sand live oak) with *Quercus virginiana* (live oak), *Quercus hemisphaerica* (Darlington oak), *Quercus margarettiae* (runner oak), *Quercus laevis* (turkey oak), and/or *Magnolia grandiflora* (southern magnolia) also potentially present in the canopy, which can be rather low in stature. Subcanopy species include the same as well as *Ilex opaca* (American holly), *Pinus palustris* (longleaf pine), *Carya pallida* (sand hickory), *Nyssa sylvatica* (blackgum), *Pinus glabra* (spruce pine), and *Pinus clausa* (sand pine) within its range. Important shrubs include *Vaccinium arboreum* (farkleberry), *Vaccinium stamineum* (deerberry), *Morella cerifera* (wax myrtle), and *Osmanthus americanus* (devilwood). Other shrubs include *Quercus hemisphaerica* (Darlington oak), *Ilex opaca* (American holly), *Quercus virginiana* (live oak), *Vaccinium elliotii* (Elliott's blueberry), *Callicarpa americana* (American beautyberry), *Ilex glabra* (inkberry), *Serenoa repens* (saw palmetto), *Quercus nigra* (water oak), *Vaccinium myrsinites* (shiny blueberry), *Hypericum hypericoides* (St. Andrew's cross), *Licania michauxii* (gopher apple), and *Quercus incana* (bluejack oak). Herbaceous flora is sparse but can include *Pteridium aquilinum* (western brackenfern), *Dichantheium* (rosette grass) spp., *Rhynchospora megalocarpa* (sandyfield beaksedge), *Elephantopus nudatus* (smooth elephantsfoot), *Desmodium* (ticktrefoil) spp., *Vernonia angustifolia* (tall ironweed), and *Smilax pumila* (sarsparilla vine). The lichens *Cladina evansii* (Evans' reindeer lichen) and *Cladina subtenuis* (reindeer lichen) may be important. Vines such as *Vitis rotundifolia* (muscadine) and *Smilax auriculata* (earleaf greenbrier) are common. The epiphytes *Tillandsia usneoides* (Spanish moss) and *Pleopeltis polypodioides* ssp. *michauxiana* (resurrection fern) are often present.

(7020) The overstory is dominated by *Quercus geminata* (sand live oak); *Quercus virginiana* (live oak) may also be present, along with *Quercus myrtifolia* (myrtle oak). The dense shrub layer includes *Serenoa repens* (saw palmetto), *Lyonia fruticose* (coastalplain staggerbush), *Lyonia ferruginea* (rusty staggerbush), *Osmanthus americanus* var. *americanus* (devilwood), *Persea borbonia* (redbay), and *Morella cerifera* (wax myrtle). An understory of *Sabal palmetto* (cabbage palmetto) may also be present.

(7032) This forest has a low to moderately high tree canopy, often stunted and pruned by salt spray into streamlined shapes. The canopy is mostly closed with well-developed subcanopy and shrub layers and a sparse herb layer. The canopy along the seaward edge of this community tends to be quite low in stature with shrub species grading smoothly into the dominant canopy species. Vines are often an important component of this community. Species that may be found in the canopy, subcanopy or shrub layers include *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto), *Pinus elliotii* var. *elliotii* (Honduras pine), *Pinus taeda* (loblolly pine), *Magnolia grandiflora* (southern magnolia), *Persea borbonia* (redbay), *Quercus hemisphaerica* (Darlington oak), *Quercus nigra* (water oak), *Quercus phellos* (willow oak), *Magnolia virginiana* (sweetbay), *Acer rubrum* var.

drummondii (Drummond's maple), *Liquidambar styraciflua* (sweetgum), *Juniperus virginiana* var. *silicicola* (southern redcedar), *Celtis laevigata* (sugarberry), *Morella cerifera* (wax myrtle), *Ilex vomitoria* (yaupon), *Osmanthus americanus* var. *americanus* (devilwood), *Sabal minor* (dwarf palmetto), *Serenoa repens* (saw palmetto), *Ilex opaca* var. *opaca* (American holly), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Prunus caroliniana* (Carolina laurelcherry), *Zanthoxylum clava-herculis* (Hercules' club), *Callicarpa americana* (American beautyberry), *Baccharis halimifolia* (eastern baccharis), *Baccharis angustifolia* (saltwater false willow), *Lyonia lucida* (fetterbush lyonia), *Sageretia minutiflora* (smallflower mock buckthorn), *Sideroxylon tenax* (tough bully), *Vaccinium arboreum* (farkleberry), *Forestiera segregata* (Florida swampprivet), and *Opuntia humifusa* var. *humifusa* (devil's-tongue). Typical vines and herbaceous species include *Toxicodendron radicans* (eastern poison ivy), *Smilax* (greenbrier) spp., *Vitis rotundifolia* (muscadine), *Parthenocissus quinquefolia* (Virginia creeper), *Houstonia procumbens* (roundleaf bluet), *Bignonia capreolata* (crossvine), *Mitchella repens* (partridgeberry), *Berchemia scandens* (Alabama supplejack), *Ampelopsis arborea* (peppervine), *Oplismenus hirtellus* ssp. *setarius* (bristle basketgrass), *Boehmeria cylindrica* (smallspike false nettle), *Galium pilosum* (hairy bedstraw), *Dichanthelium commutatum* (variable panicgrass), *Elephantopus nudatus* (smooth elephantsfoot), *Passiflora incarnata* (purple passionflower), *Passiflora lutea* (yellow passionflower), *Scleria triglomerata* (whip nutrush), *Piptochaetium avenaceum* (blackseed speargrass), *Panicum* (panicgrass) spp., *Chasmanthium laxum* (slender woodoats), *Juncus* (rush) spp., *Asplenium platyneuron* var. *bacculum-rubrum* (ebony spleenwort), *Osmunda cinnamomea* (cinnamon fern), and *Woodwardia virginica* (Virginia chainfern). In general, from Cape Fear, North Carolina, south to mid-South Carolina, the canopy is dominated by *Quercus virginiana* (live oak) and *Pinus taeda* (loblolly pine) occurring with *Sabal palmetto* (cabbage palmetto). Farther south, *Pinus elliottii* var. *elliottii* (Honduras pine) replaces *Pinus taeda* (loblolly pine), and *Sabal palmetto* (cabbage palmetto) becomes more prominent. Some floristic elements of the Georgia islands, such as *Lyonia ferruginea* (rusty staggerbush) and *Forestiera segregata* (Florida swampprivet), are completely absent from barrier islands in the Carolinas. *Serenoa repens* (saw palmetto) does not occur on the North Carolina barrier islands. In mid-Florida, tropical species begin to dominate the understory, while temperate species retain canopy dominance. South of Martin County, Florida, tropical species such as *Bursera simaruba* (gumbo limbo), *Sideroxylon foetidissimum* (false mastic), and *Ficus aurea* (Florida strangler fig) begin to dominate the forest canopy and mark the northern limits of the Tropical Barrier Island Forest community. At the northern limit of the range of this type, *Persea palustris* (swamp bay) may replace *Persea borbonia* (redbay).

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

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