



# Vegetation Mapping at Fort Frederica National Monument

Natural Resource Data Series NPS/FOFR/NRR—2013/684



**ON THE COVER**

Fort Frederica on St. Simons Island, GA.

Photograph by Rachel McManamay, Southeast Coast Network.

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# **Vegetation Mapping at Fort Frederica National Monument**

Natural Resource Report NPS/FOFR/NRR—2013/684

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## Executive Summary

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

The mapping area is 192 hectares (474 ac), encompassing the entire boundary of FOFR and an additional buffered area of adjacent private lands. NatureServe ecologists identified plant associations for FOFR and a remote sensing specialist from the SECN completed the vegetation mapping using 1:12,000-scale, color-infrared aerial photography and digital orthophotography. NatureServe collected vegetation and environmental data from four vegetation classification plots, and the remote sensing specialist assessed 10 observation points. The SECN hired and trained Student Conservation Association (SCA) interns to conduct the accuracy assessment (AA), which entailed sampling 74 additional points. Fieldwork and mapping were completed between 2005 and 2012.

A total of 12 map classes were developed to map the vegetation and general land cover of FOFR and surroundings, including the following: seven map classes representing natural vegetation at the association level in the National Vegetation Classification System (NVCS), one map class representing cultural vegetation (e.g., developed) in the NVCS, and four map classes representing non-vegetated units (e.g., open water bodies, buildings, roads, etc.). Features were interpreted using 1:12,000 scale digital color-infrared aerial photography (flown 07 May 2011) through heads-up-digitizing in ArcGIS (Version 10, © 2010 Environmental Systems Research Institute, Redlands, California). Polygons were mapped to a 0.5-ha minimum mapping unit (MMU).

A geodatabase containing various feature-class layers and tables show the locations of vegetation types and general land cover (vegetation map), vegetation plot samples, AA sites, project boundary extent, and aerial photographic centers. The feature-class layer for the FOFR vegetation map provides 50 polygons of detailed attribute data covering 192 ha, with an average polygon size of 8.9 ha. Of the area mapped, 33 polygons (66%) represent natural vegetation types in the NVCS, encompassing 117 ha (61% of the total map extent).

Summary reports generated from the vegetation map layer indicate that the Needlerush High Marsh dominates the vegetated landscape (five polygons covering 60.8 ha), with the Southern Atlantic Coast Salt Marsh comprising a considerable portion of the park (six polygons totaling 31.7 ha). Collectively these associations make-up the extensive salt marsh found within FOFR.

A thematic study was conducted on the seven map classes within the boundary of FOFR representing floristic types within the NVCS. Results present an overall accuracy of 92.2% (kappa statistic = 75.2 %) based on data from 74 AA sites.

Products resulting from the FOFR vegetation mapping project include:

Available in this report:

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

Available elsewhere<sup>1</sup>:

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

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

<sup>1</sup> Products and additional information can be found at the following website:  
<http://biology.usgs.gov/npsveg/>.

## **Acknowledgments**

Funding for this project was provided by the National Park Service Vegetation Inventory Program. The Southeast regional office of NatureServe (Raleigh/Durham, NC) completed the field survey and other tasks associated with the vegetation classification portion of the mapping project. The Southeast Coast Network completed the vegetation mapping and accuracy assessment. Special thanks to the staff of Fort Frederica National Monument for their cooperation with this project.



# Introduction

## Fort Frederica National Monument Vegetation Mapping Project

The Fort Frederica National Monument (FOFR) Vegetation Mapping project was organized and coordinated by the Southeast Coast Network (SECN) between 2005 and 2013, with assistance from the Southeast regional office of NatureServe for the vegetation classification portion of the project. The purpose of this project was to inventory and map existing plant associations on approximately 103 ha of FOFR and a buffered area surrounding the park. The mapping information is provided in written, tabular, digital, and spatial formats that are useful to resource managers, the SECN, and others. The mapping product will serve as a baseline of vegetation information that will assist park natural- and cultural-resource stewardship. The identification and description of plant communities also provides habitat information important to understanding associated organisms (reptiles, amphibians, mammals, etc.) and providing inference to the location and abundance of species that are characteristic of each community.

## The Vegetation Inventory Program

The Vegetation Inventory Program (VIP) is an effort by the National Park Service (NPS) to classify, describe, inventory, and map vegetation communities in more than 280 national park units across the United States. The primary objective of the VIP is to produce high-quality, standardized maps and associated data sets of vegetation and other land cover occurring within parks. Since vegetation species and communities are unique from park to park, the inventory of these resources assists park managers on a wide array of management issues. For more information about the Vegetation Inventory Program, visit <http://science.nature.nps.gov/im/inventory/veg/index.cfm>.

## Vegetation Inventory Program Standards

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

### *Protocols*

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

### *Standards*

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

## **National Vegetation Classification Standard**

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

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

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

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

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

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

### Federal Geographic Data Committee Standards

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

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



# Methods

## Study Area

### **Location and History**

Fort Frederica National Monument is on St. Simons Island in southeast Georgia (Figure 1). The Monument is divided by the Frederica River, one of the primary salt marsh rivers in the Brunswick area, with 40 ha of marsh lands at the Frederica site on the west side of the river and approximately 55 ha of uplands adjoining the east side of the river. The focal area of the park is the colonial-era townsite of Fort Frederica, and this area is maintained as a mowed field. The separate Bloody Marsh site is approximately 3 ha, half of which is tidal marsh (from Byrne et al. 2012).

Coastal Indian tribes were the first to occupy the Georgia Sea Islands. The Spanish established missions in the area shortly after the founding of the city of St. Augustine in 1565. Fort Frederica was first settled by English colonists in 1736. The site was originally selected by James Oglethorpe, founder of the colony of Georgia, because of its prime location on high ground near the Frederica River. In 1742, Bloody Marsh was a significant battle site where English troops stationed at Fort Frederica defeated invading Spanish forces from Florida. A period of abandonment of the fort as a military post occurred from the 1750s to 1780s, followed by a plantation period, then abandonment again during the Civil War (1862-1865). Post Civil War the area was reoccupied by farmers. During the Depression era the Sea Island Company purchased the lands (1920s to 1940s), followed by the area being developed for recreation and housing (Bratton 1983).

### **Vegetation**

The site of Fort Frederica has undergone several human-induced changes over the past 200 years that have altered the area from its pre-colonial climax Maritime Live Oak Hammock condition (Bratton 1983). These include the original occupation of the site as a fort, farming of corn, tobacco, and cotton, and later as a pine plantation. Some drainage ditches were installed for agricultural purposes and still exist in the Monument. Prolonged drainage of these areas has facilitated a shift in vegetation from wetland to upland species (Bratton 1983, from Byrne et al. 2012).

Vegetation communities at FOFR can be generally divided into salt marsh and upland areas. The salt marsh contains low marsh, dominated typically by cordgrasses (*Spartina* spp.; Figure 2), and high marsh, dominated typically by needlerush (*Juncus roemerianus*; Figure 3). Upland areas are a mix of coastal maritime hammock, dominated by live oak (*Quercus virginiana*; Figure 4) and areas dominated by loblolly pine (*Pinus taeda*; Figure 5) and/or slash pine (*Pinus elliottii* var. *elliottii*).

### **Climate and Weather**

Summer months at FOFR are hot and humid, though can be moderated somewhat by ocean breezes. The mean monthly maximum temperature in July ranges 31.1– 32.0°C (88.0 – 89.6°F; 1961-1990). Winter months at FOFR are typically mild with only brief cold spells. The mean monthly minimum temperature in January ranges 4.1 – 6.0°C (39.4 – 42.8° F; 1961-1990). Precipitation mostly comes in the form of rain from storm fronts in winter and spring months,

and from thunderstorms, tropical storms, and hurricanes in the summer and fall months. FOFR receives an average precipitation amount that ranges 1,201-1,400 millimeters/year (47.3 – 55.1 in/year; 1961-1990; Davey et al. [2007]).



**Figure 1.** Location of Main Park and Bloody Marsh Units of Fort Frederica National Monument, Georgia.



**Figure 2.** Example of Southern Atlantic Coast Salt Marsh in Fort Frederica National Monument dominated by cordgrasses (*Spartina* spp.).



**Figure 3.** Needlerush High Marsh in Fort Frederica National Monument. This association covers the most wetland area within the park.



**Figure 4.** A Maritime Live Oak Hammock in Fort Frederica National Monument.



**Figure 5.** Example of a Successional Loblolly Pine – Oak Forest. This association covers the most area of the upland vegetation classes found in Fort Frederica National Monument.

## **Project Scoping and Planning**

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

### ***Project Boundary Extent***

The SECN determined that the FOFR vegetation mapping boundary extent should include the entire area within the park plus an additional buffer surrounding the park boundary of 100 meters (328 ft). Therefore, the total map extent is 192.4 ha, with 103 ha occurring within park boundaries and the remaining 89 ha occurring outside of park boundaries.

### **Field Survey**

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

Extensive review of imagery (i.e., color IR and true color aerial photos) was done prior to fieldwork, and distinct areas were identified which were targeted for vegetation plot placement. Plots were placed non-randomly in such a way as to sample as many of the vegetation associations as possible given the minimum number of plots for the project (C. Nordman, pers. comm., 21 Feb. 2011). Plots were deliberately placed in certain areas in order to capture the diversity of vegetation communities at the park. Plot size was variable (e.g., 20 × 30 m and 50 × 20 m) and decided at the time of sampling based on which dimension would most adequately characterize the vegetation sampled in each plot. Four vegetation plots were sampled in FOFR at in May of 2008 (Figure 6).



## Locations of plots sampled by NatureServe in Fort Frederica National Monument for vegetation classification

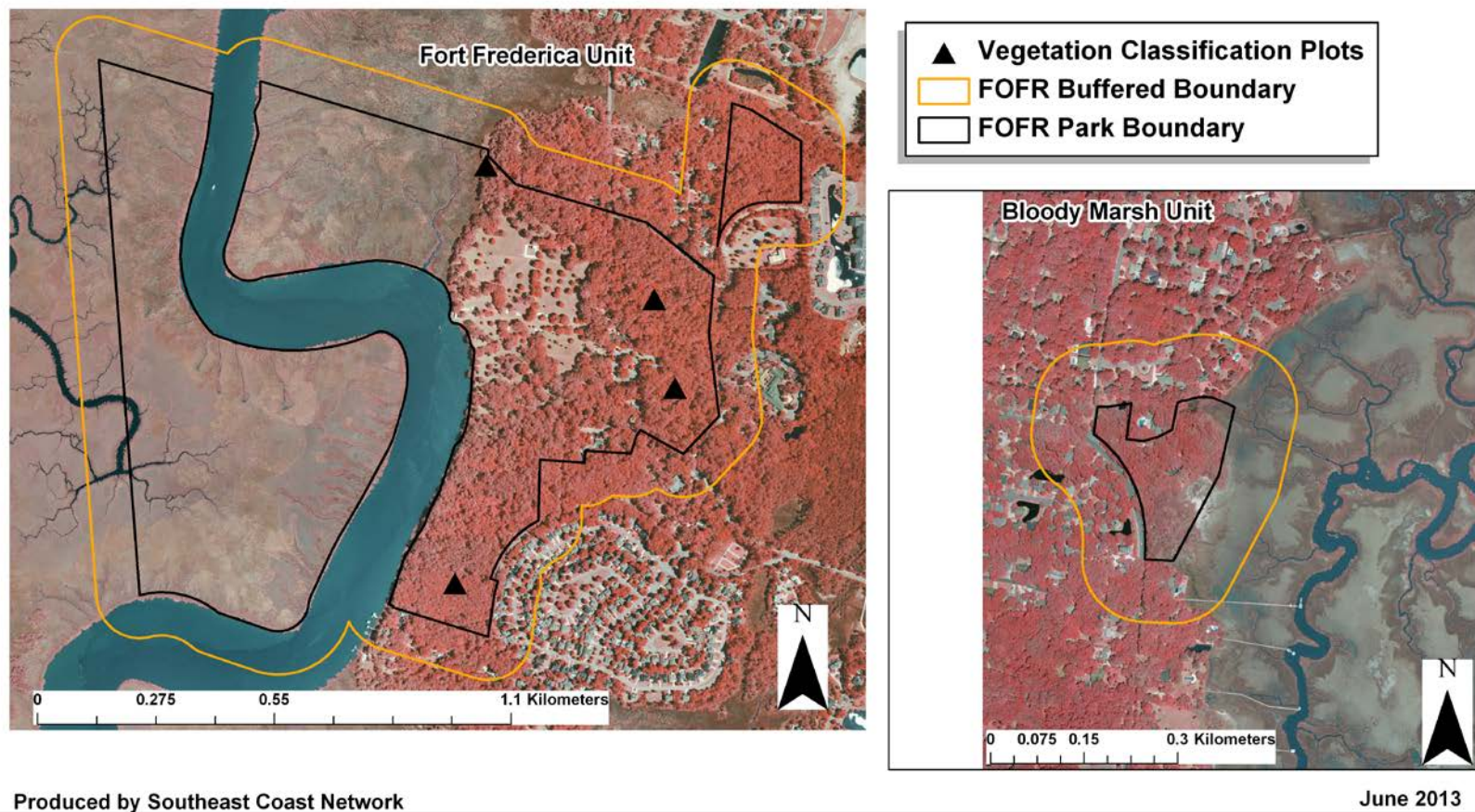


**Figure 6.** Locations of plots sampled by NatureServe in Fort Frederica National Monument used for vegetation classification.

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

### ***Location and Plot Identifiers***

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

### ***Environmental Description***

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

### ***Vegetation Description***

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

**Table 2.** Vegetation height and cover classes used in the Fort Frederica National Monument Vegetation Mapping Project.

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

### ***Other Ancillary Information Useful to Classification***

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

### ***Vegetation Classification***

Plot data were manually entered into the NatureServe PLOTS Database Version 3.0, a Microsoft Access database designed for the NPS VIP (NatureServe 2010). The PLOTS database was designed specifically for the NPS vegetation and mapping program so that the electronic data entry fields mirror the standard field form. Data entry was facilitated by assigning each plant

taxon a unique, standardized code and name based on the PLANTS database developed by the Natural Resources Conservation Service in cooperation with the Biota of North America Program (USDA and NRCS 2009). Data were thoroughly proofed after entry to minimize errors.

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

### ***Map Classifications***

A dichotomous key, that was originally developed by NatureServe and later revised by the SECN (Appendix C), was utilized for the map classifications. The full NVCS hierarchical classification and global descriptions are available in Appendix B. FOFR specific vegetation (i.e., local) descriptions were written based on FOFR plot data. In addition, the NVCS associations were linked to map classes for use in the photo-interpretation and mapping portions of the project. We assigned a map class code merely for ease of assigning information to polygons and for display purposes for the remote sensing specialist. The last four digits of the NVCS codes were used as the map class codes (for example, 7813 represents CEG007813, or the Coastal Red-cedar – Live Oak – Cabbage Palmetto Marsh Hammock).

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

For non-vegetated features (e.g., open water bodies, structures, etc.), we derived map classes from Level II of the Land Use and Land Cover Classification System (Anderson et al. 1976). The “Residential” category was used for private residences outside of park boundaries within the environs of the project mapping boundary. The “Transportation, Communications, and Utilities” category was used to characterize mainly roads within the mapping boundaries. The “Mixed Urban or Built-up Land” was used to characterize a small area outside of park boundaries where it was not clear what types of structures were present. Finally, the “Bays and Estuaries” category was used to map the water within the salt marsh.

We further classified vegetated wetlands (natural vegetation) to the System Level of the U.S. Fish and Wildlife Service’s Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). All the wetlands within FOFR are considered estuarine systems (Table 3).

**Table 3.** Map classification codes for wetlands derived from the U.S. Fish and Wildlife Service's Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

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

## Digital Imagery and Interpretation

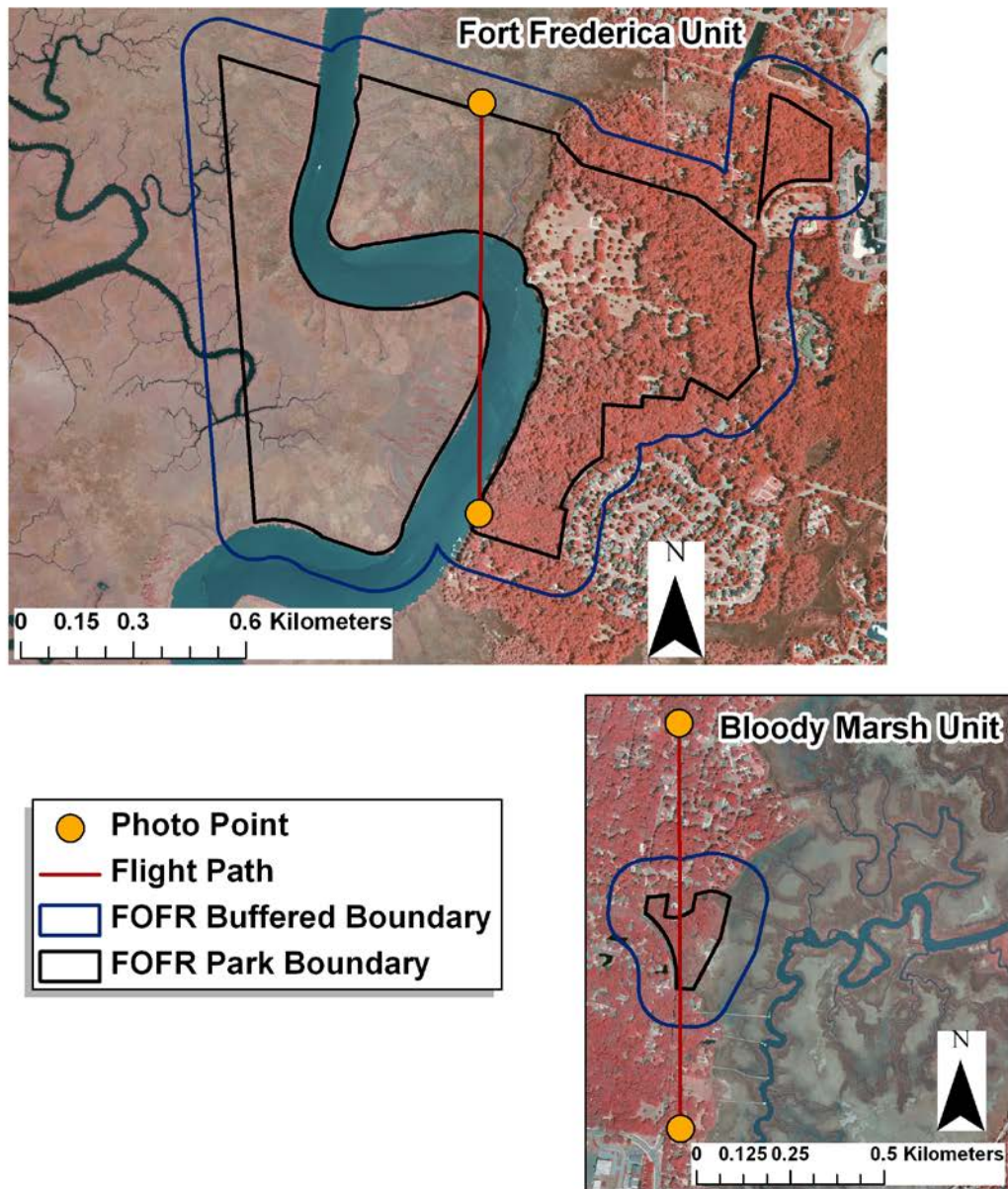
### *Aerial Photography Acquisition and Processing*

The SECN contracted with AeroMetric Inc., through the USGS Rolla, Missouri office to provide color-infrared aerial photographs. Color-infrared imagery was chosen because healthy green vegetation is a very strong reflector of infrared radiation and appears bright red in color-infrared imagery, which helps tremendously in vegetation mapping efforts. This set of photography covered the full project boundary extent plus a buffer surrounding the boundary of 500 meters. The flight path and centers of the aerial photo mission were planned with 60% forward-lap and 30% side-lap in order to assure stereo viewing (Figure 7). Airborne GPS data and color-infrared (CIR) images were provided by Richard Crouse & Associates, Inc. These images were scanned by HAS Images, Inc. Ground check point data was provided by AeroMetric, Inc. The project was referenced to the North American Datum of 1983/2007 (NAD83/07), UTM Zone 17 horizontally and to the North American Vertical Datum of 1988 vertically. The aerial photographs were taken on 07 May 2011 at a scale of 1:12,000. The calibration focal length for the photos were 153.557 mm, and 153.384 mm. Contact prints of the CIR imagery were created for use in the field, and diapositives of the CIR set were created for photo-interpretation. Scanned images (14 micron) were processed to 0.3 meter (1.0 ft) resolution and provided in a digital orthophotograph mosaic. The scanned imagery was rectified through an aerotriangulation process. The scanned images, Airborne Global Positioning System (ABGPS) data, ground check point data, and camera calibration data were used as inputs to the Zeiss/Intergraph ImageStation Automatic Triangulation (ISAT) softcopy program. ISAT correlated image points are aerotriangulated in a block of images to create the exposure station exterior orientations. Three ground check points were manually measured on the imagery. All of these points had vertical and horizontal coordinates. Statistics associated with the aerotriangulation bundle adjustment are as follows:

1. Six photographs.
2. 316 image points.
3. Four horizontal and vertical ground control points.
4. Two vertical ground points.
5. 4.0 microns image sigma.
6. 196 degrees of freedom.
7. Root mean square error of residuals for six ground control points:
  - a. 0.159 meters for horizontal-control eastings.
  - b. 0.218 meters for horizontal-control northings.
  - c. 0.030 meters for vertical control.
8. Root mean square error of residuals for six ABPGS exposure station control points:
  - a. 0.097 meters for horizontal-control eastings.
  - b. 0.266 meters for horizontal-control northings.
  - c. 0.095 meters for vertical control.



## Flight paths for aerial photography used in Fort Frederica National Monument Vegetation Mapping Project



Produced by the Southeast Coast Network

October 2012

**Figure 7.** Flight lines for the 2011 color-infrared stereo aerial photograph coverage of Fort Frederica National Monument.

### ***Preliminary Photo-Interpretation***

Prior to field reconnaissance, it is advantageous for the individual(s) interpreting the imagery to become familiar with the project imagery as well as the vegetation types to be mapped. The benefit of this early mapping step is that it allows the interpreters to identify particular areas of interest to visit during the field reconnaissance step. For this preliminary mapping, the SECN remote sensing specialist delineated vegetation polygons on the digital orthophoto mosaics to at least the Formation-level of the NVCS. In addition to vegetation, other features were mapped as well, such as non-vegetated surfaces that were classified according to the Anderson Land Use Level II mapping regime (Anderson et al. 1976). Polygons were digitized on-screen using Arc GIS (Version 10.0, © 2010 Environmental Systems Research Institute, Redlands, California).

### ***Field Reconnaissance***

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

A field reconnaissance trip was taken to FOFR in March 2012. During this trip, the SECN remote sensing specialist spent time investigating ground conditions with copies of the aerial photographs in hand. Notes were taken directly on the copies of the aerial imagery as observations were made. The remote sensing specialist used a Garmin® Rino GPS unit to navigate to a set of predetermined points of interest within the vegetation polygons mapped during the preliminary mapping step. These points of interest were chosen specifically to aid in the identification of vegetation photo-signatures. Upon reaching each point, vegetation at that point was keyed to its association by using the key developed by NatureServe (NatureServe 2008). Difficulties in determining association, if any, were documented on the field sheet (Appendix E). Dominant species found in each vegetation strata were documented. Ground photographs of each point were taken.

### ***Photo-Interpretation and Polygon Attribution***

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

identify types, but also to properly place polygon boundaries. Polygons were interpreted and digitized on-screen using ArcGIS (Version 10.0, © 2010 Environmental Systems Research Institute, Redlands, California). Features were mapped to a minimum mapping unit (MMU) of 0.5 ha, which is the NPS VIP standard. Exceptions for mapping below the MMU were allowed for map-class units with vegetation unique to the immediate surroundings. For each polygon, the appropriate map-class code along with its NVCS code, alliance, association, and association common name were entered into the fields of the associated attribute table (Table 4).

**Table 4.** Fields used in the attribute table of the vegetation polygon layer of the Fort Frederica National Monument Vegetation Mapping Project.

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

### **Field Verification**

Methodology for the field verification is nearly identical to the field reconnaissance step. The field verification step allows the remote sensing specialist to feel confident with the mapping product prior to submitting it for accuracy assessment. A field verification trip was not deemed necessary for this park due to its relatively small size and the number of sites visited during the field reconnaissance trip.

### **Accuracy Assessment**

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

classes that were mapped correctly. The Kappa Index is another measure of overall accuracy, which takes into account the probability that mapped polygons will be correct due to random chance.

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

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

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

### ***Sampling Design***

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

We determined the sample size needed for each map class by following guidelines outlined in Thematic Accuracy Assessment Procedures (Lea and Curtis 2010; Table 5).

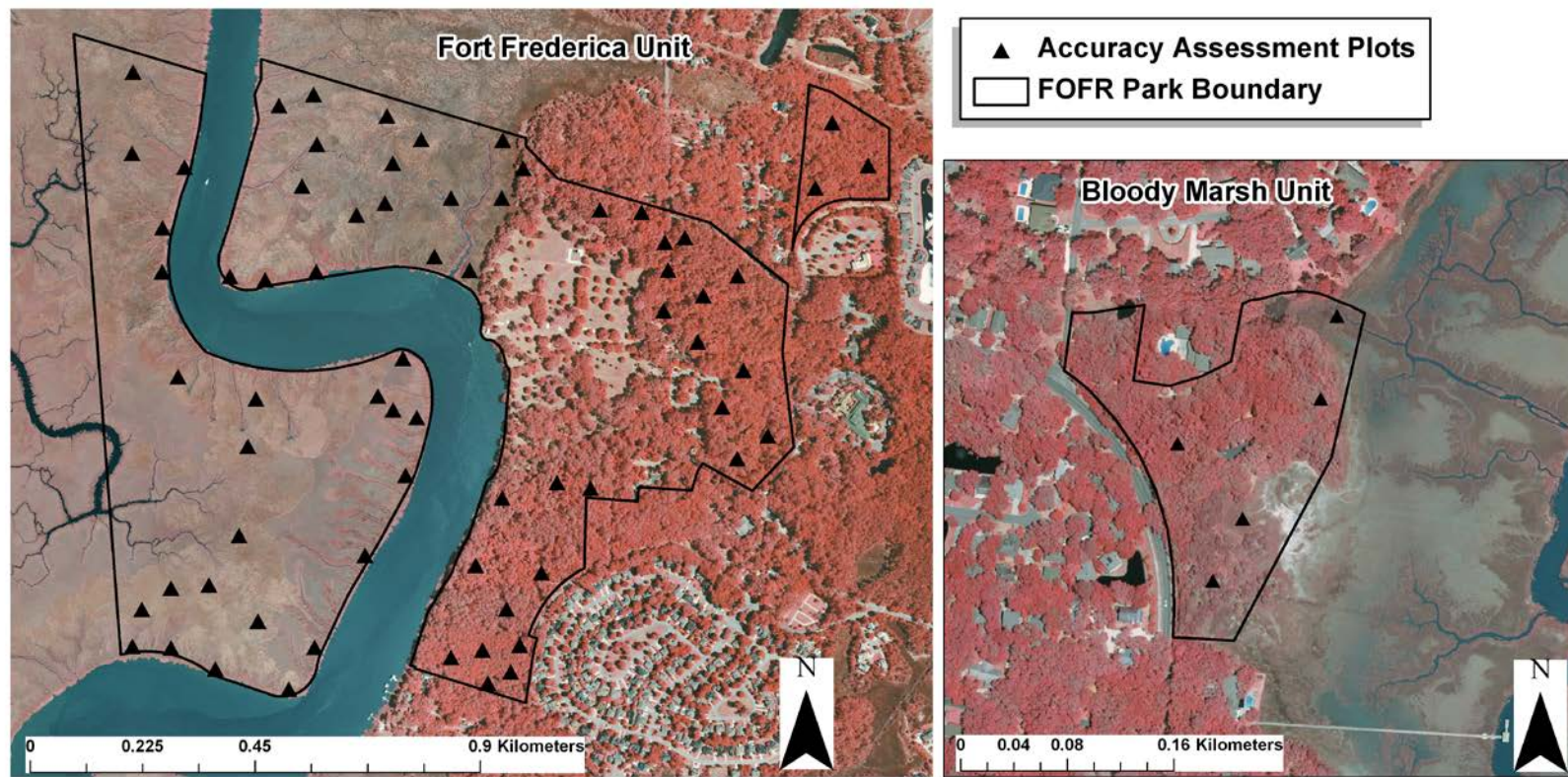
**Table 5.** Standard sample size allocations for accuracy assessment based on map-class area (Lea and Curtis 2010).

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

In order to account for positional error due to site location (GPS error), vegetation polygons were buffered internally by 10 meters prior to generation of the AA points. The AA points were generated randomly in ArcGIS using the Create Random Points tool in ArcToolbox. Based on these guidelines, the total number of observations for the AA of FOFR was 74 (Figure 8).



## Locations of accuracy assessment plots sampled in Fort Frederica National Monument



Produced by Southeast Coast Network

October 2012

**Figure 8.** Locations of accuracy assessment points sampled in Fort Frederica National Monument.

### **Field Data Collection**

Accuracy assessment point data were collected at FOFR during October of 2012. The SECN hired and trained a field crew of two Student Conservation Association (SCA) interns to complete the AA. The interns loaded the AA points into a GPS receiver in order to navigate to the points in the field. In addition to the GPS receivers, the field crew used copies of the orthophotographs overlaid with the AA points (not including any of the lines from the mapped vegetation polygons) as an additional navigation aid. Upon reaching an AA point, the field crew assessed the site within an area of equal size to the minimum ha radius of the observation area following methodology outlined by Lea and Curtis (2010). The field crew collected environmental data, such as hydrology and topography, where meaningful for each AA plot. Vegetation data collected included leaf phenology, leaf type of the dominant stratum, physiognomic class, and vegetation composition in each stratum (see Appendix F for example of AA form). The field crew also made general comments about the classification made for each plot, noting any problems that were encountered (if any). Photographs in each cardinal direction, as well as of the canopy and ground (as applicable), were taken at each site to provide a visual documentation of each AA site.

### **Data Analysis**

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

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

#### Initial Comparative Analysis

We used the Intersect Tool in Arc Toolbox to combine the AA point layer and the map vegetation polygon layer. The resulting layer from the intersection allowed us to compare each AA field-site call (vegetation type) to the corresponding map-polygon call (map class representing vegetation type). We used Microsoft Excel 2007 (Microsoft Corporation) to compare and tabulate the field-site call to the map-polygon call.

#### Review of Disagreements

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

### Final Comparison

None of the mismatches were determined to be a result of a false error. Therefore, we used all 74 of the 74 AA field sites for the final comparative analysis of the vegetation map layer.

### Individual Map-class Analysis

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

### Final Output

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

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

### AA Spatial Database

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

# Results

## Vegetation Classification

The final classification for FOFR resulted in seven vegetation associations in the NVCS (see Appendix B for full association descriptions).

Both historical and current land management practices have strongly influenced the types and distributions of vegetation communities throughout FOFR. Currently, the upland forested areas are protected within park boundaries and will likely return to their original hardwood structure in the future as disturbance removes the pines from the canopy and releases the hardwoods. Therefore, it can be expected that much of the Successional Loblolly Pine – Oak Forest will transition to the Maritime Live Oak Hammock. The marsh land (including needlerush and smooth cordgrass) will continue to be important wetland area, and barring major disturbance, will likely remain relatively unchanged in the future. However, one exception may be the role that global climate change may have in shifting the low marsh (Southern Atlantic Coast Salt Marsh) to high marsh (Needlerush High Marsh), since changes caused by variations in fresh water flow and sea level rise can affect the distribution of vegetation along the salinity gradient of an estuary (Higinbotham et al. 2004).

## Digital Imagery and Interpretation

For FOFR, seven map units were developed and directly matched to corresponding plant associations in the NVCS (Table 6). One map class representing cultural vegetation in the NVCS (e.g., Warm Season Lawn) was identified. Four map classes representing non-vegetated units (e.g., open water bodies, buildings, roads, etc.) were identified (Table 7).

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

**Table 6.** Final vegetation associations of the NVCS used for vegetation mapping (with their assigned Map Codes) in Fort Frederica National Monument.

| Association Common Name                                       | NVCS Code  | Map Code |
|---------------------------------------------------------------|------------|----------|
| <b>Forest</b>                                                 |            |          |
| Atlantic Coastal Plain Swamp Island Forest                    | CEGL007022 | 7022     |
| Coastal red-cedar - Live-oak - Cabbage Palmetto Marsh Hammock | CEGL007813 | 7813     |
| Maritime Live Oak Hammock                                     | CEGL007032 | 7032     |
| Successional Loblolly Pine-Oak Forest                         | CEGL008450 | 8450     |
| <b>Shrubland</b>                                              |            |          |
| Seaside Oxeye Tidal Shrub Flat                                | CEGL003924 | 3924     |
| <b>Herbaceous</b>                                             |            |          |
| Needlerush High Marsh                                         | CEGL004186 | 4186     |
| Southern Atlantic Coast Salt Marsh                            | CEGL004191 | 4191     |

**Table 7.** Map classification codes for non-vegetated areas in Fort Frederica National Monument, following Land Use and Land Cover Level II (Anderson et al. 1976).

| Map Class Code | Anderson Land Use and Land Cover Level II (1976) |
|----------------|--------------------------------------------------|
| 11             | Residential                                      |
| 14             | Transportation, Communications, and Utilities    |
| 16             | Mixed Urban or Built-up Land                     |
| 54             | Bays and Estuaries                               |

## Vegetation Map

Table 8 provides a summary report of the spatial-data layer (map) of FOFR and summarizes frequency, mean area (ha), and the sum of areas (ha) for each map class.

Collectively, the FOFR spatial database layer is composed of 50 polygons covering 192.4 ha, with an average polygon size of 8.9 ha. Map classes representing natural/semi-natural types in the NVCS apply to 33 polygons (66% of all polygons) covering 116.7 ha (61% of entire area) with an average polygon size of 6.4 ha. Of these natural/semi-natural types, the Needlerush High Marsh covers the most area (60.8 ha). The Southern Atlantic Coast Salt Marsh covers the second most area in the park (31.7 ha). Collectively, these two marsh types account for nearly 80% of the natural/semi-natural vegetation within FOFR.

The single cultural type in the NVCS (warm season lawn) consists of one polygon that covers 14.9 ha (7.7% of the entire area). The lawn is found in the center of the Fort Frederica unit and contains the fort along with other monuments.

Non-vegetated areas (including developed areas) consist of 16 polygons (32% of all polygons) and cover 60.8 ha (31.6% of the entire area). Developed areas in the park include the NPS Visitor Center and maintenance buildings, roads, and some private residences outside of park boundaries.

Wetlands consist of 16 polygons (32% of all polygons) and cover 125 ha (65% of entire area). Vegetation associations in the NVCS that are considered wetlands according to the U.S. Fish and Wildlife Service include the following: Needlerush High Marsh, Southern Atlantic Coast Salt Marsh, and the Seaside Oxeye Tidal Flat. All three of these associations are classified as estuarine wetlands (see Table 4).

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

**Table 8.** Summary statistics for the map classes occurring in Fort Frederica National Monument.

| Map Class                                                     | Park Boundary and Buffer  |             |              | Within Park Boundary Only |             |              |
|---------------------------------------------------------------|---------------------------|-------------|--------------|---------------------------|-------------|--------------|
|                                                               | Frequency<br>(# Polygons) | Mean (ha)   | Sum (ha)     | Frequency<br>(# Polygons) | Mean (ha)   | Sum (ha)     |
| <b>Natural Vegetation</b>                                     |                           |             |              |                           |             |              |
| Atlantic Coastal Plain Swamp Island Forest                    | 2                         | 0.47        | 0.94         | 2                         | 0.44        | 0.89         |
| Coastal red-cedar - Live oak - Cabbage Palmetto Marsh Hammock | 2                         | 0.59        | 1.2          | 2                         | 0.41        | 0.8          |
| Maritime Live Oak Hammock                                     | 8                         | 23.0        | 2.9          | 5                         | 13.4        | 2.7          |
| Successional Loblolly Pine - Oak Forest                       | 7                         | 2.6         | 18.1         | 7                         | 2.1         | 14.7         |
| Seaside Oxeye Tidal Shrub Flat                                | 3                         | 0.4         | 1.1          | 3                         | 0.17        | 0.52         |
| Needlerush High Marsh                                         | 5                         | 12.2        | 60.8         | 5                         | 9.0         | 45.2         |
| Southern Atlantic Coast Salt Marsh                            | 6                         | 5.3         | 31.7         | 6                         | 3.40        | 20.6         |
| <b>Natural Vegetation subtotal:</b>                           | <b>33</b>                 | <b>6.4</b>  | <b>116.7</b> | <b>30</b>                 | <b>4.1</b>  | <b>85.4</b>  |
| <b>Cultural Vegetation</b>                                    |                           |             |              |                           |             |              |
| Warm Season Lawn                                              | 1                         | 14.9        | 14.9         | 1                         | 14.8        | 14.8         |
| <b>Cultural vegetation subtotal:</b>                          | <b>1</b>                  | <b>14.9</b> | <b>14.9</b>  | <b>1</b>                  | <b>14.8</b> | <b>14.8</b>  |
| <b>Non-Vegetated Areas</b>                                    |                           |             |              |                           |             |              |
| Residential                                                   | 11                        | 2.3         | 25.5         | 5                         | 0.43        | 2.2          |
| Transportation, Communications, and Utilities                 | 2                         | 0.84        | 1.68         | 2                         | 0.19        | 0.38         |
| Mixed Urban or Built-up Land                                  | 1                         | 2.2         | 2.2          | 0                         | 0           | 0            |
| Bays and Estuaries                                            | 2                         | 15.7        | 31.4         | 2                         | 0.30        | 0.6          |
| <b>Non-Vegetated Areas subtotal:</b>                          | <b>16</b>                 | <b>5.3</b>  | <b>60.8</b>  | <b>9</b>                  | <b>0.2</b>  | <b>3.2</b>   |
| <b>Grand Total:</b>                                           | <b>50</b>                 | <b>8.9</b>  | <b>192.4</b> | <b>40</b>                 | <b>6.4</b>  | <b>103.4</b> |

***Map Layer Presentation***

Figure 9 presents the map layer produced for the FOFR vegetation mapping project. The map is shown at its finest level, i.e. vegetation classes are shown at the association level and are labeled by the association common name. The boundary for FOFR and the mapping boundary for the project are both included. Figure 10 presents vegetated wetland layer polygons in FOFR.



## Vegetation and developed land classes in Fort Frederica National Monument

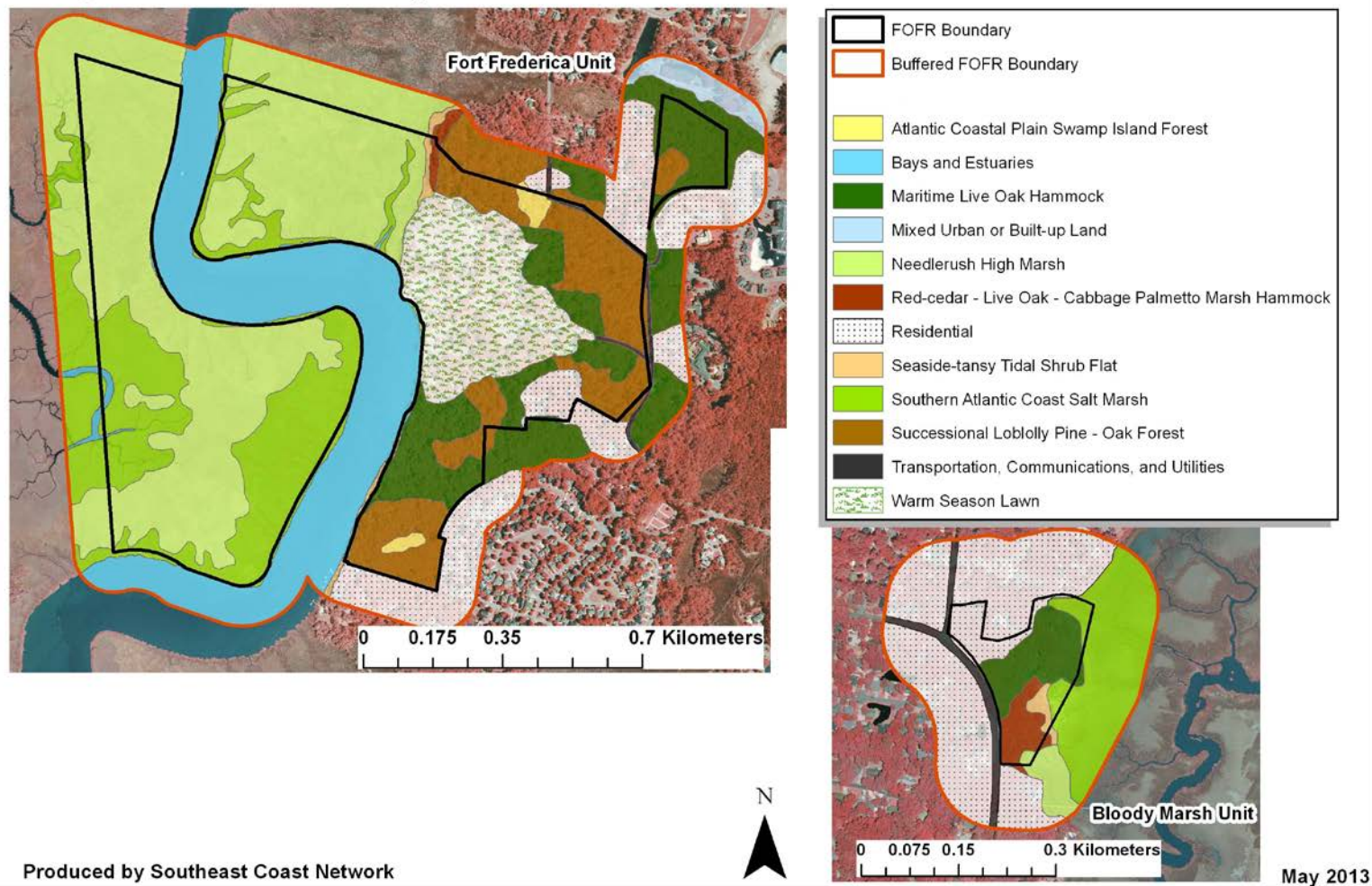
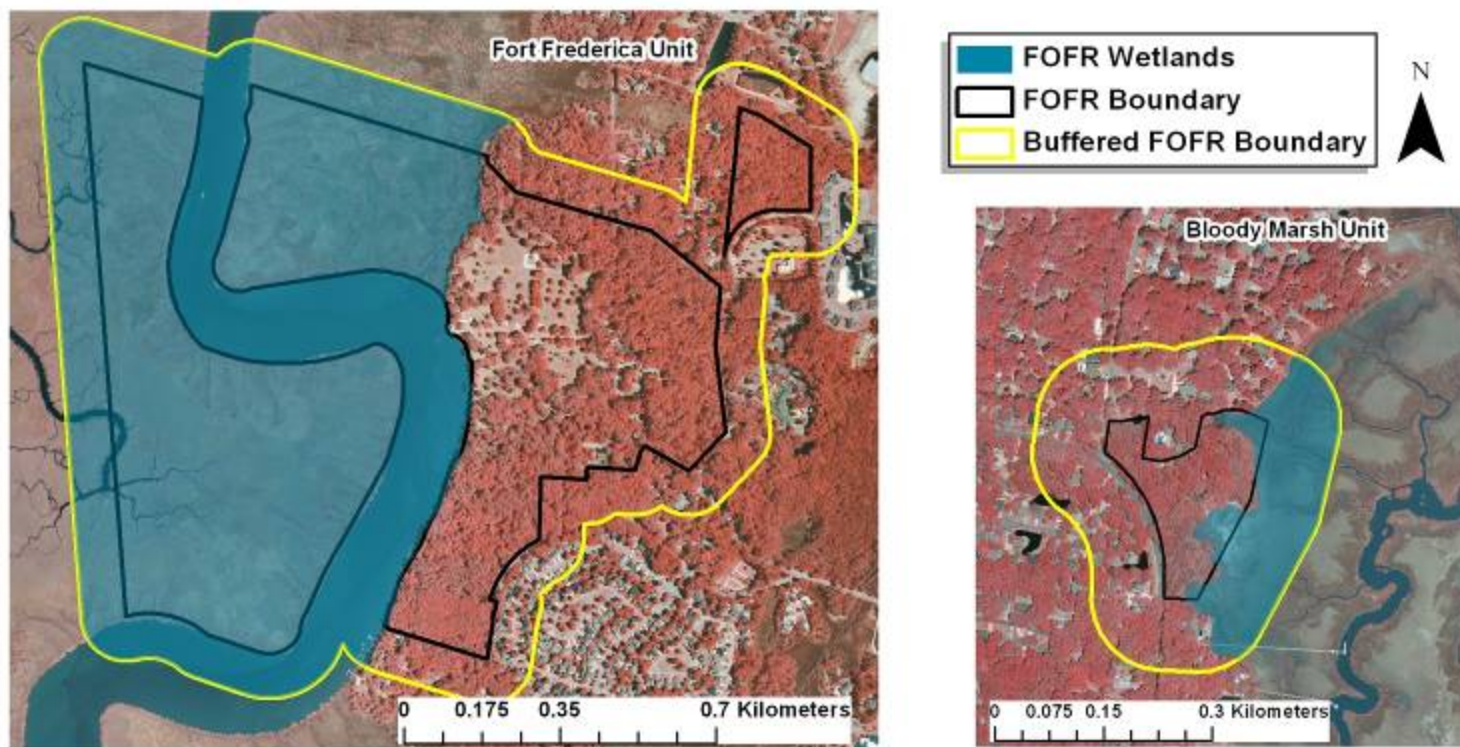


**Figure 9.** Vegetation (NVCS; FGDC 1997) and Land Use (Anderson et al. 1976) map classes for Fort Frederica National Monument.



## Wetlands in Fort Frederica National Monument



Produced by Southeast Coast Network

May 2013

**Figure 10.** Distribution of wetland (Cowardin et al. 1979) vegetation map classes in Fort Frederica National Monument.

## **Accuracy Assessment**

Overall accuracy is 89.5% (90% confidence interval [CI]: 83.3 – 95.8%) for primary map classes representing natural vegetation floristic types in the NVCS. A Kappa adjustment for chance agreements resulted in a final overall accuracy of 71.8% (90% CI: 62.2 – 81.5%). The sample and population contingency matrices for AA results are provided in Appendix G. The population contingency matrix shows the accuracy of each map class (along with 90% CIs), with the user's accuracy reflecting errors of inclusion (commission errors) and the producer's accuracy reflecting errors of exclusion (omission errors) present in the mapping. The width of each CI is affected by the sample size used to derive the point estimate.

Our overall AA met the accuracy requirement of 80% established by the NPS VIP. We attribute our accuracy in part to the relatively small size of the park and our ability to visit a variety of vegetation types represented on the ground during the field reconnaissance portion of the mapping project. Some individual classes, however, did not meet the 80% accuracy requirement. The following section discusses the individual map classes that did not meet the required accuracy.

### ***User's Accuracy (Errors of Commission)***

#### Atlantic Coastal Plain Swamp Island Forest (CEGL007022)

The user's accuracy for Atlantic Coastal Plain Swamp Island Forest was 0% (90% CI: 0 – 10%). Such low accuracy resulted from a sample size of five sites, none of which were mapped correctly. All five sites were located in a single polygon representing what the remote sensing specialist interpreted as the Atlantic Coastal Plain Swamp Island Forest. However, the AA revealed that these five sites were actually Successional Loblolly Pine – Oak Forest. The Successional Loblolly Pine – Oak Forest has a dominant pine component in the canopy, and the Atlantic Coastal Plain Swamp Island Forest contains a fair amount of loblolly pine in the canopy layer as well. Therefore, these two associations can be easy to confuse based on their appearance on the imagery.

#### Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock (CEGL007813)

The user's accuracy for the Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock was 66.7% (90% CI: 5.2 – 100%). The sample size for this association was only three sites, and one of these sites was determined to be Maritime Live Oak Hammock. The Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock and Maritime Live Oak Hammock share some similar species (they are in the same alliance), so it is not too surprising that they may have been confused on the imagery. A main difference is that the Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock has coastal red-cedar as a main canopy component; whereas the Maritime Live Oak Hammock does not. The site that was mapped incorrectly was located in an area that is likely somewhat transitional between Maritime Live Oak Hammock and Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock.

#### Maritime Live Oak Hammock (CEGL007032)

The user's accuracy for Maritime Live Oak Hammock was 68.8% (90% CI: 39.5 – 85.5%). Of the 16 sites sampled, five were determined to be Successional Loblolly Pine – Oak Forest. The remaining 11 were Maritime Live Oak Hammock.

### ***Producer's Accuracy (Errors of Omission)***

#### Atlantic Coastal Plain Swamp Island Forest (CEGL007022)

The producer's accuracy for the Atlantic Coastal Plain Swamp Island Forest was 0% (90% CI: 0 – 50%). One site that was mapped as Coastal red-cedar – Live oak – Cabbage Palmetto Marsh Hammock was identified on the ground as the Atlantic Coastal Plain Swamp Island Forest. Also, two sites mapped as Atlantic Coastal Plain Swamp Island Forest were identified on the ground as Maritime Live Oak Hammock. Since oak species are prevalent in the canopy of all three of these associations, they can be somewhat easy to confuse on the imagery.

#### Successional Loblolly Pine – Oak Forest (CEGL008450)

The producer's accuracy for Successional Loblolly Pine – Oak Forest was 40% (90% CI: 27-80%). Five sites mapped as Maritime Live Oak Hammock were identified on the ground as Successional Loblolly Pine – Oak Forest. Upon review, the mapping error in these five sites resulted from the remote sensing specialist failing to recognize MMUs within Maritime Live Oak Hammock Forest where loblolly pine was actually more dominant than live oak.

Additionally, one site mapped as the Atlantic Coastal Plain Swamp Island Forest was identified on the ground as Successional Loblolly Pine – Oak Forest. As previously discussed, these two associations can appear similarly on the imagery due to both having loblolly pine within the canopy.

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## Appendix A: Field Survey Form

Plots# FOFR001

NPS SE COAST PROJECT: Plot Sampling Form

FOFR01

Page 1

County: ~~Camden~~ Park: ~~Cumberland Island National Seashore~~ Plot Code: ~~FF01~~ State: GA Location org: NPS  
Fort Frederica

Provisional community name Darlington Oak - Loblolly Pine Forest  
Classified community name \_\_\_\_\_  
Classifier \_\_\_\_\_ Date \_\_\_\_\_ NVC ELCODE CEGL00 7022  
Survey date: 5/29/08 time 12:04 Surveyors initials: LK TV SM

Directions to plot (including any notes on best access route, and mile marker): head south from Fort  
to along river to bulwarks. Follow trail into oak  
Forest; continue past vine area at gap and head  
east.

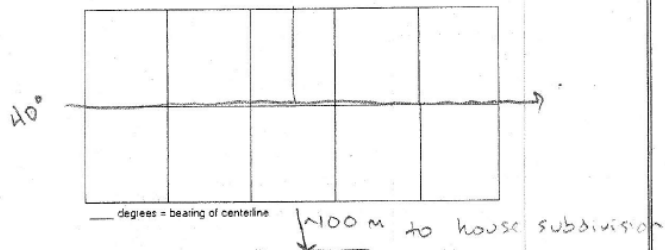
Time taken to walk to plot: ~10 min.

PLOT CONFIGURATION (Depict the plot layout on right with respect to the surrounding area and attempt to draw in points where GPS positions were collected, witness tree, bearing of centerline, locations of pictures taken, and communities near the plot.)

Plot representativeness -Is the surrounding area all the same? ☐ YES ☐ NO - If not, depict below)

PLOT LOCATION (Below show general plot location)

Plot dimensions: 50 m X 20 m



Est. Extent of occurrence of community:

<1HA 1-10 HA 10-100HA >100HA

PIC # 1, 2, 3, 4

Description of pictures (N,E,S & W from GPS point at middle of plot): NESW

Select one: UTM / Lat/long (If lat/long, then values are 31.21823°N -81.39324°W)

GPS Techniques/Equipment: Garmin V Datum(pick one) WGS84 NAD83 / NAD27 UTM Zone: \_\_\_\_\_

GPS Unit ID \_\_\_\_\_ GPS file name FOFR01 (standard = First letter(s) of park + # of plot (e.g. CH04, CL04, MO04))

Field UTM X \_\_\_\_\_ m E Y \_\_\_\_\_ m N Elevation 30 m / ft

Averaging performed (at least 120 observations)? 15.4 Coordinate accuracy \_\_\_\_\_ m / ft DOP \_\_\_\_\_ # sats \_\_\_\_\_

## NPS SE COAST PROJECT: Plot Sampling Form

Page 2

County: Camden Park: Cumberland Island National Seashore Plot Code: FF01 State: GA Location org: NPS

## ENVIRONMENTAL / SITE INFORMATION

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>Measured Slope</b> <u>0</u> ° <u>0</u> %<br><input type="radio"/> Flat 0 ° 0 %<br><input type="radio"/> Gentle 0-5 ° 1-9 %<br><input type="radio"/> Moderate 6-14 ° 10-25 %<br><input type="radio"/> Somewhat steep 15-25 ° 26-49 %<br><input type="radio"/> Steep 27-45 ° 50-100 %<br><input type="radio"/> Very steep 45-69 ° 101-275 %<br><input type="radio"/> Abrupt 70-100 ° 276-300 %<br><input type="radio"/> Overhanging/steep >100 ° >300 %                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | <b>Measured Aspect</b> <u>0</u> ° (N=0 °)<br><input type="radio"/> Flat <u>SE</u> 113-157 °<br><input type="radio"/> Variable <u>S</u> 158-202 °<br><input type="radio"/> N 338-22 ° SW 203-247 °<br><input type="radio"/> NE 23-67 ° W 248-292 °<br><input type="radio"/> E 68-112 ° NW 293-337 °                                                                                                 |                                             | <b>Topographic Position</b><br><input checked="" type="checkbox"/> Interfluvial (Ridge/summit/crest) <input type="checkbox"/> Toeslope<br><input type="checkbox"/> High Slope (upper/convex slope) <input type="checkbox"/> Low level (terrace)<br><input type="checkbox"/> Midslope <input type="checkbox"/> Channel bed<br><input type="checkbox"/> Lowslope (lower/footslope)                 |  |
| <b>Cowardin System</b><br><input checked="" type="checkbox"/> Upland <input type="checkbox"/> Palustrine <input type="checkbox"/> Riverine<br><input type="checkbox"/> Estuarine <input type="checkbox"/> Lacustrine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>Landform</b> (check most applicable)<br><input type="checkbox"/> Alluvial flat <input type="checkbox"/> Bottomlands <input type="checkbox"/> Interdune flat <input type="checkbox"/> Spit<br><input type="checkbox"/> Alluvial terrace <input type="checkbox"/> Carolina Bay <input type="checkbox"/> Lagoon <input type="checkbox"/> Streambed<br><input type="checkbox"/> Backslope Terrace <input type="checkbox"/> Channel <input type="checkbox"/> Lowland <input type="checkbox"/> Streamhead<br><input type="checkbox"/> Bank <input type="checkbox"/> Depression <input type="checkbox"/> Mound <input type="checkbox"/> Swale<br><input type="checkbox"/> Bar <input type="checkbox"/> Draw <input type="checkbox"/> Mudflat <input type="checkbox"/> Tidal flat<br><input checked="" type="checkbox"/> Barrier Island <input type="checkbox"/> Dune <input type="checkbox"/> Ravine <input type="checkbox"/> Toe slope<br><input type="checkbox"/> Beach <input type="checkbox"/> Estuary <input type="checkbox"/> Ridge <input type="checkbox"/> Washover fan<br><input type="checkbox"/> Beach Ridge <input type="checkbox"/> Floodplain <input type="checkbox"/> Seep<br><input type="checkbox"/> Bench <input type="checkbox"/> Gap <input type="checkbox"/> Slope<br><input type="checkbox"/> Gravel Bar <input type="checkbox"/> Slough |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>Rock types present:</b><br><b>Hydrologic Regime:</b><br><input checked="" type="checkbox"/> Not a wetland (Upland: XERIC : DRY - MESIC : MESIC)<br><input type="checkbox"/> Intermittently flooded <input type="checkbox"/> Permanently flooded <input type="checkbox"/> Semipermanently flooded <input type="checkbox"/> Temporarily flooded (e.g. floodplains) <input type="checkbox"/> Tidally flooded<br><input type="checkbox"/> Seasonally flooded (e.g. seasonal ponds) <input type="checkbox"/> Saturated (e.g. bogs, perennial seeps) <input type="checkbox"/> Unknown <input type="checkbox"/> Irregularly flooded <input type="checkbox"/> Irregularly exposed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>QUALITATIVE ASSESSMENT:</b><br>A) HYDROLOGY:<br><br>B) LANDSCAPE AND LANDUSE HISTORY (including disturbance history and possible threats to sustainability):<br><u>Nearby housing developments, recently (w/in 30 yrs) yacht club w/ gardens, recent (1-2 yrs) wisteria eradication</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>Soil Texture:</b> <u>high organic matter</u><br><input checked="" type="checkbox"/> Sand <input type="checkbox"/> Peat <input type="checkbox"/> Silt loam <input type="checkbox"/> Muck<br><input type="checkbox"/> Sandy loam <input type="checkbox"/> Loam <input type="checkbox"/> Clay loam <input type="checkbox"/> Clay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | <b>Drainage:</b><br><input type="checkbox"/> Rapidly drained <input checked="" type="checkbox"/> Moderately well drained <input type="checkbox"/> Somewhat poorly drained<br><input type="checkbox"/> Well drained <input type="checkbox"/> Poorly drained <input type="checkbox"/> Very poorly drained                                                                                            |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>Ground cover</b> [Exclusive of living plants; adds to 100%]<br><input type="checkbox"/> % Bedrock <input checked="" type="checkbox"/> 95 % Litter, duff <input type="checkbox"/> % Other<br><input type="checkbox"/> % Large rocks (cobbles, boulders >10cm) <input type="checkbox"/> 5 % Wood (> 1 cm)<br><input type="checkbox"/> % Small rocks (gravel, 0.2-10 cm) <input type="checkbox"/> % Water<br><input type="checkbox"/> % Loose sand (0.1-2 mm) <input type="checkbox"/> % Bare soil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <b>Leaf type:</b><br><input type="checkbox"/> Broad-leaved <input checked="" type="checkbox"/> Succulent<br><input type="checkbox"/> Needle-leaved <input checked="" type="checkbox"/> Mixed<br><input type="checkbox"/> Microphyllous<br><input type="checkbox"/> Graminoid<br><input type="checkbox"/> Broad-leaved herbaceous<br><input type="checkbox"/> Pteridophyte<br><input type="checkbox"/> Extremely xeromorphic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  | <b>Leaf phenology</b> (dominant stratum)<br><input checked="" type="checkbox"/> Evergreen<br><input type="checkbox"/> Cold-deciduous<br><input type="checkbox"/> Drought-deciduous<br><input type="checkbox"/> Mixed evergreen-cold-deciduous<br><input type="checkbox"/> Mixed evergreen drought deciduous<br><input type="checkbox"/> Herb - Annual<br><input type="checkbox"/> Herb - Perennial |                                             | <b>Physlognomic Class</b><br><input checked="" type="checkbox"/> Forest (closed tree canopy)<br><input type="checkbox"/> Woodland (open tree canopy)<br><input type="checkbox"/> Shrubland<br><input type="checkbox"/> Dwarf Shrubland<br><input type="checkbox"/> Herbaceous (less than 25% woody layers)<br><input type="checkbox"/> Nonvascular<br><input type="checkbox"/> Sparse Vegetation |  |
| <b>Natural and Anthropogenic Disturbance</b><br><input type="checkbox"/> logging <input type="checkbox"/> fire <input type="checkbox"/> Hydrologic<br><input type="checkbox"/> erosion <input checked="" type="checkbox"/> trails/roads <input type="checkbox"/> Agriculture<br><input type="checkbox"/> grazing/browsing <input type="checkbox"/> wind/ice damage <input type="checkbox"/> Old Growth<br><input type="checkbox"/> pine bark beetle <input type="checkbox"/> exotic plants <input type="checkbox"/> Fire Suppression<br><input type="checkbox"/> dogwood anthr <input type="checkbox"/> ORV <input type="checkbox"/> Redbay mortality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Disturbance and animal use comments:</b> |                                                                                                                                                                                                                                                                                                                                                                                                  |  |

Community Survey  
Page 2

29 May 09

## NPS SE COAST PROJECT: Plot Sampling Form

FOPR01

Page 3

County: Camden Park: Cumberland Island National Seashore

Plot Code: FOPR01

State: GA Location org: NPS

## QUANTITATIVE VEGETATION SAMPLE

"DEFAULT" TAXONOMIC REFERENCE:

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

T1: Emergent \ T2: Tree Canopy \ T3 Subcanopy \ S1 Tall Shrub (&gt;1m; to 5m) \ S2 Short Shrub (&lt; 1m) \ H Herbaceous \ N Nonvascular \ V Vines (lianas)

E Epiphytes

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

| T | T | T | S | S | H | N | V | E | Total Cover | Name (7 letter code or full name)     | Collected? Spec #? | Discarded? |
|---|---|---|---|---|---|---|---|---|-------------|---------------------------------------|--------------------|------------|
|   | 6 |   | 2 |   | 1 |   |   |   | 6           | <i>Pinus taeda</i>                    |                    |            |
|   | 8 |   |   |   | 3 |   |   |   | 8           | <i>Q. hemispherica</i>                | ✓                  | ✓          |
|   |   |   |   | 2 | 6 |   |   |   | 6           | <i>V. rotundifolia</i>                |                    |            |
|   |   |   |   |   | 3 |   |   |   | 3           | <i>Smilax bona-nox</i>                |                    |            |
|   |   |   | 2 | 3 | 2 |   |   |   | 3           | <i>Ilex ambigua</i>                   | ✓                  | ✓          |
|   |   |   | 4 | 5 | 2 |   |   |   | 6           | <i>Morella cerifera</i>               |                    |            |
|   |   |   |   |   | 2 |   |   |   | 2           | <i>Ilex opaca</i>                     |                    |            |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Sorbus repens</i>                  |                    |            |
|   |   |   | 3 | 4 |   |   |   |   | 4           | <i>Ilex vomitoria</i>                 |                    |            |
|   |   |   | 3 |   |   |   |   |   | 3           | <i>Sabale palmetto</i>                |                    |            |
|   |   |   | 3 |   | 2 |   |   |   | 3           | <i>Persea borbonia</i> (tip of blade) |                    |            |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Desmodium sp. (glabellum)</i>      | ✓                  | ✓          |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Prunus caroliniana</i>             |                    |            |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Parthenocissus quinquifolia</i>    |                    |            |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Crataegus stimuleus</i>            |                    |            |
|   |   |   | 3 |   |   |   |   |   | 3           | <i>Vaccinium arboreum</i>             |                    |            |
|   |   |   |   |   | 1 |   |   |   | 1           | <i>Tillandsia usneoides</i>           |                    |            |

| Cover cls |
|-----------|
| 1 trace   |
| 2 0.1-1%  |
| 3 1-2%    |
| 4 2-5%    |
| 5 5-10%   |
| 6 10-25%  |
| 7 25-50%  |
| 8 50-75%  |
| 9 75-95%  |
| 10 >95%   |

D. glabellum

Community Survey

Page 3

## Page 4

Plot Code: FF04

State: GA Location org: NPS

| SPECIES COMPOSITION AND COVEY ABUNDANCE CLASS BY STRATUM |        |        |        |        |   |   |   |   |                |                                                    |                       |                |
|----------------------------------------------------------|--------|--------|--------|--------|---|---|---|---|----------------|----------------------------------------------------|-----------------------|----------------|
| T<br>1                                                   | T<br>2 | T<br>3 | S<br>1 | S<br>2 | H | N | V | E | Total<br>cover | Name (7 letter acronym or full name)               | Collected?<br>Spec #? | Discar<br>ded? |
|                                                          | 5      | 5      |        |        |   |   |   |   | 5              | <i>Q. nigra</i>                                    | ✓                     | ✓              |
|                                                          |        |        |        | 1      |   |   |   |   | 1              | <i>Rubus argutus</i>                               |                       |                |
|                                                          |        |        |        | 1      |   |   |   |   | 1              | <i>Diervillium connatum</i>                        |                       |                |
|                                                          |        |        |        | 1      |   |   |   |   | 1              | <i>Calliandra americana</i>                        |                       |                |
|                                                          |        |        | 4      |        |   |   |   |   | 4              | <i>Vaccinium corymbosum</i>                        |                       |                |
|                                                          |        |        |        | 1      |   |   |   |   | 1              | <i>Diervillium sabulorum</i><br>var. <i>thinum</i> | ✓                     | ✓              |
|                                                          |        |        |        | 1      |   |   |   |   | 1              | <i>Besleria sempervirens</i>                       |                       |                |
|                                                          |        |        | 1      |        |   |   |   |   | 1              | <i>Magnolia grandiflora</i>                        |                       |                |
|                                                          |        |        | 1      | 1      |   |   |   |   | 1              | <i>Smilax asperifolia hispida</i>                  | ✓                     | ✓              |

| Cover classes |
|---------------|
| 1. trace      |
| 2. 0.1-1%     |
| 3. 1-2%       |
| 4. 2-5%       |
| 5. 5-10%      |
| 6. 10-25%     |
| 7. 25-50%     |
| 8. 50-75%     |
| 9. 75-95%     |
| 10. >95%      |

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

Community Survey  
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## Appendix B: Descriptions of Vegetation Types

This subset of the International Ecological Classification Standard covers associations and alliances attributed to Cumberland Island National Seashore and Fort Frederica National Monument. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, Durham, NC <mary\_russo@natureserve.org> and Heather Summer, Regional Ecologist, Durham, NC <heather\_summer@natureserve.org>. Some classifications were altered by SECN staff and are detailed in the descriptions below. In those instances, comments should be directed to the authors of this report.

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

NatureServe. 2008. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 29 October 2008.

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## Forest (I.)

### Lowland temperate seasonal evergreen forest (I. A.4.N.a)

#### *Quercus hemisphaerica* Forest Alliance (A.53)

##### Alliance Concept

**Summary:** This alliance includes dry-mesic to mesic forests of lower and adjacent upper coastal plains. These communities are characteristically dominated or codominated by the evergreen oak *Quercus hemisphaerica* (Darlington oak). Representative examples occur in fire-sheltered topographic situations, or in more fire-prone topographic situations as the result of fire suppression. Soils are typically sandy and nutrient-poor. Examples also occur on nutrient-poor sandy and gravelly sites where the topsoil has been lost due to heavy erosion. These more successional forests on highly eroded nutrient-poor sites may be related to and possibly represent depauperate examples of the *Quercus hemisphaerica* - *Carya glabra* Forest Alliance (A.372). Other typical tree species in stands of this alliance include *Pinus taeda* (loblolly pine), *Quercus virginiana* (live oak), *Quercus nigra* (water oak), *Quercus falcata* (southern red oak), *Magnolia grandiflora* (southern magnolia), *Ilex opaca* var. *opaca* (American holly), *Carya glabra* (pignut hickory), *Carya pallida* (sand hickory), and *Carya alba* (mockernut hickory). Early successional communities in this alliance are likely to be strongly dominated by *Quercus hemisphaerica* (Darlington oak) and to lack (or only have minor amounts of) later successional species, such as *Carya glabra* (pignut hickory), *Tilia americana* var. *caroliniana* (Carolina basswood), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Ostrya virginiana* (hophornbeam), and *Quercus michauxii* (swamp chestnut oak). Other characteristic species may include *Persea borbonia* (redbay), *Persea palustris* (swamp bay), *Ilex opaca* var. *opaca* (American holly), *Vitis rotundifolia* (muscadine), and *Lyonia lucida* (fetterbush lyonia). Examples of this alliance typically occur on submesic to xeric upland sands. The absence of fire is a critical part of the environmental parameters of this alliance; in natural types, this absence of fire results from topographic position. In early successional ruderal types, absence of fire is the result of fragmentation of the landscape and fire suppression in remaining fragments. Dominance by *Quercus hemisphaerica* (Darlington oak) indicates that fire has been excluded from these forests for a period of many years; stands of this species are probably more common and widespread than in pre-settlement times.

**Classification Comments:** In many references (e.g., Sharitz 1975), the evergreen *Quercus hemisphaerica* of dry, sandy habitats has been mistakenly referred to as *Quercus laurifolia*, a (tardily) deciduous tree of floodplain forests (Weakley 1997).

##### **Similar Alliances:**

- *Quercus hemisphaerica* - *Carya glabra* Forest Alliance (A.372)--related mixed forests, with *Quercus hemisphaerica* sharing dominance with *Carya* or other deciduous trees, more natural and diverse.
- *Quercus nigra* Forest Alliance (A.247)--includes similarly fire-sheltered or fire-suppressed vegetation but on comparatively finer-textured soils.

##### **Related Concepts:**

- Coastal Plain upland broad-leaved evergreen forest (Ambrose 1990a)?
- High hammock (Platt and Schwartz 1990)?

- Pioneer Hammock (Wolfe 1990)?
- Upland Hardwood Forest (FNAI 1992a)?
- Xeric Hammock (FNAI 1992a)?

#### Alliance Description

**Environment:** Stands in this alliance are dry-mesic to mesic forests of lower and adjacent upper coastal plains, especially in fire-sheltered topographic situations, or the result of fire suppression in fire-prone topographic situations. Examples of this alliance typically occur on submesic to xeric, upland, nutrient-poor sandy soils. Examples may occur on nutrient-poor sandy and gravelly sites where the topsoil has been lost due to heavy erosion. Vegetation of this alliance is presumably transitional between forests or woodlands of ridges and upper slopes (dominated by *Pinus palustris* and/or dry-site oaks) and mesic forests of lower slopes dominated by *Fagus grandifolia* and more mesic oaks.

**Vegetation:** These communities are characteristically dominated or codominated by *Quercus hemisphaerica* (Darlington oak). Other typical tree species include *Pinus taeda* (loblolly pine), *Quercus virginiana* (live oak), *Quercus nigra* (water oak), *Quercus falcata* (southern red oak), *Magnolia grandiflora* (southern magnolia), *Ilex opaca* var. *opaca* (American holly), *Carya glabra* (pignut hickory), *Carya pallida* (sand hickory), and *Carya alba* (mockernut hickory). Early successional communities in this alliance are likely to be strongly dominated by *Quercus hemisphaerica* (Darlington oak), and to lack (or only have minor amounts of) later successional species, such as *Carya glabra* (pignut hickory), *Tilia americana* var. *caroliniana* (Carolina basswood), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Ostrya virginiana* (hophornbeam), and *Quercus michauxii* (swamp chestnut oak). Other characteristic species may include *Persea borbonia* (redbay), *Persea palustris* (swamp bay), *Ilex opaca* var. *opaca* (American holly), *Vitis rotundifolia* (muscadine), and *Lyonia lucida* (fetterbush lyonia).

**Dynamics:** The absence of fire is a critical part of the environmental parameters of this alliance; in natural types, this absence of fire results from topographic position. In early successional ruderal types, absence of fire is the result of fragmentation of the landscape and fire suppression in remaining fragments.

#### Alliance Distribution

**Range:** This alliance is found in Florida, Alabama, Georgia, North Carolina, and South Carolina, but it is not found in Mississippi.

**Nations:** US

**Subnations:** AL, FL, GA, NC, SC

**TNC Ecoregions:** 43:C, 53:C, 54:P, 55:C, 56:C, 57:C

**USFS Ecoregions:** 231Ba:CC?, 231Bc:CCP, 231Bj:CCP, 231Bl:CCP, 232Be:CCP, 232Bf:CCP, 232Bg:CCC, 232Bh:CCC, 232Bi:CCP, 232Bj:CCC, 232Bl:CCP, 232Bm:CCP, 232Bn:CCP, 232Bo:CCP, 232Bp:CCC, 232Bq:CCP, 232Br:CCC, 232Bs:CC?, 232Bu:CCP, 232Bv:CCP, 232Ca:CCC, 232Cb:CCC, 232Cc:CCP, 232Ce:CCC, 232Cf:CCP, 232Da:CC?, 232Db:CCP, 232Dc:CCC, 232Ga:CCP, 232Gb:CCC

**Federal Lands:** DOD (Camp Lejeune, Eglin, Fort Benning, Fort Gordon, Fort Stewart); NPS (Canaveral, Cumberland Island, Fort Frederica, Fort Sumter); USFS (Apalachicola, Conecuh, Tuskegee?); USFWS (Eufaula)

**(CEGL007022) Atlantic Coastal Plain Swamp Island Forest*****Quercus hemisphaerica* – *Pinus taeda* – (*Quercus nigra*) / *Osmanthus americanus* var. *americanus* / *Ilex glabra* Forest****Sand Laurel Oak – Loblolly Pine – (Water Oak) / Wild Olive / Inkberry Forest**

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**NVC Classification**

|                            |                                                                                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class         | Forest (I)                                                                                                                                                    |
| Physiognomic Subclass      | Evergreen forest (I.A.)                                                                                                                                       |
| Physiognomic Group         | Temperate broad-leaved seasonal evergreen forest (I.A.4.)                                                                                                     |
| Physiognomic Subgroup      | Natural/Semi-natural temperate broad-leaved seasonal evergreen forest (I.A.4.N.)                                                                              |
| Formation                  | Lowland temperate seasonal evergreen forest (I.A.4.N.a.)                                                                                                      |
| Alliance                   | <i>Quercus hemisphaerica</i> Forest Alliance (A.53)                                                                                                           |
| Alliance (English name)    | Sand Laurel Oak Forest Alliance                                                                                                                               |
| Association                | <i>Quercus hemisphaerica</i> – <i>Pinus taeda</i> – ( <i>Quercus nigra</i> ) / <i>Osmanthus americanus</i> var. <i>americanus</i> / <i>Ilex glabra</i> Forest |
| Association (English name) | Sand Laurel oak – Loblolly Pine – (Water Oak) / Wild Olive / Inkberry Forest                                                                                  |
| Association (Common name)  | Atlantic Coastal Plain Swamp Island Forest                                                                                                                    |
| Ecological System(s)       | Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)                                                                                              |

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Element Concept

**Global Summary:** This association is found on swamp islands in the outer and middle Coastal Plain of North Carolina, South Carolina and Georgia. The canopy is characteristically dominated by *Quercus hemisphaerica* (Darlington oak) with *Pinus taeda* (loblolly pine). Some stands may contain *Quercus nigra* (water oak). Some typical small trees or shrubs include *Osmanthus americanus* var. *americanus* (devilwood) and *Ilex glabra* (inkberry). Other characteristic species include *Persea palustris* (swamp bay), *Ilex opaca* var. *opaca* (American holly), *Vitis rotundifolia* (muscadine), and *Lyonia lucida* (fetterbush lyonia).

Environmental Description**Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This swamp island forest was sampled once at Fort Frederica on a flat barrier island with moderately well-drained sand soil. The unvegetated surface is dominated by leaf litter (95% cover) with some wood (5%). Evidence of disturbance includes trails and roads some redbay twig dieback. There have been efforts made recently to remove invasive *Wisteria*.

**Global Environment:** This association is found on swamp islands in the outer and middle Coastal Plain of North Carolina.

Vegetation Description**Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

The very dense (90% cover) tree canopy, 20-35 m tall, is dominated by *Quercus hemisphaerica* (Darlington oak), along with lesser amounts of *Pinus taeda* (loblolly pine) and *Quercus nigra* (water oak), the latter also forming a very sparse (10%) subcanopy (15-20 m). The sparse (30%) tall-shrub layer (2-5 m) is dominated by *Morella cerifera* (wax-myrtle) and includes *Ilex ambigua* (Carolina holly), *Ilex vomitoria* (yaupon), *Persea borbonia* (redbay), *Pinus taeda* (loblolly pine), and *Sabal palmetto* (cabbage palmetto). *Morella cerifera* (wax-myrtle) also dominates the very sparse (10%) short-shrub layer (0.5-1 m) along with *Ilex ambigua* (Carolina holly), *Ilex vomitoria* (yaupon), *Vaccinium arboreum* (farkleberry), and *Vaccinium corymbosum* (highbush blueberry). The herbaceous layer is sparse (30%) and dominated by vines of *Vitis rotundifolia* (muscadine) which climb into the shrub layers. Additional herbs and vines include

*Cnidioscolus stimulosus* (finger rot), *Desmodium glabellum* (Dillenius' ticktrefoil), *Dichanthelium commutatum* (variable panicgrass), *Dichanthelium sabulorum* var. *thinium* (hemlock rosette grass), *Gelsemium sempervirens* (evening trumpetflower), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax bona-nox* (saw greenbrier), and *Smilax tamnoides* (bristly greenbrier).

**Global Vegetation:** The canopy of this swamp island association is characteristically dominated by *Quercus hemisphaerica* (Darlington oak) with *Pinus taeda* (loblolly pine). Some stands may contain *Quercus nigra* (water oak). Some typical small trees, shrubs, and woody vines include *Osmanthus americanus* var. *americanus* (devilwood), *Vitis rotundifolia* (muscadine) and *Ilex glabra* (inkberry). Other characteristic species include *Persea palustris* (swamp bay), *Ilex opaca* var. *opaca* (American holly), *Vitis rotundifolia* (muscadine), and *Lyonia lucida* (fetterbush lyonia). In some contrast to the primary description, stands of this type occasionally lack *Osmanthus americanus* var. *americanus* (devilwood) and have more *Quercus nigra* (water oak) than *Quercus hemisphaerica* (Darlington oak) (M. Schafale pers. comm.).

#### Most Abundant Species

##### **Cumberland Island National Seashore and Fort Frederica National Monument**

| <u>Stratum</u>               | <u>Lifeform</u>              | <u>Species</u>                                                            |
|------------------------------|------------------------------|---------------------------------------------------------------------------|
| Tree (canopy & subcanopy)    | Broad-leaved deciduous tree  | <i>Quercus nigra</i> (water oak)                                          |
| Tree canopy                  | Needle-leaved tree           | <i>Pinus taeda</i> (loblolly pine)                                        |
| Tree canopy                  | Broad-leaved evergreen tree  | <i>Quercus hemisphaerica</i> (Darlington oak)                             |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Ilex ambigua</i> (Carolina holly)                                      |
| Shrub/sapling (tall & short) | Broad-leaved evergreen shrub | <i>Ilex vomitoria</i> (yaupon), <i>Morella cerifera</i> (wax-myrtle)      |
| Tall shrub/sapling           | Broad-leaved evergreen shrub | <i>Persea borbonia</i> (redbay), <i>Sabal palmetto</i> (cabbage palmetto) |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Vaccinium corymbosum</i> (highbush blueberry)                          |
| Short shrub/sapling          | Broad-leaved evergreen shrub | <i>Vaccinium arboreum</i> (farkleberry)                                   |
| Herb (field)                 | Vine/Liana                   | <i>Vitis rotundifolia</i> (muscadine)                                     |

#### Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Pinus taeda* (loblolly pine), *Quercus hemisphaerica* (Darlington oak), *Quercus nigra* (water oak)

#### Conservation Status Rank

**Global Rank & Reasons:** G2G3 (22-Jan-1998). This evergreen forest is restricted to fire-sheltered topographic situations, in particular swamp islands in the outer and middle Coastal Plain of North Carolina. It is naturally restricted in range and in the topographic situations where it occurs. It is vulnerable to hydrologic alterations and to the effects of timber removal.

#### Classification

**Status:** Standard

**Classification Confidence:** 2 - Moderate

#### **Cumberland Island National Seashore and Fort Frederica National Monument Comments:**

The plot attributed to this association (FOFR.01) is in a successional area that was likely historically Maritime Live Oak Hammock (CEGL007032) or some other maritime forest association. In adjacent areas are large live oaks and canopy gaps with live oak and abundant *Vitis rotundifolia* cover.

**Global Comments:** The former *Pinus taeda* - *Quercus nigra* / Shrubs / Mixed Herbs Upland Forest (CEGL007533) was merged in here with consensus from Mike Schafale (pers. comm. 2004). This merger does not affect the resulting Grank for this association (CEGL007022). Successional vegetation could be dominated by these species (*Quercus hemisphaerica*, *Pinus taeda*, *Quercus nigra*) in fire-suppressed cutover flatwoods or in cutover mesic forest situations. Usually though you would have *Liquidambar styraciflua* as a major component as well.

**Global Similar Associations:**

- *Pinus taeda* - *Quercus hemisphaerica* / *Osmanthus americanus* / *Ilex glabra* Woodland (CEGL003619)

Element Distribution

**Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This forest dominates the forested portion of Fort Frederica that lies to the south of the archeological complex.

**Global Range:** This association is found on swamp islands in the outer and middle Coastal Plain of North Carolina and Georgia.

**Nations:** US

**States/Provinces:** GA, NC, SC

**TNC Ecoregions:** 56:C, 57:C

**USFS Ecoregions:** 232Cb:CCC, 232Ce:CCC

**Federal Lands:** DOD (Camp Lejeune); NPS (Fort Frederica)

Element Sources

**Cumberland Island National Seashore and Fort Frederica National Monument Plots:** FOFR.01.

**Local Description Authors:** M.J. Russo, H. Summer and L. Kruse

**Global Description Authors:** M. Pyne

**References:** Southeastern Ecology Working Group n.d.

***Quercus virginica* – (*Sabal palmetto*) Forest Alliance (A.55)**

Alliance Concept

**Summary:** This alliance includes communities of barrier islands, maritime hammocks, and some more inland coastal hammocks and other fire-protected situations, which are dominated and characterized by *Quercus virginiana* (live oak), and often containing *Sabal palmetto* (cabbage palmetto) and *Juniperus virginiana* var. *silicicola* (southern redcedar) within their ranges. Habitats for associations in this alliance range from xeric and subxeric to moist. Vegetation of this alliance most typically lies just landward of maritime shrub zones; it ranges from temperate to subtropical and often has a component of deciduous broad-leaved trees as well, particularly in the north. Some examples are affected by varying intensities of salt spray; these situations display more-or-less wind- and salt spray-sculpted vegetation. Other upland examples are not affected by salt spray and correspondingly differ in composition and stature. Composition varies along a latitudinal gradient. Examples occur on sand flats, lower slopes, and on stabilized dunes that are protected from saltwater flooding but which experience light to moderate salt spray. Some more protected examples have relatively closed and diverse canopies

and well-developed shrub strata; vines are often conspicuous and abundant, but the herbaceous stratum is typically sparse and low in diversity. This community occurs over moist, sandy soils, on low areas of the mainland coast, and stands are protected from the most extreme maritime influences (i.e., salt spray) but are susceptible to high winds and flooding during hurricanes. Extending south from the vicinity of Cape Fear, North Carolina, the canopy is dominated by *Quercus virginiana* (live oak) and *Pinus taeda* (loblolly pine) with some *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. 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. The more tropically influenced examples may contain shrubs such as *Eugenia axillaris* (white stopper), *Myrsine floridana* (Guianese colicwood), and *Coccoloba uvifera* (seagrape) on the west coast of Florida, and *Myrcianthes fragrans* (twinberry), *Ardisia escallonioides* (island marlberry), and *Psychotria nervosa* (Seminole balsamo) on the east coast. The alliance also includes tropical/temperate maritime hammocks of the east coast of Florida, in mid-peninsula, characteristically with oak canopy and tropical subcanopy; as well as temperate maritime hammocks of the northeast and Panhandle coasts of Florida. Vegetation of this alliance may be found on xeric to mesic sites, often occurring as linear strands behind frontal dunes. The seaward edge is generally found on the leeward side of dune complexes which provide shelter from excessive salt spray and overwash; this vegetation is also found on top of relict dune ridges and other areas with xeric to mesic hydrology. While relatively protected, the vegetation frequently exhibits effects of wind-pruning and salt spray. The alliance also includes some dry hammocks, found from Florida to North Carolina; in these examples, *Quercus virginiana* (live oak) is dominant, and sometimes *Juniperus virginiana* var. *silicicola* (southern redcedar) is present in the canopy. Frequently small *Cladina* - *Cladonia*-dominated openings are present. On small hammocks in salt marshes, *Juniperus virginiana* var. *silicicola* (southern redcedar), *Baccharis halimifolia* (eastern baccharis), and *Morella cerifera* (wax-myrtle) are characteristic. Another type of xeric hammock contains *Serenoa repens* (saw palmetto) under a *Quercus virginiana* (live oak) canopy. On Amelia Island, Florida, *Magnolia grandiflora* (southern magnolia) is characteristically in the understory, increasing after cutting or with a greater shell content in the soil. Some Mississippi vegetation included here is found on coastal sand ridges along inlets of marsh channels.

#### **Similar Alliances:**

- *Quercus virginiana* - *Carya illinoensis* Woodland Alliance (A.665)
- *Quercus virginiana* - *Celtis laevigata* Forest Alliance (A.374)
- *Quercus virginiana* - *Juniperus virginiana* - (*Sabal palmetto*) Woodland Alliance (A.479)--related vegetation which occurs under more severe conditions.
- *Quercus virginiana* - *Quercus nigra* Saturated Forest Alliance (A.379)
- *Quercus virginiana* - *Quercus stellata* Woodland Alliance (A.668)

**Similar Alliance Comments:** Also compare other West Gulf Coastal Plain *Quercus virginiana* alliances.

#### **Related Concepts:**

- Cabbage Palmetto: 74 (Eyre 1980) I
- IA9a. Mid-Atlantic Barrier Island Forest (Allard 1990) I
- IA9b. South Atlantic Inland Maritime Forest (Allard 1990) I

- IA9c. Mid-Atlantic Inland Maritime Forest (Allard 1990) I
- IA9d. South Atlantic Barrier Island Forest (Allard 1990) ?
- Interdune Forest (Ambrose 1990a) ?
- Live Oak: 89 (Eyre 1980) I
- Maritime Evergreen Forest (Schafale and Weakley 1990) I
- Maritime Forest (Nelson 1986) I
- Maritime Hammock (FNAI 1990) I
- Maritime Hammock (FNAI 1992a) I
- Maritime Strand Forest (Ambrose 1990a) ?
- Oak-bay forest (Sharitz 1975) ?
- Upland Maritime Forest (Ambrose 1990a) ?
- Xeric Hammock (FNAI 1992a) ?
- Xeric Hammock, Sandhill Hammock subtype (FNAI 1992b) ?

#### Alliance Description

**Environment:** These forests occur on barrier islands or coastal hammocks, in situations ranging from xeric and subxeric to moist. Some examples are affected by varying intensities of salt spray; these situations display more-or-less wind- and salt spray-sculpted vegetation. Other upland examples are not affected by salt spray and correspondingly differ in composition and stature. This community occurs over moist, sandy soils, on low areas of the mainland coast, and stands are protected from the most extreme maritime influences (i.e., salt spray) but are susceptible to high winds and flooding during hurricanes. The alliance also includes tropical/temperate maritime hammocks of the east coast of Florida, in mid-peninsula, characteristically with oak canopy and tropical subcanopy; as well as temperate maritime hammocks of the northeast and Panhandle coasts of Florida. Vegetation of this alliance may be found on xeric to mesic sites, often occurring as linear strands behind frontal dunes. The seaward edge is generally found on the leeward side of dune complexes which provide shelter from excessive salt spray and overwash; this vegetation is also found on top of relict dune ridges and other areas with xeric to mesic hydrology. The alliance also includes some dry hammocks, found from Florida to North Carolina. Some Mississippi vegetation included here is found on coastal sand ridges along inlets of marsh channels.

**Vegetation:** These forest communities are dominated by *Quercus virginiana* (live oak), and often contain *Sabal palmetto* (cabbage palmetto) and *Juniperus virginiana* var. *silicicola* (southern redcedar) within their ranges. The northernmost examples, in Virginia and extreme northeastern North Carolina, contain *Morella pensylvanica* (northern bayberry) as a shrub. Further south, stabilized dunes where salt spray is light to moderate display wind-sculpted vegetation dominated by *Quercus virginiana* (live oak) and *Quercus hemisphaerica* (Darlington oak) with lesser amounts of *Pinus taeda* (loblolly pine) and *Juniperus virginiana* var. *silicicola* (southern redcedar); typical understory components here include *Persea borbonia* (redbay), *Carpinus caroliniana* ssp. *caroliniana* (American hornbeam), *Juniperus virginiana* var. *silicicola* (southern redcedar), *Cornus florida* (flowering dogwood), *Osmanthus americanus* var. *americanus* (devilwood), *Ilex opaca* var. *opaca* (American holly), and *Zanthoxylum clava-herculis* (Hercules' club). Shrub species include *Ilex vomitoria* (yaupon), *Morella cerifera* (wax-myrtle), *Sabal minor* (dwarf palmetto), and *Callicarpa americana* (American beautyberry). Dominant vines are *Toxicodendron radicans* (eastern poison-ivy), *Vitis rotundifolia* (muscadine), *Smilax* (greenbrier) spp., *Parthenocissus quinquefolia* (Virginia creeper), *Bignonia capreolata*

(crossvine), *Berchemia scandens* (Alabama supplejack), *Ampelopsis arborea* (peppervine), and *Gelsemium sempervirens* (evening trumpetflower). Typical herbs are *Mitchella repens* (partridgeberry), *Asplenium platyneuron* var. *platyneuron* (ebony spleenwort), *Chasmanthium laxum* (slender woodoats), *Piptochaetium avenaceum* (blackseed speargrass), *Galium pilosum* (hairy bedstraw), *Dichanthelium commutatum* (variable panicgrass), *Elephantopus nudatus* (smooth elephantsfoot), and *Passiflora lutea* (yellow passionflower). Canopies in more protected examples are dominated by *Quercus virginiana* (live oak), *Quercus hemisphaerica* (Darlington oak), and *Pinus taeda* (loblolly pine) and may also contain *Quercus falcata* (southern red oak), *Carya glabra* (pignut hickory), *Quercus nigra* (water oak), and *Pinus palustris* (longleaf pine). Understory species include *Persea palustris* (swamp bay), *Magnolia virginiana* (sweetbay), *Osmanthus americanus* var. *americanus* (devilwood), *Ilex opaca* var. *opaca* (American holly), *Juniperus virginiana* var. *silicicola* (southern redcedar), and *Sassafras albidum* (sassafras). Typical shrubs in these examples include *Ilex vomitoria* (yaupon), *Morella cerifera* (wax-myrtle), *Hamamelis virginiana* (American witch-hazel), and *Sabal minor* (dwarf palmetto). Vines include *Vitis rotundifolia* (muscadine), *Smilax bona-nox* (saw greenbrier), *Gelsemium sempervirens* (evening trumpetflower), and *Campsis radicans* (trumpet creeper). Common herbaceous species are *Mitchella repens* (partridgeberry) and *Asplenium platyneuron* var. *platyneuron* (ebony spleenwort). Extending south from the vicinity of Cape Fear, North Carolina, the canopy is dominated by *Quercus virginiana* (live oak) and *Pinus taeda* (loblolly pine) with some *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. 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. These more tropically influenced examples may contain shrubs such as *Eugenia axillaris* (white stopper), *Myrsine floridana* (Guianese colicwood), and *Coccoloba uvifera* (seagrape) on the west coast of Florida, and *Myrcianthes fragrans* (twinberry), *Ardisia escallonioides* (island marlberry), and *Psychotria nervosa* (Seminole balsamo) on the east coast. In some examples, small *Cladina* - *Cladonia*-dominated openings are present. Other characteristic species include *Scleria triglomerata* (whip nutrush), *Paronychia baldwinii* (Baldwin's nailwort), *Cladina evansii* (Evans' reindeer lichen), *Stipulicida setacea* (pineland scalypink), and *Hypericum hypericoides* (St. Andrew's cross). Some examples (e.g., on Amelia Island, Florida), *Magnolia grandiflora* (southern magnolia) is characteristically in the understory, increasing after cutting or with a greater shell content in the soil.

**Dynamics:** Habitats for associations in this alliance range from xeric and subxeric to moist. Vegetation of this alliance lies just landward of maritime shrub zones; it ranges from temperate to subtropical and often has a component of deciduous broad-leaved trees as well, particularly in the north. Some examples are affected by varying intensities of salt spray; these situations display more-or-less wind- and salt spray-sculpted vegetation. Other upland examples are not affected by salt spray and correspondingly differ in composition and stature. Composition varies along a latitudinal gradient; the northernmost examples, in Virginia and extreme northeastern North Carolina, contain *Morella pensylvanica* as a shrub. Farther south, stabilized dunes where salt spray is light to moderate display variants of this vegetation as well. Some Mississippi vegetation included here is found on coastal sand ridges along inlets of marsh channels. This alliance occurs on sandy soils which are generally poorly developed and low in natural fertility

and organic matter content. It is typically found on old dunes which have been stable for long enough to permit forest growth. While fire cycles are generally long (26-100 years), *Sabal palmetto* is fire-resistant and produces flammable litter. Under dry conditions, fires will burn in from adjoining pinelands and kill fire-sensitive species such as *Quercus hemisphaerica* and some tropical species. In the northern portion of this community's range, siliceous sands dominate in preference to carbonate ones; the siliceous sands are generally nutrient-poor while carbonate ones are richer. Farther south, the carbonate fraction increases. Carbonate sands begin to dominate in the Deep South, especially along the coast of Florida. Barrier island soils are derived from material carried onto the island by water and wave action and not from weathering of rock. The major nutrient input to the terrestrial vegetation is from salt spray and precipitation.

#### Alliance Distribution

**Range:** This alliance is found in the Coastal Plain from Virginia to Alabama and Florida, and possibly Mississippi.

**Nations:** US

**Subnations:** AL, FL, GA, MS?, NC, SC, VA

**TNC Ecoregions:** 53:C, 54:P, 55:C, 56:C, 57:C, 58:?

**USFS Ecoregions:** 232Bc:CCC, 232Be:CCC, 232Bf:CCC, 232Bg:CCC, 232Bh:CCC, 232Bi:CCP, 232Bj:CCC, 232Bo:CC?, 232Bp:CCP, 232Ca:CCC, 232Cb:CCC, 232Cc:CCP, 232Ce:CCC, 232Cf:CC?, 232Ch:CCC, 232Ci:CCC, 232Db:CCC, 232Dc:CCC, 232Dd:CCC, 232De:CCC, 232Ga:CCP, 232Gb:CCC, 232Gc:CCP, 232Gd:CCP

**Federal Lands:** DOD (Cape Canaveral, Eglin, Fort Story, Tyndall?); NPS (Canaveral, Cape Hatteras, Cape Lookout, Cumberland Island, Fort Caroline, Fort Frederica, Fort Matanzas, Fort Pulaski, Timucuan); USFS (Apalachicola, Croatan, De Soto, Francis Marion, Ocala, Osceola); USFWS (Back Bay, Blackbeard Island?, Bon Secour, Cape Romain, Currituck, Lake Woodruff?, Merritt Island?, Swanquarter?, Wassaw?, Wolf Island?)

#### **(CEGL007813) Red-cedar - Live Oak - Cabbage Palmetto Marsh Hammock**

*Juniperus virginiana* var. *silicicola* - (*Quercus virginiana*, *Sabal palmetto*) Forest

**Southern Red-cedar - (Live Oak, Cabbage Palmetto) Forest**

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#### **NVC Classification**

|                              |                                                                                                                                                               |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class           | Forest (I)                                                                                                                                                    |
| Physiognomic Subclass        | Evergreen forest (I.A.)                                                                                                                                       |
| Physiognomic Group           | Temperate broad-leaved seasonal evergreen forest (I.A.4.)                                                                                                     |
| Physiognomic Subgroup        | Natural/Semi-natural temperate broad-leaved seasonal evergreen forest (I.A.4.N.)                                                                              |
| Formation                    | Lowland temperate seasonal evergreen forest (I.A.4.N.a.)                                                                                                      |
| Alliance                     | <i>Quercus virginiana</i> - ( <i>Sabal palmetto</i> ) Forest Alliance (A.55)                                                                                  |
| Alliance (English name)      | Live Oak - (Cabbage Palmetto) Forest Alliance                                                                                                                 |
| Association                  | <i>Juniperus virginiana</i> var. <i>silicicola</i> - ( <i>Quercus virginiana</i> , <i>Sabal palmetto</i> ) Forest                                             |
| Association (English name)   | Southern Red-cedar - (Live Oak, Cabbage Palmetto) Forest                                                                                                      |
| Association (Common name)    | Red-cedar - Live Oak - Cabbage Palmetto Marsh Hammock                                                                                                         |
| <b>Ecological System(s):</b> | Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260)<br>Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270) |

#### Element Concept

**Global Summary:** This association occupies marsh hammocks (small islands surrounded by tidal marsh) along the South Atlantic Coast from eastern North Carolina south through South Carolina and Georgia to northeastern Florida. Related vegetation along central Florida spring

runs is also covered here for now. The canopy can be relatively open or completely closed. *Juniperus virginiana* var. *silicicola* (southern redcedar) typically dominates the canopy, while other species such as *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto), and *Celtis laevigata* var. *laevigata* (sugarberry) may be present. This association is related to other associations in this alliance in the same geographic range but differs in being shorter in stature, coastal red-cedar-dominated, with fewer strata, and floristically depauperate (often with some marsh species present).

#### Environmental Description

##### **Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This red-cedar - live oak - cabbage palmetto marsh hammock forest was sampled once on Cumberland Island and once at Fort Frederica. The Cumberland Island site is on the sandy soil of a narrow spit in the salt marsh that may occasionally experience tidal overwash, while the Fort Frederica site is a low flat between the live oak forest and the salt marsh, with poorly drained loam and muck soil, likely flooded both tidally and with brackish water from a nearby stream. The unvegetated surface is dominated by leaf litter (80-85% cover) with some wood (1-5%), bare soil (14-15%) and oyster shell (0-1%). No evidence of disturbance is apparent.

**Global Environment:** This association occupies marsh hammocks (small islands surrounded by tidal marsh) along the South Atlantic Coast. In North Carolina this type is found primarily in a matrix of brackish or full salt marshes (M. Schafale pers. comm.). The community may be dependent on occasional salty inundation to keep less salt-tolerant plants out. Related vegetation found near the edge of Silver Glen Spring Run, Ocala National Forest in Florida is also covered here for now.

#### Vegetation Description

##### **Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

The Fort Frederica stand has a dense (80% cover) tree canopy, 15-20 m tall, very sparse (10%) subcanopy (10-15 m), and moderate (50%) tall-shrub layer (5-10 m). The Cumberland Island stand is sparser and shorter with a moderate (40%) canopy (5-10 m), very sparse (5%) subcanopy (2-5 m) and no tall-shrub layer. On Cumberland Island, this forest is likely in an earlier successional stage; it was sampled on a narrow spit within the salt marsh. Both stands have a moderate (40-50%) short-shrub layer (0.5-2 m) and very sparse (5-10%) herbaceous layer, and they do share a common species composition. *Quercus virginiana* (live oak) dominates the tree layers along with *Juniperus virginiana* var. *silicicola* (southern redcedar), *Celtis laevigata* (sugarberry), and *Sabal palmetto* (cabbage palmetto). The tall-shrub layer is made up of sapling tree species, as well as *Ilex vomitoria* (yaupon) and *Morus rubra* (red mulberry). Dominant and/or common short shrubs may include *Baccharis angustifolia* (saltwater false willow), *Borrichia frutescens* (bushy seaside-tansy), *Sabal minor* (dwarf palmetto), *Sabal palmetto* (cabbage palmetto), *Serenoa repens* (saw palmetto), and *Yucca gloriosa* (moundlily yucca). Herbs include *Arisaema dracontium* (green dragon), *Chasmanthium sessiliflorum* (longleaf woodoats), *Dichanthelium commutatum* (variable panicgrass), *Distichlis spicata* (inland saltgrass), *Fimbristylis caroliniana* (Carolina fimbry), *Nuttallanthus canadensis* (Canada toadflax), *Opuntia humifusa* (devil's-tongue), *Spartina bakeri* (sand cordgrass), and *Spartina patens* (saltmeadow cordgrass). *Tillandsia usneoides* (Spanish moss) is a common epiphyte. Vines include *Vitis rotundifolia* (muscadine) and *Smilax bona-nox* (saw greenbrier).

**Global Vegetation:** *Juniperus virginiana* var. *silicicola* (southern redcedar) typically dominates the canopy, while other species, such as *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto), and *Celtis laevigata* var. *laevigata* (sugarberry), may be present. Exotic species, such as *Triadica sebifera* (tallowtree), *Tamarix* (tamarisk) spp., and *Melia azedarach* (Chinaberrytree), can be invasive in these communities. On Ocala National Forest a plot attributed to this association is additionally characterized by *Quercus hemisphaerica* (Darlington oak), *Callicarpa americana* (American beautyberry), *Persea borbonia* (redbay), *Morella carolinensis* (southern bayberry), *Ageratina aromatica* (lesser snakeroot), *Dichondra carolinensis* (Carolina ponysfoot), *Oplismenus hirtellus* ssp. *setarius* (bristle basketgrass), *Chasmanthium sessiliflorum* (longleaf woodoats), *Thelypteris kunthii* (Kunth's maiden fern), *Parthenocissus quinquefolia* (Virginia creeper), *Bignonia capreolata* (crossvine), *Toxicodendron radicans* (eastern poison-ivy), *Smilax smallii* (lanceleaf greenbrier), and *Vitis aestivalis* (summer grape) (NatureServe Ecology unpubl. data).

### Most Abundant Species

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

| <u>Stratum</u>               | <u>Lifeform</u>              | <u>Species</u>                                                                                                                                                       |
|------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tree (canopy & subcanopy)    | Needle-leaved tree           | <i>Juniperus virginiana</i> var. <i>silicicola</i> (southern redcedar)                                                                                               |
| Tree (canopy & subcanopy)    | Broad-leaved evergreen tree  | <i>Quercus virginiana</i> (live oak), <i>Sabal palmetto</i> (cabbage palmetto)                                                                                       |
| Tree (canopy & subcanopy)    | Epiphyte                     | <i>Tillandsia usneoides</i> (Spanish moss)                                                                                                                           |
| Shrub/sapling (tall & short) | Broad-leaved evergreen shrub | <i>Ilex vomitoria</i> (yaupon), <i>Sabal palmetto</i> (cabbage palmetto)                                                                                             |
| Tall shrub/sapling           | Needle-leaved shrub          | <i>Juniperus virginiana</i> var. <i>silicicola</i> (southern redcedar)                                                                                               |
| Tall shrub/sapling           | Broad-leaved deciduous shrub | <i>Celtis laevigata</i> (sugarberry)                                                                                                                                 |
| Short shrub/sapling          | Broad-leaved evergreen shrub | <i>Borrchia frutescens</i> (bushy seaside-tansy), <i>Sabal minor</i> (dwarf palmetto), <i>Serenoa repens</i> (saw palmetto), <i>Yucca gloriosa</i> (moundlily yucca) |
| Herb (field)                 | Vine/Liana                   | <i>Vitis rotundifolia</i> (muscadine)                                                                                                                                |

### Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Juniperus virginiana* var. *silicicola* (southern redcedar), *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto).

### Other Noteworthy Species

#### Exotic and Invasive Species

*Melia azedarach* (Chinaberrytree)  
*Triadica sebifera* (tallowtree)

#### I-Rank

Medium/Low  
High

#### Note

invasive exotic  
invasive exotic

### Conservation Status Rank

**Global Rank & Reasons:** G3? (14-Dec-1998). This community occupies marsh hammock islands along the South Atlantic Coast of North Carolina, South Carolina, Georgia, and northern Florida. This community is restricted in occurrence, and most occurrences are small, but threats are few.

### Classification

**Status:** Standard

**Classification Confidence:** 2 - Moderate

**Global Comments:** There are examples of this type in Onslow County, North Carolina, and in the brackish marshes of the Embayed Region of North Carolina, such as along the estuarine Pungo River, and probably Swanquarter National Wildlife Refuge as well (M. Schafale pers. comm.). This type is presumably most common in the Sea Islands region. The hydrology of this association is variable, and some examples are near the conceptual border between upland, saturated, and tidal. These communities' simpler structure may be maintained in part by infrequent catastrophic storm events (hurricane wind and overwash events). Exotic species, such as *Triadica sebifera* (= *Sapium sebiferum*), *Tamarix* spp., and *Melia azedarach* can be invasive in these communities.

### **Global Similar Associations:**

- *Juniperus virginiana* var. *silicicola* - *Zanthoxylum clava-herculis* - *Quercus virginiana* - (*Sabal palmetto*) / *Sageretia minutiflora* - (*Sideroxylon tenax*) Woodland (CEGL003525)--more calcareous.
- *Quercus virginiana* - (*Juniperus virginiana*) - *Zanthoxylum clava-herculis* / *Sideroxylon lanuginosum* Woodland (CEGL003523)--more open, more *Sabal palmetto*.
- *Sabal palmetto* - (*Juniperus virginiana* var. *silicicola*) Woodland (CEGL003526)

### Element Distribution

#### **Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This community occurs on the narrowest portions of the Raccoon Keys on Cumberland Island, and is also likely to occur on the southern side of the island along the salt marsh.

**Global Range:** This association is found along the South Atlantic Coast from eastern North Carolina south through South Carolina and Georgia to northeastern Florida. Related vegetation along certain central Florida spring runs is also covered here for now.

**Nations:** US

**States/Provinces:** FL, GA, NC, SC

**TNC Ecoregions:** 55:C, 56:C, 57:C

**USFS Ecoregions:** 232Bf:CCC, 232Cb:CCC, 232Ce:CCC, 232Ci:CCC

**Federal Lands:** NPS (Cumberland Island, Fort Frederica, Fort Pulaski, Timucuan?); USFS (Ocala); USFWS (Swanquarter?)

### Element Sources

#### **Cumberland Island National Seashore and Fort Frederica National Monument Plots:**

CUIS.120, FOFR.02.

**Local Description Authors:** M.J. Russo, H. Summer and L. Kruse

**Global Description Authors:** C.W. Nordman, mod. J. Gramling

**References:** EPA 2004, Govus 1998, Keys et al. 1995, NatureServe Ecology - Southeastern U.S. unpubl. data, Peet et al. unpubl. data 2002, Schafale pers. comm., Southeastern Ecology Working Group n.d.

(CEGL007032) Maritime Live Oak Hammock

*Quercus virginiana* - (*Pinus elliottii* var. *elliottii*, *Sabal palmetto*) / *Persea borbonia* - *Callicarpa americana* Forest

Live Oak - (Slash Pine, Cabbage Palmetto) / Redbay - Beautyberry Forest

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## NVC Classification

|                              |                                                                                                                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class           | Forest (I)                                                                                                                                                                          |
| Physiognomic Subclass        | Evergreen forest (I.A.)                                                                                                                                                             |
| Physiognomic Group           | Temperate broad-leaved seasonal evergreen forest (I.A.4.)                                                                                                                           |
| Physiognomic Subgroup        | Natural/Semi-natural temperate broad-leaved seasonal evergreen forest (I.A.4.N.)                                                                                                    |
| Formation                    | Lowland temperate seasonal evergreen forest (I.A.4.N.a.)                                                                                                                            |
| Alliance                     | <i>Quercus virginiana</i> - ( <i>Sabal palmetto</i> ) Forest Alliance (A.55)                                                                                                        |
| Alliance (English name)      | Live Oak - (Cabbage Palmetto) Forest Alliance                                                                                                                                       |
| Association                  | <i>Quercus virginiana</i> - ( <i>Pinus elliottii</i> var. <i>elliottii</i> , <i>Sabal palmetto</i> ) / <i>Persea borbonia</i> - <i>Callicarpa americana</i> Forest                  |
| Association (English name)   | Live Oak - (Slash Pine, Cabbage Palmetto) / Redbay - Beautyberry Forest                                                                                                             |
| Association (Common name)    | Maritime Live Oak Hammock                                                                                                                                                           |
| <b>Ecological System(s):</b> | Southern Atlantic Coastal Plain Maritime Forest (CES203.537)<br>East Gulf Coastal Plain Maritime Forest (CES203.503)<br>Central Atlantic Coastal Plain Maritime Forest (CES203.261) |

## Element Concept

**Global Summary:** This forest of barrier islands and related habitats 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. Along the seaward edge of this community, the canopy tends to be quite low in stature with shrub species grading smoothly into the dominant canopy species. Vines are often an important component. This community ranges from Smith Island complex, Brunswick County, North Carolina, south to mid-peninsula, Atlantic Coast Florida (Cape Canaveral); the concept also includes temperate maritime hammocks of the northeastern and Panhandle coasts of Florida. The species composition varies along a latitudinal gradient throughout the geographic limits of its range. In general, from Cape Fear, North Carolina (Bald Head Island), 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 swamp-privet), are completely absent from barrier islands in the Carolinas. *Serenoa repens* (saw palmetto) does not occur on the North Carolina barrier islands. This association has been found along the St. Johns River in Florida on the Ocala National Forest, far upstream from brackish water influence. 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. In northeastern Florida, at the Timucuan Ecological and Historic Preserve, dead and dying *Persea borbonia* (redbay) indicate that these maritime hammocks are being affected by laurel wilt, which is caused by a vascular wilt fungus that is transmitted to species in the Lauraceae family via the non-native redbay ambrosia beetle (*Xyleborus glabratus*).

## Environmental Description

### Cumberland Island National Seashore and Fort Frederica National Monument

**Environment:** This maritime live oak hammock forest was sampled at eight locations on Cumberland Island and once at Fort Frederica. Sites are on upland flats or gentle east-facing slopes with moderately well- to well-drained sand or sandy loam soil, often with some organic

material mixed in. The unvegetated surface is dominated by leaf litter (90-99% cover) with some wood (1-5%) and bare soil/sand (0-4%). Evidence of disturbance includes some redbay twig dieback and redbay death due to laurel wilt, trails and roads, horse grazing/browsing, past logging and agricultural/pasture use, fire suppression, lack of tree regeneration, and the presence of exotic plants.

**Global Environment:** This community is found on xeric to mesic sites within the range described, often occurring as linear strands behind frontal dunes. The seaward edge of this vegetation is generally found on the leeward side of dune complexes which are capable of providing shelter from excessive salt spray and overwash. The interior of this community occurs on top of relict dune ridges and other areas with xeric to mesic hydrology.

The soils of these forests are generally poorly developed, sandy soils, low in natural fertility and organic matter content. In the northern portion of this community's range, siliceous sands dominate with little in the way of carbonate sands present. Further south, the carbonate fraction increases. In the deep south, and especially along the coast of Florida, carbonate sands begin to dominate. In terms of nutrients, siliceous sands are quite poor while carbonate sands are somewhat richer. Barrier island soils are derived from material carried onto the island by water and wave action and not from weathering of rock. The major input of nutrients to the terrestrial vegetation is from salt spray and precipitation (Godfrey 1976).

#### Vegetation Description

##### **Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

The moderate to very dense (50-90% cover) tree canopy, 10-35 m tall, is strongly dominated by *Quercus virginiana* (live oak); additional species may include *Liquidambar styraciflua* (sweetgum), *Persea borbonia* (redbay), *Pinus elliottii* (slash pine), *Pinus taeda* (loblolly pine), and *Quercus hemisphaerica* (Darlington oak). The very sparse (5-30%) subcanopy (5-20 m) may also include *Ilex opaca* (American holly), *Persea borbonia* (redbay), and *Sabal palmetto* (cabbage palmetto). The very sparse to dense (10-80%) tall-shrub layer (2-10 m) includes *Ilex opaca* (American holly), *Lyonia ferruginea* (rusty staggerbush), *Morella cerifera* (wax-myrtle), *Persea borbonia* (redbay), *Sabal palmetto* (cabbage palmetto), and *Vaccinium arboreum* (farkleberry). The very sparse to moderately dense (5-70%) short-shrub layer (1-5 m) is made up of tall-shrub species along with other *Vaccinium* (blueberry) spp. (especially *Vaccinium stamineum* (deerberry)), and *Serenia repens* (saw palmetto), which often dominates at a cover of greater than 50%. The herbaceous layer is very sparse (5-30%) under the dense upper layers, and important components include *Andropogon* (bluestem) spp., *Bignonia capreolata* (crossvine), *Chasmanthium laxum* (slender woodoats), *Chasmanthium sessiliflorum* (longleaf woodoats), *Cnidoscolus stimulosus* (finger rot), *Dichanthelium commutatum* (variable panicgrass), *Dichanthelium sabulorum* var. *thinium* (hemlock rosette grass), *Oplismenus hirtellus* ssp. *setarius* (bristle basketgrass), *Scleria triglomerata* (whip nutrush), along with many others, including large numbers of tree and shrub seedlings. Vines (5-20%) of *Smilax auriculata* (earleaf greenbrier), *Smilax bona-nox* (saw greenbrier), *Vitis aestivalis* (summer grape), and particularly *Vitis rotundifolia* (muscadine) climb into the tree and shrub layers. Epiphytes include *Pleopeltis polypodioides* (resurrection fern) and *Tillandsia usneoides* (Spanish moss). In addition, this community supports state-critically imperiled *Tillandsia recurvata* (small ballmoss) and vulnerable *Aristida lanosa* (woollysheath threeawn) and *Cyperus tetragonus* (fourangle flatsedge).

**Global Vegetation:** 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 elliottii* var. *elliottii* (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 swamp-privet), 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* (small-spike 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 swamp-privet), are completely absent from barrier islands in the Carolinas. *Serenoa repens* (saw palmetto) does not occur on the North Carolina barrier islands but is important on Georgia 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).

## Most Abundant Species

### **Cumberland Island National Seashore and Fort Frederica National Monument**

| <u>Stratum</u>               | <u>Lifeform</u>              | <u>Species</u>                                                                                                                                                |
|------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tree (canopy & subcanopy)    | Epiphyte                     | <i>Pleopeltis polypodioides</i> (resurrection fern),<br><i>Tillandsia usneoides</i> (Spanish moss)                                                            |
| Tree canopy                  | Needle-leaved tree           | <i>Pinus elliottii</i> (slash pine)                                                                                                                           |
| Tree canopy                  | Broad-leaved evergreen tree  | <i>Quercus virginiana</i> (live oak)                                                                                                                          |
| Tree subcanopy               | Broad-leaved evergreen tree  | <i>Ilex opaca</i> (American holly), <i>Persea borbonia</i> (redbay), <i>Sabal palmetto</i> (cabbage palmetto)                                                 |
| Shrub/sapling (tall & short) | Broad-leaved evergreen shrub | <i>Lyonia ferruginea</i> (rusty staggerbush), <i>Morella cerifera</i> (wax-myrtle), <i>Vaccinium arboreum</i> (farkleberry)                                   |
| Tall shrub/sapling           | Broad-leaved evergreen shrub | <i>Persea borbonia</i> (redbay)                                                                                                                               |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Vaccinium corymbosum</i> (highbush blueberry)                                                                                                              |
| Short shrub/sapling          | Broad-leaved evergreen shrub | <i>Sabal palmetto</i> (cabbage palmetto), <i>Serenoa repens</i> (saw palmetto)                                                                                |
| Herb (field)                 | Vine/Liana                   | <i>Vitis rotundifolia</i> (muscadine)                                                                                                                         |
| Herb (field)                 | Graminoid                    | <i>Chasmanthium laxum</i> (slender woodoats),<br><i>Chasmanthium sessiliflorum</i> (longleaf woodoats), <i>Dichanthelium commutatum</i> (variable panicgrass) |

| <u>Global Stratum</u>        | <u>Lifeform</u>              | <u>Species</u>                                                                                                                                                           |
|------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tree canopy                  | Needle-leaved tree           | <i>Juniperus virginiana</i> var. <i>silicicola</i> (southern redcedar), <i>Pinus elliottii</i> var. <i>elliottii</i> (Honduras pine), <i>Pinus taeda</i> (loblolly pine) |
| Tree canopy                  | Broad-leaved evergreen tree  | <i>Quercus virginiana</i> (live oak)                                                                                                                                     |
| Tree canopy                  | Palm tree                    | <i>Sabal palmetto</i> (cabbage palmetto)                                                                                                                                 |
| Tree subcanopy               | Needle-leaved tree           | <i>Juniperus virginiana</i> var. <i>silicicola</i> (southern redcedar)                                                                                                   |
| Tree subcanopy               | Broad-leaved deciduous tree  | <i>Celtis laevigata</i> (sugarberry)                                                                                                                                     |
| Tree subcanopy               | Broad-leaved evergreen tree  | <i>Persea borbonia</i> (redbay)                                                                                                                                          |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Parthenocissus quinquefolia</i> (Virginia creeper),<br><i>Toxicodendron radicans</i> (eastern poison-ivy),<br><i>Vitis rotundifolia</i> (muscadine)                   |
| Tall shrub/sapling           | Broad-leaved evergreen tree  | <i>Serenoa repens</i> (saw palmetto)                                                                                                                                     |
| Tall shrub/sapling           | Palm tree                    | <i>Sabal minor</i> (dwarf palmetto)                                                                                                                                      |
| Tall shrub/sapling           | Broad-leaved evergreen shrub | <i>Ilex vomitoria</i> (yaupon), <i>Morella cerifera</i> (wax-myrtle), <i>Osmanthus americanus</i> var. <i>americanus</i> (devilwood)                                     |
| Herb (field)                 | Semi-shrub                   | <i>Mitchella repens</i> (partridgeberry)                                                                                                                                 |
| Herb (field)                 | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern poison-ivy)                                                                                                                       |
| Herb (field)                 | Graminoid                    | <i>Chasmanthium laxum</i> (slender woodoats)                                                                                                                             |
| Herb (field)                 | Fern or fern ally            | <i>Asplenium platyneuron</i> var. <i>bacculum-rubrum</i> (ebony spleenwort)                                                                                              |

## Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Persea borbonia* (redbay), *Pinus elliottii* (slash pine), *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto)

**Global:** *Ilex vomitoria* (yaupon), *Juniperus virginiana* var. *silicicola* (southern redcedar), *Morella cerifera* (wax-myrtle), *Persea borbonia* (redbay), *Pinus elliottii* var. *elliottii* (Honduras pine), *Pinus taeda* (loblolly pine), *Prunus caroliniana* (Carolina laurelcherry), *Quercus virginiana* (live oak), *Sabal palmetto* (cabbage palmetto), *Serenoa repens* (saw palmetto), *Sideroxylon tenax* (tough bully)

#### Other Noteworthy Species

### **Cumberland Island National Seashore and Fort Frederica National Monument**

#### Exotic and Invasive Species

*Eremochloa ophiuroides* (centipede grass)

#### I-Rank

-

#### Note

exotic

#### Other Plant Species

*Aristida lanosa* (woollysheath threeawn)

*Cyperus tetragonus* (fourangle flatsedge)

*Tillandsia recurvata* (small ballmoss)

#### G-Rank

G5

G4?

G5

#### Note

state-vulnerable

state-vulnerable

state-critically  
imperiled

#### **Global**

#### Other Plant Species

*Agrimonia incisa* (incised agrimony)

*Cynanchum scoparium* (leafless swallow-wort)

*Cyperus tetragonus* (fourangle flatsedge)

*Sageretia minutiflora* (smallflower mock buckthorn)

*Sideroxylon tenax* (tough bully)

#### G-Rank

G3

G4

G4?

G4

G3?

#### Note

#### Conservation Status Rank

**Global Rank & Reasons:** G2 (31-Dec-1997). This maritime forest association has a low to moderately high tree canopy, often stunted and pruned by salt spray into streamlined shapes. This community is found on xeric to mesic sites from Brunswick County, North Carolina, south to mid-peninsula Atlantic Coast Florida (Cape Canaveral). It often occurs as linear strands behind frontal dunes. The seaward edge of this vegetation is generally found on the leeward side of dune complexes which are capable of providing shelter from excessive salt spray and overwash. The interior of this community occurs on top of relict dune ridges and other areas with xeric to mesic hydrology. The composition varies along a latitudinal gradient throughout the geographic limits of its range. This community has a restricted range, and much of it has been lost as the result of human activity. Historically, animal grazing, land clearing, and fire had significant impacts on barrier island vegetation. However, the greatest damage to this vegetation has occurred in more recent years with the development of summer residences and cities on barrier islands. Many remaining occurrences have been fragmented, and their long-term viability is now questionable, since disturbance of the stream-lined canopy profile can result in overexposure of interior trees and branches to the deleterious effects of salt spray. Such exposure can result in canopy die-back and a shift in the floristic composition of the forest. The exotic *Triadica sebifera* has successfully established in many occurrences of this community.

#### Classification

**Status:** Standard

**Classification Confidence:** 2 - Moderate

**Global Comments:** Sharitz (1975) reports "Palmetto forest" on Kiawah Island, South Carolina, dominated by *Sabal palmetto* and *Quercus hemisphaerica*, with *Pinus palustris*, *Pinus taeda*, *Juniperus virginiana* var. *silicicola*, *Magnolia grandiflora*, and *Morella cerifera* (= *Myrica cerifera*). The open understory is dominated by *Ilex vomitoria*. In terms of dominant species, this community is very similar to the inland maritime forests of the South Atlantic but differs by its occurrence on outer barrier islands, its younger soils, and by its relatively low species richness. Similar communities occur on the mid-Atlantic and Gulf coasts. They may be distinguished by their geographic location and the resulting differences in species composition. On Kiawah Island, South Carolina, *Magnolia grandiflora* may be codominant in the canopy. *Pinus taeda*, *Pinus palustris*, and *Sabal palmetto* may also be present; *Ilex vomitoria* and *Persea borbonia* dominate the understory; *Vaccinium* sp. and *Crataegus* sp. are also present (Sharitz 1975). On nearby Seabrook Island, this forest type (or a slightly more inland variant) is found on ancient relictual dunes and additionally contains *Carya* sp. and *Ulmus* sp. (*Ulmus* 'floridana') in the canopy; *Liquidambar styraciflua* and *Acer rubrum* in the subcanopy (E. Harrison pers. comm.).

**Global Similar Associations:**

- *Quercus virginiana* - *Pinus clausa* / *Carya (glabra, pallida)* / *Serenoa repens* Forest (CEGL004976)
- *Quercus virginiana* - *Quercus hemisphaerica* - *Pinus taeda* / *Persea palustris* - *Ilex vomitoria* Forest (CEGL007027)--found to the north of CEGL007032 with some minor overlap in range.
- *Quercus virginiana* - *Sabal palmetto* - *Persea borbonia* / *Myrcianthes fragrans* - *Ardisia escallonioides* - *Psychotria nervosa* Forest (CEGL007033)--similar maritime hammock that is dominated by tropical species.

**Global Related Concepts:**

- IA9d. South Atlantic Barrier Island Forest (Allard 1990) ?
- Interdune Forest (Ambrose 1990a) B
- Maritime Strand Forest (Ambrose 1990a) B
- Oak-Magnolia forest (Sharitz 1975)?

Element Distribution

**Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This community occurs across Cumberland Island National Seashore as the dominant upland forest association, as well as on Fort Frederica. Where the island is narrow on the southern end, *Quercus virginiana* is the sole canopy dominant. *Pinus elliottii* and *Pinus taeda* both frequently enter into the canopy as dominants on the older landscapes of the northern two-thirds of the island, and are often legacies of past disturbance such as pasture openings, canopy gaps, and fire. This community also varies notably with the moisture levels in the soil. More mesic areas include shrubs such as *Lyonia lucida*, *Persea borbonia*, and *Ilex ambigua* and ferns such as *Woodwardia virginica* and *Osmunda regalis*, while drier sites have different components such as *Vaccinium arboreum* and *Quercus hemisphaerica*.

**Global Range:** This community ranges from Smith Island complex, Brunswick County, North Carolina, south to mid-peninsula, Atlantic Coast Florida (Cape Canaveral); the concept also includes temperate maritime hammocks of the northeastern and Panhandle coasts of Florida.

**Nations:** US

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

**TNC Ecoregions:** 53:C, 55:C, 56:C, 57:C

**USFS Ecoregions:** 232Ce:CCC, 232Ci:CCC, 232Dc:CCC, 232Gb:CCC

**Federal Lands:** NPS (Canaveral, Cumberland Island, Fort Caroline, Fort Frederica, Fort Matanzas, Timucuan); USFS (De Soto?, Francis Marion, Ocala); USFWS (Bon Secour, Cape Romain, Lake Woodruff?)

#### Element Sources

**Cumberland Island National Seashore and Fort Frederica National Monument Plots:**

CUIS.023, CUIS.027, CUIS.040, CUIS.047, CUIS.057, CUIS.058, CUIS.065, CUIS.099, CUIS.157, FOFR.03.

**Local Description Authors:** M.J. Russo, H. Summer and L. Kruse

**Global Description Authors:** K.D. Patterson, mod. H. Summer and J. Gramling

**References:** Allard 1990, Ambrose 1990a, Aulbach-Smith 1984, Bozeman 1975, E. Harrison pers. comm., EPA 2004, FNAI 1992a, Gaddy 1981, Godfrey 1976, Hardin 1990, Hillestad et al. 1975, Johnson et al. 1990b, Keys et al. 1995, Nelson 1986, Peet et al. unpubl. data 2002, Rayner 1984, Rayner and Batson 1976, Sandifer et al. 1980, Schafale and Weakley 1990, Schotz pers. comm., Sharitz 1975, Soil Conservation Service 1980, Soil Conservation Service 1982, South Carolina Wildlife and Marine Resources Department 1984, Southeastern Ecology Working Group n.d., Wharton 1978

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

#### ***Pinus taeda* Forest Alliance A.130**

##### Alliance Concept

**Summary:** This alliance includes both successional forests of *Pinus taeda* (loblolly pine), which develop following cropping or site conversion, as well as natural forests in the Piedmont, Cumberlands and Ridge and Valley, and Coastal Plain of the southeastern United States. Other canopy and subcanopy species that may be present in successional stands are *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus virginiana* (Virginia pine), *Juniperus virginiana* var. *virginiana* (eastern red-cedar), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Ulmus rubra* (slippery elm), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), *Ulmus alata* (winged elm), *Cornus florida* (flowering dogwood), *Prunus serotina* var. *serotina* (black cherry), and *Carya* (hickory) spp. *Vaccinium* (blueberry) spp., especially *Vaccinium stamineum* (deerberry), are common in these forests. One association in this alliance occurs on barrier islands in the Mid-Atlantic Coastal Plain. Along with the dominant *Pinus taeda* (loblolly pine), canopy associates often include *Quercus falcata* (southern red oak), *Acer rubrum* (red maple), *Prunus serotina* var. *serotina* (black cherry), and *Sassafras albidum* (sassafras). The tall-shrub layer is comprised of *Morella cerifera* (wax-myrtle) and *Vaccinium formosum* (southern blueberry). Vines and lianas are always present in abundance; *Vitis rotundifolia* (muscadine) is most commonly present, but *Toxicodendron radicans* (eastern poison-ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper) are usually present in abundance as well. The herbaceous layer may be sparse, particularly if shrubs and vines are dense, but *Chasmanthium laxum* (slender woodoats) may be fairly abundant in this community. Other herbs include *Panicum amarum* var. *amarulum* (bitter panicgrass), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), and *Elephantopus nudatus* (smooth elephantsfoot). In southern

Virginia and North Carolina, *Quercus virginiana* (live oak) and *Gelsemium sempervirens* (evening trumpetflower) may also be present, but *Quercus virginiana* (live oak) is never abundant and when present is usually restricted to the understory. *Pinus taeda* (loblolly pine) may occur rarely in the Ouachita Mountains and Ozarks of Arkansas where the species is becoming naturalized, expanding from its native range in the Coastal Plain, where it naturally occurs in low, moist areas (e.g., deep, well-drained soils of floodplains). However, a natural *Pinus taeda* (loblolly pine) forest association is not recognized for the Ozark or Ouachita region. **Classification Comments:** On the Bankhead National Forest in the Cumberland Plateau of northern Alabama, this alliance includes streamside terraces that are presumed to have been previously farmed. Associations occurring as plantations are classed in *Pinus taeda* Planted Forest Alliance (A.99).

**Similar Alliances:**

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

**Related Concepts:**

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

Alliance Description

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

**Vegetation:** Canopy and subcanopy species that may be present in successional stands are *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Pinus virginiana* (Virginia pine), *Juniperus virginiana* var. *virginiana* (eastern red-cedar), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Ulmus rubra* (slippery elm), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), *Ulmus alata* (winged elm), *Cornus florida* (flowering dogwood), *Prunus serotina* var. *serotina* (black cherry), and *Carya* (hickory) spp. *Vaccinium* (blueberry) spp., especially *Vaccinium stamineum* (deerberry), are common in these forests. One association in this alliance occurs on barrier islands in the Mid-Atlantic Coastal Plain. Along with the dominant *Pinus taeda* (loblolly pine), canopy associates often include *Quercus falcata* (southern red oak), *Acer rubrum* (red maple), *Prunus serotina* var. *serotina* (black cherry), and *Sassafras albidum* (sassafras). The tall-shrub layer is comprised of *Morella cerifera* (wax-myrtle) and *Vaccinium formosum* (southern blueberry). Vines and lianas are always present in abundance; *Vitis rotundifolia* (muscadine) is most commonly present, but *Toxicodendron radicans* (eastern poison-ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (cat greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper) are usually present in abundance as well. The herbaceous layer may be sparse, particularly if shrubs and vines are

dense, but *Chasmanthium laxum* (slender woodoats) may be fairly abundant in this community. Other herbs include *Panicum amarum* var. *amarulum* (bitter panicgrass), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), and *Elephantopus nudatus* (smooth elephantsfoot). In southern Virginia and North Carolina, *Quercus virginiana* (live oak) and *Gelsemium sempervirens* (evening trumpetflower) may also be present, but *Quercus virginiana* (live oak) is never abundant and when present is usually restricted to the understory. *Pinus taeda* (loblolly pine) forests may occur rarely in the Ouachita Mountains and Ozarks of Arkansas where the species is becoming naturalized, expanding from its native range in the Coastal Plain, where it naturally occurs in low, moist areas (e.g., deep, well-drained soils of floodplains).

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

#### Alliance Distribution

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

**Nations:** US

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

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

**USFS Ecoregions:** 221D:CC, 221Jb:CCC, 222Cb:CCC, 222Dc:CCC, 222Dd:CCC, 222Eb:CCC, 222Ec:CCC, 222Ef:CCC, 222Eg:CCC, 231Aa:CCC, 231Ab:CCC, 231Ac:CCC, 231Ad:CCC, 231Ae:CCC, 231Af:CCC, 231Ag:CCC, 231Ah:CCC, 231Ai:CCC, 231Aj:CCC, 231Ak:CCC, 231Al:CCC, 231Am:CCC, 231An:CCC, 231Ao:CCP, 231Ba:CCC, 231Bb:CCC, 231Bc:CCP, 231Bd:CCC, 231Be:CCC, 231Bf:CCP, 231Bg:CCC, 231Bh:CCC, 231Bi:CCC, 231Bj:CCC, 231Bk:CCC, 231Bl:CCC, 231Ca:CCP, 231Cb:CCP, 231Cc:CCC, 231Cd:CCC, 231Ce:CCC, 231Cf:CCC, 231Cg:CCP, 231Da:CCP, 231Dc:CCC, 231De:CC?, 231Ea:CCC, 231Eb:CC?, 231Ec:CC?, 231Ed:CC?, 231Ef:CC?, 231Eg:CCP, 231Eh:CCC, 231Ei:CC?, 231Ej:CC?, 231Ek:CCP, 231En:CC?, 231Fa:CPP, 231Fb:CP?, 232Ac:CCC, 232Ad:CCC, 232Ba:CCC, 232Bb:CCC, 232Bc:CC?, 232Bd:CC?, 232Be:CC?, 232Bg:CCC, 232Bh:CC?, 232Bi:CC?, 232Bj:CCC, 232Bk:CC?, 232Bl:CC?, 232Bm:CCC, 232Bn:CC?, 232Bo:CC?, 232Bp:CC?, 232Bq:CCC, 232Br:CCC, 232Bt:CC?, 232Bu:CC?, 232Bv:CC?, 232Bx:CCC, 232Bz:CCC, 232Ca:CCC, 232Cb:CCC, 232Cc:CC?, 232Ce:CCC, 232Cf:CC?, 232Cg:CC?, 232Ci:CC?, 232Da:CC?, 232Dc:CCC, 232Fa:CC?, 232Fb:CC?, 232Fe:CCC, 255Da:PPP, M221D:??

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

**(CEGL008450) Successional Loblolly Pine - Oak Forest*****Pinus taeda* - *Quercus (falcata, hemisphaerica, nigra)* - *Liquidambar styraciflua* / *Rhus copallinum* - *Vaccinium stamineum* Forest****Loblolly Pine - (Southern Red Oak, Sand Laurel Oak, Water Oak) - Sweetgum / Winged Sumac - Deerberry Forest**

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**NVC Classification**

|                              |                                                                                                                                                                   |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class           | Forest (I)                                                                                                                                                        |
| Physiognomic Subclass        | Evergreen forest (I.A.)                                                                                                                                           |
| Physiognomic Group           | Temperate or subpolar needle-leaved evergreen forest (I.A.8.)                                                                                                     |
| Physiognomic Subgroup        | Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)                                                                              |
| Formation                    | Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)                                                                                 |
| Alliance                     | <i>Pinus taeda</i> Forest Alliance (A.130)                                                                                                                        |
| Alliance (English name)      | Loblolly Pine Forest Alliance                                                                                                                                     |
| Association                  | <i>Pinus taeda</i> - <i>Quercus (falcata, hemisphaerica, nigra)</i> - <i>Liquidambar styraciflua</i> / <i>Rhus copallinum</i> - <i>Vaccinium stamineum</i> Forest |
| Association (English name)   | Loblolly Pine - (Southern Red Oak, Sand Laurel Oak, Water Oak) - Sweetgum / Winged Sumac - Deerberry Forest                                                       |
| Association (Common name)    | Successional Loblolly Pine - Oak Forest                                                                                                                           |
| <b>Ecological System(s):</b> | Southern Coastal Plain Dry Upland Hardwood Forest (CES203.560)                                                                                                    |

**Element Concept**

**Global Summary:** This successional, essentially evergreen forest of the Upper East Gulf Coastal Plain is dominated by a mixture of *Pinus taeda* (loblolly pine) with hardwoods, including *Quercus* (oak) spp. and *Liquidambar styraciflua* (sweetgum). The oaks present may include *Quercus falcata* (southern red oak), *Quercus hemisphaerica* (Darlington oak), and *Quercus nigra* (water oak). These forests develop on former mesic to dry-mesic *Pinus palustris* (longleaf pine) sites, following removal of *Pinus palustris* (longleaf pine) and disturbance. There may be some variation in canopy composition with soil texture. *Quercus hemisphaerica* (Darlington oak) may be more prevalent on sandy soils, *Quercus nigra* (water oak) on finer-textured ones. Common shrubs include *Rhus copallinum* (flameleaf sumac) and *Vaccinium stamineum* (deerberry).

**Environmental Description****Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This association was not documented as part of this project, although it is likely that it does occur at Fort Frederica.

**Global Environment:** This forest is described from the Upper East Gulf Coastal Plain of Fort Benning, Georgia. It occurs on rolling uplands on sandy loam soils at various aspects. These forests develop on former mesic to dry-mesic *Pinus palustris* sites, following removal of *Pinus palustris* and disturbance.

**Vegetation Description****Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

This association was not documented as part of this project, although it is likely that it does occur at Fort Frederica.

**Global Vegetation:** The canopy is dominated by a mixture of *Pinus taeda* (loblolly pine) (typically greater than 75%) with hardwoods, including *Quercus* (oak) spp. and *Liquidambar styraciflua* (sweetgum). The oaks present may include *Quercus falcata* (southern red oak),

*Quercus hemisphaerica* (Darlington oak), and *Quercus nigra* (water oak). *Quercus hemisphaerica* (Darlington oak) may be more prevalent on sandy soils, *Quercus nigra* (water oak) on finer-textured ones. Common shrubs include *Rhus copallinum* (flameleaf sumac) and *Vaccinium stamineum* (deerberry). On the Apalachicola National Forest, a related somewhat diverse stand on dissected slopes near a creek contains *Pinus taeda* (loblolly pine), *Nyssa biflora* (swamp tupelo), *Quercus hemisphaerica* (Darlington oak), *Quercus nigra* (water oak), *Liquidambar styraciflua* (sweetgum), *Magnolia virginiana* (sweetbay), *Magnolia grandiflora* (southern magnolia), and *Acer rubrum* (red maple). Shrubs are moderately diverse and include *Clethra alnifolia* (coastal sweet-pepperbush), *Cliftonia monophylla* (buckwheat tree), *Cyrilla racemiflora* (swamp titi), *Ilex coriacea* (large gallberry), *Ilex opaca* (American holly), *Itea virginica* (Virginia sweetspire), *Leucothoe axillaris* (coastal doghobble), *Lyonia lucida* (fetterbush lyonia), *Osmanthus americanus* (devilwood), *Symplocos tinctoria* (common sweetleaf), and *Vaccinium stamineum* (deerberry). The classification status of this stand is somewhat unclear, but it is placed here pending further investigation. It may be in fact a fully natural, not a "modified" type.

### Other Noteworthy Species

#### **Global**

#### **Other Plant Species**

*Stylisma pickeringii* var. *pickeringii* (Pickering's dawnflower)

#### **GRank**

G4T3

#### **Note**

### Conservation Status Rank

**Global Rank & Reasons:** GNA (modified/managed) (19-Aug-2002). This is a successional forest composed of species native to the southeastern United States; it is not of conservation concern and does not receive a conservation status rank.

### Classification

**Status:** Standard

**Classification Confidence:**

**Global Comments:** There may be substantial hardwoods (*Quercus* spp., *Liquidambar styraciflua*) in the canopy and subcanopy, but this association is primarily composed of *Pinus taeda*.

**Global Similar Associations:**

- *Pinus taeda* - *Quercus nigra* Southern Coastal Plain Forest [Provisional] (CEGL007531)
- *Pinus taeda* / *Liquidambar styraciflua* - *Acer rubrum* var. *rubrum* / *Vaccinium stamineum* Forest (CEGL006011)
- *Pinus taeda* Planted Forest (CEGL007179)--applies to young, dense, monospecific, stands with plantation structure.

### Element Distribution

**Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This association was not documented as part of this project, although it is likely that it does occur at Fort Frederica.

**Global Range:** This forest occurs in the Upper East Gulf Coastal Plain and adjacent East Gulf Coastal Plain of Mississippi, Alabama, Florida and Georgia, and the South Atlantic Coastal Plain of Florida and Georgia.

**Nations:** US

**States/Provinces:** AL, FL, GA, MS

**TNC Ecoregions:** 43:C, 53:C, 56:P

**USFS Ecoregions:** 222Ef:CCC, 231Bd:CCC, 231Bg:CCC, 231Bi:CCC, 231Bk:CCC, 232Ce:CCP, 232Dc:CPC

**Federal Lands:** DOD (Fort Benning); NPS (Fort Frederica?, Natchez Trace); USFS (Apalachicola)

#### Element Sources

**Cumberland Island National Seashore and Fort Frederica National Monument Plots:** None.

**Local Description Authors:** H. Summer

**Global Description Authors:** M. Pyne

**References:** Schotz pers. comm., Southeastern Ecology Working Group n.d.

## Shrubland (III.)

### Tidal cold-deciduous shrubland (III.B.2.N.h)

#### ***Borrichia frutescens* Tidal Shrubland Alliance (A.1026)**

#### Alliance Concept

**Summary:** This alliance includes tidal areas in upper marsh edges and flats dominated by *Borrichia frutescens* (bushy seaside-tansy). It occurs at spatial scales ranging from narrow bands to flats in excess of 500 ha; it often occurs either just below *Iva frutescens* (Jesuit's bark) or *Baccharis halimifolia* (eastern baccharis), or just above *Juncus roemerianus* (needlegrass rush) or *Spartina alterniflora* (smooth cordgrass). Other characteristic species include *Spartina patens* (saltmeadow cordgrass), *Iva frutescens* ssp. *frutescens* (Jesuit's bark), *Iva frutescens* ssp. *oraria* (Jesuit's bark), and *Limonium carolinianum* (Carolina sealavender). In Texas, the composition of this low-diversity, irregularly tidally flooded shrubland is variable and can include *Spartina spartinae* (gulf cordgrass), *Sporobolus virginicus* (seashore dropseed), *Monanthochloe littoralis* (shoregrass), *Sarcocornia perennis* (chickenclaws), *Limonium carolinianum* (Carolina sealavender), *Lycium carolinianum* var. *quadrifidum* (Carolina desert-thorn), *Rayjacksonia phyllocephala* (camphor daisy), and *Batis maritima* (turtleweed). Here, these communities often occur just above the lower tidal flat communities *Batis maritima* - *Sarcocornia perennis* Dwarf-shrubland (CEGL003956) or *Sarcocornia perennis* - (*Batis maritima*, *Distichlis spicata*) Dwarf-shrubland (CEGL002278).

**Classification Comments:** Consideration should be given to placement of this alliance in Class IV. Dwarf-shrubland. Although stature can be more than 0.5 m, it is typically 0.3-0.5 m in height.

#### **Related Concepts:**

- Glasswort-Saltwort Series (Diamond 1993) I
- Salt Shrub (Schafale and Weakley 1990) I
- Tidal Marsh (FNAI 1990)?

### Alliance Description

**Environment:** This alliance occurs along upper marsh edges and in tidal flats ranging in scale from narrow bands to hundreds of hectares. It is found along mainland shores and the bayside of barrier islands.

**Vegetation:** This alliance is dominated by *Borrichia frutescens* (bushy seaside-tansy), often in monospecific stands. Other characteristic species may include *Spartina patens* (saltmeadow cordgrass), *Spartina spartinae* (gulf cordgrass), *Sporobolus virginicus* (seashore dropseed), *Monanthochloe littoralis* (shoregrass), *Iva frutescens* ssp. *frutescens* (Jesuit's bark), *Iva frutescens* ssp. *oraria* (Jesuit's bark), *Limonium carolinianum* (Carolina sealavender), *Sarcocornia perennis* (chickenclaws), *Lycium carolinianum* var. *quadrifidum* (Carolina desert-thorn), *Rayjacksonia phyllocephala* (camphor daisy), and *Batis maritima* (turtleweed).

### Alliance Distribution

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

**Nations:** US

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

**TNC Ecoregions:** 31:C, 53:C, 55:C, 56:C, 57:C, 58:C

**USFS Ecoregions:** 231Fb:CCC, 232Cb:CC?, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC, 232Dc:CCC, 232Eb:CCC, 232Gb:CCC, 255Dc:CCC

**Federal Lands:** NPS (Canaveral, Cape Lookout, Cumberland Island, Fort Pulaski, Timucuan?); USFS (Croatan); USFWS (Anahuac, Aransas, Back Bay?, Big Boggy, Brazoria, Laguna Atascosa, Matagorda Island, McFaddin, San Bernard, Texas Point)

### **(CEGL003924) Seaside-tansy Tidal Shrub Flat**

***Borrichia frutescens* / (*Spartina patens*, *Juncus roemerianus*) Shrubland**

**Bushy Seaside-tansy / (Saltmeadow Cordgrass, Black Needlerush) Shrubland**

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### **NVC Classification**

|                              |                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class           | Shrubland (III)                                                                                                                                                                                                                                                                                                                                                                                   |
| Physiognomic Subclass        | Deciduous shrubland (III.B.)                                                                                                                                                                                                                                                                                                                                                                      |
| Physiognomic Group           | Cold-deciduous shrubland (III.B.2.)                                                                                                                                                                                                                                                                                                                                                               |
| Physiognomic Subgroup        | Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)                                                                                                                                                                                                                                                                                                                                        |
| Formation                    | Tidal cold-deciduous shrubland (III.B.2.N.h.)                                                                                                                                                                                                                                                                                                                                                     |
| Alliance                     | <i>Borrichia frutescens</i> Tidal Shrubland Alliance (A.1026)                                                                                                                                                                                                                                                                                                                                     |
| Alliance (English name)      | Bushy Seaside-tansy Tidal Shrubland Alliance                                                                                                                                                                                                                                                                                                                                                      |
| Association                  | <i>Borrichia frutescens</i> / ( <i>Spartina patens</i> , <i>Juncus roemerianus</i> ) Shrubland                                                                                                                                                                                                                                                                                                    |
| Association (English name)   | Bushy Seaside-tansy / (Saltmeadow Cordgrass, Black Needlerush) Shrubland                                                                                                                                                                                                                                                                                                                          |
| Association (Common name)    | Seaside-tansy Tidal Shrub Flat                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Ecological System(s):</b> | Central Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh (CES203.376)<br>Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270)<br>Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260)<br>Central and Upper Texas Coast Salt and Brackish Tidal Marsh (CES203.473)<br>Gulf Coast Chenier Plain Salt and Brackish Tidal Marsh (CES203.468) |

### Element Concept

**Global Summary:** This association includes upper marsh edges and flats strongly dominated by *Borrichia frutescens* (bushy seaside-tansy), ranging in size from narrow bands to flats in excess of 500 ha. It is broadly described to include vegetation ranging from the Mid- and South Atlantic Coast to the West Gulf Coast of the United States. It may occur just below *Iva frutescens* (Jesuit's bark) or *Baccharis halimifolia* (eastern baccharis) shrublands and just above marshes

dominated by *Juncus roemerianus* (needlegrass rush) or *Spartina alterniflora* (smooth cordgrass). Other characteristic species may include *Spartina patens* (saltmeadow cordgrass), *Iva frutescens* (Jesuit's bark), and *Limonium carolinianum* (Carolina sealavender). In Texas, the composition of this low-diversity, irregularly tidally flooded shrubland is variable and can include *Distichlis spicata* (inland saltgrass), *Schoenoplectus robustus* (sturdy bulrush), *Sporobolus virginicus* (seashore dropseed), *Monanthochloe littoralis* (shoregrass), *Atriplex matamorenensis* (Matamoros saltbush) (in south Texas), *Sarcocornia pacifica* (Pacific swampfire), *Limonium carolinianum* (Carolina sealavender), *Lycium carolinianum* var. *quadrifidum* (Carolina desert-thorn), *Rayjacksonia phyllocephala* (camphor daisy), *Prosopis reptans* (tornillo) (in south Texas), and *Batis maritima* (turtleweed). Here, this community often occurs just above the lower tidal flat communities *Batis maritima* - *Sarcocornia pacifica* Dwarf-shrubland (CEGL003956) or *Sarcocornia pacifica* - (*Batis maritima*, *Distichlis spicata*) Dwarf-shrubland (CEGL002278).

This shrubland usually occurs as a very narrow band adjacent and below tidal shrublands. Two large examples of this association at Fort Pulaski, Georgia, are extensive enough to map and occur on tidal flats adjacent the extensive salt marsh communities of eastern Cockspar Island. Typically this community is monospecific, being made up almost exclusively of *Borrichia frutescens* (bushy seaside-tansy).

#### Environmental Description

**USFWS Wetland System:** Estuarine

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This seaside-tansy shrubland was sampled at three locations on Cumberland Island on tidally flooded flats. Soils are very poorly to poorly drained sand. The unvegetated surface is made up of leaf litter (20-55% cover), wood (0-1%), bare soil (0-60%), and standing water (0-80%). There is very little evidence of disturbance other than nearby horse trails.

**Global Environment:** This association occurs along upper marsh edges and in tidal flats ranging in scale from narrow bands to hundreds of hectares. It is found along mainland shores and the bayside of barrier islands. In south Texas, it can also occur around the base of lomas.

#### Vegetation Description

#### **Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

The dominant vegetation is the moderate (40-60% cover) herbaceous layer of the subshrub *Borrichia frutescens* (bushy seaside-tansy). There may also be a moderate (40%) tall-shrub layer (1-5 m) and sparse (20%) short-shrub layer (0.5-1 m) of *Iva frutescens* (Jesuit's bark) and *Sabal palmetto* (cabbage palmetto). Additional species found in the herbaceous layer include *Batis maritima* (turtleweed), *Distichlis spicata* (inland saltgrass), *Fimbristylis castanea* (marsh fimbry), *Iva frutescens* (Jesuit's bark), *Limonium carolinianum* (Carolina sealavender), *Sarcocornia pacifica* (Pacific swampfire), *Schoenoplectus pungens* var. *pungens* (common threesquare), and *Stenotaphrum secundatum* (St. Augustine grass). This community also supports state-vulnerable *Cynanchum angustifolium* (gulf coast swallow-wort).

**Global Vegetation:** This community is strongly dominated by *Borrichia frutescens* (bushy seaside-tansy). Other characteristic species may include *Spartina patens* (saltmeadow cordgrass), *Iva frutescens* (Jesuit's bark), *Distichlis spicata* (inland saltgrass), *Schoenoplectus robustus* (sturdy bulrush), *Sporobolus virginicus* (seashore dropseed), *Monanthochloe littoralis* (shoregrass), *Sarcocornia pacifica* (Pacific swampfire), *Limonium carolinianum* (Carolina

sealavender), *Lycium carolinianum* var. *quadrifidum* (Carolina desert-thorn), *Rayjacksonia phyllocephala* (camphor daisy), and *Batis maritima* (turtleweed). In Texas, *Spartina patens* (saltmeadow cordgrass) is a less important component of this community, but it often forms a fringe along the upper margin.

#### Most Abundant Species

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

| <u>Stratum</u>               | <u>Lifeform</u>              | <u>Species</u>                                                                                       |
|------------------------------|------------------------------|------------------------------------------------------------------------------------------------------|
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Iva frutescens</i> (Jesuit's bark)                                                                |
| Short shrub/sapling          | Broad-leaved evergreen shrub | <i>Batis maritima</i> (turtleweed), <i>Borrichia frutescens</i> (bushy seaside-tansy)                |
| Herb (field)                 | Forb                         | <i>Limonium carolinianum</i> (Carolina sealavender), <i>Sarcocornia pacifica</i> (Pacific swampfire) |
| Herb (field)                 | Graminoid                    | <i>Fimbristylis castanea</i> (marsh fimbry), <i>Stenotaphrum secundatum</i> (St. Augustine grass)    |

#### Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Borrichia frutescens* (bushy seaside-tansy)

#### Other Noteworthy Species

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

| <u>Other Plant Species</u>                               | <u>GRank</u> | <u>Note</u>      |
|----------------------------------------------------------|--------------|------------------|
| <i>Cynanchum angustifolium</i> (gulf coast swallow-wort) | G5           | state-vulnerable |

#### **Global**

| <u>Animal Species</u>                  | <u>GRank</u> | <u>Note</u>                                                |
|----------------------------------------|--------------|------------------------------------------------------------|
| <i>Grus americana</i> (whooping crane) | G1           | Federally listed endangered; globally critically imperiled |

#### Conservation status Rank

**Global Rank & Reasons:** G4 (10-Oct-1997). This is a common tidal flat community along the Gulf and Middle and South Atlantic coasts of the United States.

#### Classification

**Status:** Standard

**Classification Confidence:** 1 - Strong

**Global Comments:** The relationship between this community and similar *Borrichia frutescens* / *Spartina spartinae* Shrubland (CEGL004617) is poorly documented. The ranges of these two communities overlap along the middle and south Texas coast where *Borrichia frutescens* / *Spartina spartinae* Shrubland (CEGL004617) dominates less saline, higher ground than this community (CEGL003924).

NatureServe identified the perennial glasswort plants at Fort Pulaski as *Sarcocornia pacifica* using the recent key in Weakley (2007), which follows Flora of North America (FNA Editorial Committee 2003). The perennial glassworts on the U.S. East Coast have been called *Sarcocornia*

*perennis* in the past (Kartesz 1999), and their taxonomy remains unsettled. For the time being, NatureServe will continue to follow the Kartesz (1999) nomenclature in our global descriptions and U.S. National Vegetation Classification association names.

**Global Similar Associations:**

- *Borrchia frutescens* / *Spartina spartinae* Shrubland (CEGL004617)

**Global Related Concepts:**

- Glasswort-Saltwort Series (Diamond 1993) B
- Salt Shrub (Low Subtype) (Schafale 2000)?

Element Distribution

**Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This association is found in wide bands at the upper side of the salt panne marsh on the south side of Cumberland Island, adjacent to *Juncus roemerianus* herbaceous marsh and *Sarcocornia pacifica* herbaceous marsh. It was also sampled along the marsh-side perimeter of a dredge-spoil island, and likely occurs in additional bands in shallow salt marsh along the southeastern side of the island.

**Global Range:** This association is found in coastal areas from North Carolina to Texas.

**Nations:** US

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

**TNC Ecoregions:** 31:C, 53:C, 55:C, 56:C, 57:C

**USFS Ecoregions:** 231Fb:CCP, 232Cb:CC?, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC, 232Dc:CCC, 232Eb:CCC, 232Gb:CCC, 255Dc:CPP

**Federal Lands:** NPS (Canaveral, Cape Lookout, Cumberland Island, Fort Pulaski, Timucuan?); USFS (Croatan); USFWS (Anahuac, Aransas, Back Bay?, Big Boggy, Brazoria, Laguna Atascosa, Matagorda Island, McFaddin, San Bernard, Texas Point)

Element Sources

**Cumberland Island National Seashore and Fort Frederica National Monument Plots:**

CUIS.041, CUIS.090, CUIS.093.

**Local Description Authors:** M.J. Russo, H. Summer and L. Kruse

**Global Description Authors:** A.S. Weakley

**References:** Diamond 1993, FNA Editorial Committee 2003, FNAI 1990, FNAI 1992a, Govus 1998, Kartesz 1999, McAlister and McAlister 1993, McAlister and McAlister 1995, Peet et al. unpubl. data 2002, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Schotz pers. comm., Southeastern Ecology Working Group n.d., Weakley 2007

## Herbaceous Vegetation (V.)

### Tidal temperate or subpolar grassland (V.A.5.N.n.)

#### *Juncus roemerianus* Tidal Herbaceous Alliance (A.1475)

Alliance Concept

**Summary:** *Juncus roemerianus* (needlegrass rush)-dominated marshes with tidal hydrology. Associations in this alliance have a range of water chemistry, including saline, brackish, and (rarely) freshwater. This widely distributed salt marsh alliance occurs in association with low salt marshes or in brackish marshes, and is characterized by discrete, dense patches of vegetation

usually strongly dominated by *Juncus roemerianus* (needlegrass rush) with few other associates. Associates which occur at low cover may include *Borrchia frutescens* (bushy seaside-tansy), *Baccharis halimifolia* (eastern baccharis), *Spartina alterniflora* (smooth cordgrass), *Distichlis spicata* (inland saltgrass), *Schoenoplectus robustus* (sturdy bulrush), *Symphyotrichum tenuifolium* (perennial saltmarsh aster), and *Symphyotrichum subulatum* (eastern annual saltmarsh aster). This community may occur as isolated patches within low salt marsh, or may dominate vast areas at the heads of tidal creeks that drain the marsh. Its hydrology is generally irregularly tidally flooded. Soils of this association are generally poorly to very poorly drained, often with standing water atop peat accumulations (averaging 15 cm in depth) which in turn overlie gleyed sands. Degree of tidal inundation and relative elevation control the distribution of salt marsh vegetation in general; *Juncus roemerianus* (needlegrass rush) is typically found at lower elevation than the associated *Spartina patens* (saltmeadow cordgrass) marshes or mixed marshes. *Juncus roemerianus* (needlegrass rush) generally occurs on sandy substrates. The alliance may more rarely occur in freshwater, wind tidal situations. In these examples, *Juncus roemerianus* (needlegrass rush) is the dominant, but other characteristic species may include *Thelypteris palustris* var. *pubescens* (eastern marsh fern), *Polygonum punctatum* (dotted smartweed), *Cladium mariscus* ssp. *jamaicense* (Jamaica swamp sawgrass), *Asclepias lanceolata* (fewflower milkweed), *Osmunda regalis* var. *spectabilis* (royal fern), *Eleocharis fallax* (creeping spikerush), *Boehmeria cylindrica* (small-spike false nettle), and others. This species composition is indicative of the freshwater marsh conditions, as they do not occur in more brackish and saline associations in the *Juncus roemerianus* (needlegrass rush) alliance.

**Classification Comments:** Few associations have been described; more may be necessary to accommodate variation in this wide-ranging alliance.

**Similar Alliances:**

- *Schoenoplectus americanus* Tidal Herbaceous Alliance (A.2007)
- *Spartina patens* - (*Distichlis spicata*) Tidal Herbaceous Alliance (A.1481)

**Related Concepts:**

- Brackish Marsh (Nelson 1986) I
- Brackish Marsh (Schafale and Weakley 1990) I
- Brackish Marsh (Wieland 1994b) I
- Brackish Marsh (Smith 1996a) I
- Brackish Marsh (Wieland 1994a) ?
- Smooth Cordgrass Series (Diamond 1993) I
- Tidal Marsh (FNAI 1992a) I

Alliance Description

**Environment:** *Juncus roemerianus*-dominated marshes with tidal hydrology. Associations in this alliance have a range of water chemistry, including saline, brackish, and (rarely) freshwater. This community may occur as isolated patches within low salt marsh, or may dominate vast areas at the heads of tidal creeks that drain the marsh. Its hydrology is generally irregularly tidally flooded. Soils of this association are generally poorly to very poorly drained, often with standing water atop peat accumulations (averaging 15 cm in depth) which in turn overlie gleyed sands. Degree of tidal inundation and relative elevation control the distribution of salt marsh vegetation in general; *Juncus roemerianus* is typically found at lower elevation than the associated *Spartina patens* marshes or mixed marshes. *Juncus roemerianus* generally occurs on sandy substrates. The alliance may more rarely occur in freshwater, wind tidal situations.

**Vegetation:** This widely distributed salt marsh alliance occurs in association with low salt marshes or in brackish marshes, and is characterized by discrete, dense patches of vegetation usually strongly dominated by *Juncus roemerianus* (needlegrass rush) with few other associates. Associates which occur at low cover may include *Borrchia frutescens* (bushy seaside-tansy), *Baccharis halimifolia* (eastern baccharis), *Spartina alterniflora* (smooth cordgrass), *Distichlis spicata* (inland saltgrass), *Schoenoplectus robustus* (sturdy bulrush), *Symphyotrichum tenuifolium* (perennial saltmarsh aster), and *Symphyotrichum subulatum* (eastern annual saltmarsh aster). The alliance may more rarely occur in freshwater, wind tidal situations. In these examples, *Juncus roemerianus* (needlegrass rush) is the dominant, but other characteristic species may include *Thelypteris palustris* var. *pubescens* (eastern marsh fern), *Polygonum punctatum* (dotted smartweed), *Cladium mariscus* ssp. *jamaicense* (Jamaica swamp sawgrass), *Asclepias lanceolata* (fewflower milkweed), *Osmunda regalis* var. *spectabilis* (royal fern), *Eleocharis fallax* (creeping spikerush), *Boehmeria cylindrica* (small-spike false nettle), and others. This species composition is indicative of the freshwater marsh conditions, as they do not occur in more brackish and saline associations in the *Juncus roemerianus* (needlegrass rush) alliance.

#### Alliance Distribution

**Range:** This alliance occurs in the southeastern Coastal Plain from Maryland south to Florida and west to Louisiana and Texas.

**Nations:** US

**Subnations:** AL, DE, FL, GA, LA?, MD, MS, NC, SC, TX, VA

**TNC Ecoregions:** 30:P, 31:C, 41:P, 42:P, 53:C, 54:C, 55:C, 56:C, 57:C, 58:C

**USFS Ecoregions:** 231Fb:CCC, 232Ad:CCC, 232Br:CCC, 232Bx:CCC, 232Bz:CCC, 232Cb:CCC, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Db:CCP, 232Dc:CCC, 232Dd:CCC, 232De:CCP, 232Eb:CCC, 232Ec:CC?, 232Ed:CCC, 232Gb:CCC, 255Da:CCP, 255Dc:CCC

**Federal Lands:** NPS (Assateague Island, Canaveral, Cape Hatteras, Cape Lookout, Cumberland Island, Fort Frederica?, Fort Pulaski, Timucuan); USFS (Croatan); USFWS (Anahuac, Back Bay, Big Boggy, Bon Secour, Brazoria, Chesapeake Marshlands, McFaddin, San Bernard, Texas Point)

#### **(CEGL004186) Needlerush High Marsh**

***Juncus roemerianus* Herbaceous Vegetation**

**Black Needlerush Herbaceous Vegetation**

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#### **NVC Classification**

|                              |                                                                                                                                                                                                                        |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physiognomic Class           | Herbaceous Vegetation (V)                                                                                                                                                                                              |
| Physiognomic Subclass        | Perennial graminoid vegetation (V.A.)                                                                                                                                                                                  |
| Physiognomic Group           | Temperate or subpolar grassland (V.A.5.)                                                                                                                                                                               |
| Physiognomic Subgroup        | Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)                                                                                                                                                        |
| Formation                    | Tidal temperate or subpolar grassland (V.A.5.N.n.)                                                                                                                                                                     |
| Alliance                     | <i>Juncus roemerianus</i> Tidal Herbaceous Alliance (A.1475)                                                                                                                                                           |
| Alliance (English name)      | Black Needlerush Tidal Herbaceous Alliance                                                                                                                                                                             |
| Association                  | <i>Juncus roemerianus</i> Herbaceous Vegetation                                                                                                                                                                        |
| Association (English name)   | Black Needlerush Herbaceous Vegetation                                                                                                                                                                                 |
| Association (Common name)    | Needlerush High Marsh                                                                                                                                                                                                  |
| <b>Ecological System(s):</b> | Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260)<br>Atlantic Coastal Plain Indian River Lagoon Tidal Marsh (CES203.257)<br>Florida Big Bend Salt and Brackish Tidal Marsh (CES203.508) |

Mississippi Delta Salt and Brackish Tidal Marsh (CES203.471)  
Northern Atlantic Coastal Plain Tidal Salt Marsh (CES203.519)  
Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270)  
Mississippi Sound Salt and Brackish Tidal Marsh (CES203.303)  
Central and Upper Texas Coast Salt and Brackish Tidal Marsh (CES203.473)  
Gulf Coast Chenier Plain Salt and Brackish Tidal Marsh (CES203.468)

### Element Concept

**Global Summary:** This broad-ranging *Juncus roemerianus* (needlegrass rush) salt marsh community is characterized by discrete, dense patches usually strongly dominated by *Juncus roemerianus* (needlegrass rush), often with few other associates, or with low cover of *Distichlis spicata* (inland saltgrass), *Spartina alterniflora* (smooth cordgrass), *Spartina patens* (saltmeadow cordgrass), and *Limonium carolinianum* (Carolina sealavender). As currently defined, this community occurs in a variety of settings in different marsh regions including both "high" and "low" marshes. For example, large expanses of this type are found in northwest Florida at or below the mean high water line. In other regions it may be found as isolated patches within high salt marsh, or may dominate vast areas at the heads of tidal creeks. In general, the prevalence of *Juncus roemerianus* (needlegrass rush) in Florida indicates the prevalence of high marshes (above mean high water). Its hydrology is generally irregularly tidally flooded.

### Environmental Description

**USFWS Wetland System:** Estuarine

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This needlerush high marsh community was sampled at three locations on Cumberland Island. It tends to occur in narrow bands within the salt marsh at higher elevations than *Spartina alterniflora* herbaceous marsh, but below areas dominated by *Borrichia frutescens*, *Iva frutescens*, *Spartina patens*, and *Distichlis spicata*. Sites are flat to very gently sloping tidally flooded areas with very poorly drained muck or sand soil. The unvegetated surface is made up of leaf litter (5-40% cover), bare soil (0-95%), standing water (0-60%), and wrack (0-15%). Evidence of disturbance includes horse trails and grazing. This community likely also occurs at Fort Frederica, although no plots were sampled.

**Global Environment:** Large expanses of this type are found in northwest Florida, where approximately 60% of the salt marshes consist of monospecific stands of this type. These stands extend nearly to the water's edge and may be considered low marsh (Montague and Wiegert 1990). In other regions of Florida, including northeast Florida, Indian River (central Atlantic coast), and south Florida, *Juncus roemerianus* occurs in smaller discrete patches of high marsh (Montague and Wiegert 1990). Presumably, this type also occurs primarily as high salt marsh along the Atlantic coast as well (Hackney and de la Cruz 1982). In Mississippi *Juncus roemerianus* marsh was inundated less than 5.4% of the time that any portion of the marsh was flooded (Eleuterius and Eleuterius 1979). Due to longer and more frequent periods of exposure and resulting evaporation, interstitial water salinity may be higher than more frequently inundated zones. In addition, the interstitial water salinity was generally higher and more stable than flood water (Hackney and de la Cruz 1982). A range of soil conditions may be present in this broadly defined association, but soils are generally poorly to very poorly drained. In some areas, including tall-growth zones, soils were highly organic and peaty (averaging 15 cm in depth?), while shorter zones occurred on sandy soils underlain by clay (Eleuterius and Caldwell 1984). In general, *Juncus roemerianus* occurs on sandy substrates (Penfound 1952). pH at the Mississippi site was 6.2 (Hackney and de la Cruz 1982).

### Vegetation Description

#### **Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

The moderate to dense (50-90% cover) herbaceous layer, 0.5-2 m tall, is dominated by *Juncus roemerianus* (needlegrass rush), which is frequently in monospecific stands. Stands may be codominated by *Borrichia frutescens* (bushy seaside-tansy) or *Spartina alterniflora* (smooth cordgrass). Additional species include *Distichlis spicata* (inland saltgrass), *Limonium carolinianum* (Carolina sealavender), and *Sarcocornia pacifica* (Pacific swampfire). This constitutes the entire floristic composition for the three sampled plots.

**Global Vegetation:** The very dense vegetation is typically exclusively codominated by *Juncus roemerianus* (needlegrass rush) and *Spartina alterniflora* (smooth cordgrass). Tall and short growth-form zones have been noted in several areas (Kruczynski et al. 1978, Hackney and de la Cruz 1982, Stout 1984, Montague and Wiegert 1990). Associates that may occur at low cover include *Borrichia frutescens* (bushy seaside-tansy), *Baccharis halimifolia* (eastern baccharis), *Spartina alterniflora* (smooth cordgrass), *Distichlis spicata* (inland saltgrass), *Schoenoplectus robustus* (sturdy bulrush), *Limonium carolinianum* (Carolina sealavender), *Symphyotrichum tenuifolium* (perennial saltmarsh aster), *Symphyotrichum subulatum* (eastern annual saltmarsh aster), and (in more southern occurrences) *Ipomoea sagittata* (saltmarsh morning-glory).

### Most Abundant Species

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

##### Stratum

Short shrub/sapling  
Herb (field)  
Herb (field)

##### Lifeform

Broad-leaved evergreen shrub  
Forb  
Graminoid

##### Species

*Borrichia frutescens* (bushy seaside-tansy)  
*Sarcocornia pacifica* (Pacific swampfire)  
*Juncus roemerianus* (needlegrass rush), *Spartina alterniflora* (smooth cordgrass)

##### **Global**

##### Stratum

Herb (field)

##### Lifeform

Graminoid

##### Species

*Juncus roemerianus* (needlegrass rush)

### Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Juncus roemerianus* (needlegrass rush)

**Global:** *Juncus roemerianus* (needlegrass rush)

### Other Noteworthy Species

##### **Global**

##### Other Plant Species

*Ptilimnium nodosum* (piedmont mock bishopweed)

##### GRank

G2

##### Note

Federally listed  
endangered; globally  
imperiled

### Conservation Status Rank

**Global Rank & Reasons:** G5 (29-Mar-2001). This is a common coastal marsh of the Gulf and Atlantic coasts of the United States.

### Classification

**Status:** Standard

**Classification Confidence:** 1 - Strong

**Global Comments:** This community is common on the southeastern seaboard, but large undisturbed areas are of high conservation concern. Although this community exhibits little floristic variation across its range, the associated animal species may vary to a greater extent. This community may not occur west of Texas. *Juncus roemerianus* was found to be lower in elevation than the associated *Spartina patens* type and mixed type (Cooper and Waits 1973).

**Global Similar Associations:**

- *Spartina alterniflora* - *Juncus roemerianus* - *Distichlis spicata* Louisianian Zone Salt Tidal Herbaceous Vegetation (CEGL004190)
- *Spartina patens* - *Distichlis spicata* - (*Juncus roemerianus*) Herbaceous Vegetation (CEGL004197)

**Global Related Concepts:**

- *Juncus roemerianus* Tidal Herbaceous Vegetation (Harrison 2001) =
- *Juncus roemerianus* Herbaceous Vegetation (Bowman 2000) =
- *Juncus roemerianus* Tidal Herbaceous Vegetation (Coulling 2002) =
- *Juncus roemerianus* Tidal Herbaceous Vegetation (VDNH 2003) =
- *Juncus roemerianus* association of the low marsh (Adams 1963) =
- *Juncus* type (Cooper and Waits 1973) =
- *Spartina* - *Distichlis* - *Juncus* associates (Penfound 1952) B
- Brackish Marsh (Wieland 1994b) B
- Brackish Marsh (Needlerush Subtype) (Schafale 2000)?
- Irregularly flooded salt marsh (Jenkins 1974) =
- Lower high marsh (Stalter 1973a) =
- Needlerush - saltmeadow type (Nicholson and Van Deusen 1954) =
- Saline Marsh (Wieland 1994a) B
- Salt marsh (Higgins et al. 1971) B
- Salt marsh community (Hill 1986) B
- Smooth Cordgrass Series (Diamond 1993) B

Element Distribution

**Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This association occurs frequently within the marsh along the eastern and southern sides of Cumberland Island, often forming distinctive bands of vegetation at the transition zone from high marsh to *Spartina alterniflora* herbaceous marsh. This association was not documented at Fort Frederica as part of this project, although it is likely that it does occur at the park. Bands of *Juncus roemerianus* were observed within the marsh adjacent to the upland lawn area.

**Global Range:** This community is widespread along the Atlantic and Gulf coasts of North America ranging from Delaware south to Florida, and west to Texas.

**Nations:** US

**States/Provinces:** AL:S2S3, DE:S2S3, FL, GA, LA?, MD:S4, MS, NC, SC, TX, VA:S5

**TNC Ecoregions:** 31:C, 53:C, 54:C, 55:C, 56:C, 57:C, 58:C

**USFS Ecoregions:** 231Fb:CCC, 232Ad:CCC, 232Br:CCC, 232Bx:CCC, 232Bz:CCC, 232Cb:CCC, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Db:CCP, 232Dc:CCC, 232Dd:CCC, 232De:CCP, 232Eb:CCC, 232Ec:CC?, 232Ed:CCC, 232Gb:CCC, 255Da:CCP, 255Dc:CCC

**Federal Lands:** NPS (Assateague Island, Canaveral, Cape Hatteras, Cape Lookout, Cumberland Island, Fort Frederica?, Fort Pulaski, Timucuan); USFS (Croatan); USFWS (Anahuac, Big Boggy, Bon Secour, Brazoria, Chesapeake Marshlands, McFaddin, San Bernard, Texas Point)

#### Element Sources

**Cumberland Island National Seashore and Fort Frederica National Monument Plots:** CUIS.104, CUIS.111, CUIS.903.

**Local Description Authors:** M.J. Russo, H. Summer and L. Kruse

**Global Description Authors:** R.E. Evans, mod. L.A. Sneddon and M. Pyne

**References:** Adams 1963, Bowman 2000, Cooper and Waits 1973, Coulling 2002, Diamond 1993, Eleuterius and Caldwell 1984, Eleuterius and Eleuterius 1979, Fleming et al. 2001, Govus 1998, Hackney and de la Cruz 1981, Hackney and de la Cruz 1982, Harrison 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Jenkins 1974, Kruczynski et al. 1978, Lynch 1941, Montague and Wiegert 1990, Nelson 1986, Nicholson and Van Deusen 1954, Peet et al. unpubl. data 2002, Penfound 1952, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Schotz pers. comm., Smith 1996a, Southeastern Ecology Working Group n.d., Stalter 1973a, Stalter 1973b, Stout 1984, VDNH 2003, Wieland 1994a, Wieland 1994b, Wieland 2000b

#### ***Spartina alterniflora* Tidal Herbaceous Alliance (A.1471)**

##### Alliance Concept

**Summary:** This alliance includes various tidal marshes dominated by *Spartina alterniflora* (smooth cordgrass). The hydrology is usually regularly tidally flooded. In the northern part of its range, southern Maine to Cape Hatteras, North Carolina, this alliance is generally limited to the zone between mean sea level and the mean high water level. The habitat occurs in protected inlets behind barrier beaches or in drowned river valleys. Peat depth ranges from a few feet, if the community formed over a mudflat, to 24 m (80 feet) in drowned river valleys. *Spartina alterniflora* (smooth cordgrass) is limited to the low marsh zone by moderate salinity; it can withstand longer submergence than other salt marsh grasses, but still requires periodic exposure of the substrate. It also requires moderately high levels of iron (7-15 ppm). 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. It occurs in nearly pure stands, with occasional low growing species such as *Spergularia salina* (salt sandspurry), *Salicornia* (pickleweed) spp., *Suaeda maritima* (herbaceous seepweed), and seaweeds such as *Ulva lactuca* and other algae such as *Fucus vesiculosus* and *Ascophyllum nodosum*, which grow at the bases of the *Spartina* (cordgrass) plants. Herbs of *Salicornia virginica* (Virginia glasswort) and *Salicornia bigelovii* (dwarf saltwort) 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 variability of the alliance in the southern parts of its range.

##### **Similar Alliances:**

- *Schoenoplectus americanus* Tidal Herbaceous Alliance (A.2007)
- *Spartina patens* - (*Distichlis spicata*) Tidal Herbaceous Alliance (A.1481)

##### **Related Concepts:**

- Brackish Marsh (Nelson 1986) I
- Estuarine Intertidal: Brackish Tidal Marsh (Swain and Kearsley 2001)?

- Estuarine Intertidal: Salt Marsh (Swain and Kearsley 2001)?
- Saline Marsh (Wieland 1994b) I
- Saline Marsh (Wieland 1994a) I
- Salt Marsh (Smith 1996a)?
- Salt Marsh (Nelson 1986)?
- Salt Marsh (Schafale and Weakley 1990)?
- Smooth Cordgrass Marsh (Wharton 1978)?
- Smooth Cordgrass Series (Diamond 1993) I
- Tidal Marsh (FNAI 1992a) I

#### Alliance Description

**Environment:** This alliance includes various tidal marshes dominated by *Spartina alterniflora*. The hydrology is usually regularly tidally flooded. In the northern part of its range, southern Maine to Cape Hatteras, North Carolina, this alliance is generally limited to the zone between mean sea level and the mean high water level. The habitat occurs in protected inlets behind barrier beaches or in drowned river valleys. Peat depth ranges from a few feet, if the community formed over a mudflat, to 24 m (80 feet) in drowned river valleys. *Spartina alterniflora* is limited to the low marsh zone by moderate salinity; it can withstand longer submergence than other salt marsh grasses, but still requires periodic exposure of the substrate. It also requires moderately high levels of iron (7-15 ppm).

**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. It occurs in nearly pure stands, with occasional low growing species such as *Spergularia salina* (salt sandspurry), *Salicornia* (pickleweed) spp., *Suaeda maritima* (herbaceous seepweed), and seaweeds such as *Ulva lactuca* and other algae such as *Fucus vesiculosus* and *Ascophyllum nodosum*, which grow at the bases of the *Spartina* (cordgrass) plants. Herbs of *Salicornia virginica* (Virginia glasswort) and *Salicornia bigelovii* (dwarf saltwort) 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.

#### Alliance Distribution

**Range:** This alliance is found in coastal areas from Maine to Texas.

**Nations:** CA, US

**Subnations:** AL, CT, DE, FL, GA, LA, MA, MD, ME, MS, NB, NC, NH, NJ, NS, NY, RI, SC, TX, VA

**TNC Ecoregions:** 30:P, 31:C, 41:P, 53:C, 54:P, 55:P, 56:C, 57:C, 58:C, 62:C, 63:C

**USFS Ecoregions:** 212Cb:CCC, 212Db:CCC, 212Dc:CCC, 221Aa:CCP, 221Ab:CCC, 221Ac:CCC, 221Ad:CCC, 221Ae:CCC, 221Ak:CCC, 221Dc:CPP, 231Fb:CCC, 232Aa:CCC, 232Ab:CCC, 232Ac:CCC, 232Ad:CCC, 232Ae:CCC, 232Bb:CCP, 232Bc:CCP, 232Bd:CCP, 232Br:CCC, 232Bt:CCC, 232Bx:CCC, 232Bz:CCC, 232Cb:CCC, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC, 232Cj:CCC, 232Db:CCP, 232Dc:CCC, 232Dd:CCC, 232De:CCP, 232Eb:CCC, 232Ed:CCC, 232Ee:CCC, 232Gb:CPP, 255Da:CC?, 255Dc:CCC

**Federal Lands:** NPS (Acadia, Assateague Island, Boston Harbor Islands, Cape Cod, Cape Hatteras, Cape Lookout, Colonial, Cumberland Island, Fire Island, Fort Frederica?, Fort Pulaski, Gateway, George Washington Birthplace, Muskeget Island, Sagamore Hill, Timucuan); USFS

(Croatan); USFWS (Anahuac?, Aransas?, Back Bay?, Big Boggy, Bon Secour, Brazoria, Chesapeake Marshlands, Chincoteague, Matagorda Island, McFaddin, Monomoy, Moosehorn?, Parker River, Prime Hook, Rachel Carson, San Bernard, Texas Point)

**(CEGL004191) Southern Atlantic Coast Salt Marsh**

***Spartina alterniflora* Carolinian Zone Herbaceous Vegetation**

**Smooth Cordgrass Carolinian Zone Herbaceous Vegetation**

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**NVC Classification**

|                              |                                                                                  |
|------------------------------|----------------------------------------------------------------------------------|
| Physiognomic Class           | Herbaceous Vegetation (V)                                                        |
| Physiognomic Subclass        | Perennial graminoid vegetation (V.A.)                                            |
| Physiognomic Group           | Temperate or subpolar grassland (V.A.5.)                                         |
| Physiognomic Subgroup        | Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)                  |
| Formation                    | Tidal temperate or subpolar grassland (V.A.5.N.n.)                               |
| Alliance                     | <i>Spartina alterniflora</i> Tidal Herbaceous Alliance (A.1471)                  |
| Alliance (English name)      | Smooth Cordgrass Tidal Herbaceous Alliance                                       |
| Association                  | <i>Spartina alterniflora</i> Carolinian Zone Herbaceous Vegetation               |
| Association (English name)   | Smooth Cordgrass Carolinian Zone Herbaceous Vegetation                           |
| Association (Common name)    | Southern Atlantic Coast Salt Marsh                                               |
| <b>Ecological System(s):</b> | Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260) |
| <b>Ecological System(s):</b> | Atlantic Coastal Plain Indian River Lagoon Tidal Marsh (CES203.257)              |
|                              | Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270)        |

Element Concept

**Global Summary:** This vegetation includes various tidal marshes dominated by *Spartina alterniflora* (smooth cordgrass), from Cape Hatteras, North Carolina, south to the Atlantic Coast of the Florida peninsula. The hydrology is usually regularly tidally flooded. *Spartina alterniflora* (smooth cordgrass) is limited to the low marsh zone by moderate salinity; it can withstand longer submergence than other salt marsh grasses, but still requires periodic exposure of the substrate. It also requires moderately high levels of iron (7-15 ppm). 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-statured species.

Environmental Description

**USFWS Wetland System:** Estuarine

**Cumberland Island National Seashore and Fort Frederica National Monument**

**Environment:** This smooth cordgrass herbaceous vegetation was sampled at five locations on Cumberland Island on tidal flats with very poorly drained muck soil. The unvegetated surface for two of the sampled plots is dominated by standing water (96-98% cover) with some leaf litter (0-2%) and bare soil (2%). No disturbance is evident.

**Global Environment:** This vegetation is found along the margins of sounds and estuaries, backs of barrier islands, and old flood tide deltas near closed inlets (Schafale and Weakley 1990). These are areas with diurnal salt tides. The hydrology is estuarine, tidally flooded, and euhaline (30-40 ppt). This range is consistent with the "Carolinian Province" of Cowardin et al. (1979).

### Vegetation Description

#### **Cumberland Island National Seashore and Fort Frederica National Monument Vegetation:**

This vegetation is a sparse to moderately dense (20-70% cover) monoculture of *Spartina alterniflora* (smooth cordgrass) ranging from 0.5 to 2 m tall. Cover and height of the vegetation, and percent of flowering stems, seem to correlate negatively with inundation duration in sampled plots.

**Global Vegetation:** This community is commonly known as "low salt marsh," occurring as 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-statured 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).

### Most Abundant Species

#### **Cumberland Island National Seashore and Fort Frederica National Monument**

##### Stratum

Herb (field)

##### Lifeform

Graminoid

##### Species

*Spartina alterniflora* (smooth cordgrass)

##### **Global**

##### Stratum

Herb (field)

##### Lifeform

Graminoid

##### Species

*Spartina alterniflora* (smooth cordgrass)

### Characteristic Species

**Cumberland Island National Seashore and Fort Frederica National Monument:** *Spartina alterniflora* (smooth cordgrass)

**Global:** *Spartina alterniflora* (smooth cordgrass)

### Conservation Status Rank

**Global Rank & Reasons:** G5 (1-Dec-1997). Since it occurs over large areas, this community is in no danger of disappearing. However, its role in the functioning of ecosystems makes the presence of large areas very important. Losses of this community could have serious consequences for nutrient cycling and reproduction of estuarine and marine organisms (Schafale and Weakley 1990).

### Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Similar Associations:

- *Spartina alterniflora* / (*Ascophyllum nodosum*) Acadian/Virginian Zone Herbaceous Vegetation (CEGL004192)

Global Related Concepts:

- Salt Marsh (Carolinian Subtype) (Schafale 2000) ?

#### Element Distribution

##### **Cumberland Island National Seashore and Fort Frederica National Monument Range:**

This association forms the dominant community type within the salt marsh along the eastern and southern sides of Cumberland Island. It was not documented at Fort Frederica as part of this project, although it is likely that it does occur at the park.

**Global Range:** This vegetation ranges from Cape Hatteras, North Carolina, south to the Atlantic Coast of the Florida peninsula (Cowardin 1979). The northern limit corresponds with the southern limit of the Virginian province of the American Atlantic Temperate Region, a transitional area harboring animal species of both southern and northern affinities.

**Nations:** US

**States/Provinces:** FL, GA, NC, SC

**TNC Ecoregions:** 55:P, 56:C, 57:C

**USFS Ecoregions:** 232Cb:CCC, 232Ce:CCC, 232Ch:CCC, 232Ci:CCC

**Federal Lands:** NPS (Cape Hatteras, Cape Lookout, Cumberland Island, Fort Frederica?, Fort Pulaski, Timucuan); USFS (Croatan)

#### Element Sources

##### **Cumberland Island National Seashore and Fort Frederica National Monument Plots:**

CUIS.094, CUIS.112, CUIS.113, CUIS.213, CUIS.313.

**Local Description Authors:** M.J. Russo and H. Summer

**Global Description Authors:** A.S. Weakley

**References:** Cowardin et al. 1979, FNA Editorial Committee 2003, FNAI 1992a, Govus 1998, Kartesz 1999, Nelson 1986, Peet et al. unpubl. data 2002, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d., Weakley 2007

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# Appendix C: Key to the National Vegetation Classification (NVC) Associations that occur or potentially occur at Fort Frederica National Monument.

Produced by NatureServe, October 2008.

Revised by the Southeast Coast Inventory & Monitoring Network, October 2012.

Associations which are documented from Fort Frederica National Monument are in **bold type**. Associations which may potentially occur, but that were not documented from Fort Frederica as part of this project, are in normal type. For each association, the common name is given, with the Element Code in parentheses (CEGL00####) and the Alliance Code in brackets [A.###].

## FORT FREDERICA NATIONAL MONUMENT

1. Vegetation dominated by trees; forest or woodland associations ..... 2
1. Vegetation dominated by low shrubs, graminoids or forbs; trees absent or sparse ..... 6
2. Pine (*Pinus* spp.) dominated canopy, broadleaf trees may be present in the canopy but with lower cover..... 3
2. Broadleaf evergreen dominated canopy, occasionally with coastal red cedar (*Juniperus virginiana* var. *silicicola*); pine may be present but not composing more than 50% of the canopy..... 4
3. Canopy dominated by slash pine (*Pinus elliottii*) and usually sweetgum (*Liquidambar styraciflua*); woody components in the understory and shrub layers may include water oak (*Quercus nigra*), inkberry (*Ilex glabra*), wax myrtle (*Morella cerifera*), red maple (*Acer rubrum*), and red bay (*Persea borbonia*) .....  
..... **Mid- to Late-Successional Slash Pine Managed Forest (CEGL7171) [A.123]**
3. Canopy dominated by loblolly pine (*Pinus taeda*); hardwood species such as sweet gum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), Darlington oak (*Quercus hemisphaerica*) and southern red oak (*Quercus falcata*) are usually present; understory layers variable .....  
..... **Successional Loblolly Pine - Oak Forest (CEGL008450) [A.130]**
4. Vegetation of flat marsh edges or narrow spits within the marsh, just above or near to high tide level; live oak (*Quercus virginiana*) and coastal red cedar (*Juniperus virginiana* var. *silicicola*) are canopy dominants with cabbage palmetto (*Sabal palmetto*) a strong component; canopy may be sparse and wind-sheared; non-vegetative ground cover usually with oyster shells .....

.....**Coastal Red Cedar - Live Oak - Cabbage Palmetto Marsh Hammock (CEGL007813) [A.55]**

4. Vegetation of the main island, well above tidal flooding; canopy not wind-sheared and usually closed; oak (*Quercus* spp.) the most dominant canopy component; oyster shells not important in the soil profile ...

..... 5

5. Canopy strongly dominated by live oak (*Quercus virginiana*), frequently with pine (*Pinus* spp.), water oak (*Quercus nigra*), sweetgum (*Liquidambar styraciflua*), or black gum (*Nyssa sylvatica*); understory and shrub layers variable but most frequently with horse sugar (*Symplocos tinctoria*), American holly (*Ilex opaca*), wax myrtle (*Morella cerifera*), sparkleberry (*Vaccinium arboreum*), or southern magnolia (*Magnolia grandiflora*); mesic-site species such as swamp bay (*Persea palustris*), chain fern (*Woodwardia areolata*), and cinnamon fern (*Osmunda cinnamomea*) can be important components.....

.....**Maritime Live Oak Hammock (CEGL007032) [A.55]**

5. Canopy strongly dominated by Darlington oak (*Quercus hemisphaerica*) with lesser amounts of loblolly pine (*Pinus taeda*) and water oak (*Quercus nigra*); understory and shrub layers variable but dominated by wax myrtle (*Morella cerifera*), and likely including yaupon (*Ilex vomitoria*), cabbage palm (*Sabal palmetto*), red bay (*Persea borbonia*), and sparkleberry (*Vaccinium arboreum*).....

.....**Atlantic Coastal Plain Swamp Island Forest (CEGL007022) [A.53]**

6. Shrub dominated tidal flats.....7

7. Shrub layer dominated by seaside tansy (*Borrchia frutescens*), sometimes occurring with marsh elder (*Iva frutescens*) and black rush (*Juncus roemerianus*); herbaceous layer tends to be moderate (40-60% cover), and may be dominated by turtleweed (*Batis maritima*), chestnut fimbry (*Fimbristylis castanea*), and St. Augustine grass (*Stenotaphrum secundum*).....

.....**Seaside Oxeye Tidal Shrub Flat (CEGL003924) [A.1026]**

8. Herbaceous vegetation of a variety of soil and site types, possibly associated with disturbance; dominated by St. Augustine grass (*Stenotaphrum secundum*) that may be in monoculture or with scattered native and exotic species .....St. Augustine Grass Herbaceous Vegetation (CEGL004883) [A.1139]

9. Herbaceous or low shrub vegetation associated with the salt marsh, salt marsh edges, or tidally-influenced creeks ..... 10

10. Vegetation of the low salt marsh or salt panne within the low marsh ..... 11

10. Vegetation associated with the high salt marsh, marsh edges, or tidally influenced creeks ..... 13

11. Community dominated by dwarf (less than 0.5 m), succulent-leaved, halophytic shrubs..... **13**
12. Community dominated by herbaceous vegetation ..... **14**
13. Community dominated by the dwarf-shrub swampfire (*Sarcocornia pacifica*) .....  
.....Salt Flat (Swampfire Type) (CEGL002278) [A.1705]
13. Community dominated by the dwarf-shrub turtleweed (*Batis maritima*) .....  
.....Turtleweed - Swampfire Dwarf-shrubland (CEGL003956) [A.1111]
14. Vegetation composed of monospecific stands of smooth cordgrass (*Spartina alterniflora*) .....  
.....**Southern Atlantic Coast Salt Marsh (CEGL004191) [A.1471]**
14. Vegetation dominated by halophytic herbs, including Virginia glasswort (*Salicornia virginica*), dwarf glasswort (*Salicornia bigelovii*), and/or stunted smooth cordgrass (*Spartina alterniflora*).....  
.....Salt Panne (Salicornia Type) (CEGL004308) [A.1704]
15. Vegetation dominated by black needle rush (*Juncus roemerianus*), frequently in mono-specific bands at the transition from low to high salt marsh .....**Needlerush High Marsh (CEGL004186) [A.1475]**
15. Vegetation dominated by Jamaica swamp sawgrass (*Cladium mariscus* ssp. *jamaicense*); of marsh edges where the salt water marsh intergrades with freshwater streams or marsh.....  
.....Tidal Sawgrass Marsh (CEGL004178) [A.1473]
16. Vegetation dominated by inland saltgrass (*Distichlis spicata*), saltmeadow cordgrass (*Spartina patens*) and possibly *Juncus roemerianus* (black needlerush). Additional species may include chestnut fimbry (*Fimbristylis castanea*), maritime marsh elder (*Iva frutescens*), and scattered saltmarsh false foxglove (*Agalinis maritima*), sea lavender (*Limonium carolinianum*), and swamp fire (*Sarcocornia pacifica*) .....  
.....Mid- and Southern Atlantic High Salt Marsh (CEGL004197) [A.1481]



## Appendix D: Photo-Interpretation Guide to the Vegetated Map Classes of Fort Frederica National Monument

### ***Upland Forest***

Map Class 1: Atlantic Coastal Plain Swamp Island Forest

Map Class 2: Coastal red-cedar – Live Oak – Cabbage Palmetto Marsh Hammock

Map Class 3: Maritime Live Oak Hammock

Map Class 4: Successional Loblolly Pine – Oak Forest

### ***Wetland Shrubland***

Map Class 5: Seaside-tansy Tidal Shrub Flat

### ***Wetland Herbaceous***

Map Class 6: Needlerush High Marsh

Map Class 7: Southern Atlantic Coast Salt Marsh

### ***I. Upland Forest***

#### ***MAP CLASS 1***

#### ***Atlantic Coastal Plain Swamp Island Forest***



#### ***Abundant species:***

- *Quercus nigra* (water oak)
- *Pinus taeda* (loblolly pine)
- *Quercus hemisphaerica* (Darlington oak)

- *Ilex ambigua* (Carolina holly)
- *Ilex vomitoria* (yaupon)
- *Morella cerifera* (wax myrtle)
- *Persea borbonia* (redbay)
- *Sabal palmetto* (cabbage palmetto)
- *Vaccinium corymbosum* (farkleberry)
- *Vaccinium arboreum* (farkleberry)

#### Map Class Statistics

Frequency: 2 polygons

Total area: 0.95 ha

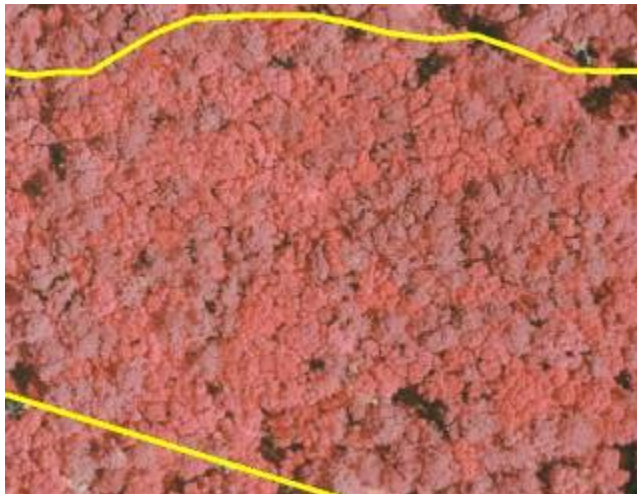
Average polygon size: 0.47 ha

Producer's accuracy: 0%

User's accuracy: 0%

#### Interpretation:

This upland forest occupies a small (0.95 ha) area within the Fort Frederica Unit. The tree canopy is dominated by *Quercus hemisphaerica*, which has a relatively small crown size and appears bright pink on the imagery. Scattered *Pinus taeda* are present in the midst of the *Q. hemisphaerica*. The *P. taeda* has a relatively small crown size and is brown in color.



Example of photo-signature of Atlantic Coast Plain Swamp Island Forest.

## **MAP CLASS 2**

### Coastal red-cedar – Live Oak – Cabbage Palmetto Marsh Hammock



#### Abundant species:

- *Juniperus virginiana* var. *silicicola* (southern redcedar)
- *Quercus virginiana* (live oak)
- *Sabal palmetto* (cabbage palmetto)
- *Tillandsia usneoides* (Spanish moss)
- *Ilex vomitoria* (yaupon)
- *Celtis laevigata* (sugarberry)
- *Sabal minor* (dwarf palmetto)
- *Serenoa repens* (saw palmetto)
- *Yucca gloriosa* (moundlily yucca)

#### Map Class Statistics

Frequency: 2 polygons

Total area: 1.2 ha

Average polygon size: 0.59 ha

Producer's accuracy: 100%

User's accuracy: 67%

Interpretation:

The strong presence of *Juniperus virginiana* var. *silicicola* in this community lends a distinct purple color to the photo-signature of this community. *Quercus virginiana* is also a canopy and appears a reddish-pink color with a fairly large crown-size visible in the imagery.



Example of photo-signature of Coastal red-cedar – Live Oak – Cabbage Palmetto Marsh Hammock (polygon highlighted in blue).

**MAP CLASS 3**

Maritime Live Oak Hammock



Abundant species:

- *Pleopeltis polypodioides* (resurrection fern)
- *Quercus virginiana* (live oak)
- *Pinus elliottii* (slash pine)
- *Pinus taeda* (loblolly pine)
- *Ilex opaca* (American holly)
- *Persea borbonia* (redbay)
- *Sabal palmetto* (cabbage palmetto)
- *Lyonia ferruginea* (rusty staggerbush)
- *Morella cerifera* (wax-myrtle)
- *Vaccinium arboreum* (farkleberry)
- *Vaccinium corymbosum* (highbush blueberry)
- *Serenoa repens* (saw palmetto)

Map Class Statistics

Frequency: 8 polygons

Total area: 23.0 ha

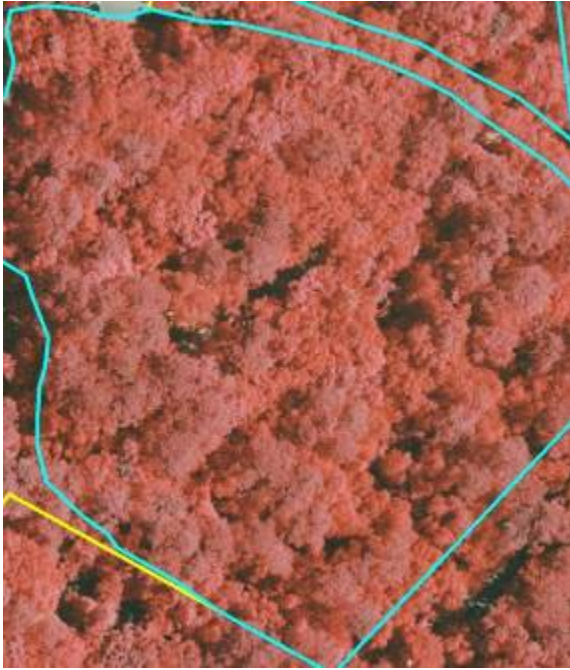
Average polygon size: 2.9 ha

Producer's accuracy: 73%

User's accuracy: 42%

Interpretation:

The main canopy component, *Quercus virginiana*, appears reddish-pink in color and has a fairly large crown size. Scattered *Pinus taeda* and/or *Pinus elliottii* in the canopy appear brown in color and have a relatively small crown size. This community is fairly common on the forested, upland sites in Fort Frederica.



Example of photo-signature of Maritime Live Oak Hammock.

#### **MAP CLASS 4**

##### Successional Loblolly Pine – Oak Forest



##### Abundant species:

- *Pinus taeda* (loblolly pine)
- *Liquidambar styraciflua* (sweetgum)
- *Quercus nigra* (water oak)
- *Quercus hemisphaerica* (Darlington oak)

##### Map Class Statistics

Frequency: 7 polygons

Total area: 18.1 ha

Average polygon size: 2.6 ha

Producer's accuracy: 91%

User's accuracy: 86%

##### Interpretation:

*Pinus taeda* is the main canopy component and appears brown on the imagery and has a relatively small crown size.



Example of photo-signature of Successional Loblolly Pine – Oak Forest.

## ***II. Wetland Shrubland***

### ***MAP CLASS 5***

#### ***Seaside Oxeye Tidal Shrub Flat***



#### ***Abundant species:***

- *Borrchia frutescens* (bushy seaside tansy)
- *Iva frutescens* (Jesuit's bark)
- *Batis maritima* (turtleweed)

- *Limonium carolinianum* (Carolina sealavender)
- *Sarcocornia pacifica* (Pacific swampfire)

#### Map Class Statistics

Frequency: 3 polygons

Total area: 1.1 ha

Average polygon size: 0.36 ha

Producer's accuracy: 100%

User's accuracy: 100%

#### Interpretation:

This community is typically dominated by *Borrchia frutescens* and appears dark pink with a very smooth texture on the imagery. At Fort Frederica, this community is found along tidal fringe areas.



Example of photo-signature of Seaside-tansy Tidal Shrub Flat.

### ***III. Wetland Herbaceous***

#### **MAP CLASS 6**

#### Needlerush High Marsh



Abundant species:

- *Juncus roemerianus* (needlerush)
- *Spartina alterniflora* (smooth cordgrass)
- *Sarcocornia pacifica* (Pacific swampfire)

Map Class Statistics

Frequency: 5 polygons

Total area: 60.8 ha

Average polygon size: 12.2 ha

Producer's accuracy: 82%

User's accuracy: 100%

Interpretation:

*Juncus roemerianus* dominates this herbaceous wetland, and on the imagery appears brown-to-gray with a smooth texture. This community is one of the two major salt marsh vegetation communities found at Fort Frederica.



Example of photo-signature of Needlerush High Marsh.

## **MAP CLASS 7**

### Southern Atlantic Coast Salt Marsh



#### Abundant species:

- *Spartina alterniflora* (smooth cordgrass)

#### Map Class Statistics

Frequency: 6 polygons

Total area: 31.7 ha

Average polygon size: 5.3 ha

Producer's accuracy: 81%

User's accuracy: 90%

#### Interpretation:

*Spartina alterniflora* dominates this herbaceous wetland, and on the imagery it appears pinkish-gray with a smooth texture. This community is one of the two major salt marsh vegetation communities found at Fort Frederica.



Example of photo-signature of Southern Atlantic Coast Salt Marsh.



## **Appendix E: Field Reconnaissance Form**

## Fort Frederica National Monument Field Reconnaissance Data Sheet:

### I. LOCATION DATA

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

### II. ENVIRONMENTAL/ SITE DESCRIPTION

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

Soil Texture-

Soil Drainage-

Topo/Landscape Position-

Disturbance-

### III. VEGETATION DESCRIPTION

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

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

| Species | Canopy | Sub-canopy | Shrub | Herb |
|---------|--------|------------|-------|------|
|         |        |            |       |      |
|         |        |            |       |      |
|         |        |            |       |      |
|         |        |            |       |      |
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|         |        |            |       |      |
|         |        |            |       |      |
|         |        |            |       |      |
|         |        |            |       |      |

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



## Appendix F: Accuracy Assessment Form

### I. LOCATION DATA:

1. AA Point Code: \_\_\_\_\_ 2. Date: \_\_\_\_\_

3. Observers: \_\_\_\_\_

4. Photo (s) #: \_\_\_\_\_

5. Coordinates: X: \_\_\_\_\_ Y: \_\_\_\_\_

6. Estimated Accuracy (m): \_\_\_\_\_ 7. Number of Satellites: \_\_\_\_\_

## II. ENVIRONMENTAL/ SITE DESCRIPTION:

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

### III. VEGETATION DESCRIPTION:

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

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

[illegible]

**V. VEGETATION ASSOCIATION:**

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

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

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

**V. SOIL CHARACTERISTICS:**

Soil Notes:

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



## Appendix G: Accuracy Assessment Contingency Tables

### Explanation of the Contingency Matrices

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

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

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

| Field Determination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |      |      |     |      |      |      |                                |        |                 |                         |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|------|-----|------|------|------|--------------------------------|--------|-----------------|-------------------------|----------------------------|----|------|-----|-----|------|------|-----|--------------------------------|--|--|--|--------------------------------|------|-----|-----|-----|-----|-----|-----|------------------------|--|--|--|--|-------|------|------|-----|------|------|------|--|--|--|--|
| Map Units                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        | A    | B    | C   | D    | E    | F    | G                              | Totals | User's Accuracy | 90% Confidence Interval |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
| Photo-interpreter's Determination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | A      | 0    |      |     | 5    |      |      |                                | 5      | 0%              | - 0% + 10%              |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | B      | 1    | 2    |     |      |      |      |                                | 3      | 67%             | 5% 100%                 |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | C      | 2    |      | 10  | 4    |      |      |                                | 16     | 63%             | 39% 86%                 |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | D      |      |      | 1   | 6    |      |      |                                | 7      | 86%             | 57% 100%                |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | E      |      |      |     |      | 1    |      |                                | 1      | 100%            | 50% 100%                |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | F      |      |      |     |      |      | 26   | 3                              | 29     | 90%             | 79% 100%                |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | G      |      |      |     |      |      |      | 13                             | 13     | 100%            | 96% 100%                |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Totals | 3    | 2    | 11  | 15   | 1    | 26   | 16                             |        |                 |                         |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
| <table> <tr> <td><b>Producer's Accuracy</b></td><td>0%</td><td>100%</td><td>91%</td><td>40%</td><td>100%</td><td>100%</td><td>81%</td><td colspan="4"><b>58 Total Correct Points</b></td></tr> <tr> <td><b>90% Confidence Interval</b></td><td>- 0%</td><td>75%</td><td>72%</td><td>16%</td><td>50%</td><td>98%</td><td>62%</td><td colspan="4"><b>74 Total Points</b></td></tr> <tr> <td></td><td>+ 17%</td><td>100%</td><td>100%</td><td>64%</td><td>100%</td><td>100%</td><td>100%</td><td colspan="4"></td></tr> </table> |        |      |      |     |      |      |      |                                |        |                 |                         | <b>Producer's Accuracy</b> | 0% | 100% | 91% | 40% | 100% | 100% | 81% | <b>58 Total Correct Points</b> |  |  |  | <b>90% Confidence Interval</b> | - 0% | 75% | 72% | 16% | 50% | 98% | 62% | <b>74 Total Points</b> |  |  |  |  | + 17% | 100% | 100% | 64% | 100% | 100% | 100% |  |  |  |  |
| <b>Producer's Accuracy</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0%     | 100% | 91%  | 40% | 100% | 100% | 81%  | <b>58 Total Correct Points</b> |        |                 |                         |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
| <b>90% Confidence Interval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | - 0%   | 75%  | 72%  | 16% | 50%  | 98%  | 62%  | <b>74 Total Points</b>         |        |                 |                         |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | + 17%  | 100% | 100% | 64% | 100% | 100% | 100% |                                |        |                 |                         |                            |    |      |     |     |      |      |     |                                |  |  |  |                                |      |     |     |     |     |     |     |                        |  |  |  |  |       |      |      |     |      |      |      |  |  |  |  |

#### Key to Map Class Code

A = Atlantic Coastal Plain Swamp Island Forest

B = Coastal Red-cedar - Live oak - Cabbage Palmetto Marsh Hammock

C = Maritime Live Oak Forest

D = Successional Loblolly Pine - Oak Forest

E = Seaside Oxeye Tidal Shrub Flat

F = Southern Atlantic Coast Salt Marsh

G = Needlerush High Marsh

| Reference Data (Observations Classified as Vegetation Type on Ground) |        |        |        |        |        |        |        |           |                              |                                                                                                                                                                                   |                                  |                                   |
|-----------------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|-----------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------|
| Sample Data<br>(Observations<br>Selected Within<br>the Map Class)     | A      | B      | C      | D      | E      | F      | G      | Row Total | Map<br>Class<br>Area<br>(Ha) | Point Estimate<br>(User's Accuracy)                                                                                                                                               | Lower Limit,<br>90% Conf<br>Int. | Upper<br>Limit, 90%<br>Conf. Int. |
| A                                                                     | 0.00   | 0.00   | 0.0083 | 0.0021 | 0.00   | 0.00   | 0.00   | 0.0104    | 0.89                         | 0.0%                                                                                                                                                                              | 0.0%                             | 10.0%                             |
| B                                                                     | 0.00   | 0.0062 | 0.0031 | 0.00   | 0.00   | 0.00   | 0.00   | 0.0093    | 0.80                         | 66.7%                                                                                                                                                                             | 5.2%                             | 100.0%                            |
| C                                                                     | 0.0079 | 0.00   | 0.0198 | 0.0040 | 0.00   | 0.00   | 0.00   | 0.0317    | 2.70                         | 62.5%                                                                                                                                                                             | 39.5%                            | 85.5%                             |
| D                                                                     | 0.00   | 0.00   | 0.0246 | 0.1475 | 0.00   | 0.00   | 0.00   | 0.1721    | 14.7                         | 85.7%                                                                                                                                                                             | 56.8%                            | 100.0%                            |
| E                                                                     | 0.00   | 0.00   | 0.00   | 0.00   | 0.0061 | 0.00   | 0.00   | 0.0061    | 0.52                         | 100%                                                                                                                                                                              | 50%                              | 100.0%                            |
| F                                                                     | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.4745 | 0.0547 | 0.5292    | 45.2                         | 89.7%                                                                                                                                                                             | 78.6%                            | 100%                              |
| G                                                                     | 0.0107 | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.2412 | 0.2519    | 20.6                         | 100%                                                                                                                                                                              | 96.2%                            | 100.0%                            |
| Column Total                                                          | 0.0186 | 0.0062 | 0.0558 | 0.1536 | 0.0061 | 0.4745 | 0.2959 | 1.0       | 85.41                        | Overall Accuracy (with 90% Confidence Interval):<br><b>89.5% (83.3% - 95.8%)</b><br>Overall Accuracy Kappa Statistic (with 90% Confidence Interval): <b>71.8% (62.2% - 81.5%)</b> |                                  |                                   |
| Estimated True Map Class Area (Ha)                                    | 0.68   | 0.53   | 4.05   | 13.83  | 0.52   | 40.52  | 25.28  |           |                              |                                                                                                                                                                                   |                                  |                                   |
| Point Estimate, Mean Producer's Accuracy                              | 0%     | 100%   | 41.6%  | 91.1%  | 100%   | 100%   | 81.5%  |           |                              |                                                                                                                                                                                   |                                  |                                   |
| Lower Limit, 90% Conf. Int.                                           | 0%     | 99.6%  | 40.1%  | 87.7%  | 100%   | 97.4%  | 79.7%  |           |                              |                                                                                                                                                                                   |                                  |                                   |
| Upper Limit, 90% Conf. Int.                                           | 0%     | 100%   | 43.1%  | 94.6%  | 100%   | 100%   | 83.3%  |           |                              |                                                                                                                                                                                   |                                  |                                   |

## Key to Map Class Codes

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

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



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