



Terrestrial Vegetation Monitoring at Fort Frederica National Monument

2020 Data Summary

Natural Resource Data Series NPS/SECN/NRDS—2022/1372





ON THIS PAGE

M. Forbes Boyle, SECN Botanist, searches for new species in one of the vegetation monitoring plots at Fort Frederica National Monument. NPS photo / Elizabeth Rico.

ON THE COVER

Oak and pine dominated maritime forests of varying age-classes represent the natural upland habitat of Fort Frederica National Monument. NPS photo / M. Forbes Boyle.

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible and technically accurate.

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Executive Summary

The Southeast Coast Network (SECN) conducts long-term terrestrial vegetation monitoring as part of the nationwide Inventory and Monitoring Program of the National Park Service (NPS). The vegetation community vital sign is one of the primary-tier resources identified by SECN park managers, and it is currently conducted at 15 network parks (DeVivo et al. 2008). Monitoring plants and their associated communities over time allows for targeted understanding of ecosystems within the SECN geography, which provides managers information about the degree of change within their parks' natural vegetation.

The year 2020 was the first time for conducting this monitoring effort within Fort Frederica National Monument (FOFR). Five vegetation plots were established throughout the park from August to September. Data collected in each plot included species richness across multiple spatial scales, species-specific cover and constancy, species-specific woody stem seedling/sapling counts and adult tree (greater than 10 centimeters [3.9 inches {in}]) diameter at breast height (DBH), overall tree health, landform, soil, observed disturbance, and woody biomass (i.e., fuel load) estimates.

This report summarizes the baseline (year 1) terrestrial vegetation data collected at Fort Frederica National Monument in 2020. Data were stratified across Maritime Upland Forest and Shrubland habitat within the park. Noteworthy findings include:

- Ninety-one vascular plant taxa (species or lower) were observed across five vegetation plots within the Maritime Upland Forest and Shrubland broadly defined habitat of the park, including 19 species not previously documented within the park.

- The most frequently encountered species included yaupon (*Ilex vomitoria*), Darlington oak (*Quercus hemisphaerica*), wax myrtle (*Morella cerifera*), muscadine (*Muscadinia rotundifolia* var. *rotundifolia*), redbay (*Persea borbonia*), live oak (*Quercus virginiana*), Spanish moss (*Tillandsia usneoides*), cabbage palmetto (*Sabal palmetto*), and Virginia creeper (*Parthenocissus quinquefolia*).
- Two non-native species categorized as invasive by the Georgia Exotic Pest Plant Council (GA-EPPC 2022) were present in four of the five monitoring plots; these included camphortree (*Camphora officinarum*) (constancy = 80%) and Chinese tallow (*Triadica sebifera*) (constancy = 10%).
- One vascular plant species listed as rare and tracked by the Georgia Department of Natural Resources (GADNR 2022) was observed in these monitoring plots—small ball moss (*Tillandsia recurvata*).
- Darlington oak and loblolly pine (*Pinus taeda*) were the most dominant species (based on density) within the tree stratum of upland forests within Fort Frederica National Monument. Species that dominated the sapling and seedling strata of this type included yaupon, inkberry (*Ilex glabra*), redbay, and Darlington oak.
- Eighty-five percent of the trees measured in the parks Maritime Upland Forest and Shrubland habitat type were alive and greater than 75% were experiencing healthy vigor.

List of Terms

Aspect: The compass direction that a slope faces.

Basal Area (BA): The cross-sectional area of woody stems at DBH; used to describe the amount of area occupied by a single or group of stems. BA is expressed in this report as m²/ha (square meters per hectare).

Coarse Woody Debris (CWD): Downed woody stems on the ground that are either lying prone on the ground, or at least one end of the broken bole of a dead tree is touching the ground at an angle of greater than 45° from vertical. Coarse woody debris includes pieces of wood greater than 8 centimeters (3.1 inch [in]) in diameter (approximately 1,000-hour fuel class).

Constancy: The percentage of plots in a given dataset in which a species occurs.

Cover: The vertical projection of vegetation from the ground as viewed from above, and in this protocol is estimated as a percentage of area that covers the ground above the ground surface (areal cover).

Density: The number of individual woody stems in a given area.

DBH: Diameter at breast height of an individual woody stem, or 1.37 meters (4.5 feet [ft]) above the ground surface.

Duff: An organic fuel layer that lies below the litter layer and above mineral soil. It is made up of litter material that has decomposed to the point where individual pieces are no longer identifiable. In general, the duff layer is darker than the litter layer.

Fine Woody Debris (FWD): Pieces of wood less than 8 centimeters (3.1 in) in diameter. They are either (1) not attached to the woody stem where they once grew and have fallen to the ground, (2) not attached to the stem where they once grew and are supported off the ground by live or dead material, or (3) attached to stems of woody material that are themselves considered 'dead' and 'down.' Fine woody debris is composed of the following fire size classes: 1-hour fuels (0–0.64 centimeters [0–0.2 in]), 10-hour fuels (0.64–2.54 centimeters [0.2–1 in]), and 100-hour fuels (2.54–8.1 centimeters [1–3.2 in]).

Global / State Status: Conservation status assessment ranks developed by NatureServe and individual state Natural Heritage Programs used to determine the extinction risk of species and ecosystems at the global and state scales. Global codes are as follows:

- G1: Critically imperiled-very high risk of extinction
- G2: Imperiled-high risk of extinction
- G3: Vulnerable-moderate risk of extinction
- G4: Apparently Secure-fairly low risk of extinction
- G5: Secure-very low risk of extinction

Growth Form: The shape and physical appearance of a species, reflecting site conditions and genetics. In this report, the following growth forms, following definitions set by USDA (2022), are used:

- Tree: a perennial, woody plant with a single stem (trunk), normally greater than 4–5 meters (13.1–16.4 ft) in height
- Shrub: a perennial, multi-stemmed woody plant that is usually less than 4–5 meters (13.1–16.4 ft) in height
- Vine: a twining or climbing plant with relatively long stems; can be woody or herbaceous
- Herb/Forb: a plant without significant woody tissue and lacking significant thickening by secondary woody growth
- Graminoid: a grass or grass-like plant; includes grasses (*Poaceae*), sedges (*Cyperaceae*), and rushes (*Juncaceae*).

Litter: An organic fuel layer made up of twigs, dead grasses, recently fallen leaves, and pine or other needles where the individual pieces are still identifiable and not altered by decomposition.

Sapling: Any live woody stem more than 1.37 meters (4.5 ft) in height but less than 10 centimeters (3.9 in) in diameter at breast height (DBH).

Seedling: Any live woody stem with at least two true leaves that are less than 1.37 meters (4.5 ft) tall.

Slope: The rise and fall of a land surface.

Species Richness: The overall number of species, or group of species, within a defined area.

Terrain Shape Index (TSI): A quantitative expression of the geometric shape (ranging from concave to convex) of the land surface. Negative TSI values indicate convex shape, positive values indicate concavity, and values around 0 indicate flat surfaces.

Tree: Any woody stem more than 1.37 meters (4.5 ft) in height and greater than or equal to 10 centimeters (3.9 in) in diameter at breast height (DBH). This term is also used to describe a specific growth form (see Growth Form above).

Introduction

Overview

Vegetation communities are the primary drivers of a range of ecological processes and are integral to the proper function of park ecosystems. Moreover, vegetation communities integrate the biological and physical environment—they serve as the foundation for food webs, provide wildlife habitat for many species, function as a carbon sink, produce oxygen, and cycle nutrients and energy through an ecosystem. Parks within the Southeast Coast Network (SECN) host a diverse assemblage of plants and terrestrial communities. Vegetation communities vary widely across network parks. Approximately 180 vegetation associations (i.e., fine-resolution floristic description), as defined by the National Vegetation and Classification Standard, Version 2.0 (FGDC 2008), occur in SECN park units. A diversity of vegetation types is found in these parks, including dry grassland dunes, maritime oak and pine dominated forests, pyrogenic pine flatwoods, black and brown water floodplain forests, and Piedmont upland forests.

Vegetation communities are dynamic entities whose species composition, abundance, distribution, and structure are influenced by environmental factors and the impacts over time by natural and anthropogenic disturbances. For communities to be considered ‘natural,’ native species must be predominately distributed across the landscape as a consequence of disturbance factors (i.e., stressors) or site condition (i.e., environmental factors; e.g., soil nutrients, landform; Comer et al. 2003). The timing, type, and extent of a disturbance generally evoke a distinguishable response in vegetation across the landscape (Turner et al. 1990; Foster et al. 1998). Natural disturbance processes in SECN parks include those brought about by fire regimes and weather patterns (e.g., hurricanes and drought), while anthropogenic influences include landscape fragmentation, fire suppression, altered hydrology, shifts in seasonal weather patterns, and non-native species introduction.

Determining trends in vegetation communities over time and identifying plant stressors is vital to understanding the ecological health of terrestrial ecosystems within SECN parks. Collectively, this information can be used to guide management actions that sustain park’s ecological integrity and support plant conservation across a diversity of spatial scales. The Southeast Coast Network collects long-term data on vegetation communities within its parks using a protocol that is largely based on the forest monitoring approaches

used by the Cumberland Piedmont Network (White et al. 2011) and Gulf Coast Network (Carlson et al. 2018).

This report provides a summary of data collected in late summer 2020 within Fort Frederica National Monument (FOFR) as part of the SECN’s terrestrial vegetation monitoring effort. This report is intended to provide FOFR resource managers and partners with (a) baseline information on the composition, abundance, and structure of vegetation across broad habitat types, (b) documentation of observable stressors to park vegetation resources, and (c) a summary of ancillary data associated with terrestrial ecosystems (e.g., soil nutrient status and fuel abundance).

Monitoring Objectives

The overall objective of this effort is: to detect meaningful changes in species composition and vegetation structure within natural and semi-natural vegetation communities of SECN parks and determine whether these changes are correlated with trends in key stressors.

The data presented herein are from the first iteration of sampling activities in Fort Frederica National Monument utilizing the recently published SECN terrestrial vegetation monitoring protocol (Boyle et al. 2019). For this ‘baseline’ status report, 2020 data were synthesized to answer the following questions across broad habitat types within the park:

- How does species richness vary across terrestrial vegetation communities?
- What is the status of composition and abundance among native versus non-native, invasive species?
- What are the most common plants encountered during the monitoring effort, and conversely, were there rare species detected?
- In forests, woodlands, and shrublands, what is the relative frequency of woody seedlings, saplings, and subcanopy or canopy species?
- Do observable stressors appear to impact vegetation communities?
- What is the current condition of soil nutrient chemistry and fuel volume?

Methods

Study Area

Fort Frederica National Monument (FOFR) is on St. Simons Island in Glynn County, Georgia (Figure 1). St. Simons Island is approximately 19 kilometers (12 miles [mi]) east of Brunswick, Georgia and is the second largest of the state's barrier islands (after Cumberland Island, Camden County). The 123-hectare (305 acre [ac]) park is split between two parcels on the island—the primary management unit and the Bloody Marsh Battle Site. The primary management unit is located on a bluff on the western central part of St. Simons Island overlooking the Mackay (Frederica) River and includes the park headquarters, visitor center, and historical fort. The Bloody Marsh Battle Site (not in Figure 1) is a small unit (3 hectares [7.5 ac]) located approximately 9.5 kilometers (6 mi) south of the primary management unit. The focal area of the park is the colonial-era townsite surrounding the fort, which is currently maintained as a mowed field.

Prior to colonization by the English in the early 18th century, Native Americans used the site of Fort Frederica for agriculture and also used fire to control forest vegetation—a practice that early English settlers adopted as well (Bratton 1985). The pre-colonial landscape surrounding the site of Fort Frederica was dominated by maritime live oak (*Quercus virginiana*) hammock forests and also included a 200-acre (80.9 ha) wetland 'savannah' (See figure 1 in Bratton 1985). Land clearing for cotton expanded by the late 18th century across St. Simons Island, as did timber harvesting of select hardwoods (e.g., live oak); drainage ditches were also installed across the Fort Frederica site, including those used to drain the 'savannah,' in order to promote farming (See figure 2 in Bratton 1985). Land use throughout the 19th and 20th centuries continued to reduce the original maritime hardwood forests of Fort Frederica and favor successional

pine (e.g., loblolly [*Pinus taeda*] and slash [*P. elliottii*]) forests (See figure 3 in Bratton 1985).

The current vegetation of Fort Frederica National Monument includes upland forests dominated by a mixture of live oak and other hardwoods or pine-dominated successional forests occupying sites that were originally hardwood-dominated. Salt marsh vegetation, dominated by smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*), occupy the lowest vegetated sites of the park along the Frederica River.

Schmidt (2004) reports 203 vascular species within Fort Frederica National Monument, including 12 cultivated species and an additional 17 non-native species. Of these 29 species, six are listed as either a Category 1 (a serious problem) or Category 2 (a moderate problem) invasive species by the Georgia Exotic Pest Plant Council (GA-EPPC 2022). These include:

- Camphortree (*Camphora officinarum*; Cat 2)
- Bermudagrass (*Cynodon dactylon*; Cat 2)
- Japanese privet (*Ligustrum japonicum*; Cat 2)
- Chinese privet (*Ligustrum sinense*; Cat 1)
- Rattlebox (*Sesbania punicea*; Cat 2)
- Chinese tallow-tree (*Triadica sebifera*; Cat 1)

There were no state or federally listed endangered or threatened species found within the park during the previous floristic survey, nor were there any rare plants of special concern listed by the Georgia Department of Natural Resources (GADNR 2022) present (Schmidt 2004).



Figure 1. Southeast Coast Network terrestrial vegetation monitoring plot locations within Fort Frederica National Monument.

Sampling Design

The Southeast Coast Network monitors vegetation in long-term plots located in natural and semi-natural habitats of targeted parks, including Fort Frederica National Monument. Sample size (i.e., number of plots) is determined by a combination of factors, including (1) priority plots are located in broadly defined habitats that cover more than 30% of the total area of park's natural and semi-natural vegetation (i.e., dominant and co-dominant habitat); (2) the number of priority plots is scaled according to the overall size of dominant/codominant mapped polygons, such that the distribution of plots is between 1 and 25 per 100 hectares (247 ac) of these habitat types; (3) the secondary sample target is any broadly defined habitat that cover between 1 and 30% of a park's natural and semi-natural vegetation; (4) each of the secondary sample target habitat types is allotted four plots.

Five vegetation plots were established and sampled at Fort Frederica National Monument in August and September 2020 (Figure 1). These plots were all in the Maritime Upland Forest and Shrubland broadly defined habitat of the park. Plot locations were determined using the generalized random-tessellation stratified (GRTS) sampling methodology, which creates a spatially balanced array of sample points across an area of interest while maintaining flexibility in a project's sample size (Stevens and Olsen 2004).

Nomenclature Standard, Growth Form Determination, and Conservation Status

Species nomenclature for this report follows the Flora of the Southern and Mid-Atlantic States (Weakley 2020). Every attempt was made to identify all plants to species, variety, or subspecies; when this was not possible, the lowest level of identifiable taxa (e.g., genera, family) was used. Occasionally, a taxonomic concept was created by 'lumping' several species

of the same genus of known occurrence within a park. For example, both southern red cedar (*Juniperus silicicola*) and eastern red cedar (*J. virginiana*) occur on the park; both species occur in abundance in the natural and semi-natural habitats targeted by this monitoring effort; the species can often be difficult to distinguish based on vegetative features; and, finally, no other species within the genus *Juniperus* are known to occur within the park. A taxonomic concept was created—*Juniperus [silicicola + virginiana]*—that combined the two species into a single concept. This 'lumped' taxon is of finer scale taxonomic resolution than if these records had been identified as *Juniperus* sp. Once the final list was determined, each species was cross-referenced with the USDA Plants Database (USDA 2022) to determine growth form, native status, federal/state noxious status, and to provide a unique common name. When a single taxon linked to multiple growth forms, the lead author subjectively chose a single growth form to link with the taxa. The species list was also cross-referenced with the 782 rare plants in Georgia to determine the state and federal conservation status (e.g., Endangered, Threatened, Rarity) of each species (GADNR 2022) and the list of non-native invasive plants in Georgia to determine the degree of invasiveness (GA-EPPC 2022).

Sampling Methodology

The vegetation plot layout for this monitoring effort is based upon the plot design used by the Carolina Vegetation Survey (Peet et al. 1998; Lee et al. 2008) and the Cumberland Piedmont Network (White et al. 2011). The plot array consists of a 20 × 20 meter (65.6 × 65.6 ft) bounded square with multiple nested sampling frames ranging from 1 square meter (10.8 square feet [ft²]) to 400 square meters (4,305.5 ft²), three 25 meters (82.0 ft) fuel transects that cross both inside and outside the bounded square, and three soil sample frames located adjacent to the bounded square (Figure 2).

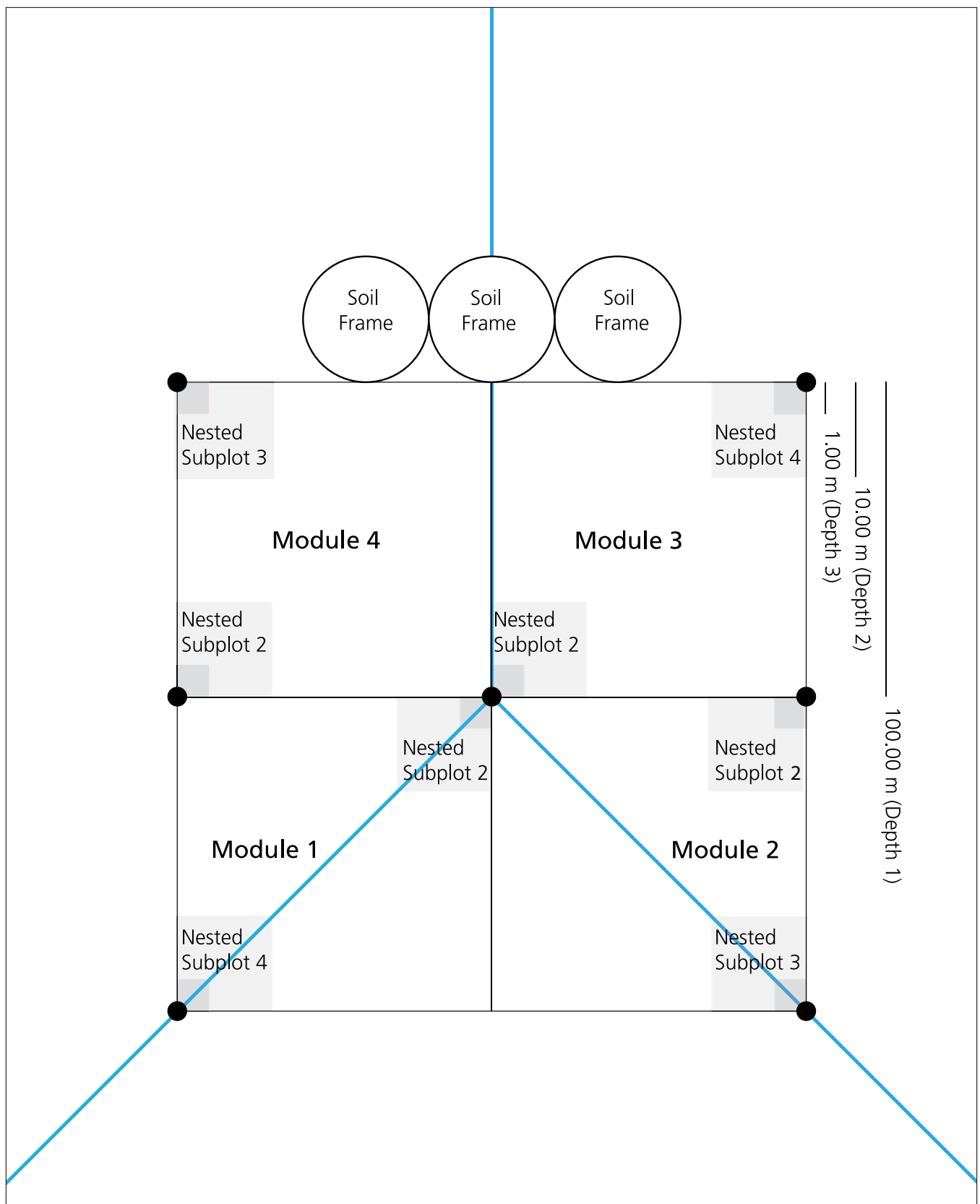


Figure 2. The layout of the sampling plot for the Southeast Coast Network, which is a modified version of the standard Level 5 Carolina Vegetation Survey plot. Ideal locations of rebar used as permanent structures to monument the plot are represented by black shaded circles. Blue lines represent locations of the three 25-meter (82-foot) fuel transects.

Vascular plant species presence was determined at three scales within each of the four 100 square meters (1,076.4 ft²) modules: the 1 square meter (10.8 ft²) nested depth, the 10 square meters (107.6 ft²) nested depth, and the full modular depth. The nested depth ‘quadrats’ were located in two of four corners within each module. For each species either rooted in or overhanging a module, an areal cover value was assigned using the cover class codes developed by the Carolina Vegetation Survey (Peet et al. 1998; Table 1).

Table 1. Vascular plant cover metrics of the Carolina Vegetation Survey (Peet et al. 1998) and used by the SECN terrestrial vegetation monitoring protocol (Boyle et al. 2019).

Cover Class	Cover Range (%)	Geometric Mean
1	0–0.1	0.03
2	0.1–1.0	0.32
3	1.0–2.0	1.41
4	2.0–5.0	3.16
5	5.0–10.0	7.07
6	10.0–25.0	15.81
7	25.0–50.0	35.36
8	50.0–75.0	61.24
9	75.0–95.0	84.41
10	95.0–100.0	97.47

Individual woody stem data were also calculated within each module. For each stem greater than or equal to 10 centimeters (3.9 in; tree) in diameter at 1.4 meters (4.5 ft) linear distance from the ground layer, its species, DBH, and health status was recorded. Within the two 10 square-meter (107.6 ft²) nested depth ‘quadrats’ used for detecting overall species presence (see above), each woody stem that reached 1.4 meters (4.5 ft) in linear distance from the ground layer but was less than 10 centimeters (3.9 in) in diameter at this height (sapling) was identified to species and DBH was determined. Finally, each woody stem less than 1.4 meters (4.5 ft) in linear distance from the ground layer (seedling) was identified to species and

a height class was determined (5–15 centimeters [2–5.9 in]; 15–30 centimeters [5.9–11.8 in]; 30–50 centimeters [11.8–19.7 in]; or 50–137 centimeters [19.7–53.9 in]) within the two 1 square meter (10.8 ft²) nested depth ‘quadrats’ used for detecting overall species presence (see above).

Surface fuels were assessed at each plot site using the planar transect method for the standard fuel size classes (1-hour [0–0.6 cm], 10-hour [0.6–2.5 cm], 100-hour [2.5–7.6 cm], and 1000-hour [> 7.6 cm]), and duff and litter depths (Brown 1974). Counts of each fuel size class were tallied across three fuel transects, with diameter and decay class recorded for each piece of 1000-hour fuel. These field data were incorporated into equations using constant multipliers defined by Brown (1974)—including quadratic mean diameter, nonhorizontal correction factor, specific gravity, and bulk density—to estimate fuel load weight (units = tons/acre) within each plot.

Additional site characteristics were also measured at each plot. Elements taken from the center of each plot included dominant slope, aspect, and terrain shape; basic hydrological condition; and presence and abundance of disturbance indicators. General canopy conditions were assessed, including canopy closure and average height. Closure was measured from the center of each module using a spherical densiometer, and height was taken from three representative trees within (or just outside) the plot. Soil samples were collected from the upper 10 centimeters (0.3 ft) of mineral soil in three sampling frames located adjacent to each vegetation plot. These samples were combined by plot upon return from the field and dried prior to shipping to a soil testing laboratory for standard nutrient analysis. Each plot was qualitatively assigned to one or two National Vegetation Classification (NVC) vegetation association types that best matched the sample site. Finally, two-dimensional photo points were taken with a point and shoot camera at the western and eastern center edge of each plot; a third photo point was made from the plot center using a 360-degree camera.

Results and Discussion

Ninety-one vascular plant species were detected during this monitoring effort (Appendix A), including 19 taxa not detected in previous lists documented in Schmidt (2004), Byrne et al. (2012), or NPSpecies (2022; Table 2). New vascular plant species to Fort Frederica National Monument include one species—small ballmoss (*Tillandsia recurvata*)—tracked on the state of Georgia’s rare plant list (GADNR 2022) and one non-native species—sticky nightshade (*Solanum sisymbriifolium*). Most of the taxa encountered during this monitoring effort are relatively widespread across the Southeastern Coastal Plain. Native richness ranged from 26 to 43 species per plot and at least one non-native plant was encountered in four of the five plots (Table 3). A total of two invasive species listed

as Category 1 or 2 by the Georgia Exotic Pest Plant Council (GA-EPPC 2022) were observed in these monitoring plots. These species included camphortree and Chinese tallow-tree (Appendix A).

In the southeastern Coastal Plain, small-scale vegetation diversity patterns are largely influenced by complex edaphic factors, those factors’ associated relationship with steep environmental gradients (e.g, hydrology and substrate texture), and the variability of timing and impact from disturbance events (e.g., fire; Sorrie and Weakley 2001). What follows is a synopsis of vegetation and environmental data stratified by each of the broadly defined habitats sampled within the park.

Table 2. Vascular plant species, subspecies, or varieties not reported from Schmidt (2004), Byrne et al. (2012), or NPSpecies (2022) but found at Fort Frederica National Monument in 2020 through this current monitoring effort.

Scientific Name	Common Name ¹	Growth Form ¹	Native Status ¹	Global Rank ²	State Rank ² (Georgia)
<i>Acalypha gracilens</i>	slender threeseed mercury	Forb/herb	Native	G5	S5
<i>Anchistea virginica</i>	Virginia chainfern	Forb/herb	Native	G5	SNR
<i>Andropogon ternarius</i>	splitbeard bluestem	Graminoid	Native	G5	S5
<i>Andropogon virginicus</i>	broomsedge bluestem	Graminoid	Native	G5	S5
<i>Asplenium platyneuron</i>	ebony spleenwort	Forb/herb	Native	G5	S5
<i>Convolvulus limnophilus</i>	hedge false bindweed	Forb/herb, Vine	Native	G5	SNR
<i>Dichanthelium laxiflorum</i>	openflower rosette grass	Graminoid	Native	G5	SNR
<i>Dichanthelium portoricense</i>	hemlock rosette grass	Graminoid	Native	G5	SNR
<i>Erechtites hieraciifolius</i>	American burnweed	Forb/herb	Native	G5	SNR
<i>Ilex ambigua</i>	Carolina holly	Tree, Shrub	Native	G5	S4
<i>Melothria pendula</i>	Guadeloupe cucumber	Forb/herb, Vine	Native	G5	S4
<i>Osmunda spectabilis</i>	royal fern	Forb/herb	Native	G5	SNR
<i>Paspalum setaceum</i>	thin paspalum	Graminoid	Native	G5	S5
<i>Pinus elliottii</i>	slash pine	Tree	Native	G5	SNR
<i>Smallanthus uvedalia</i>	hairy leafcup	Forb/herb	Native	G4	SNR
<i>Smilax hispida</i>	bristly greenbrier	Shrub, Vine	Native	G5	SNR
<i>Solanum sisymbriifolium</i>	sticky nightshade	Forb/herb	Non-native	SNR	SNR
<i>Tillandsia recurvata</i>	small ballmoss	Forb/herb	Native	G5	S1
<i>Zanthoxylum clava-herculis</i>	Hercules's club	Shrub, Tree	Native	G4	S3

¹ Information obtained from the PLANTS database (USDA 2022)

² Conservation Status (G4/S4: Apparently Secure; G5: Secure; SNR: Not Yet Accessed) obtained from NatureServe Explorer 2.0 (NatureServe 2022)

Table 3. Vascular plant species richness across multiple spatial scales on Southeast Coast Network vegetation plots located within Fort Frederica National Monument. The data are summarized by total number of native versus non-native species/plot, and by vegetative growth forms (T: tree, S: shrub, V: vine, H: herbs/forbs, G: graminoids). Growth form information was obtained from the USDA Plants Database (USDA 2022).

Broadly Defined Habitat	Plot	Native ¹	Non-native ¹	Unknown ¹	T ¹	S ¹	V ¹	H ¹	G ¹	T ²	S ²	V ²	H ²	G ²	T ³	S ³	V ³	H ³	G ³	T ⁴	S ⁴	V ⁴	H ⁴	G ⁴
Maritime Upland Forests and Shrublands	FOFR001	37.0	2.0	0.0	11.0	3.0	5.0	13.0	7.0	6.5	2.8	3.0	6.3	4.8	4.5	1.1	2.0	2.3	1.9	2.6	0.4	1.4	0.8	1.0
	FOFR002	43.0	2.0	3.0	10.0	6.0	8.0	18.0	6.0	7.0	3.0	5.5	9.3	4.3	2.6	2.1	3.1	3.3	1.5	1.0	0.8	2.3	2.1	0.9
	FOFR003	36.0	1.0	1.0	12.0	8.0	4.0	9.0	5.0	8.8	4.0	4.0	5.0	2.5	4.6	2.6	1.9	1.6	0.6	2.8	1.9	1.0	0.5	0.0
	FOFR005	26.0	0.0	1.0	10.0	5.0	6.0	5.0	1.0	6.0	3.8	4.0	3.0	0.3	3.0	2.0	2.3	1.6	0.1	1.5	1.3	1.3	1.0	0.0
	FOFR006	38.0	1.0	0.0	11.0	5.0	9.0	10.0	4.0	7.0	3.8	6.3	5.3	2.3	3.9	2.6	4.5	2.4	1.4	1.4	1.4	2.9	1.6	1.1
	average	36.0	1.2	1.0	10.8	5.4	6.4	11.0	4.6	7.1	3.5	4.6	5.8	2.8	3.7	2.1	2.8	2.2	1.1	1.9	1.1	1.8	1.2	0.6
	standard deviation	6.2	0.8	1.2	0.8	1.8	2.1	4.8	2.3	1.0	0.5	1.3	2.3	1.8	0.9	0.6	1.1	0.7	0.7	0.8	0.6	0.8	0.7	0.6

¹ Total species richness at the full plot (400 square meters [4,305.6 ft²]) depth

² Mean species richness at the modular (100 square meters [1,076.3 ft²]) depth

³ Mean species richness at the nested 10 square meters (107.6 ft²) depth

⁴ Mean species richness at the nested 1 square meter (10.8 ft²) depth

Maritime Upland Forests and Shrublands

Maritime Upland Forests and Shrublands of the South Atlantic outer Coastal Plain are located on stabilized dunes of barrier islands and ridges and bluffs of mainland settings adjacent to the coast (Figure 3). These upland communities are typically protected from tidal inundation, but occasionally can flood during strong storm surge. More persistent natural disturbances include aerosol salt spray, strong winds, and sandy, low productive soils. These conditions are more pronounced on the forest edges of Maritime Upland Forests and Shrublands, where they border ocean and dune habitat or salt marsh habitat. Across Georgia's coast, forests dominated by large diameter live oaks represent the later stages of succession within upland maritime ecosystems (Zomlefer et al. 2008). However, due to widespread logging and land clearing for agriculture across the island over the past 200 years, many of Fort Frederica National Monument's maritime forests represent early- to middle-aged secondary successional stage classes (Bratton 1985). Representative canopy species in these younger forests include Darlington oak (*Quercus hemisphaerica*), and a mixture of pines (e.g., loblolly and slash pine). Vegetation associations sampled in Fort Frederica

National Monument that belong to this broadly defined habitat type include (descriptions from NatureServe 2022):

- Atlantic Coastal Plain Swamp Island Forest (CEGL007022; 2 plots): Coastal evergreen forests occurring in fire-sheltered topographic settings (e.g., swamp islands) and dominated by a combination of Darlington oak and loblolly pine. (Global Status: G2—Imperiled; State [GA] Status: No Status Rank)
- Maritime Live Oak Hammock (CEGL007032; 2 plots): This association occurs on barrier islands and has a low to moderately tall tree canopy that is often pruned by salt spray. The soils of these sites are sandy, low in fertility, and low in organic matter content. (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- Ruderal Loblolly Pine-Oak-Sweetgum Forest (CEGL008450; 1 plot): This early-to-mid successional evergreen forest is dominated by loblolly pine, with a mixture of hardwoods (e.g., oaks and sweetgum [*Liquidambar styraciflua*]); these forests typically occur on sandy loam soils. (Global Status: No Status Rank; State (GA) Status: No Status Rank)



Figure 3. Five Maritime Upland Forest and Shrubland sites were sampled during this monitoring effort within Fort Frederica National Monument. NPS photo / SECN staff.

Species Diversity and Abundance

Native species richness ranged from 26 to 43 (mean = 36.0) within vegetation plots of this broadly defined habitat type in Fort Frederica National Monument (Table 3). Trees represented the most diverse growth form across all nested spatial scales, while herbaceous species represented the most diverse growth form at the full plot scale (Table 3). Four of the five Maritime Upland Forest and Shrubland plots contained at least one non-native species (Table 3), including the invasive Chinese tallow-tree in FOFR001 and camphortree in FOFR001, FOFR002, FOFR003, and FOFR006. A complete species list, along with constancy and average cover per species, is located in Appendix B, Table B-1. Species with high constancy in this habitat are listed below, by growth form:

Trees

- Darlington oak (100%)
- Redbay (*Persea borbonia*; 100%)
- Live oak (100%)
- Cabbage palmetto (*Sabal palmetto*; 100%)

Shrubs

- Yaupon (*Ilex vomitoria*) (100%)
- Wax myrtle (*Morella cerifera*; 100%)
- Aloe yucca (*Yucca aloifolia*; 60%)

Vines

- Muscadine (*Muscadinia rotundifolia* var. *rotundifolia*; 100%)
- Virginia creeper (*Parthenocissus quinquefolia*; 100%)

Herbs/Forbs/Graminoids

- Spanish moss (*Tillandsia usneoides*; 100%)
- Basketgrass (*Oplismenus setarius*; 80%)

- Southern dewberry (*Rubus trivialis*; 80%)
- Variable panicgrass (*Dichanthelium commutatum*; 80%)
- Resurrection fern (*Pleopeltis michauxiana*; 80%)

Woody Stem Metrics

Total basal area (BA) of trees ranged from 23.4 to 53.9 m²/ha with an overall average of 43.9 m²/ha; density of canopy stems ranged from eight to 25 per plot, with an average of 14.0 (Table 4). Canopy height was similar among these sites, ranging from 28 to 32 meters (average 29.7), and canopy cover ranged from 52 to 88% (average = 67.8%; Table 4). The most dominant canopy species was loblolly pine (mean BA = 21.94 m²/ha, mean density = 95/ha), while other canopy species included live oak (mean BA = 6.04 m²/ha, mean density = 10/ha), sweetgum (mean BA = 5.71 m²/ha, mean density = 70/ha), and Darlington oak (mean BA = 5.29 m²/ha, mean density = 120/ha). The full list of woody stem metrics by species is in Appendix B, Table B-2. Sapling density at the 80 square meter scale ranged from 18 to 134 stems, with an average of 56.0, while seedling density at the 8 meter square scale ranged from 98 to 161 stems, with an average of 130.0 across all plots (Table 4). Dominant sapling species included yaupon, inkberry (*Ilex glabra*), and redbay; dominant seedlings included yaupon, Darlington oak, saw greenbrier (*Smilax bona-nox*), and sweetgum (Appendix B, Table B-2).

Based on stem count alone, Darlington and water (*Quercus nigra*) oak comprised nearly 40% of the relative abundance among species within the tree stratum, while pines comprised 26% (Figure 4). The sapling and seedling strata were both dominated by yaupon (Figure 4). Of the 92 trees measured within these vegetation plots, 78 (85%) were living (Figure 5). No single species dominated the trees that were identified as dead. The majority of trees were categorized with healthy vigor and minimal (< 10%) dieback (Figure 5).

Table 4. Woody stem abundance and canopy metrics on Southeast Coast Network vegetation plots located in Fort Frederica National Monument [m—meters; ha—hectares].

Broadly Defined Habitat	Plot	Tree Basal Area (m ² /ha)	Tree Density (400 m ²)	Sapling Basal Area (m ² /ha)	Sapling Density (80 m ²)	Seedling Density (8 m ²)	Mean Canopy Cover (%)	Mean Height (m)
Maritime Upland Forests and Shrublands	FOFR001	23.4	8.0	0.6	18.0	98.0	52.0	31.0
	FOFR002	44.5	9.0	1.9	49.0	106.0	57.0	28.0
	FOFR003	48.5	14.0	3.6	134.0	161.0	75.0	28.0
	FOFR005	59.2	25.0	1.6	23.0	146.0	88.0	32.0
	FOFR006	53.9	22.0	3.4	57.0	139.0	76.0	32.0
	average	43.9	14.0	1.9	56.0	130.0	67.8	29.7
	standard deviation	15.0	7.8	1.3	53.7	30.5	16.7	1.8

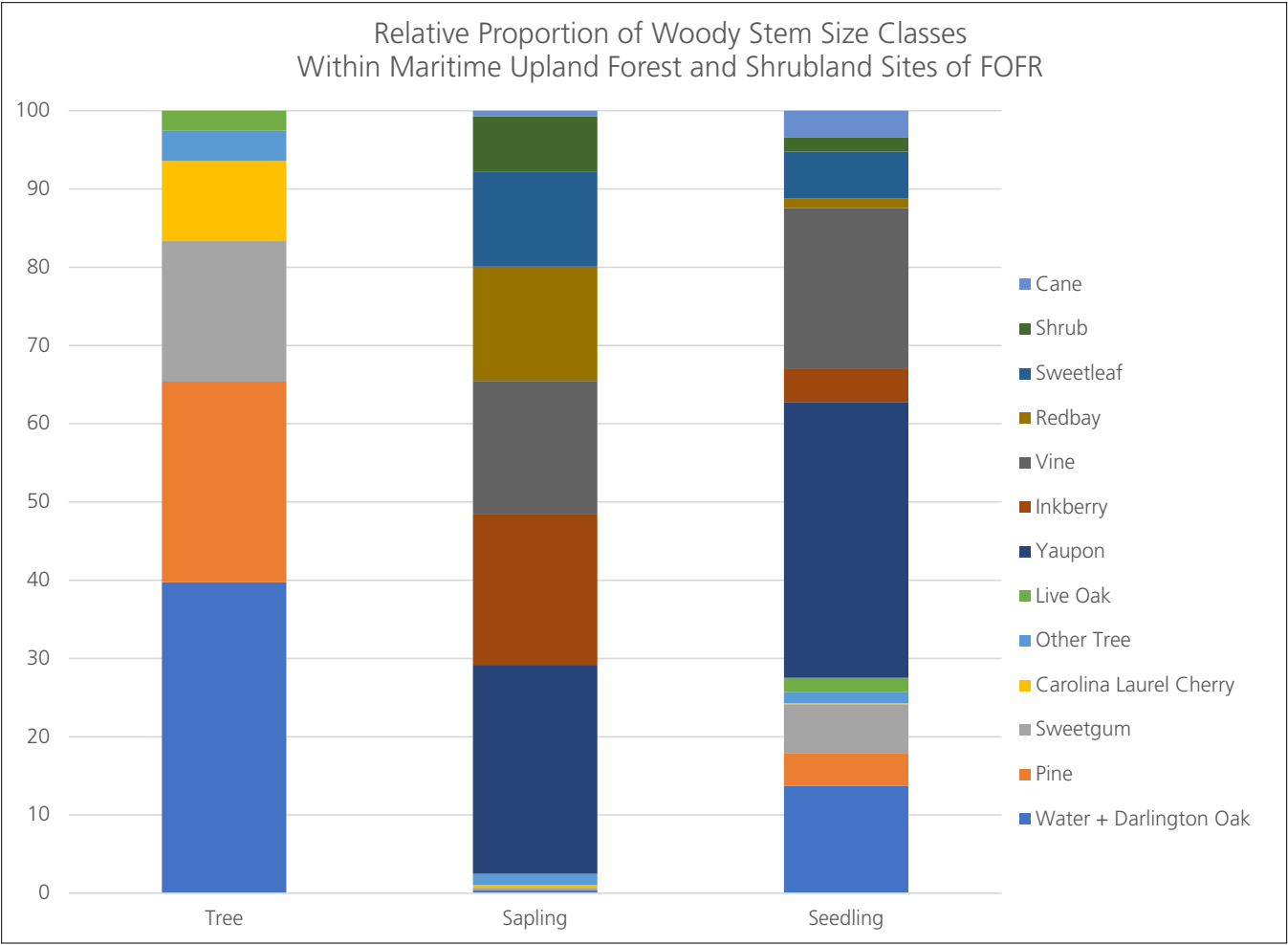


Figure 4. Relative proportion of species groups across three woody stem strata—trees, saplings, and seedlings— within Maritime Upland Forest and Shrubland vegetation monitoring plots of Fort Frederica National Monument.

Health Condition of Trees Observed at Maritime Upland Forests and Shrublands of FOFR

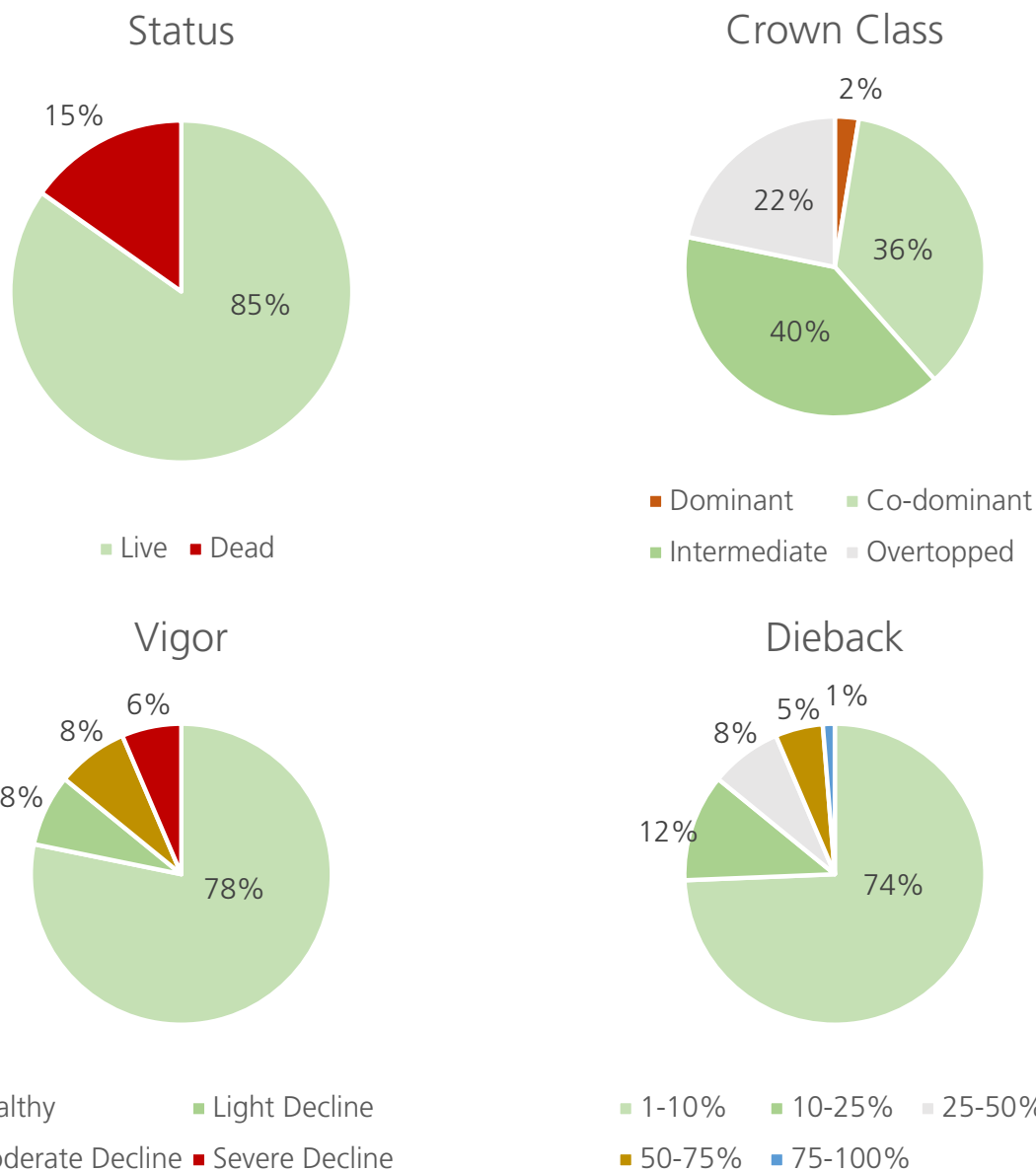


Figure 5. Health status of woody stems greater than or equal to 10 centimeters (3.9 in) DBH ('trees') measured on Maritime Upland Forests and Shrubland vegetation monitoring plots of Fort Frederica National Monument.

Disturbance and Threats

The most frequent and noticeable disturbance type affecting this habitat type was associated with windthrow; this is not an uncommon natural disturbance event in these ecosystems

(Table 5). Other disturbances observed across these five plots reflect the impact of cultural factors (e.g., evidence of homesites) on Fort Frederica's forest communities.

Table 5. Disturbance observations and abundance (% cover) measured on vegetation monitoring plots in Fort Frederica National Monument.

Broadly Defined Habitat	Plot	Homesite Evidence	Logging Evidence	Plowing Evidence	Trash	Windthrow
Maritime Upland Forests and Shrublands	FOFR001	–	80	–	–	100
	FOFR002	100	–	–	10	60
	FOFR003	–	–	20	–	60
	FOFR005	100	–	–	–	20
	FOFR006	–	–	–	–	60

Geomorphology and Soil

Plots located within Maritime Upland Forests and Shrublands within Fort Frederica National Monument occurred on landforms with flat slopes and none of the sites sampled were submerged (Table 6). Although classified as uplands, these

forests can occasionally flood during extreme storm events. Upland Forest and Shrubland soils within the park ranged from strongly to slightly acidic and had highly variable organic matter content (Table 7).

Table 6. Local landform and hydrologic condition from vegetation monitoring plots at Fort Frederica National Monument.

Broadly Defined Habitat	Plot	Slope (°)	Aspect (°)	TSI ¹ (°)	Landform Type	Water Source	Submerged (%)
Maritime Upland Forests and Shrublands	FOFR001	0	–	0	flat plain	None	0
	FOFR002	0	–	0	flat plain	None	0
	FOFR003	0	–	0	flat plain	None	0
	FOFR005	0	–	0	flat plain	None	0
	FOFR006	0	–	0	flat plain	None	0

¹ Terrain Shape Index: the larger the value, the higher degree of microsite concavity; the lower the value, the higher degree of microsite convexity; "0" values indicate a completely flat shape.

Table 7. Soil nutrient status from vegetation monitoring plots at Fort Frederica National Monument. The Mehlich III method was used to obtain volume of exchangeable cations and extractable minor elements within soil samples. Methods to obtain other soil chemistry metrics (e.g., total exchange capacity [TEC], pH, and organic matter content [OM]) can be found at [Brookside Laboratories, Inc](#) (BL 2022).

Broadly Defined Habitat	Plot	TEC (ME/100g)	pH H ₂ O 1:1	OM (%)	P ¹	Ca ¹	Mg ¹	K ¹	Na ¹	B ¹	Fe ¹	Mn ¹	Cu ¹	Zn ¹	Al ¹
Maritime Upland Forests and Shrublands	FOFR001	3.50	5.50	3.10	159.00	333.00	49.00	28.00	16.00	0.22	98.00	13.00	0.29	0.50	1590.00
	FOFR002	13.60	6.40	5.80	119.00	2045.00	160.00	33.00	20.00	0.43	69.00	8.00	0.43	5.82	1102.00
	FOFR003	13.00	4.00	25.60	16.00	441.00	112.00	31.00	25.00	< 0.20	28.00	2.00	< 0.20	3.63	227.00
	FOFR005	7.90	4.80	6.90	44.00	507.00	83.00	28.00	26.00	0.26	208.00	5.00	0.63	5.15	618.00
	FOFR006	8.60	4.60	8.20	94.00	482.00	85.00	37.00	29.00	0.29	143.00	10.00	0.25	1.38	944.00
	average	9.32	5.06	9.93	86.40	761.60	97.80	31.40	23.20	0.30	109.20	7.60	0.40	3.30	896.20
	standard deviation	4.15	0.92	8.98	57.33	720.52	41.34	3.78	5.17	0.09	69.35	4.28	0.17	2.31	512.65

¹Anions (P: Phosphorous); Exchangeable Cations (Ca: Calcium, Mg: Magnesium, K: Potassium, Na: Sodium); Extractable Minors (B: Boron, Fe: Iron, Mn: Manganese, Cu: Copper, Zn: Zinc, Al: Aluminum). Data reported in parts per million (ppm).

Fuel Load Estimates

Most fuel loads ranged from 20.1 to 27.1 tons/acre (4.5 to 6.1 kg/m²) within the park; however fuel loads were extremely high (69.7 tons/acre [15.6 kg/m²]) within one plot (FOFR006) on the park's north end (Figure 6). Variation in fuel loads among sites is typical and related to differences in live and dead vegetation structure, disturbance history, hydrology, and edaphic conditions.

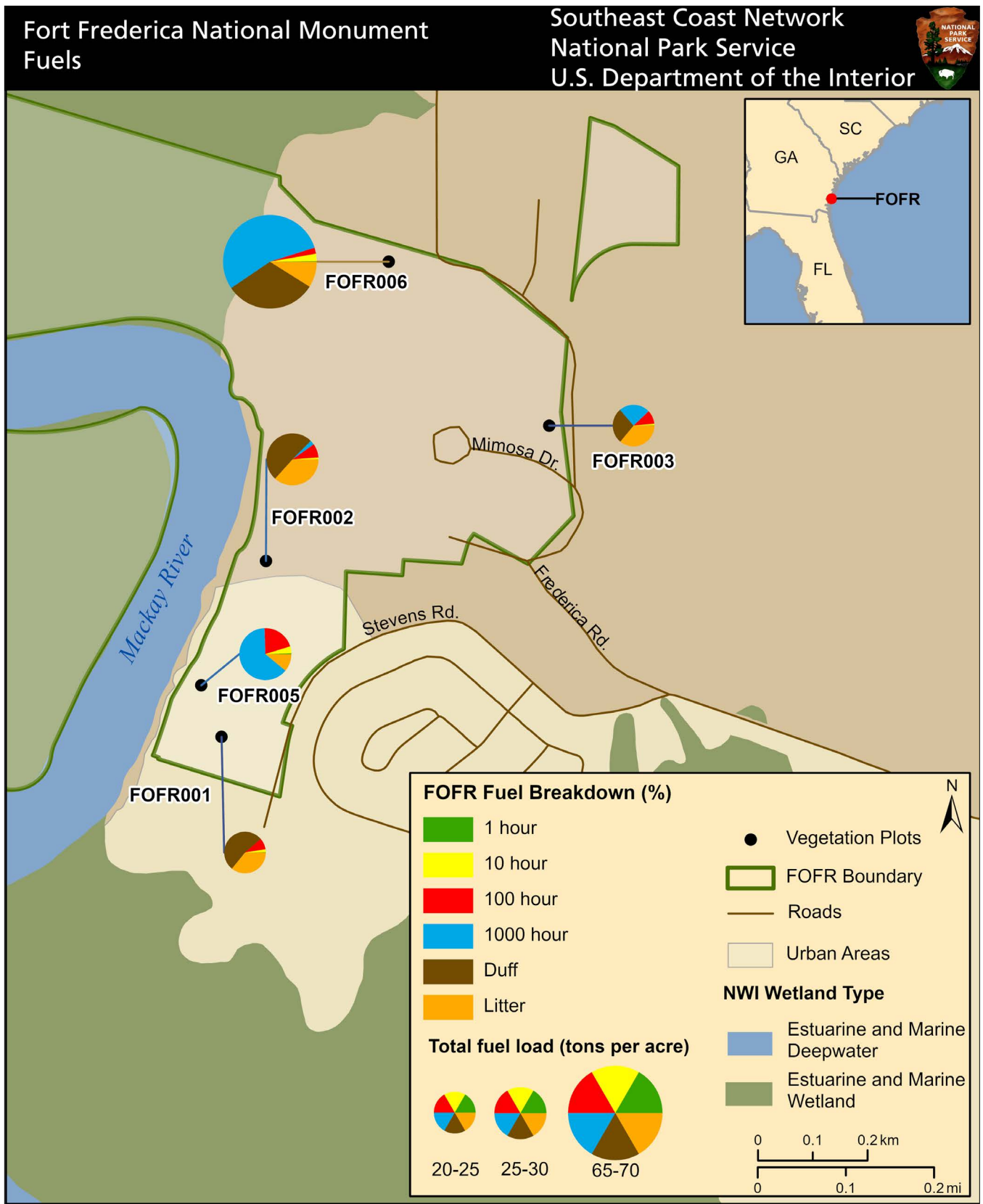


Figure 6. Fuel load estimates from vegetation monitoring plots located at Fort Frederica National Monument.

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Appendix A. Vascular Plants Observed During the 2020 Southeast Coast Network Terrestrial Vegetation Monitoring Effort at Fort Frederica National Monument

Table A-1. Vascular plant species present in five vegetation monitoring plots within Fort Frederica National Monument, August–September 2020.

Order ¹	Family ¹	Scientific Name	Common Name ¹	Native Status ¹	Growth Form ¹	State Invasive Status ²	Georgia Rare - Protected Status ³
Euphorbiales	Euphorbiaceae	<i>Acalypha gracilens</i>	slender threeseed mercury	Native	Forb/herb	–	–
Sapindales	Aceraceae	<i>Acer rubrum</i>	red maple	Native	Tree	–	–
Polypodiales	Blechnaceae	<i>Anchistea virginica</i>	Virginia chainfern	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Andropogon ternarius</i>	splitbeard bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon virginicus</i>	broomsedge bluestem	Native	Graminoid	–	–
Arales	Araceae	<i>Arisaema dracontium</i>	green dragon	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Arundinaria gigantea</i>	giant cane	Native	Graminoid, Shrub, Subshrub	–	–
Magnoliales	Annonaceae	<i>Asimina parviflora</i>	smallflower pawpaw	Native	Tree, Shrub	–	–
Polypodiales	Aspleniaceae	<i>Asplenium platyneuron</i>	ebony spleenwort	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Asteraceae</i>	Aster Family	Unknown	Forb/herb	–	–
Asterales	Asteraceae	<i>Bidens bipinnata</i>	Spanish needles	Native	Forb/herb	–	–
Scrophulariales	Bignoniaceae	<i>Bignonia capreolata</i>	crossvine	Native	Vine	–	–
Lamiales	Verbenaceae	<i>Callicarpa americana</i>	American beautyberry	Native	Shrub	–	–
Laurales	Lauraceae	<i>Camphora officinarum</i>	camphortree	Non-native	Tree	Category 2	–
Juglandales	Juglandaceae	<i>Carya glabra</i>	pignut hickory	Native	Tree	–	–
Cyperales	Poaceae	<i>Chasmanthium laxum</i>	slender woodoats	Native	Graminoid	–	–
Euphorbiales	Euphorbiaceae	<i>Cnidoscolus stimulosus</i>	finger rot	Native	Forb/herb	–	–
Solanales	Convolvulaceae	<i>Convolvulus limnophilus</i>	hedge false bindweed	Native	Forb/herb, Vine	–	–
Cyperales	Cyperaceae	<i>Cyperus</i>	flatsedge	Unknown	Graminoid	–	–
Cyperales	Cyperaceae	<i>Cyperus retrorsus</i>	pine barren flatsedge	Native	Graminoid	–	–
Fabales	Fabaceae	<i>Desmodium</i>	ticktrefoil	Unknown	Forb/herb, Vine	–	–
Fabales	Fabaceae	<i>Desmodium tenuifolium</i>	slimleaf ticktrefoil	Native	Forb/herb, Vine	–	–
Cyperales	Poaceae	<i>Dichanthelium commutatum</i>	variable panicgrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium laxiflorum</i>	openflower rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium portoricense</i>	hemlock rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium strigosum</i> var. <i>leucoblepharis</i>	roughhair rosette grass	Native	Graminoid	–	–
Asterales	Asteraceae	<i>Elephantopus nudatus</i>	smooth elephantsfoot	Native	Forb/herb	–	–

¹ Information obtained from the PLANTS database (USDA 2022)² Information obtained from the Georgia Exotic Pest Plant Council (GA-EPPC 2022)³ Information obtained from the Georgia Department of Natural Resources (GA DNR 2022)

Table A-1 (continued). Vascular plant species present in five vegetation monitoring plots within Fort Frederica National Monument, August–September 2020.

Order ¹	Family ¹	Scientific Name	Common Name ¹	Native Status ¹	Growth Form ¹	State Invasive Status ²	Georgia Rare - Protected Status ³
Asterales	Asteraceae	<i>Erechtites hieraciifolius</i>	American burnweed	Native	Forb/herb	–	–
Fabales	Fabaceae	<i>Erythrina herbacea</i>	redcardinal	Native	Shrub, Subshrub, Tree	–	–
Asterales	Asteraceae	<i>Eupatorium capillifolium</i>	dogfennel	Native	Forb/herb	–	–
Rubiales	Rubiaceae	<i>Galium bermudense</i>	coastal bedstraw	Native	Forb/herb	–	–
Rubiales	Rubiaceae	<i>Galium obtusum</i>	bluntleaf bedstraw	Native	Forb/herb	–	–
Gentianales	Loganiaceae	<i>Gelsemium sempervirens</i>	evening trumpetflower	Native	Vine, Shrub	–	–
Rubiales	Rubiaceae	<i>Houstonia procumbens</i>	roundleaf bluet	Native	Forb/herb	–	–
Theales	Clusiaceae	<i>Hypericum hypericoides</i>	St. Andrew's cross	Native	Shrub, Subshrub	–	–
Celastrales	Aquifoliaceae	<i>Ilex ambigua</i>	Carolina holly	Native	Tree, Shrub	–	–
Celastrales	Aquifoliaceae	<i>Ilex glabra</i>	inkberry	Native	Shrub	–	–
Celastrales	Aquifoliaceae	<i>Ilex opaca</i>	American holly	Native	Tree, Shrub	–	–
Celastrales	Aquifoliaceae	<i>Ilex vomitoria</i>	yaupon	Native	Tree, Shrub	–	–
Rosales	Grossulariaceae	<i>Itea virginica</i>	Virginia sweetspire	Native	Shrub	–	–
Pinales	Cupressaceae	<i>Juniperus [silicicola + virginiana]</i>	eastern redcedar	Native	Tree	–	–
Hamamelidales	Hamamelidaceae	<i>Liquidambar styraciflua</i>	sweetgum	Native	Tree	–	–
Polypodiales	Blechnaceae	<i>Lorinseria areolata</i>	netted chainfern	Native	Forb/herb	–	–
Magnoliales	Magnoliaceae	<i>Magnolia grandiflora</i>	southern magnolia	Native	Vine, Shrub	–	–
Violales	Cucurbitaceae	<i>Melothria pendula</i>	Guadeloupe cucumber	Native	Forb/herb, Vine	–	–
Myricales	Myricaceae	<i>Morella cerifera</i>	wax myrtle	Native	Tree, Subshrub, Shrub	–	–
Rhamnales	Vitaceae	<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	muscadine	Native	Vine	–	–
Cornales	Cornaceae	<i>Nyssa sylvatica</i>	blackgum	Native	Tree	–	–
Cyperales	Poaceae	<i>Oplismenus setarius</i>	basketgrass	Native	Graminoid	–	–
Polypodiales	Osmundaceae	<i>Osmunda spectabilis</i>	royal fern	Native	Forb/herb	–	–
Polypodiales	Osmundaceae	<i>Osmundastrum cinnamomeum</i>	cinnamon fern	Native	Forb/herb	–	–
Geraniales	Oxalidaceae	<i>Oxalis dillenii</i>	slender yellow woodsorrel	Native	Forb/herb	–	–
Geraniales	Oxalidaceae	<i>Oxalis violacea</i>	violet woodsorrel	Native	Forb/herb	–	–
Rhamnales	Vitaceae	<i>Parthenocissus quinquefolia</i>	Virginia creeper	Native	Vine	–	–
Cyperales	Poaceae	<i>Paspalum laeve</i>	field paspalum	Native	Graminoid	–	–

¹ Information obtained from the PLANTS database (USDA 2022)² Information obtained from the Georgia Exotic Pest Plant Council (GA-EPPC 2022)³ Information obtained from the Georgia Department of Natural Resources (GA DNR 2022)

Table A-1 (continued). Vascular plant species present in five vegetation monitoring plots within Fort Frederica National Monument, August–September 2020.

Order ¹	Family ¹	Scientific Name	Common Name ¹	Native Status ¹	Growth Form ¹	State Invasive Status ²	Georgia Rare - Protected Status ³
Cyperales	Poaceae	<i>Paspalum setaceum</i>	thin paspalum	Native	Graminoid	–	–
Violales	Passifloraceae	<i>Passiflora incarnata</i>	purple passionflower	Native	Forb/herb, Vine	–	–
Laurales	Lauraceae	<i>Persea borbonia</i>	redbay	Native	Tree, Shrub	–	–
Caryophyllales	Phytolaccaceae	<i>Phytolacca americana</i>	American pokeweed	Native	Forb/herb	–	–
Pinales	Pinaceae	<i>Pinus elliottii</i>	slash pine	Native	Tree	–	–
Pinales	Pinaceae	<i>Pinus taeda</i>	loblolly pine	Native	Tree	–	–
Cyperales	Poaceae	<i>Piptochaetium avenaceum</i>	blackseed speargrass	Native	Graminoid	–	–
Polypodiales	Polypodiaceae	<i>Pleopeltis michauxiana</i>	resurrection fern	Native	Forb/herb	–	–
Scrophulariales	Buddlejaceae	<i>Polypremum procumbens</i>	juniper leaf	Native	Forb/herb	–	–
Rosales	Rosaceae	<i>Prunus caroliniana</i>	Carolina laurelcherry	Native	Shrub, Tree	–	–
Polypodiales	Dennstaedtiaceae	<i>Pteridium pseudocaudatum</i>	western brackenfern	Native	Forb/herb	–	–
Fagales	Fagaceae	<i>Quercus hemisphaerica</i>	Darlington oak	Native	Tree	–	–
Fagales	Fagaceae	<i>Quercus nigra</i>	water oak	Native	Tree	–	–
Fagales	Fagaceae	<i>Quercus virginiana</i>	live oak	Native	Tree	–	–
Rosales	Rosaceae	<i>Rubus trivialis</i>	southern dewberry	Native	Subshrub, Vine	–	–
Arecales	Arecaceae	<i>Sabal palmetto</i>	cabbage palmetto	Native	Tree	–	–
Apiales	Apiaceae	<i>Sanicula canadensis</i>	Canadian blacksnakeroot	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Smallanthus uvedalia</i>	hairy leafcup	Native	Forb/herb	–	–
Liliales	Smilacaceae	<i>Smilax auriculata</i>	saw greenbrier	Native	Shrub, Vine	–	–
Liliales	Smilacaceae	<i>Smilax bona-nox</i>	saw greenbrier	Native	Shrub, Vine	–	–
Liliales	Smilacaceae	<i>Smilax glauca</i>	cat greenbrier	Native	Shrub, Vine	–	–
Liliales	Smilacaceae	<i>Smilax hispida</i>	bristly greenbrier	Native	Shrub, Vine	–	–
Solanales	Solanaceae	<i>Solanum sisymbriifolium</i>	sticky nightshade	Non-native	Forb/herb	–	–
Asterales	Asteraceae	<i>Solidago odora</i>	anisescented goldenrod	Native	Forb/herb	–	–
Lamiales	Lamiaceae	<i>Stachys floridana</i>	Florida hedgenettle	Native	Forb/herb	–	–
Ebenales	Symplocaceae	<i>Symplocos tinctoria</i>	common sweetleaf	Native	Shrub, Tree	–	–
Bromeliales	Bromeliaceae	<i>Tillandsia recurvata</i>	small ballmoss	Native	Forb/herb	–	S1
Bromeliales	Bromeliaceae	<i>Tillandsia usneoides</i>	Spanish moss	Native	Vine, Forb/herb	–	–

¹ Information obtained from the PLANTS database (USDA 2022)² Information obtained from the Georgia Exotic Pest Plant Council (GA-EPPC 2022)³ Information obtained from the Georgia Department of Natural Resources (GA DNR 2022)

Table A-1 (continued). Vascular plant species present in five vegetation monitoring plots within Fort Frederica National Monument, August–September 2020.

Order ¹	Family ¹	Scientific Name	Common Name ¹	Native Status ¹	Growth Form ¹	State Invasive Status ²	Georgia Rare - Protected Status ³
Sapindales	Anacardiaceae	<i>Toxicodendron radicans</i> var. <i>radicans</i>	eastern poison ivy	Native	Shrub, Subshrub, Vine	–	–
Euphorbiales	Euphorbiaceae	<i>Triadica sebifera</i>	Chinese tallow	Non-native	Tree	Category 1	–
Ericales	Ericaceae	<i>Vaccinium arboreum</i>	farkleberry	Native	Tree, Shrub	–	–
Ericales	Ericaceae	<i>Vaccinium elliotii</i>	Elliott's blueberry	Native	Shrub	–	–
Ericales	Ericaceae	<i>Vaccinium fuscatum</i>	black highbush blueberry	Native	Shrub	–	–
Fabales	Fabaceae	<i>Vicia</i>	vetch	Unknown	Forb/herb	–	–
Rhamnales	Vitaceae	<i>Vitis aestivalis</i> var. <i>aestivalis</i>	summer grape	Native	Vine	–	–
Sapindales	Rutaceae	<i>Zanthoxylum clava-herculis</i>	Hercules's club	Native	Shrub, Tree	–	–

¹ Information obtained from the PLANTS database (USDA 2022)

² Information obtained from the Georgia Exotic Pest Plant Council (GA-EPPC 2022)

³ Information obtained from the Georgia Department of Natural Resources (GA DNR 2022)

Appendix B. Species Diversity, Abundance, and Woody Stem Metrics Summarized by Broadly Defined Habitats of Fort Frederica National Monument

Table B-1. Constancy and average cover class for all vascular plant species observed in five Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: MUFS = Maritime Upland Forests and Shrublands (five plots). Cover classes are as follows: 1: 0–0.1%, 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: 95–100%.

Species	MUFS Constancy	MUFS Cover
<i>Ilex vomitoria</i>	100	6
<i>Quercus hemisphaerica</i>	100	6
<i>Morella cerifera</i>	100	4
<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	100	4
<i>Persea borbonia</i>	100	4
<i>Quercus virginiana</i>	100	4
<i>Tillandsia usneoides</i>	100	4
<i>Sabal palmetto</i>	100	3
<i>Parthenocissus quinquefolia</i>	100	2
<i>Pinus taeda</i>	80	6
<i>Prunus caroliniana</i>	80	4
<i>Oplismenus setarius</i>	80	3
<i>Rubus trivialis</i>	80	3
<i>Callicarpa americana</i>	80	2
<i>Dichanthelium commutatum</i>	80	2
<i>Ilex opaca</i>	80	2
<i>Pleopeltis michauxiana</i>	80	2
<i>Smilax auriculata</i>	80	2
<i>Smilax bona-nox</i>	80	2
<i>Toxicodendron radicans</i> var. <i>radicans</i>	80	2
<i>Camphora officinarum</i>	80	1
<i>Quercus nigra</i>	60	5
<i>Cnidoscolus stimulosus</i>	60	2
<i>Cyperus retrorsus</i>	60	2
<i>Erechtites hieraciifolius</i>	60	2
<i>Eupatorium capillifolium</i>	60	2
<i>Itea virginica</i>	60	2
<i>Vitis aestivalis</i> var. <i>aestivalis</i>	60	2
<i>Liquidambar styraciflua</i>	40	6
<i>Arundinaria gigantea</i>	40	5
<i>Magnolia grandiflora</i>	40	5
<i>Symplocos tinctoria</i>	40	5
<i>Carya glabra</i>	40	4
<i>Chasmanthium laxum</i>	40	2
<i>Dichanthelium portoricense</i>	40	2
<i>Elephantopus nudatus</i>	40	2
<i>Erythrina herbacea</i>	40	2

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in five Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: MUFS = Maritime Upland Forests and Shrublands (five plots). Cover classes are as follows: 1: 0–0.1%, 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: 95–100%.

Species	MUFS Constancy	MUFS Cover
<i>Juniperus [silicicola + virginiana]</i>	40	2
<i>Osmundastrum cinnamomeum</i>	40	2
<i>Phytolacca americana</i>	40	2
<i>Desmodium</i>	40	1
<i>Smallanthus uvedalia</i>	40	1
<i>Ilex glabra</i>	20	6
<i>Pinus elliotii</i>	20	5
<i>Melothria pendula</i>	20	4
<i>Pteridium pseudocaudatum</i>	20	3
<i>Acalypha gracilens</i>	20	2
<i>Acer rubrum</i>	20	2
<i>Andropogon ternarius</i>	20	2
<i>Andropogon virginicus</i>	20	2
<i>Arisaema dracontium</i>	20	2
<i>Asplenium platyneuron</i>	20	2
<i>Bignonia capreolata</i>	20	2
<i>Cyperus</i>	20	2
<i>Dichanthelium strigosum</i> var. <i>leucoblepharis</i>	20	2
<i>Galium bermudense</i>	20	2
<i>Galium obtusum</i>	20	2
<i>Gelsemium sempervirens</i>	20	2
<i>Houstonia procumbens</i>	20	2
<i>Lorinseria areolata</i>	20	2
<i>Nyssa sylvatica</i>	20	2
<i>Osmunda spectabilis</i>	20	2
<i>Passiflora incarnata</i>	20	2
<i>Smilax glauca</i>	20	2
<i>Smilax hispida</i>	20	2
<i>Solidago odora</i>	20	2
<i>Vaccinium arboreum</i>	20	2
<i>Vaccinium fuscatum</i>	20	2
<i>Anchistea virginica</i>	20	1
<i>Asimina parviflora</i>	20	1
<i>Asteraceae</i>	20	1
<i>Bidens bipinnata</i>	20	1
<i>Convolvulus limnophilus</i>	20	1
<i>Desmodium tenuifolium</i>	20	1
<i>Dichanthelium laxiflorum</i>	20	1
<i>Hypericum hypericoides</i>	20	1
<i>Ilex ambigua</i>	20	1
<i>Oxalis dillenii</i>	20	1

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in five Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: MUFS = Maritime Upland Forests and Shrublands (five plots). Cover classes are as follows: 1: 0–0.1%, 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: 95–100%.

Species	MUFS Constancy	MUFS Cover
<i>Oxalis violacea</i>	20	1
<i>Paspalum laeve</i>	20	1
<i>Paspalum setaceum</i>	20	1
<i>Piptochaetium avenaceum</i>	20	1
<i>Polypremum procumbens</i>	20	1
<i>Sanicula canadensis</i>	20	1
<i>Solanum sisymbriifolium</i>	20	1
<i>Stachys floridana</i>	20	1
<i>Tillandsia recurvata</i>	20	1
<i>Triadica sebifera</i>	20	1
<i>Vaccinium elliotii</i>	20	1
<i>Vicia</i>	20	1
<i>Zanthoxylum clava-herculis</i>	20	1

Table B-2. Basal area (BA, m²/ha) and density (Den, count/ha) of woody vascular plant species observed in five Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: MUFS = Maritime Upland Forests and Shrublands (five plots).

Species	MUFS Tree BA	MUFS Tree DEN	MUFS Sapling BA	MUFS Sapling Den	MUFS Seedling Den
<i>Pinus taeda</i>	21.94	95	0.00	–	4500
<i>Quercus virginiana</i>	6.04	10	0.00	–	3000
<i>Liquidambar styraciflua</i>	5.71	70	0.11	25	10250
<i>Quercus hemisphaerica</i>	5.29	120	0.11	25	20750
<i>Pinus elliotii</i>	3.69	5	0.00	–	2250
<i>Quercus nigra</i>	1.45	35	0.00	–	1500
<i>Prunus caroliniana</i>	0.95	40	0.11	25	250
<i>Magnolia grandiflora</i>	0.60	10	–	–	–
<i>Carya glabra</i>	0.23	5	–	–	–
<i>Acer rubrum</i>	–	–	0.00	–	1000
<i>Arundinaria gigantea</i>	–	–	0.00	50	5500
<i>Bignonia capreolata</i>	–	–	0.01	75	2250
<i>Callicarpa americana</i>	–	–	0.00	–	2000
<i>Gelsemium sempervirens</i>	–	–	0.00	75	1250
<i>Ilex glabra</i>	–	–	0.19	1350	7000
<i>Ilex opaca</i>	–	–	0.00	–	250
<i>Ilex vomitoria</i>	–	–	0.77	1875	57250
<i>Morella cerifera</i>	–	–	0.10	500	750
<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	–	–	0.21	525	1500
<i>Parthenocissus quinquefolia</i>	–	–	0.01	75	7250
<i>Persea borbonia</i>	–	–	0.37	1025	2000
<i>Sabal palmetto</i>	–	–	0.00	–	1000
<i>Smilax auriculata</i>	–	–	0.01	75	2000
<i>Smilax bona-nox</i>	–	–	0.01	375	11250
<i>Smilax glauca</i>	–	–	0.00	–	1000
<i>Smilax hispida</i>	–	–	0.00	–	1000
<i>Symplocos tinctoria</i>	–	–	0.18	850	9750
<i>Toxicodendron radicans</i> var. <i>radicans</i>	–	–	0.00	–	5750
<i>Triadica sebifera</i>	–	–	0.01	25	–
<i>Vaccinium arboreum</i>	–	–	0.02	75	–
<i>Vaccinium elliotii</i>	–	–	0.00	–	250

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