



Terrestrial Vegetation Monitoring at Cumberland Island National Seashore

2020 Data Summary

Natural Resource Data Series NPS/SECN/NRDS—2022/1365





ON THIS PAGE

Common small trees and shrubs of Cumberland Island National Seashore observed during this monitoring effort include (clockwise from top left) tough bully (*Sideroxylon tenax*), American beautyberry (*Callicarpa americana*), sand live oak (*Quercus geminata*), and common sweetleaf (*Symplocos tinctoria*). NPS photos / M. Forbes Boyle.

ON THE COVER

M. Forbes Boyle, SECN Botanist, assesses the tree health of an individual live oak (*Quercus virginiana*) in one of the vegetation monitoring plots on Cumberland Island National Seashore. NPS photo / Elizabeth Rico.

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National Park Service
Cumberland Island National Seashore
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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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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Two interns, Sydne Tursky, left, and Isabel Marzullo, right, provided field support during the summer 2020 vegetation monitoring effort on Cumberland Island National Seashore. NPS photos / M. Forbes Boyle.

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.

2020 marks the first year of conducting this monitoring effort at Cumberland Island National Seashore (CUI). Fifty-six vegetation plots were established throughout the park from May through July. 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 Cumberland Island National Seashore in 2020. Data were stratified across three dominant broadly defined habitats within the park, including Coastal Plain Upland Open Woodlands, Maritime Open Upland Grasslands, and Maritime Upland Forests and Shrublands. Noteworthy findings include:

- 213 vascular plant taxa (species or lower) were observed across 56 vegetation plots, including 12 species not previously documented within the park.
- The most frequently encountered species in each broadly defined habitat included:
 - Coastal Plain Upland Open Woodlands: longleaf + pond pine (*Pinus palustris*; *P. serotina*), redbay (*Persea borbonia*), saw palmetto (*Serenoa repens*), wax-myrtle (*Morella cerifera*), deerberry (*Vaccinium stamineum*), variable panicgrass (*Dichanthelium commutatum*), and hemlock rosette grass (*Dichanthelium portoricense*).
 - Maritime Open Upland Grasslands: wax-myrtle, saw greenbrier (*Smilax auriculata*), sea oats (*Uniola paniculata*), and other forbs and graminoids.
 - Maritime Upland Forests and Shrublands: live oak (*Quercus virginiana*), redbay, saw palmetto, muscadine (*Muscadinia rotundifolia*), and Spanish moss (*Tillandsia usneoides*).
- Two non-native species, Chinaberry (*Melia azedarach*) and bahiagrass (*Paspalum notatum*), categorized as invasive by the Georgia Exotic Pest Plant Council (GA-EPPC 2022) were encountered in four different Maritime Upland Forest and Shrubland plots during this monitoring effort.
- Six vascular plant species listed as rare and tracked by the Georgia Department of Natural Resources (GADNR 2022) were observed in these monitoring plots, including the state listed “Rare” Florida swampprivet (*Forestiera segregata* var. *segregata*) and sandywoods sedge (*Carex dasycarpa*) and the “Unusual” green fly orchid (*Epidendrum conopseum*).
- Longleaf and pond pine were the most dominant species within the tree stratum of Coastal Plain Upland Open Woodland habitat types; live oak was the most dominant species of Maritime Upland Forest and Shrubland types. Saw palmetto and rusty staggerbush (*Lyonia ferruginea*) dominated the sapling stratum within Maritime Upland Forest and Shrubland habitat types.
- Of the 20 tree-sized redbay trees measured during this monitoring effort only three were living and these were observed with severely declining vigor, indicating the prevalence and recent historical impact of laurel wilt disease (LWD) across the island's maritime forest ecosystems.
- There was an unexpectedly low abundance of sweet grass (*Muhlenbergia sericea*) and saltmeadow cordgrass (*Spartina patens*) within interdune swale plots of Maritime Open Upland habitats on the island, which could be a result of grazing activity by feral horses.
- Live oak is the dominant tree-sized species across the island's maritime forests (relative proportion among other woody species = 37%), but only represents less than 2% in the sapling and 14% in the seedling strata. Continued monitoring of these plots will help determine the degree of live oak regeneration trends on the island.

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 (2022a), 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. 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 resources 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 a 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 using a protocol 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 from May through July 2020 within Cumberland Island National Seashore (CUIS) as part of the SECN’s terrestrial vegetation monitoring effort. This report is intended to provide CUIS 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 Cumberland Island National Seashore 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

Cumberland Island is the largest barrier island along Georgia's coast, measuring 28.2 kilometers (17.5 miles [mi]) long and between 0.8–9.7 kilometers (0.5–6.0 mi) wide. The island is 6.4 kilometers (4 mi) east of St. Marys, Camden County, Georgia. The boundary of the National Seashore (CUIS) is 14,709 hectares (36,347 acres [ac]) and includes the main Cumberland Island, Little Cumberland Island to the north, and Drum Point Island in Cumberland River; over half of this area is owned and managed by the National Park Service (NPS 2015; Figure 1). The majority of the island was formed during the Pleistocene (50,000 to 5,000 years ago) and is part of a chain of barrier islands along Georgia's coast known as the Silver Bluff formation. Conversely, the eastern edge, southern tip, and Little Cumberland Island were formed during the Holocene (5,000 years ago to present). Elevation ranges on Cumberland Island are from sea level to over 15 meters (50 feet [ft]) on the northwestern corner of the island (Terrapin Point) and 12 meters (40 ft) within the central portion of the island.

Like the other barrier islands along Georgia's coast, natural vegetation communities on Cumberland Island are strongly influenced by maritime-influenced tides, prevailing ocean winds and storms, and sedimentation from rivers. Strong storm events and highly saline environments affect the distribution of plants across the island, impacting the mosaic of marsh, forest, shrubland, and upland open grassland habitats. The general pattern of vegetated habitats on Cumberland Island is as follows: open beach gives way to sparsely vegetated foredunes tolerant of salt spray, high winds, and drought dominated by graminoids such as sea oats (*Uniola paniculata*), bitter panicgrass (*Panicum amarum*) and sanddune sandbur (*Cenchrus tribuloides*) along with a host of stress-tolerant herbaceous species; interdune meadows of various graminoid and herbaceous species between foredunes and woody backdunes; woody backdunes or maritime scrub/shrub thickets dominated by woody shrubs and short-statured trees such as wax-myrtle (*Morella cerifera*), tough bully (*Sideroxylon tenax*), sand live oak (*Quercus geminata*), yaupon (*Ilex vomitoria*), and saw palmetto (*Serenoa repens*); dense backdune shrublands give way to maritime forests of stabilized island-interior dunes, representing the terminal stage of vegetation succession in

maritime communities, dominated by a closed canopy of live oak (*Quercus virginiana*), a subcanopy of redbay (*Persea borbonia*), devilwood (*Cartrema americana*), and rusty staggerbush (*Lyonia ferruginea*), and oftentimes a dense shrub stratum of saw palmetto, saw greenbrier (*Smilax auriculata*; *S. bona-nox*), and muscadine (*Muscadinia rotundifolia*; Zomlefer et al. 2008; Ruckdeschel 2019). The western shore of Cumberland Island is largely composed of open salt marsh, dominated by smooth cordgrass (*Spartina alterniflora*) and other graminoids and forbs that tolerate daily inundations of salt water, anaerobic soils, and direct sunlight (Zomlefer et al. 2008). Other vegetation communities found on Cumberland Island include an array of freshwater wetlands (pond-slough, marsh, hardwood swamp) scattered throughout the island interior; xeric oak or pine-oak dominated scrub woodland most noticeable on the north end of the island; pine-dominated forests; and ruderal areas (Zomlefer et al. 2008; Ruckdeschel 2019).

Barrier islands along the South Atlantic coast have been heavily impacted by anthropogenic activities over hundreds of years that have contributed to the current distribution and condition of island vegetation ecosystems. Large-scale modification of land conversion for agriculture was prevalent on Cumberland Island throughout the 18th and 19th centuries, and throughout this same period into the 20th century logging impacted the island's forest ecosystems (e.g., live oak removal for ship building in the early 19th century; extraction of tar, pitch, and turpentine from pines and their subsequent removal throughout the 19th and mid-20th centuries; Hillestad et al. 1975; Ruckdeschel 2019). Feral livestock, including horses and hogs, were originally brought to Cumberland Island by European settlers and have had significant impacts on island ecosystems (Dilsaver 2004). Feral horses, in particular, alter dune formation by grazing plants needed for soil stabilization; furthermore, grazing and trampling around freshwater wetlands has caused severe erosion, shifted hydrologic patterns, and changed plant composition within these unique island ecosystems (Johnson et al. 1974; Hillestad et al. 1975; Dolan 2002). Feral hog behavior like rooting and trampling disturbs vegetation, particularly in freshwater wetland and dune ecosystems on Cumberland Island (Dilsaver 2004; Kammermeyer et al. 2011).

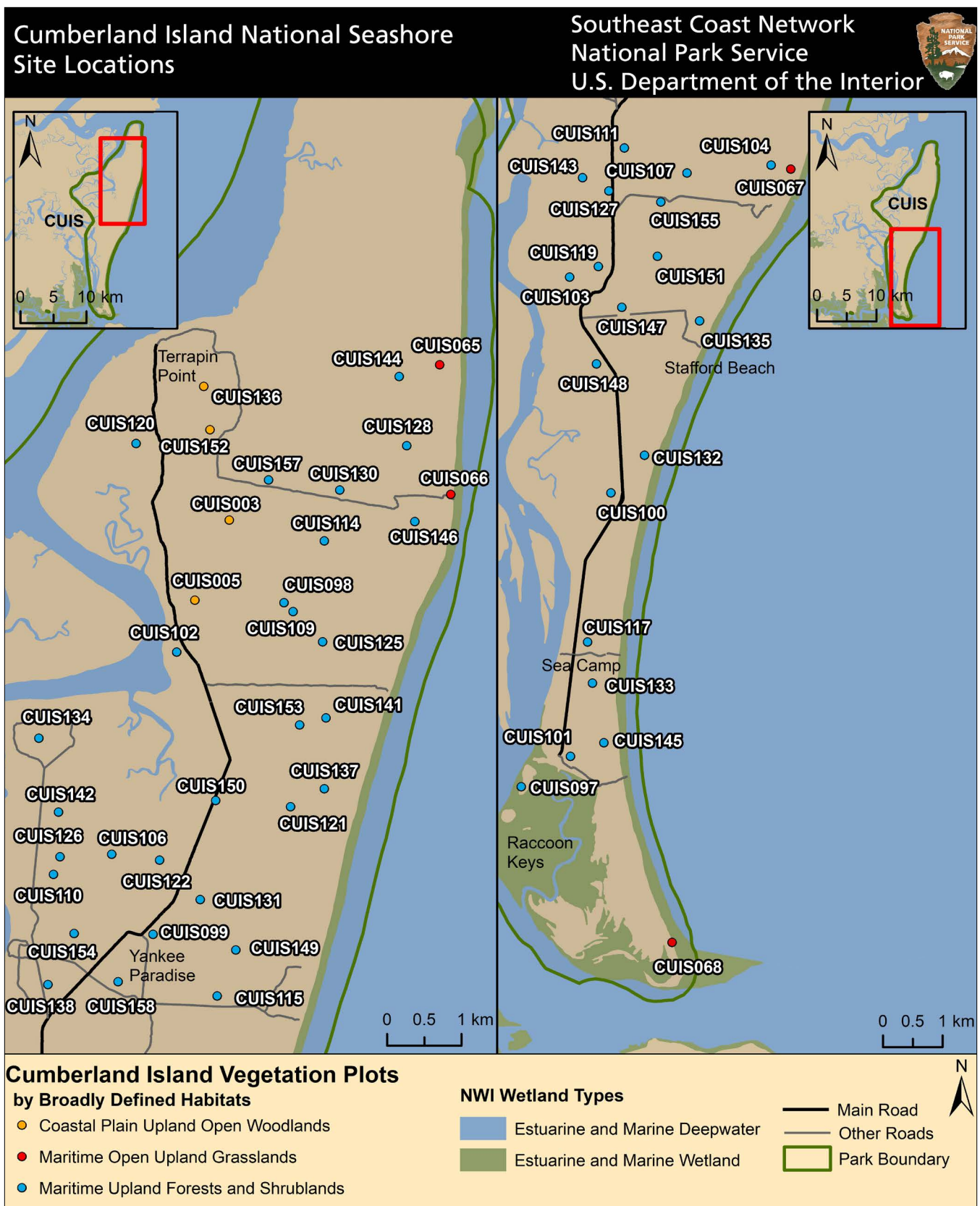


Figure 1. Southeast Coast Network terrestrial vegetation monitoring plot locations within Cumberland Island National Seashore, Camden County, Georgia.

Vegetation communities within Cumberland Island National Seashore have also been shaped by lightning ignited natural fire over millennia and, in more recent times, human-influenced manipulation of fire (e.g., fire suppression; prescribed fire). Freshwater wetlands, xeric scrub woodlands, and natural stands of pine scattered across the island require some degree of fire for their maintenance (Johnson et al. 1974).

Zomlefer et al. (2008) reported 498 vascular species within Cumberland Island National Seashore, including 46 cultivated species not likely naturalized and an additional 73 non-native species (13.6% of the total). Of these 73 non-native plants, 18 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:

- Tree-of-heaven (*Ailanthus altissima*; Cat 1)
- Silk tree (*Albizia julibrissin*; Cat 1)
- Alligatorweed (*Alternanthera philoxeroides*; Cat 1)
- Camphortree (*Cinnamomum camphora*; Cat 2)
- Bermudagrass (*Cynodon dactylon*; Cat 2)
- Silverthorn (*Elaeagnus pungens*; Cat 2)
- Silverberry (*Elaeagnus umbellata*; Cat 1)
- Japanese privet (*Ligustrum japonicum*; Cat 2)
- Chinese privet (*Ligustrum sinense*; Cat 1)
- Japanese climbing fern (*Lygodium japonicum*; Cat 1)
- Chinaberrytree (*Melia azedarach*; Cat 1)
- Bahiagrass (*Paspalum notatum*; Cat 2)
- Golden bamboo (*Phyllostachys aurea*; Cat 2)
- Popcorn tree (*Sapium sebiferum*; Cat 1)
- Danglepod (*Sesbania herbacea*; Cat 2)
- Rattlebox (*Sesbania punicea*; Cat 2)
- Smallflower tamarisk (*Tamarix parviflora*; Cat 2)
- Chinese wisteria (*Wisteria sinensis*; Cat 1)

There was one state threatened species found in the park during the previous floristic survey (climbing buckthorn [*Sageretia minutiflora*]), and no federally listed endangered or threatened species were observed; there were 16 species, rare plants of special concern listed by the Georgia Department of Natural Resources (GADNR 2022), that were present (Zomlefer et al. 2008). These include:

- Sticky joint-vetch (*Aeschynomene viscidula*; S1?)
- Savanna milkweed (*Asclepias pedicellata*; S1S2)
- American bluehearts (*Buchnera americana*; S1)
- Sandywoods sedge (*Carex dasycarpa*; S3)
- White spikerush (*Eleocharis albida*; S2S3)
- Spikerush (*Eleocharis fallax*; S1?)
- Spikerush (*Eleocharis montevidensis*; S3?)
- Greenfly orchid (*Epidendrum magnoliae* [conopseum]; State: Unusual; S3)
- Florida swampprivet (*Forestiera segregata*; State: Rare; S2)
- Goldfoot fern (*Phlebodium aureum*; S1)
- Bluff white oak (*Quercus austrina*; S3?)
- Climbing buckthorn (*Sageretia minutiflora*; State: Threatened; S2)
- Soapberry (*Sapindus marginatus*; State: Rare; S1S2)
- Needleleaf airplant (*Tillandsia setacea*; S1?)
- Sweet acacia (*Acacia* [Vachellia] *farnesiana*; S1)
- Algal bulrush (*Websteria confervoides*; S1?)

Sampling Design

The Southeast Coast Network monitors vegetation in long-term plots located in natural and semi-natural habitats of targeted parks, including Cumberland Island National Seashore. 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/co-dominant 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 covers 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.

Fifty-six vegetation plots were established and sampled at Cumberland Island National Seashore from May through July 2020 (Figure 1). These plots were located in the following broadly defined habitats of the park: Coastal Plain Upland Open Woodlands (4 plots), Maritime Open Upland Grasslands (4 plots), and Maritime Upland Forests and Shrublands (48 plots). 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 2019). 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 in 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 2022a) 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 meters (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).

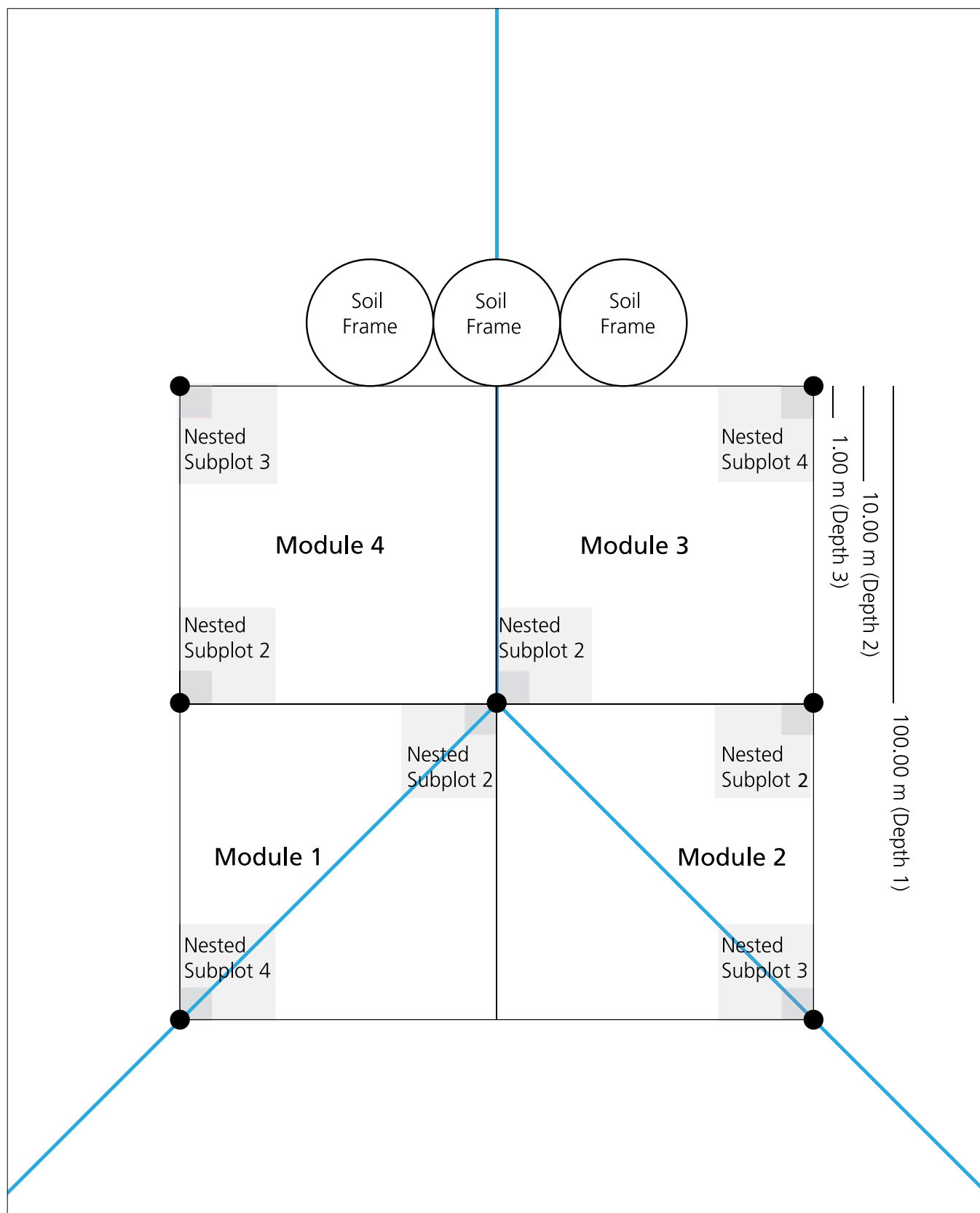


Figure 2. The layout of the sampling plot for the Southeast Coast Network, which is a modified version of the standard Level 5 Carolina Vegetation Survey plot. Ideal locations of rebar used as permanent structures to monument the plot are represented by black shaded circles. Blue lines represent locations 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 inches [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.

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

Two hundred and thirteen vascular plant species were detected during this monitoring effort (Appendix A), including 12 taxa not detected in previous lists documented in Zomlefer et al. (2008), Heath and Byrne (2014), or NPSpecies (NPS 2022; Table 2). New vascular plant species to Cumberland Island includes one species—Bartram’s airplant (*Tillandsia bartramii*)—tracked on the state of Georgia’s rare plant list (GADNR 2022). Native richness ranged from eight to 49 species per plot and at least one non-native plant was encountered in eight of the 56 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 Chinaberrytree and bahiagrass (Appendix A). Alternatively, six vascular plant species listed as rare and tracked by the Georgia Department

of Natural Resources (GADNR 2022) were observed in these monitoring plots, including the state listed “Rare” Florida swampprivet and sandywoods sedge and the “Unusual” green fly orchid. The full list of rare species is also available in 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 Zomlefer et al. (2008), Heath and Byrne (2014), or NPSpecies (NPS 2022) but found at Cumberland Island National Seashore in 2020 through this current monitoring effort.

Scientific Name	Common Name ¹	Growth Form ¹	Federal/State Noxious Status ¹	Native Status ¹	Global Rank ²	State Rank ² (Georgia)
<i>Andropogon dealbatus</i>	chalky bluestem	Graminoid	–	Native	GNR	SNR
<i>Andropogon tenuispathus</i>	bushy bluestem	Graminoid	–	Native	T5	S5
<i>Andropogon virginicus</i> var. <i>decipiens</i>	broomsedge bluestem	Graminoid	–	Native	T4	n/a
<i>Andropogon virginicus</i> var. <i>virginicus</i>	broomsedge bluestem	Graminoid	–	Native	T5	S5
<i>Aristida beyrichiana</i>	Beyrich threeawn	Graminoid	–	Native	G5	SNR
<i>Carex floridana</i>	Florida sedge	Graminoid	–	Native	G5	S3
<i>Ilex coriacea</i>	large gallberry	Shrub, Tree	–	Native	G5	SNR
<i>Lycopodiella appressa</i>	southern bog clubmoss	Forb/herb, Subshrub	–	Native	G5	S5
<i>Schizachyrium scoparium</i> var. <i>scoparium</i>	little bluestem	Graminoid	–	Native	T5	SNR
<i>Tillandsia bartramii</i>	Bartram’s airplant	Forb/herb	–	Native	G4	S2
<i>Vaccinium elliotii</i>	Elliott’s blueberry	Shrub	–	Native	G5	SNR
<i>Vaccinium formosum</i>	southern blueberry	Shrub	–	Native	G5	SNR

¹ Information obtained from the PLANTS database (USDA 2022a)

² Conservation Status (S2: Imperiled; S3: Vulnerable; G4 or S4: Apparently Secure; G5: or S5 Secure; T4: Intraspecific Taxa Apparently Secure; T5: Intraspecific Taxa 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 Cumberland Island National Seashore. 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 2022a).

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
Coastal Plain Upland Open Woodlands	CUIS003	29.0	0.0	0.0	5.0	6.0	1.0	8.0	9.0	3.8	5.0	0.8	5.5	6.3	1.5	2.1	0.4	3.6	3.3	0.5	1.4	0.3	1.4	1.6
	CUIS005	15.0	0.0	0.0	3.0	6.0	2.0	2.0	2.0	2.8	4.0	1.5	2.0	1.0	1.5	1.8	0.5	1.5	0.3	0.9	0.6	0.0	0.6	0.3
	CUIS136	16.0	0.0	0.0	6.0	3.0	1.0	2.0	4.0	3.5	1.3	0.3	1.0	1.8	1.4	0.3	0.1	0.4	0.6	0.6	0.0	0.0	0.0	0.3
	CUIS152	32.0	0.0	0.0	9.0	6.0	6.0	3.0	8.0	6.3	4.3	3.8	1.5	4.0	4.1	1.3	1.9	0.5	1.8	1.6	0.6	1.6	0.1	1.0
	average	23.0	0.0	0.0	5.8	5.3	2.5	3.8	5.8	4.1	3.6	1.6	2.5	3.3	2.1	1.3	0.7	1.5	1.5	0.9	0.7	0.5	0.5	0.8
	standard deviation	8.8	0.0	0.0	2.2	1.3	2.1	2.5	2.9	1.3	1.4	1.3	1.8	2.1	1.2	0.7	0.7	1.3	1.2	0.4	0.5	0.7	0.5	0.6
	CUIS065	34.0	0.0	0.0	4.0	2.0	4.0	15.0	9.0	2.5	0.5	2.0	10.0	6.3	0.8	0.0	1.0	5.0	3.3	0.0	0.0	0.5	2.8	1.8
	CUIS066	16.0	0.0	0.0	0.0	0.0	1.0	8.0	7.0	0.0	0.0	0.3	7.3	5.3	0.0	0.0	0.1	4.5	2.3	0.0	0.0	0.0	2.6	1.6
	CUIS067	25.0	1.0	2.0	1.0	2.0	1.0	15.0	9.0	0.3	1.0	0.5	10.8	5.0	0.1	0.3	0.3	7.6	2.9	0.1	0.0	0.1	4.4	1.6
	CUIS068	28.0	1.0	0.0	0.0	1.0	1.0	17.0	10.0	0.0	0.3	0.3	11.8	5.3	0.0	0.1	0.1	7.6	3.4	0.0	0.0	0.0	4.9	2.5
	average	25.8	0.5	0.5	1.3	1.3	1.8	13.8	8.8	0.7	0.4	0.8	9.9	5.4	0.2	0.1	0.4	6.2	2.9	0.0	0.0	0.2	3.7	1.9
	standard deviation	7.5	0.6	1.0	1.9	1.0	1.5	3.9	1.3	1.2	0.4	0.8	1.9	0.6	0.4	0.1	0.4	1.7	0.5	0.1	0.0	0.2	1.1	0.4
	CUIS097	31.0	3.0	0.0	7.0	2.0	5.0	14.0	6.0	3.3	0.8	3.8	6.0	2.0	1.6	0.4	1.6	1.4	0.1	1.4	0.3	0.3	0.9	0.0
	CUIS098	20.0	0.0	0.0	7.0	4.0	5.0	3.0	1.0	5.3	2.0	2.0	1.5	1.0	2.5	1.3	0.6	1.1	0.4	0.6	0.6	0.0	0.6	0.3
	CUIS099	20.0	0.0	0.0	8.0	1.0	3.0	2.0	6.0	4.8	0.8	3.0	1.3	5.0	3.1	0.3	2.3	0.5	3.0	1.8	0.0	1.6	0.4	2.0
	CUIS100	17.0	0.0	0.0	5.0	1.0	5.0	3.0	3.0	4.3	1.0	2.8	1.5	2.5	2.0	0.3	1.6	1.1	2.0	0.9	0.0	0.5	0.4	1.3
	CUIS101	29.0	1.0	0.0	8.0	3.0	6.0	7.0	6.0	6.8	2.0	3.3	4.0	3.8	3.8	0.8	1.5	2.0	2.3	2.1	0.4	0.5	1.1	1.5
	CUIS102	21.0	0.0	0.0	6.0	2.0	5.0	4.0	4.0	3.5	1.3	2.5	3.3	2.5	1.1	0.5	0.8	1.9	1.6	0.4	0.3	0.1	1.1	0.8
	CUIS103	19.0	0.0	0.0	8.0	4.0	4.0	2.0	1.0	3.0	2.8	2.8	1.5	0.3	1.1	1.8	1.9	0.9	0.0	0.4	1.0	0.4	0.5	0.0
	CUIS104	40.0	0.0	0.0	8.0	4.0	9.0	11.0	8.0	5.8	2.5	5.0	6.3	5.0	1.9	1.0	2.9	2.1	2.8	0.9	0.6	1.9	1.1	2.1
	CUIS106	26.0	0.0	0.0	8.0	4.0	5.0	4.0	5.0	5.8	1.8	3.0	2.5	3.0	3.0	0.9	2.0	1.5	1.9	1.6	0.3	1.3	0.9	0.9
	CUIS107	14.0	0.0	0.0	5.0	3.0	4.0	2.0	0.0	3.3	2.0	2.3	2.0	0.0	1.4	1.0	0.9	1.4	0.0	0.3	0.6	0.4	0.8	0.0
	CUIS109	12.0	0.0	0.0	6.0	3.0	2.0	1.0	0.0	5.0	1.5	1.0	1.0	0.0	2.8	1.1	0.3	1.0	0.0	0.8	0.6	0.0	0.9	0.0
	CUIS110	20.0	0.0	0.0	7.0	2.0	4.0	1.0	6.0	5.0	1.8	1.8	1.0	3.8	2.1	1.1	0.8	0.6	1.1	0.5	0.5	0.1	0.1	0.3
	CUIS111	37.0	0.0	0.0	8.0	3.0	4.0	11.0	11.0	5.0	1.8	3.5	6.5	7.8	2.1	0.5	1.5	2.3	3.3	0.5	0.0	0.9	0.8	1.4
	CUIS114	18.0	0.0	0.0	7.0	6.0	3.0	1.0	1.0	5.5	4.8	2.5	0.3	0.3	3.6	3.3	1.3	0.0	0.1	2.5	1.6	0.6	0.0	0.1

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

Table 3 (continued). Vascular plant species richness across multiple spatial scales on Southeast Coast Network vegetation plots located within Cumberland Island National Seashore. 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 2022a)

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	CUIS115	18.0	0.0	0.0	6.0	2.0	3.0	2.0	5.0	5.0	2.0	2.0	1.3	3.3	2.9	1.5	0.8	1.1	1.1	1.5	0.6	0.1	0.5	0.4
Upland	CUIS117	8.0	0.0	0.0	3.0	1.0	2.0	2.0	0.0	2.8	1.0	1.5	1.3	0.0	1.4	1.0	0.0	1.0	0.0	0.8	0.6	0.0	0.5	0.0
Forests and Shrublands	CUIS119	24.0	0.0	0.0	8.0	5.0	7.0	3.0	1.0	6.5	3.3	4.0	2.3	0.8	3.3	1.4	1.9	1.4	0.5	1.3	0.4	0.6	0.9	0.3
	CUIS120	25.0	0.0	0.0	9.0	4.0	4.0	4.0	4.0	5.5	2.0	3.0	2.0	3.3	3.4	0.8	1.9	1.5	1.4	1.1	0.4	1.8	0.6	0.5
	CUIS121	10.0	0.0	0.0	4.0	2.0	2.0	2.0	0.0	2.5	1.5	1.5	1.5	0.0	1.1	1.1	0.5	1.0	0.0	0.6	1.0	0.0	0.6	0.0
	CUIS122	22.0	0.0	0.0	9.0	3.0	4.0	3.0	3.0	6.8	2.0	2.0	2.3	2.5	4.0	1.1	1.0	1.3	1.4	1.5	0.5	0.4	0.5	0.3
	CUIS125	8.0	0.0	0.0	3.0	1.0	2.0	2.0	0.0	2.3	1.0	0.5	1.3	0.0	1.1	1.0	0.3	1.1	0.0	0.4	0.8	0.1	0.5	0.0
	CUIS126	33.0	0.0	1.0	11.0	3.0	6.0	3.0	11.0	7.0	1.0	3.0	1.5	6.5	2.8	0.1	1.3	0.3	2.8	0.5	0.0	0.6	0.1	0.9
	CUIS127	22.0	0.0	0.0	7.0	4.0	4.0	2.0	5.0	6.3	2.0	2.3	1.3	3.3	3.9	0.4	1.0	0.4	1.5	1.9	0.0	0.1	0.3	0.6
	CUIS128	27.0	1.0	0.0	7.0	2.0	7.0	4.0	8.0	3.3	1.5	5.5	2.3	3.0	0.9	1.1	4.1	0.8	0.8	0.4	0.9	2.8	0.4	0.0
	CUIS130	15.0	0.0	0.0	7.0	3.0	3.0	1.0	1.0	5.5	2.3	2.3	1.0	0.8	2.3	1.5	1.1	0.4	0.3	0.3	0.6	0.5	0.0	0.0
	CUIS131	25.0	0.0	0.0	8.0	5.0	5.0	3.0	4.0	5.3	2.5	4.3	1.8	2.5	2.9	1.0	2.6	0.6	1.6	1.1	0.5	1.0	0.4	0.8
	CUIS132	20.0	0.0	0.0	7.0	2.0	4.0	3.0	4.0	3.8	1.5	3.0	1.8	2.0	2.3	1.0	1.6	0.3	0.9	1.4	0.8	0.6	0.1	0.6
	CUIS133	11.0	0.0	0.0	3.0	3.0	2.0	3.0	0.0	3.0	1.8	0.8	1.8	0.0	2.0	1.0	0.4	1.1	0.0	0.5	0.8	0.0	0.4	0.0
	CUIS134	12.0	0.0	0.0	5.0	2.0	1.0	3.0	1.0	3.8	1.3	0.5	2.0	0.3	1.6	1.0	0.0	1.1	0.0	0.6	0.1	0.0	0.6	0.0
	CUIS135	49.0	0.0	1.0	6.0	5.0	10.0	17.0	12.0	3.8	3.8	7.8	8.0	6.0	2.1	2.0	3.4	4.6	2.0	0.9	1.0	1.1	2.4	0.8
	CUIS137	17.0	0.0	0.0	5.0	2.0	2.0	7.0	1.0	3.0	1.3	1.3	2.8	0.3	0.9	1.0	0.1	1.1	0.0	0.3	0.9	0.0	0.4	0.0
	CUIS138	27.0	0.0	1.0	7.0	6.0	5.0	3.0	7.0	5.5	3.0	3.0	2.0	5.3	3.6	1.6	1.6	1.3	2.0	1.1	0.5	0.6	0.4	0.9
	CUIS141	30.0	0.0	0.0	8.0	2.0	5.0	3.0	12.0	4.5	1.0	3.0	1.8	8.5	2.3	0.3	0.6	1.0	4.9	0.4	0.1	0.3	0.4	3.0
	CUIS142	16.0	0.0	0.0	8.0	2.0	3.0	2.0	1.0	5.5	1.3	2.3	1.8	0.3	2.8	1.1	0.6	1.1	0.0	0.4	0.5	0.1	0.8	0.0
	CUIS143	10.0	0.0	0.0	4.0	2.0	1.0	3.0	0.0	2.5	1.3	0.8	2.3	0.0	0.6	1.0	0.1	1.1	0.0	0.3	1.0	0.0	0.9	0.0
	CUIS144	29.0	0.0	0.0	8.0	3.0	4.0	7.0	7.0	5.8	1.8	3.3	2.8	2.8	2.8	1.1	2.4	1.4	0.6	0.5	1.0	1.3	0.4	0.4
	CUIS145	38.0	1.0	0.0	6.0	4.0	5.0	14.0	10.0	3.5	2.5	2.8	7.8	6.5	2.3	1.6	1.1	4.0	3.3	1.0	0.5	0.4	1.8	2.4
	CUIS146	23.0	0.0	0.0	4.0	2.0	6.0	5.0	6.0	2.3	1.8	4.5	2.5	3.3	1.1	0.9	2.0	1.0	0.8	0.1	0.3	1.1	0.5	0.1
	CUIS147	45.0	1.0	0.0	11.0	5.0	12.0	11.0	7.0	7.8	3.3	7.0	7.0	5.0	3.5	1.1	4.3	3.0	3.0	1.1	0.1	2.8	1.5	1.9
	CUIS148	43.0	4.0	0.0	7.0	4.0	7.0	17.0	12.0	3.5	1.3	6.0	10.3	9.5	2.4	0.4	3.0	3.5	5.6	1.4	0.4	1.5	1.4	2.3

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

Table 3 (continued). Vascular plant species richness across multiple spatial scales on Southeast Coast Network vegetation plots located within Cumberland Island National Seashore. 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 2022a)

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	CUIS149	17.0	0.0	0.0	5.0	3.0	5.0	1.0	3.0	3.8	2.0	3.3	1.0	2.8	2.0	1.1	1.6	0.9	1.0	0.8	1.0	0.9	0.5	0.6
Upland	CUIS150	27.0	0.0	0.0	11.0	2.0	2.0	5.0	7.0	8.3	0.8	1.0	3.0	5.3	4.3	0.4	0.5	1.4	3.0	1.6	0.3	0.1	1.0	1.1
Forests and Shrublands	CUIS151	20.0	0.0	0.0	9.0	2.0	5.0	2.0	2.0	7.3	1.3	3.8	2.0	1.5	3.8	0.8	2.4	1.6	1.0	1.4	0.3	1.4	0.6	0.4
	CUIS153	18.0	0.0	0.0	7.0	2.0	3.0	3.0	3.0	4.8	1.3	2.0	2.5	2.5	2.6	0.4	1.1	1.0	0.5	0.6	0.3	0.8	0.4	0.1
	CUIS154	21.0	0.0	0.0	7.0	5.0	3.0	3.0	3.0	6.3	3.0	3.0	2.0	1.8	4.3	1.3	1.5	1.1	0.1	1.8	0.5	0.5	0.8	0.0
	CUIS155	31.0	0.0	0.0	10.0	3.0	6.0	5.0	7.0	7.3	1.5	2.8	2.5	3.8	2.1	0.9	1.0	1.5	1.3	1.3	0.4	0.4	0.8	0.5
	CUIS157	16.0	0.0	0.0	5.0	6.0	3.0	1.0	1.0	4.3	5.0	1.8	0.8	1.0	2.8	3.3	1.3	0.3	0.3	1.0	1.6	1.0	0.0	0.1
	CUIS158	18.0	0.0	0.0	8.0	3.0	3.0	2.0	2.0	4.8	2.3	2.8	1.3	1.0	1.8	1.3	1.1	1.1	0.3	0.5	0.6	0.4	0.9	0.0
	average	22.9	0.2	0.1	6.9	3.1	4.4	4.5	4.3	4.8	1.9	2.8	2.7	2.7	2.4	1.0	1.4	1.3	1.3	0.9	0.5	0.7	0.7	0.6
	standard deviation	9.7	0.8	0.2	2.0	1.4	2.2	4.2	3.7	1.5	0.9	1.5	2.2	2.4	1.0	0.6	1.0	0.9	1.3	0.6	0.4	0.7	0.5	0.8

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

Coastal Plain Upland Open Woodlands

Open woodlands of the Southeastern Coastal Plain include relatively open canopy forests dominated by longleaf pine (*Pinus palustris*), and other southern yellow pines (e.g. pond pine [*Pinus serotina*]), occurring across a wide range of soil, hydrologic, and landform conditions (Peet 2006). These ecosystems were once widespread across the Coastal Plain mainland from Virginia to Mississippi, but close to 98% of their original coverage has been eliminated due to land conversion to agriculture or urban environments, timber management, and fire suppression (Noss et al. 1985; Ware et al. 1993). The distribution of open longleaf pine woodlands across barrier islands of the South Atlantic Coast is poorly understood. However, high seasonal lightning frequencies and human-influences such as land clearing for agriculture—factors which would promote and sustain pine development over typical oak-dominated maritime forest in certain areas—have occurred on large islands like Cumberland. Ruckdeschel (2019) mentions several 18th century accounts of pine on Cumberland Island, particularly on Terrapin Point and potentially near Yankee Paradise. It is uncertain the precise extent of longleaf pine woodlands across Cumberland Island prior to European arrival, but due to the island’s large size, distance from the mainland, edaphic conditions, and lightning activity, some degree of open pine habitat was likely to have

been supported. This broad category includes open-spaced forests and savannas occurring on low, flat topography (hence the common local name ‘flatwoods’) and on dry (xeric) to mesic, and occasionally wet (hydric) soils (Figure 3). They are typically maintained by a combination of frequent fire and water availability—which can vary widely among sites depending on soil texture, microtopography, and seasonal precipitation. Soils are typically imperfectly to poorly drained and are usually acidic. Vegetation associations sampled at Cumberland Island National Seashore that belong to this broadly defined habitat type include (descriptions from NatureServe 2022):

- Maritime Slash Pine – Longleaf Pine Upland Flatwoods (CEGL004658; 2 plots): Maritime-influenced upland woodlands on stabilized dunes of barrier islands and near-coastal mainland areas. (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- Wet Longleaf Pine – Pond Pine Flatwoods (CEGL004791; 2 plots): Saturated pine-dominated woodlands occurring on organic soils on interstream flats, with a shrub stratum that includes saw palmetto, inkberry (*Ilex glabra*), and fetterbush lyonia (*Lyonia lucida*). (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)



Figure 3. Four Coastal Plain Upland Open Woodland sites were sampled during this monitoring effort on Cumberland Island National Seashore during the summer of 2020. NPS photo / SECN staff.

Species Diversity and Abundance

Native species richness ranged from 15 to 32 (mean = 23.0) within vegetation plots of this broadly defined habitat type in Cumberland Island National Seashore (Table 3). Graminoids and trees represented the most diverse growth forms across all spatial scales (Table 3). There were no non-native species observed in plots of this broadly defined habitat. Vascular plants observed in these plots are fairly common across the Southeastern Coastal Plain, and there were no state or federally listed rare plants encountered. Sixty-four vascular plant species were found collectively within these four plots; 18 of these were only found in this broadly defined habitat (Appendix B, Table B-1). 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

- Longleaf or pond pine (100%)
- Redbay (100%)

Shrubs

- Saw palmetto (100%)
- Wax myrtle (75%)
- Deerberry (*Vaccinium stamineum*; 75%)

Herbs/Forbs/Graminoids

- Variable panicgrass (*Dichanthelium commutatum*; 75%)
- Hemlock rosette grass (*Dichanthelium portoricense*; 75%)

Woody Stem Metrics

Total basal area (BA) of trees was highly variable within these plots and ranged from 4.3 to 28.9 m²/ha with an overall average of 17.0 m²/ha; density of canopy stems ranged from nine to 57 per plot, with an average of 22.0 (Table 4). Canopy height ranged from 12 to 26 meters (average 18.3), and canopy cover ranged from seven to 72% (average=47.9%; Table 4). The most dominant canopy species included pond pine (mean BA = 5.44 m²/ha, mean density = 425/ha) and longleaf pine (mean BA=5.03 m²/ha, mean density = 44/ha; Appendix B, Table B-2). Sapling density at the 80 square meter scale ranged from zero to 116 stems, with an average of 43.5, while seedling density at the 8 meter square scale ranged from 14 to 104 stems, with an average of 42.5 across all plots (Table 4). Dominant sapling species included pond pine, saw palmetto, and farkleberry (*Vaccinium arboreum*); dominant seedlings included saw palmetto, live oak, and sand live oak (Appendix B, Table B-2).

Based on stem count alone, pond pine comprised nearly 78% of the relative abundance among species within the tree stratum, while longleaf pine comprised 8% (Figure 4). The sapling and seedling strata were dominated by pond pine and saw palmetto (Figure 4).

Most of the measured trees in Maritime Upland Forest and Shrubland plots were living (96%) and the majority of trees were categorized with healthy vigor and minimal dieback (Figure 5). Most of those individuals that were observed with decline in vigor and dieback were pond pines in plots within the footprint of the 2019 Whitney Fire (see Disturbance and Threats section).

Table 4. Woody stem abundance and canopy metrics on Southeast Coast Network vegetation plots located in Cumberland Island National Seashore [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)
Coastal Plain Upland Open Woodlands	CUIS003	4.3	11.0	0.0	0.0	104.0	7.0	12.0
	CUIS005	17.4	57.0	22.2	116.0	17.0	72.0	14.0
	CUIS136	28.9	11.0	0.0	0.0	14.0	63.0	26.0
	CUIS152	17.2	9.0	3.3	58.0	35.0	50.0	21.0
	average	17.0	22.0	6.4	43.5	42.5	47.9	18.3
	standard deviation	10.0	23.4	10.6	55.5	42.0	28.8	6.6
Maritime Open Upland Grassland Vegetation	CUIS065	0.0	0.0	1.3	16.0	4.0	0.0	4.0
	CUIS066	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	CUIS067	0.0	0.0	0.1	1.0	0.0	0.0	0.0
	CUIS068	0.0	0.0	0.2	6.0	0.0	0.0	0.0
	average	0.0	0.0	0.4	5.8	1.0	0.0	1.1
	standard deviation	0.0	0.0	0.6	7.3	2.0	0.0	2.2
Maritime Upland Forests and Shrublands	CUIS097	82.0	24.0	0.8	23.0	30.0	64.0	10.0
	CUIS098	7.0	5.0	1.3	12.0	74.0	65.0	21.0
	CUIS099	34.8	8.0	0.7	52.0	73.0	60.0	21.0
	CUIS100	1.5	6.0	2.5	55.0	19.0	69.0	20.0
	CUIS101	78.2	9.0	1.2	20.0	50.0	80.0	25.0
	CUIS102	60.0	4.0	0.8	22.0	13.0	65.0	25.0
	CUIS103	1.5	2.0	4.5	144.0	47.0	56.0	26.0
	CUIS104	115.1	7.0	1.7	17.0	70.0	68.0	19.0
	CUIS106	15.6	3.0	3.9	94.0	47.0	60.0	27.0
	CUIS107	50.0	10.0	5.8	159.0	23.0	71.0	26.0
	CUIS109	40.4	16.0	5.9	148.0	37.0	61.0	15.0
	CUIS110	35.6	18.0	2.0	44.0	19.0	62.0	26.0
	CUIS111	9.8	7.0	2.0	22.0	31.0	56.0	27.0
	CUIS114	13.0	28.0	7.5	116.0	144.0	63.0	10.0
	CUIS115	12.1	6.0	2.7	37.0	40.0	73.0	17.0
	CUIS117	23.5	10.0	2.1	66.0	28.0	54.0	17.0
	CUIS119	65.9	6.0	2.6	57.0	37.0	72.0	28.0
	CUIS120	34.4	6.0	1.5	94.0	112.0	64.0	23.0
	CUIS121	34.5	11.0	6.5	168.0	37.0	63.0	21.0
	CUIS122	54.4	6.0	1.5	37.0	36.0	68.0	28.0
	CUIS125	5.6	12.0	11.8	299.0	9.0	75.0	16.0
	CUIS126	34.8	8.0	0.4	10.0	20.0	78.0	29.0
	CUIS127	9.8	3.0	1.3	24.0	27.0	71.0	21.0
	CUIS128	43.1	12.0	0.7	91.0	112.0	65.0	22.0
	CUIS130	24.0	17.0	3.0	31.0	50.0	67.0	10.0
	CUIS131	9.9	6.0	3.2	59.0	59.0	75.0	23.0
	CUIS132	28.9	14.0	1.9	73.0	112.0	72.0	18.0
	CUIS133	28.4	14.0	2.7	52.0	46.0	54.0	21.0
	CUIS134	23.7	12.0	4.4	102.0	18.0	75.0	20.0
	CUIS135	1.1	4.0	5.4	115.0	52.0	74.0	5.0

Table 4 (continued). Woody stem abundance and canopy metrics on Southeast Coast Network vegetation plots located in Cumberland Island National Seashore [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	CUIS137	6.2	5.0	2.9	64.0	35.0	66.0	21.0
	CUIS138	23.7	7.0	2.6	75.0	40.0	61.0	21.0
	CUIS141	21.6	5.0	1.3	22.0	7.0	68.0	20.0
	CUIS142	25.9	10.0	2.2	49.0	36.0	59.0	15.0
	CUIS143	33.0	3.0	8.1	249.0	34.0	71.0	24.0
	CUIS144	8.3	4.0	2.1	111.0	176.0	67.0	16.0
	CUIS145	52.8	15.0	0.3	5.0	23.0	36.0	6.0
	CUIS146	48.9	12.0	1.5	57.0	34.0	68.0	17.0
	CUIS147	74.2	11.0	2.0	38.0	105.0	69.0	24.0
	CUIS148	33.6	16.0	1.9	37.0	63.0	63.0	16.0
	CUIS149	26.3	8.0	2.8	53.0	96.0	62.0	24.0
	CUIS150	31.1	12.0	3.9	53.0	37.0	68.0	19.0
	CUIS151	38.0	7.0	1.5	44.0	72.0	62.0	22.0
	CUIS153	21.3	6.0	2.5	27.0	15.0	70.0	20.0
	CUIS154	30.9	11.0	2.7	39.0	57.0	65.0	21.0
	CUIS155	61.4	3.0	5.2	114.0	134.0	69.0	24.0
	CUIS157	0.0	0.0	7.7	91.0	87.0	53.0	4.0
	CUIS158	10.1	4.0	4.5	113.0	15.0	58.0	19.0
	average	31.8	9.0	3.1	72.6	52.9	65.3	19.8
	standard deviation	24.4	5.6	2.3	59.4	38.1	7.7	6.0

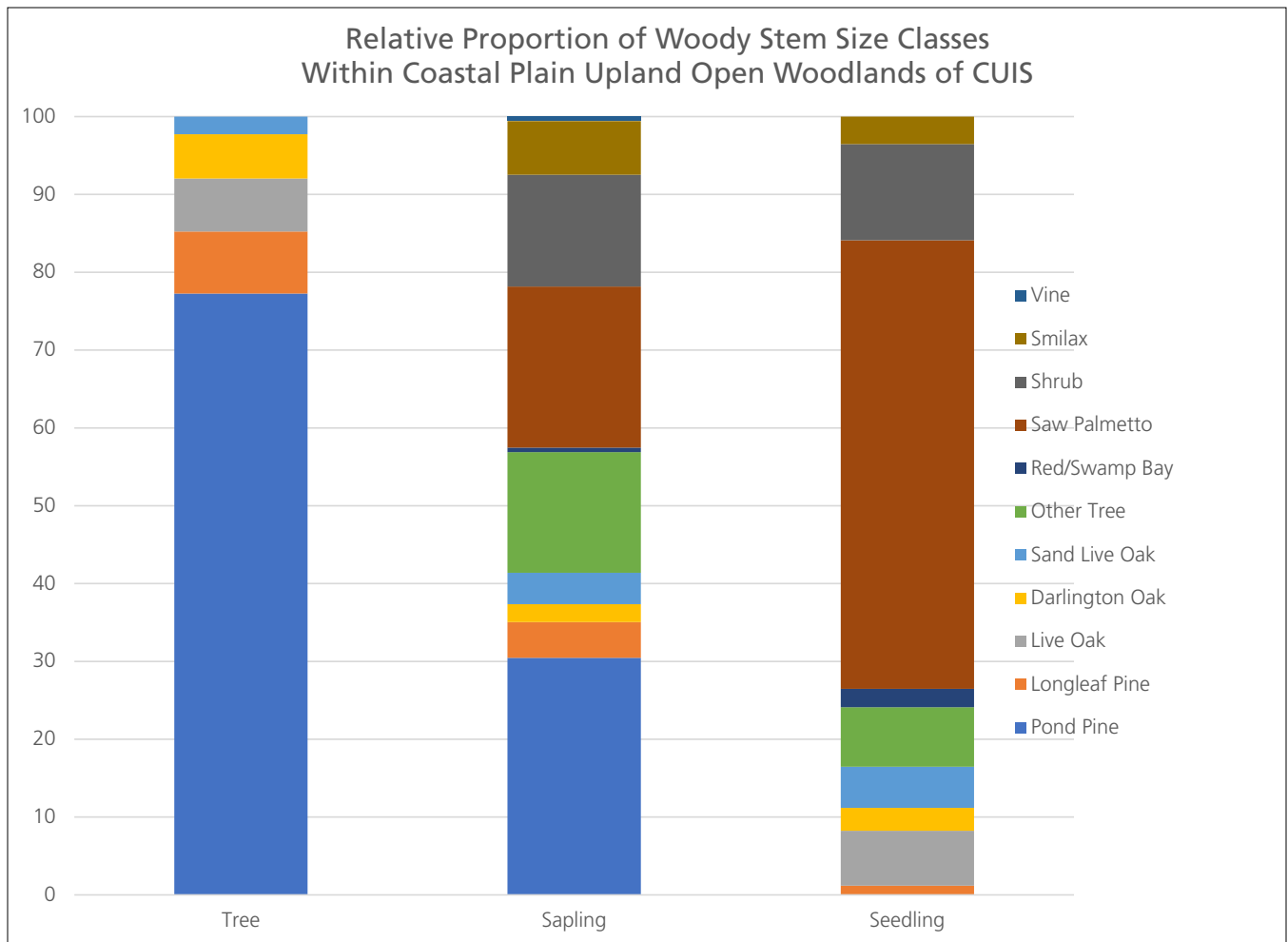


Figure 4. Relative proportion of species groups across three woody stem strata—trees, saplings, and seedlings— within Coastal Plain Upland Open Woodland vegetation monitoring plots of Cumberland Island National Seashore.

Health Condition of Trees Observed at Coastal Plain Upland Open Woodland Sites of CUIS

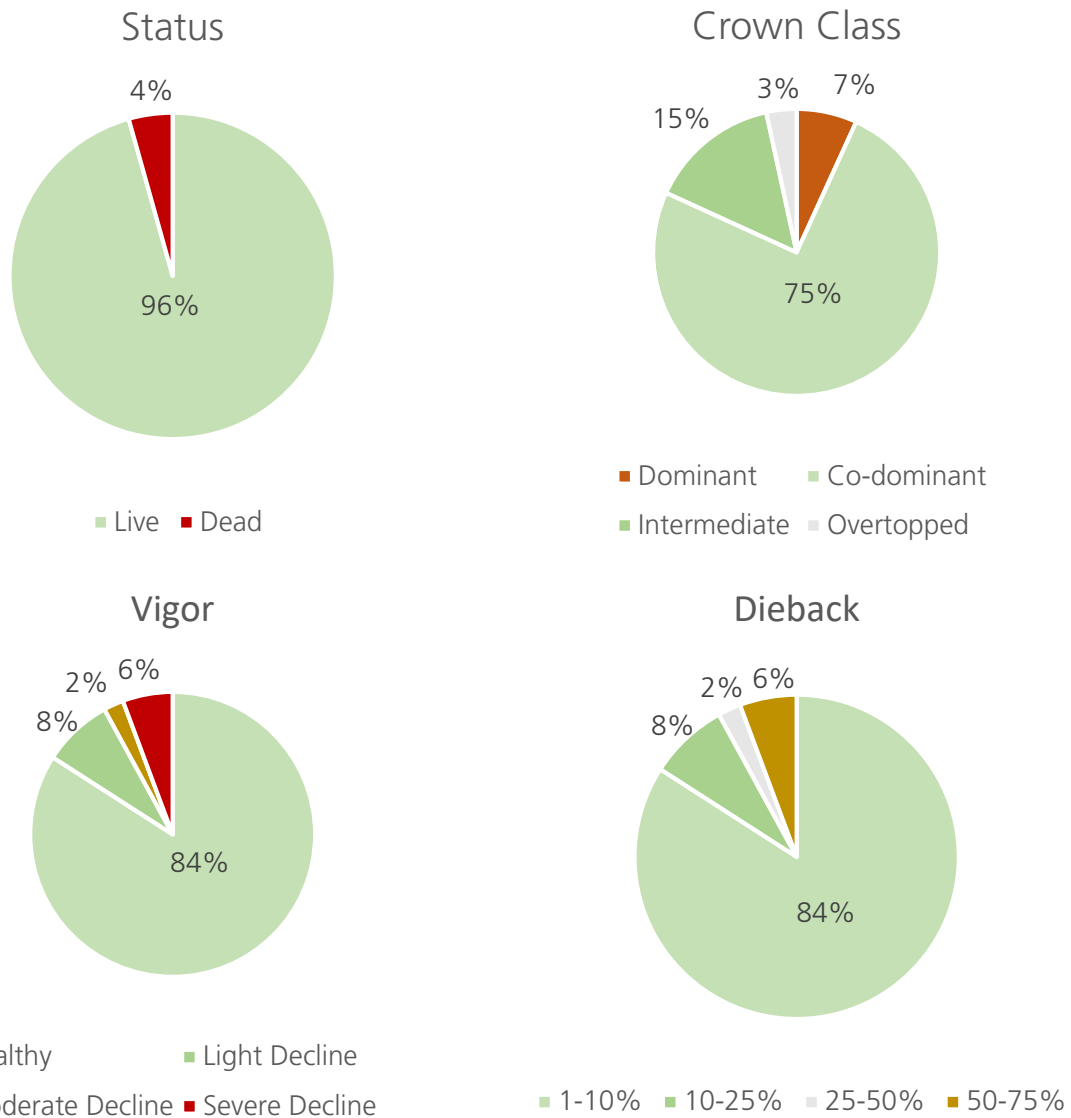


Figure 5. Health status of woody stems greater than or equal to 10 centimeters (3.9 in) DBH ('trees') measured on Coastal Plain Upland Open Woodland vegetation monitoring plots of Cumberland Island National Seashore.

Disturbance and Threats

All plots within this broadly defined habitat were located in the footprint of the 2019 Whitney Fire (Table 5). This wildfire was ignited by a lightning strike during the early morning of June 29, 2019 within the Wilderness Area of Cumberland Island National Seashore and burned 441 acres across the island's north end (NPS 2019). One potential threat to the persistence of open pine flatwoods on Cumberland Island is the lack of longleaf pine recruitment (Allen et al. 2018). In the two pine flatwoods plots sampled during this monitoring

effort (CUIS136 and CUIS 152), longleaf pine occupied 35% of the relative frequency of tree-sized woody stems, but only 4% of frequency of seedlings. Alternatively, live oak seedling frequency was 43%. Although the historical distribution of pine woodlands within the matrix maritime forests of Cumberland Island is uncertain, our data (from two plots) suggest that fire will be needed to control competing vegetation (e.g., live oak, other shrubs, saw palmetto) in order to release fire-adapted longleaf pine if park management desires to promote these flatwoods on the island.

Table 5. Disturbance observations and abundance (%cover) measured on vegetation monitoring plots in Cumberland Island National Seashore.

Broadly Defined Habitat	Plot	Feral Hog Damage	Heavy Browse	Heavy Erosion	Historic Fire (> 1 Year)	Historic Homesite	Mastication	Pasture Evidence	Plowing Evidence	Recent Fire (< 1 Year)	Salt Intrusion	Trash	Windthrow
Coastal Plain Upland Open Woodlands	CUIS003	—	—	—	—	—	—	—	—	100	—	—	—
	CUIS005	—	—	—	—	—	—	—	—	100	—	—	—
	CUIS136	—	—	—	—	—	—	—	—	100	—	—	—
	CUIS152	—	—	—	—	—	—	—	—	100	—	—	—
Maritime Open Upland Grassland Vegetation	CUIS065	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS066	—	—	—	—	—	—	—	—	—	—	10	—
	CUIS067	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS068	—	—	—	—	—	—	—	—	—	—	—	—
Maritime Upland Forests and Shrublands	CUIS097	—	—	100	—	—	—	—	—	—	—	—	—
	CUIS098	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS099	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS100	—	100	—	—	—	—	—	—	—	—	—	—
	CUIS101	—	70	—	—	—	—	—	—	—	—	—	—
	CUIS102	—	—	—	—	—	—	—	—	—	80	—	—
	CUIS103	—	—	—	—	—	—	—	—	—	—	—	100
	CUIS104	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS106	—	—	—	—	—	—	—	—	—	—	—	10
	CUIS107	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS109	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS110	—	—	—	—	—	—	100	—	—	—	—	—
	CUIS111	10	—	—	—	—	—	100	—	—	—	—	40
	CUIS114	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS115	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS117	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS119	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS120	—	—	—	—	—	—	—	—	—	—	—	20
	CUIS121	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS122	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS125	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS126	—	—	—	—	—	—	100	—	—	—	—	—
	CUIS127	—	—	—	—	—	—	—	—	—	—	—	—
	CUIS128	—	—	—	—	—	—	100	—	—	—	—	—

Table 5 (continued). Disturbance observations and abundance (%cover) measured on vegetation monitoring plots in Cumberland Island National Seashore.

[illegible]

Geomorphology and Soil

Plots located within Coastal Plain Upland Open Woodlands of Cumberland Island National Seashore occurred on flat (0 degree) landforms with straight shapes (terrain shape indices = 0 (Table 6). Plot CUIS003 was observed with standing water throughout the plot while the other three plots of this habitat type were dry (Table 6). It should be noted that these ecosystems can occasionally flood during extreme storm

events. Coastal Plain Upland Open Woodland soils were acidic and had the highest amount of available aluminum than any other habitat sampled on the park during this monitoring event (Table 7). Overall, soils from these plots had low nutrient available, low organic matter content, and low cation exchange capacity—soil characteristics equal to those described for northern Florida pine flatwoods in Abrahamson and Hartnett (1990).

Table 6. Local landform and hydrologic condition from vegetation monitoring plots at Cumberland Island National Seashore.

Broadly Defined Habitat	Plot	Slope (°)	Aspect (°)	TSI ¹ (°)	Landform Type	Water Source	Submerged (%)
Coastal Plain Upland Open Woodlands	CUIS003	0	–	0	flat plain	Permanent water	100
	CUIS005	0	–	0	flat plain	None	0
	CUIS136	0	–	0	flat plain	None	0
	CUIS152	0	–	0	flat plain	None	0
Maritime Open Upland Grassland Vegetation	CUIS065	–	–	–	rolling upland	Flood zones	0
	CUIS066	–	–	–	rolling upland	None	0
	CUIS067	–	–	–	rolling upland	None	0
	CUIS068	–	–	–	rolling upland	Flood zones	0
Maritime Upland Forests and Shrublands	CUIS097	0	–	0	flat plain	Flood zones	0
	CUIS098	0	–	0	flat plain	None	0
	CUIS099	0	–	0	flat plain	None	0
	CUIS100	0	–	0	flat plain	None	0
	CUIS101	0	–	0	flat plain	None	0
	CUIS102	0	–	0	flat plain	Flood zones	0
	CUIS103	0	–	0	flat plain	None	0
	CUIS104	0	–	0	flat plain	Flood zones	0
	CUIS106	0	–	0	flat plain	None	0
	CUIS107	0	–	0	flat plain	None	0
	CUIS109	0	–	0	flat plain	None	0
	CUIS110	0	–	0	flat plain	None	0
	CUIS111	0	–	0	flat plain	None	0
	CUIS114	0	–	0	flat plain	None	0
	CUIS115	0	–	0	flat plain	None	0
	CUIS117	0	–	0	flat plain	None	0
	CUIS119	0	–	0	flat plain	None	0
	CUIS120	0	–	0	flat plain	None	0
	CUIS121	0	–	0	flat plain	None	0
	CUIS122	0	–	0	flat plain	None	0
	CUIS125	0	–	0	flat plain	None	0
	CUIS126	0	–	0	flat plain	None	0
	CUIS127	0	–	0	flat plain	None	0
	CUIS128	0	–	0	flat plain	None	0
	CUIS130	0	–	0	flat plain	None	0
	CUIS131	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 6 (continued). Local landform and hydrologic condition from vegetation monitoring plots at Cumberland Island National Seashore.

Broadly Defined Habitat	Plot	Slope (°)	Aspect (°)	TSI ¹ (°)	Landform Type	Water Source	Submerged (%)
Maritime Upland Forests and Shrublands	CUIS132	0	–	0	flat plain	None	0
	CUIS133	0	–	0	flat plain	None	0
	CUIS134	0	–	0	flat plain	None	0
	CUIS135	–	–	–	rolling upland	None	0
	CUIS137	–	–	–	seep/swale	Other water	10
	CUIS138	0	–	0	flat plain	None	0
	CUIS141	0	–	0	flat plain	None	0
	CUIS142	0	–	0	flat plain	None	0
	CUIS143	0	–	0	flat plain	None	0
	CUIS144	0	–	0	flat plain	Flood zones	0
	CUIS145	–	–	–	rolling upland	None	0
	CUIS146	0	–	0	flat plain	None	0
	CUIS147	0	–	0	flat plain	None	0
	CUIS148	0	–	0	flat plain	None	0
	CUIS149	0	–	0	flat plain	None	0
	CUIS150	0	–	0	flat plain	None	0
	CUIS151	0	–	0	flat plain	None	0
	CUIS153	0	–	0	flat plain	None	0
	CUIS154	0	–	0	flat plain	None	0
	CUIS155	0	–	0	flat plain	Flood zones	0
	CUIS157	0	–	0	flat plain	None	0
	CUIS158	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 Cumberland Island National Seashore. 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
Coastal Plain Upland Open Woodlands	CUIS003	7.62	4.3	6.560	34.0	362.0	44.0	27.0	48.0	0.001	75.0	0.1	0.001	0.20	706.0
	CUIS005	10.00	4.3	7.990	15.0	402.0	109.0	34.0	49.0	0.001	119.0	1.0	0.001	0.20	315.0
	CUIS136	5.27	4.3	3.490	24.0	271.0	26.0	13.0	21.0	0.240	152.0	1.0	0.001	0.20	789.0
	CUIS152	4.79	4.5	2.680	15.0	298.0	18.0	14.0	18.0	0.001	105.0	0.1	0.001	0.20	862.0
	average	6.90	4.4	5.200	22.0	333.3	49.3	22.0	34.0	0.100	112.8	0.6	0.000	0.20	668.0
	standard deviation	2.40	0.1	2.500	9.1	59.6	41.3	10.2	16.8	0.100	32.0	0.5	0.000	0.00	243.8
Maritime Open Upland Grassland Vegetation	CUIS065	2.91	5.9	0.220	106.0	381.0	29.0	7.0	13.0	0.001	138.0	4.0	0.001	0.90	86.0
	CUIS066	2.75	6.3	0.001	126.0	353.0	53.0	8.0	22.0	0.001	168.0	6.0	0.001	0.63	67.0
	CUIS067	2.75	6.4	0.360	99.0	298.0	84.0	17.0	31.0	0.210	218.0	2.0	0.001	1.17	85.0
	CUIS068	4.47	7.8	0.590	56.0	724.0	68.0	12.0	22.0	0.250	170.0	6.0	0.001	0.80	56.0
	average	3.20	6.6	0.300	96.8	439.0	58.5	11.0	22.0	0.100	173.5	4.5	0.000	0.90	73.5
	standard deviation	0.80	0.8	0.200	29.5	193.1	23.4	4.5	7.3	0.100	33.1	1.9	0.000	0.20	14.6
Maritime Upland Forests and Shrublands	CUIS097	17.62	6.2	7.340	18.0	2020.0	459.0	51.0	122.0	0.840	119.0	19.0	0.270	0.76	38.0
	CUIS098	7.72	4.5	2.450	13.0	456.0	44.0	27.0	25.0	0.001	19.0	2.0	0.001	0.62	85.0
	CUIS099	4.86	4.3	3.230	61.0	230.0	33.0	15.0	23.0	0.240	246.0	10.0	0.001	0.20	826.0
	CUIS100	2.08	5.0	2.680	34.0	118.0	29.0	24.0	22.0	0.001	82.0	1.0	0.001	0.40	241.0
	CUIS101	15.45	5.7	8.830	120.0	1883.0	138.0	47.0	29.0	0.670	107.0	4.0	0.290	2.57	346.0
	CUIS102	7.78	4.2	5.940	16.0	244.0	100.0	40.0	41.0	0.001	199.0	1.0	0.001	0.43	178.0
	CUIS103	4.08	4.4	7.630	21.0	138.0	63.0	29.0	26.0	0.001	56.0	0.1	0.001	1.40	142.0
	CUIS104	22.24	5.7	11.400	193.0	2325.0	345.0	30.0	228.0	1.050	871.0	4.0	0.001	0.20	174.0
	CUIS106	6.05	4.4	3.650	20.0	313.0	45.0	20.0	21.0	0.001	59.0	1.0	0.001	0.41	143.0
	CUIS107	10.05	4.2	10.640	19.0	291.0	150.0	70.0	30.0	0.001	43.0	2.0	0.001	2.08	132.0
	CUIS109	10.06	4.0	0.001	17.0	297.0	93.0	45.0	46.0	0.001	21.0	0.1	0.001	1.35	132.0
	CUIS110	6.63	4.3	2.600	56.0	340.0	33.0	18.0	26.0	0.210	208.0	1.0	0.001	0.46	814.0
	CUIS111	3.26	4.6	1.030	40.0	194.0	23.0	10.0	18.0	0.001	88.0	6.0	0.001	0.20	249.0
	CUIS114	8.45	3.8	8.870	15.0	166.0	87.0	56.0	60.0	0.001	32.0	0.1	0.001	1.13	147.0
	CUIS115	4.38	4.8	3.210	40.0	286.0	36.0	26.0	22.0	0.001	166.0	2.0	0.001	0.20	428.0
	CUIS117	13.61	3.6	11.870	20.0	237.0	141.0	70.0	67.0	0.001	30.0	1.0	0.230	1.27	137.0

¹ Anions (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).

Table 7 continued. Soil nutrient status from vegetation monitoring plots at Cumberland Island National Seashore. 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	CUIS119	9.27	4.2	12.360	22.0	335.0	103.0	37.0	35.0	0.001	21.0	0.1	0.001	1.91	180.0
	CUIS120	7.95	4.0	4.220	40.0	328.0	31.0	16.0	22.0	0.001	145.0	2.0	0.001	0.20	490.0
	CUIS121	4.62	4.7	2.310	16.0	268.0	46.0	30.0	22.0	0.001	47.0	3.0	0.001	0.44	149.0
	CUIS122	8.91	4.0	10.490	25.0	295.0	69.0	41.0	29.0	0.001	51.0	0.1	0.001	0.20	94.0
	CUIS125	14.63	4.1	21.090	19.0	489.0	146.0	77.0	48.0	0.001	26.0	2.0	0.001	1.12	158.0
	CUIS126	6.82	4.0	2.660	88.0	266.0	33.0	16.0	23.0	0.001	294.0	0.1	0.001	0.20	608.0
	CUIS127	4.84	4.7	1.860	22.0	318.0	31.0	22.0	18.0	0.001	40.0	0.1	0.001	0.41	152.0
	CUIS128	4.62	4.5	1.600	99.0	254.0	33.0	11.0	27.0	0.001	362.0	1.0	0.001	0.47	90.0
	CUIS130	8.63	4.1	8.040	21.0	303.0	78.0	49.0	25.0	0.001	37.0	0.1	0.001	1.33	164.0
	CUIS131	2.59	4.5	1.970	47.0	137.0	19.0	15.0	15.0	0.220	221.0	3.0	0.001	0.20	447.0
	CUIS132	4.89	4.5	5.080	15.0	218.0	61.0	25.0	29.0	0.001	51.0	3.0	0.001	0.57	94.0
	CUIS133	8.87	4.3	5.750	20.0	365.0	92.0	42.0	36.0	0.001	16.0	0.1	0.001	1.30	99.0
	CUIS134	9.59	3.9	7.950	19.0	275.0	92.0	40.0	22.0	0.001	24.0	0.1	0.001	0.61	148.0
	CUIS135	9.90	4.3	4.500	22.0	487.0	67.0	22.0	32.0	0.230	208.0	5.0	0.001	0.86	57.0
	CUIS137	4.65	4.7	5.900	10.0	245.0	56.0	20.0	38.0	0.001	30.0	3.0	0.001	0.92	41.0
	CUIS138	5.12	4.8	3.410	44.0	381.0	21.0	16.0	21.0	0.280	165.0	1.0	0.001	0.20	1065.0
	CUIS141	5.60	4.1	1.830	16.0	230.0	36.0	15.0	16.0	0.001	113.0	2.0	0.001	0.41	212.0
	CUIS142	3.01	4.7	2.270	26.0	145.0	45.0	21.0	18.0	0.001	174.0	1.0	0.001	0.20	295.0
	CUIS143	10.45	3.7	5.260	13.0	333.0	55.0	24.0	26.0	0.001	41.0	1.0	0.001	0.51	170.0
	CUIS144	5.63	4.9	2.010	17.0	322.0	87.0	25.0	36.0	0.001	121.0	5.0	0.270	0.94	45.0
	CUIS145	3.22	5.7	0.770	81.0	353.0	41.0	6.0	30.0	0.001	157.0	2.0	0.001	0.51	78.0
	CUIS146	5.45	5.0	4.760	26.0	353.0	65.0	19.0	55.0	0.210	356.0	1.0	0.001	0.61	75.0
	CUIS147	6.11	5.7	2.260	94.0	728.0	58.0	13.0	27.0	0.460	157.0	22.0	0.220	5.97	821.0
	CUIS148	6.90	4.9	3.110	18.0	480.0	58.0	22.0	44.0	0.280	46.0	3.0	0.001	1.03	113.0
	CUIS149	6.03	4.0	5.030	13.0	165.0	58.0	36.0	33.0	0.001	38.0	2.0	0.001	0.80	85.0
	CUIS150	5.43	4.5	1.890	47.0	310.0	32.0	16.0	30.0	0.300	225.0	2.0	0.001	0.20	494.0
	CUIS151	5.44	4.7	2.390	29.0	361.0	32.0	26.0	21.0	0.290	126.0	4.0	0.001	0.54	214.0
	CUIS153	5.20	4.7	1.980	9.0	341.0	36.0	14.0	21.0	0.001	9.0	0.1	0.001	0.20	114.0
	CUIS154	2.49	4.2	4.280	30.0	78.0	26.0	24.0	18.0	0.001	91.0	0.1	0.001	0.20	328.0

¹ Anions (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).

Table 7 continued. Soil nutrient status from vegetation monitoring plots at Cumberland Island National Seashore. 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	CUIS155	12.13		4.2	12.92	21.0	517.0	95.0	29.0	43.0	0.001	53.0	1.0	0.001	0.65	212.0
	CUIS157	3.94		4.2	3.35	8.0	145.0	38.0	21.0	20.0	0.001	13.0	0.1	0.001	0.48	59.0
	CUIS158	3.65		4.6	3.89	30.0	169.0	45.0	33.0	26.0	0.001	53.0	3.0	0.001	0.93	279.0
	average	7.30		4.5	5.20	35.6	406.9	75.1	29.2	35.7	0.100	122.0	2.7	0.000	0.80	246.7
	standard deviation	4.10		0.6	4.10	34.4	453.9	77.7	16.2	33.3	0.200	142.7	4.2	0.100	0.90	234.0

¹ Anions (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).

Maritime Open Upland Grasslands

Maritime Open Upland Grasslands of Cumberland Island National Seashore include vegetated areas along coastal foredunes and backdunes adjacent to the open beach as well as occasional non-forested zones within older dune complexes located further inland (Figure 6). These sites are strongly influenced by shifting sands and high levels of salt spray from the adjacent ocean. Plants that colonize these sites are typically short-lived and salt-tolerant. The primary grass that stabilizes these maritime dunes is sea oats, which produces many adventitious roots from the main culm that capture sand and allow dunes to form. Other grasses that serve to stabilize dunes within the park include bitter panicgrass, red lovegrass (*Eragrostis oxylepis*), and sanddune sandbur (Zomlefer et al. 2008). Backdune vegetation includes graminoid (grasses, sedges, rushes)-dominated ‘meadows’ with occasional pockets of forbs typical of foredunes; many of these sites have been heavily impacted by horse browsing (Zomlefer et al. 2008). 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. Vegetation associations sampled at Cumberland Island National Seashore that belong to this broadly defined habitat type include (descriptions from NatureServe 2022):

- Sea-oats Dune Grassland (CEGL004040; 2 plots): The characteristic foredune vegetation community along the southeast Atlantic Coast and dominated by sea-oats. (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)
- Southern Atlantic Interdune Swale (CEGL004051; 2 plots: Moist interdune flats subject to saturation or shallow flooding by seasonally high water tables co-dominated by sweet grass (*Muhlenbergia sericea*), saltmeadow cordgrass (*Spartina patens*), and pinewoods fingergrass (*Eustachys petraea*). (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)



Figure 6. Four plots within Maritime Open Upland Grassland habitat were sampled during this monitoring event. NPS photo/ SECN staff.

Species Diversity and Abundance

Native species richness ranged from 16 to 34 (mean = 25.8) within vegetation plots of this broadly defined habitat type, and two plots were observed with a single non-native species present (Table 3). Herbaceous and graminoid diversity across all spatial scales—full plot to 1 square meter (10.8 ft²)—was higher in this habitat type than other types sampled during this monitoring effort. Forty-nine vascular plant species were found collectively within these four plots, including 16 that were only found in this broadly defined habitat (Appendix B, Table B-1). A complete species list, along with constancy and average cover per species, is located in Appendix B, Table B-1. Species with high constancy are listed below, by growth form (Appendix B, Table B-1):

Shrubs

- Wax-myrtle (75%)

Vines

- Saw greenbrier (*S. auriculata*; 100%)

Herbs/Forbs/Graminoids

- Sea oats (100%)
- Gulf croton (*Croton punctatus*; 100%)
- Harper's searocket (*Cakile harperi*; 100%)
- Sanddune sandbur (100%)
- Red lovegrass (100%)
- Canadian horseweed (*Erigeron pusillus*; 100%)
- Camphorweed (*Heterotheca subaxillaris*; 100%)
- Poorjoe (*Hexasepalum teres*; 100%)
- Seabeach evening primrose (*Oenothera humifusa*; 100%)

Most of the vascular plant species observed in these plots are common throughout dune habitats of Georgia.

Woody Stem Metrics

There were no tree-sized woody stems measured in any of these four plots, and overall woody stems were not a major component of this broadly defined habitat (Table 4). Sapling-sized species that were present included wax-myrtle, saw greenbrier, and tough bully (Appendix B, Table B-2).

Disturbance and Threats

There were essentially no observed disturbances and threats

within these plots during this monitoring effort (Table 5). However, it should be noted that the low abundance of characteristic graminoids (e.g., sweet grass and saltmeadow cordgrass) within the two Southern Atlantic Interdune Swale plots could be an effect of excessive grazing by horses.

Geomorphology and Soil

Plots located within Maritime Open Uplands of Cumberland Island National Seashore occurred on landforms with varying slope steepness, aspect, and shape (Table 6). Flood zones were evident in plots belonging to the Southern Atlantic Interdune Swale vegetation association, although no water was present when they were sampled. Soils within these plots ranged from slightly acidic to slightly alkaline and had overall low nutrient availability (Table 7).

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 7). 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. On Cumberland Island, like other barrier islands of the South Atlantic coast, forests dominated by large diameter live oaks represent the later stages of succession (Zomlefer et al. 2008). However, due to widespread logging and land clearing for agriculture across the island over the past 200 years, many of Cumberland Island's maritime forests represent early- to middle-aged secondary successional stage classes (Zomlefer et al. 2008; Ruckdeschel 2019). Representative canopy species in these younger forests include Darlington oak (*Quercus hemisphaerica*), and a mixture of pines (e.g., loblolly [*Pinus taeda*], slash [*Pinus elliottii*], and longleaf). Vegetation associations sampled at Cumberland Island National Seashore that belong to this broadly defined habitat type include (descriptions from NatureServe 2022):

- Florida Coastal Strand (Temperate Palmetto Type) (CEGL003812; 1 plot): This vegetation type includes shrub- and dwarfed tree-dominated scrub occurring in coastal dune environments behind foredunes from Volusia County, Florida to Cumberland Island. (Global Status: G1—Critically Imperiled; State (GA) Status: No Status Rank)



Figure 7. The Maritime Upland Forest and Shrubland habitat was the most dominant broadly defined habitat of Cumberland Island National Seashore monitored during this sampling effort. Forty-eight plots within this habitat were established, and collectively represent a robust range of variation of these forests and shrublands on the island. Pictured above are two flavors of oak-dominated maritime forest—one with substantial saw palmetto in the understory (left) and one with a relatively open understory (right). NPS photos / SECN staff.

- **Northeast Florida Coastal Scrub (CEGL003821; 1 plot):** This ‘coastal scrub’ community occurs as a narrow strip behind foredunes across northeastern Florida to Cape Canaveral; dominant species include sand live oak, myrtle oak (*Quercus myrtifolia*), saw-palmetto, and redbay. (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- **Florida Xeric Oak Scrubland (CEGL003825; 1 plot):** This vegetation type occurs on infertile, well-drained soils dominated by evergreen scrub oaks and maintained by fairly intense, but patchy, fire every 10–25 years. (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)
- **Dry Live Oak Hammock (CEGL004408; 6 plots):** This association occurs on dry to slightly mesic sandy uplands co-dominated by live oak, Darlington oak, and occasionally water oak (*Quercus nigra*); saw palmetto can be a dominant species of the shrub stratum. (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)
- **Ruderal Grapevine – Peppervine – Trumpet Creeper Wet Thicket (CEGL004620; 1 plot):** This early successional association occurs throughout the southeastern U.S. following blowdowns (~windthrow), clearcut logging, or other disturbances that significantly open the canopy. (Global Status: No Status Rank; State (GA) Status: No Status Rank)

- Darlington Oak – Mixed Hardwood Upland Forest (CEGL004788; 1 plot): These upland forests occur on dry to mesic soils in fire-protected areas of the southeastern Coastal Plain; dominant canopy species typically include Darlington oak and pignut hickory (*Carya glabra*); typical shrubs include farkleberry and saw palmetto. (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)
- Southeastern Florida Maritime Hammock (CEGL007020; 3 plots): This upland forest community occurs on xeric soils and the canopy is dominated by sand live oak, with occasional myrtle oak and live oak; the shrub stratum is typically very dense, and includes saw palmetto, rusty staggerbush, and devilwood. (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- Xeric Live Oak Hammock (CEGL007028; 1 plot): This association represents xeric forests dominated by live oak and is known to occur on Cumberland Island on younger landscapes of the island’s southern and eastern side, on rolling deep sands of recently colonized dunes, or on the sand ridge west of the Lake Whitney complex (McManamay 2017); yaupon and farkleberry are frequently present in the shrub layer. (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- Maritime Live Oak Hammock (CEGL007032; 30 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. On Cumberland Island, these maritime forests are strongly dominated by live oak, but also include pines (loblolly and/or slash) and Darlington oak (McManamay 2017). (Global Status: G2—Imperiled; State (GA) Status: No Status Rank)
- Southern Red-cedar – Live Oak – Cabbage Palmetto Marsh Hammock (CEGL007813; 1 plot): This association represents forests and woodlands of flat marsh edges or narrow spits within the marsh, just above or near the high tide line (McManamay 2017). Southern red cedar (*Juniperus virginiana* var. *silicicola*) is typically the canopy dominant, along with live oak, cabbage palmetto (*Sabal palmetto*), and sugarberry (*Celtis laevigata*). (Global Status: G3—Vulnerable; State (GA) Status: No Status Rank)
- Ruderal Loblolly Pine – Sweetgum Forest (CEGL008462; 2 plots): This community represents mid- to late-

successional upland forests dominated by loblolly pine, typically with sparse shrub and herbaceous strata. (Global Status: No Status Rank; State (GA) Status: No Status Rank)

Species Diversity and Abundance

Native species richness ranged from eight to 49 (mean = 22.9) within vegetation plots of this broadly defined habitat type, and six of the plots were observed with at least one non-native species (Table 3). Tree diversity across all spatial scales—full plot to 1 square meter (10.8 ft²)—was higher in this habitat type than other types sampled during this monitoring effort. One hundred seventy-nine vascular plant species were found collectively within these four plots, including 109 that were only found in this broadly defined habitat (Appendix B, Table B-1). The six rare species tracked by the Georgia Department of Natural Resources (GADNR 2022) that were documented during this monitoring effort were found only in Maritime Upland Forest and Shrubland plots; these included sandywoods sedge, green fly orchid, Florida swampprivet, Bartram’s airplant, small ballmoss, and sweet acacia. Conversely, so were the two Category 1 and 2 invasive plants listed by the Georgia Exotic Pest Plant Council (GA-EPPC 2022)—Chinaberrytree and bahiagrass. A complete species list, along with constancy and average cover per species, is located in Appendix B, Table B-1. Species with high constancy are listed below, by growth form (Appendix B, Table B-1):

Trees

- Live oak (96%)
- Redbay (92%)
- Rusty staggerbush (65%)
- Farkleberry (60%)
- American holly (58%)

Shrubs

- Saw palmetto (85%)
- Wax-myrtle (58%)

Vines

- Muscadine (88%)
- Saw greenbrier (*S. auriculata*; 54%)
- Cat greenbrier (*S. glauca*; 52%)

Herbs/Forbs/Graminoids

- Spanish moss (*Tillandsia usneoides*; 92%)
- Resurrection fern (*Pleopeltis michauxiana*; 65%)
- Whip nutrush (*Scleria triglomerata*; 56%)

Woody Stem Metrics

Total basal area (BA) of trees was highly variable within these plots and ranged from 0.0 to 115.1 m²/ha with an overall average of 31.8 m²/ha; density of canopy stems ranged from zero to 28 per plot, with an average of 9.0 (Table 4). Plots with low tree abundance either occurred in openings within matrix maritime forests or in scrub habitat with little to no tree-sized individuals present (Figure 8). Canopy heights were also variable among plots sampled in this broadly defined habitat, ranging from four to 28 meters (average 19.8), and canopy cover ranged from 53 to 80% (average=65.3%; Table 4). The most dominant canopy species was live oak (mean BA = 23.50 m²/ha, mean density = 85/ha) (Appendix B, Table B-2). Sapling density at the 80 square meter scale ranged from five to 299 stems, with an average of 72.6, while seedling density at the 8 meter square scale ranged from seven to 176 stems, with an average of 52.9 across all plots (Table 4). Dominant

sapling species included saw palmetto and rusty staggerbush; dominant seedlings included saw palmetto, live oak, crossvine (*Bignonia capreolata*), and yaupon (Appendix B, Table B-2).

Based on stem count alone, live oak comprised nearly 37% of the relative abundance among species within the tree stratum, while rusty staggerbush, pines (slash, loblolly, and longleaf), sand live oak, and cabbage palmetto each contributed between 10 and 13% (Figure 9). Live oak had a relative abundance of 14% within the seedling stratum, but less than 1% in the sapling stratum; saw palmetto comprised 54% and 23% of the relative abundance in the sapling and seedling strata, respectively (Figure 9).

Most of the measured trees in Maritime Upland Forest and Shrubland plots were living (87%), and the majority of trees were categorized with healthy vigor and minimal dieback (Figure 10). A majority of the dead stems measured were either live oak or redbay. Of the 20 tree-sized redbay trees measured during this monitoring effort, only three were living and these were observed with severely declining vigor (see discussion below under Disturbance and Threats related to redbay decline in response to laurel wilt disease).



Figure 8. Examples of Maritime Upland Forest and Shrubland plots sampled during this monitoring event with little to no tree-sized woody stems. The picture on the left is from a Xeric Oak Scrubland vegetation association on Cumberland Island National Seashore's north end; the picture on the right is from a canopy gap within a surrounding Maritime Live Oak Hammock type. Association names are from NatureServe (2022). NPS photos / SECN staff.

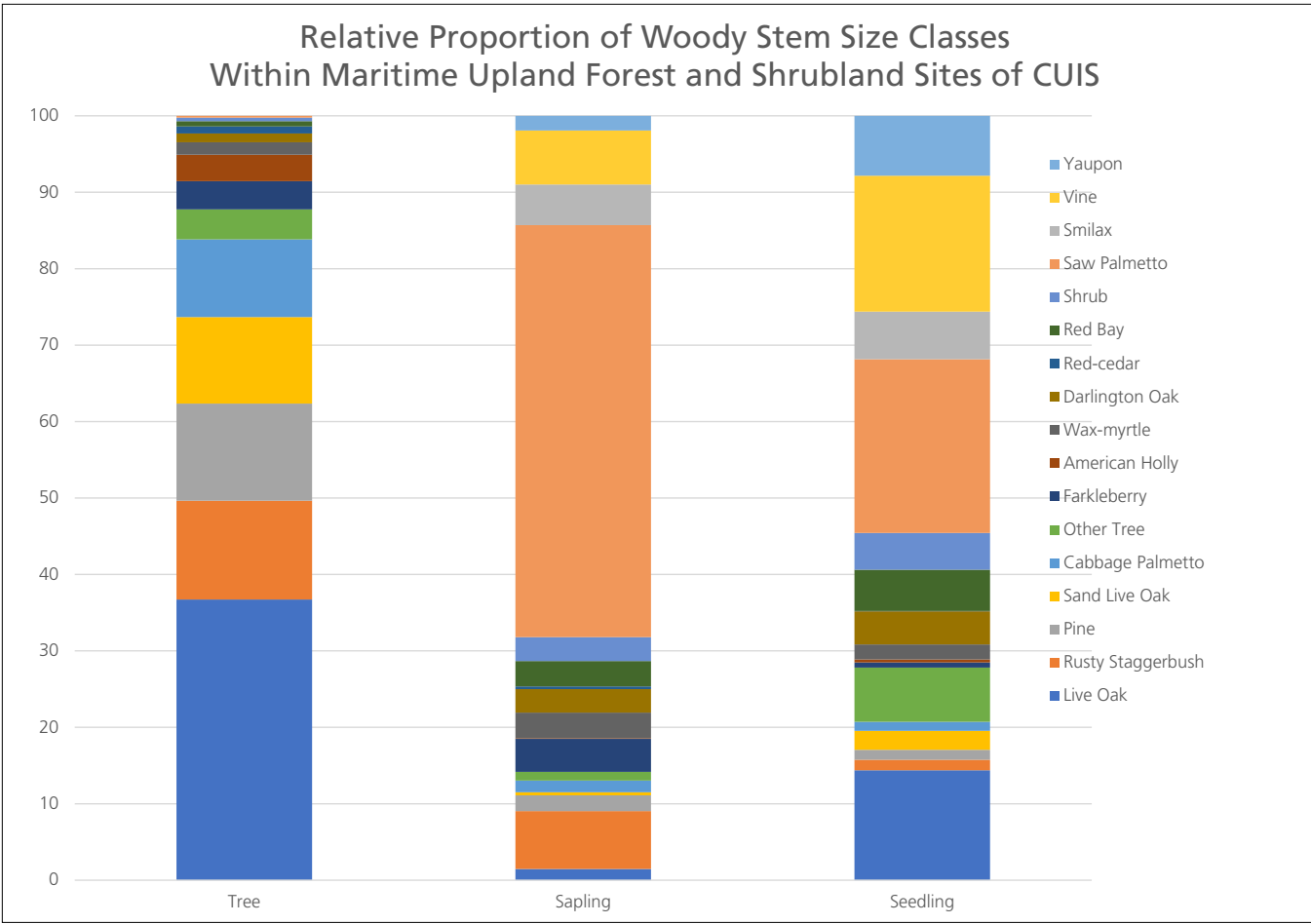


Figure 9. Relative proportion of species groups across three woody stem strata—trees, saplings, and seedlings— within Maritime Upland Forest and Shrubland vegetation monitoring plots of Cumberland Island National Seashore.

Health Condition of Trees Observed at Maritime Upland Forest and Shrubland Sites of CUIS

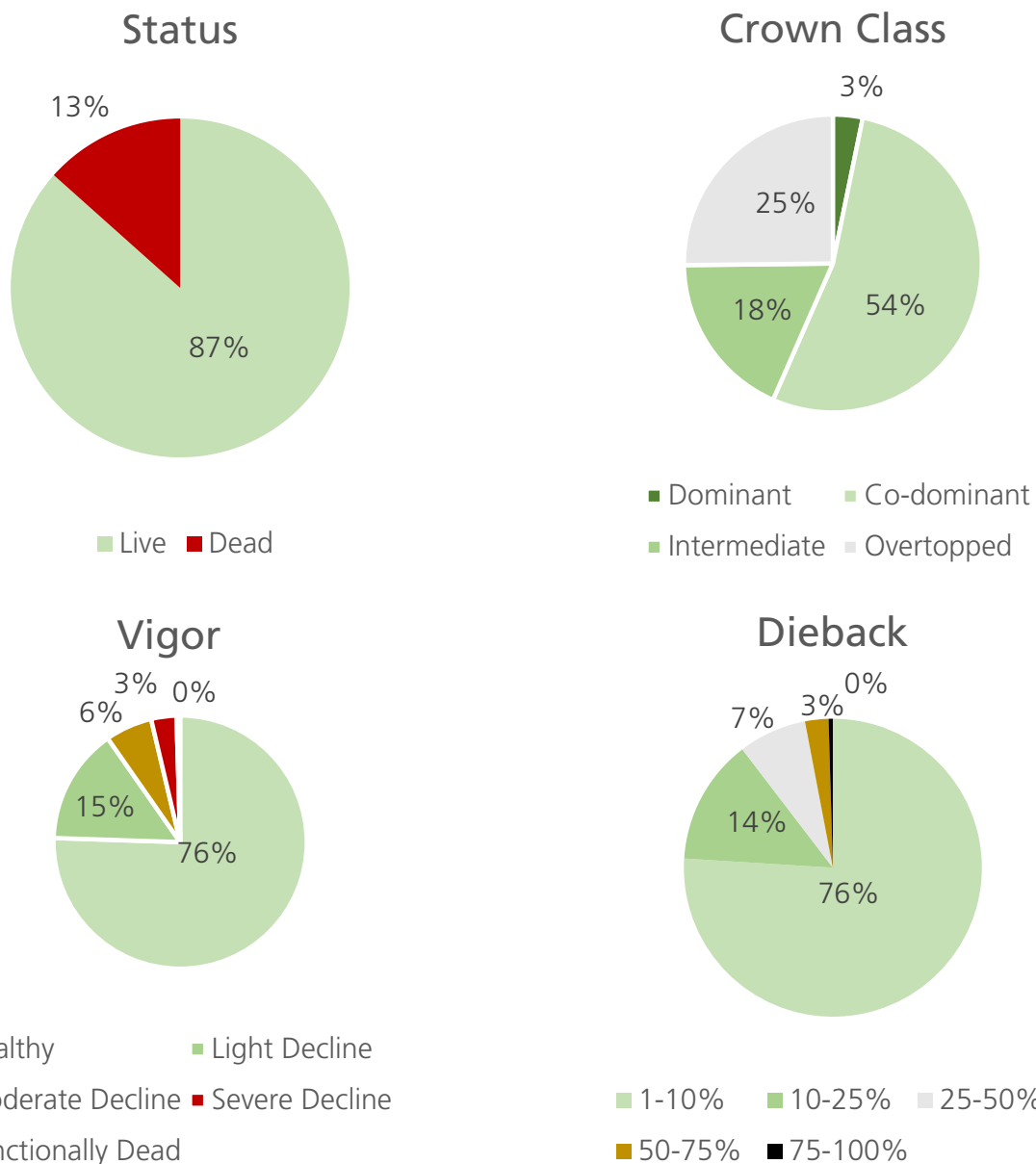


Figure 10. Health status of woody stems greater than or equal to 10 centimeters (3.9 in) DBH ('trees') measured on Maritime Upland Forest and Shrubland vegetation monitoring plots of Cumberland Island National Seashore.

Disturbance and Threats

The most common observable disturbance events in Maritime Upland Forest and Shrubland habitat were recent windfall (seven of 48 plots) and evidence of historic pasture land use (five of 48 plots; Table 5). Although browsing by horses is a noted disturbance in other island ecosystems (e.g., dunes, freshwater wetlands; see Study Area), only three of the 48 plots in Maritime Upland Forest and Shrubland habitat were observed excessively grazed. Other effects of horses, such as soil compaction, nutrient cycling alteration, and erosion were not measured during this monitoring event. Rooting by feral hogs was also minimally observed across these 48 plots.

One of the most significant threats to maritime forests on Cumberland Island, and across the South Atlantic coast, is the loss of redbay—one of the most dominant understory tree species in these communities—due to the invasion of the non-native red bay ambrosia beetle (*Xyleborus glabratus*). The beetle serves as a vector of a fungal plant pathogen (*Raffaelea lauricola*) that causes laurel wilt disease (LWD), with infected trees exhibiting rapid foliage wilt and leaves turning a reddish-brown color (Fraedrich et al. 2008; Figure 11). Declining individuals of redbay in response to LWD were initially detected on Cumberland Island in 2005 or 2006 (Ruckdeschel 2019; USDA 2022b) and mortality has since been very high (Merten 2015). The data collected during this current monitoring effort in 2020 suggest that mortality rates in tree-sized individuals are still high across the island (see Woody Stem Metrics section above), although the abundance of redbay in these plots prior to this baseline survey is unknown. It should be noted that there were high numbers of live sapling- and seedling-sized redbay individuals (Appendix B, Table B-2). Continued monitoring of these plots will determine

whether or not red bay returns as a component within the forest subcanopy of this habitat type within Cumberland Island National Seashore.

Another potential threat to the park's maritime forests is related to oak regeneration. Although live oak is the dominant, charismatic canopy species across Cumberland Island, very little is known about its ability to regenerate. Heavy browsing by white-tailed deer was speculated to be a factor in the suppression of regrowth on the island, with live oak sprouts growing taller in deer-only exclosures than sprouts in horse-exclosures and control areas (Bratton and Kramer 1989). In a study at Cannon's Point Preserve on St. Simons Island, Georgia, deer browse and competing vegetation (e.g., loblolly pine and Darlington oak, both relatively faster growing and shorter lived than live oak) were found to be limiting factors in live oak's ability to regenerate (Thyroff et al. 2019). Our data suggest that live oak is the dominant tree-sized species across Cumberland Island's maritime forests (relative proportion among other woody species = 37%), but only represents less than 2% in the sapling and 14% in the seedling strata. Continued monitoring of these plots will help determine the degree of live oak regeneration trends on the island.

Geomorphology and Soil

Plots located within Maritime Upland Forests and Shrublands of Cumberland Island National Seashore typically occurred on flat (0°) landforms with straight shapes (terrain shape indices = 0) (Table 6). A few of the plots were in noticeable flood zones, although many others have the potential to flood during extreme storm events. Maritime Upland Forest and Shrubland soils were acidic and had highly variable organic matter percentages (Table 7).



Figure 11. All sapling- and tree-sized individuals of redbay measured during this monitoring effort on Cumberland Island National Seashore exhibited symptoms of decline attributed to laurel wilt disease. Note the reddish-brown wilted leaves of this redbay. NPS photo / SECN staff.

Fuel Load Estimates

Fuel loads ranged from 6.0 to 21.0 (average = 17.1) tons/acre (1.3 to 4.7 kg/m²) in Coastal Plain Upland Open Woodland plots and 2.0 to 31.3 (average=11.4) tons/acre (0.5 to 7.0 kg/m²) in Maritime Upland Forest and Shrubland plots (Figures 12 and 13). There was high variability between fuel loads among vegetation plots in the park, even within similar areas and broadly defined habitat types. Variation in fuel loads

among sites is typical and related to differences in live and dead vegetation structure, disturbance history, hydrology, and edaphic conditions. Coarse woody debris (1000-hour fuels) contributed to most of the fuel loads within Coastal Plain Upland Open sites, while duff and litter biomass contributed the most within Maritime Upland Forest and Shrublands sites (Figures 12 and 13).

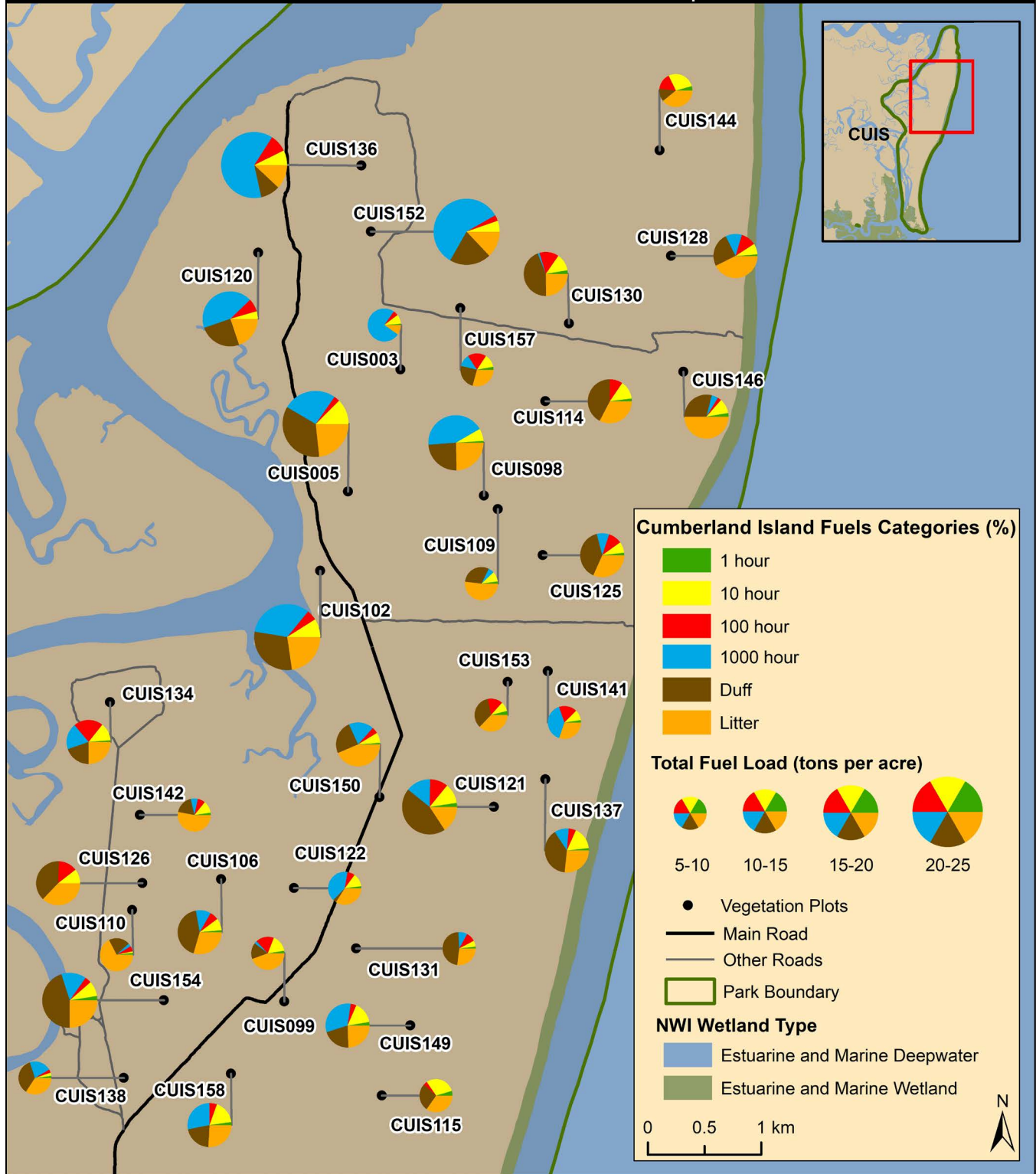


Figure 12. Fuel load estimates from vegetation monitoring plots located at Cumberland Island National Seashore (north).

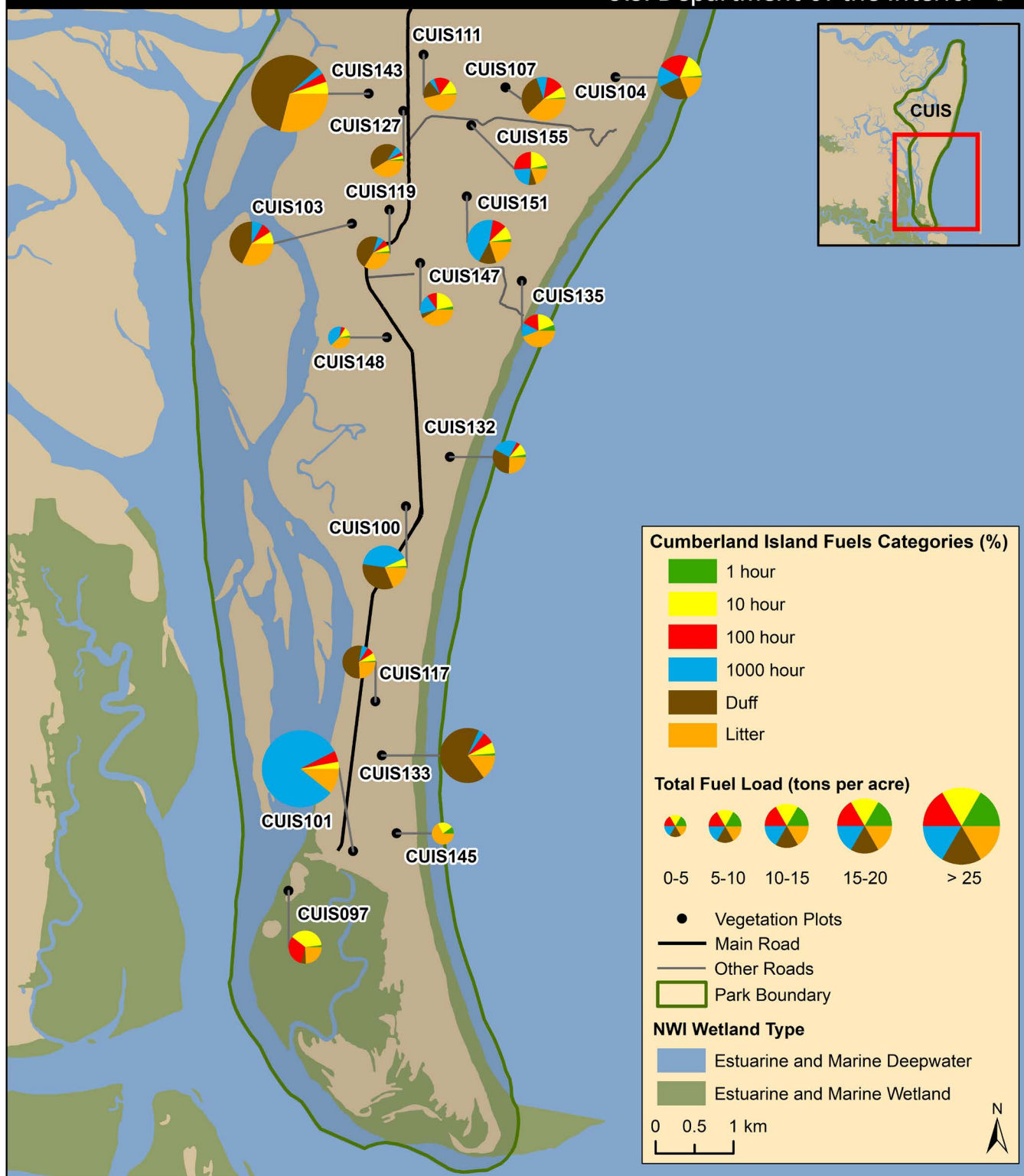


Figure 13. Fuel load estimates from vegetation monitoring plots located at Cumberland Island National Seashore (south).

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Appendix A. Vascular Plants Observed During the 2020 Southeast Coast Network Terrestrial Vegetation Monitoring Effort at Cumberland Island National Seashore

Table A-1. Vascular plant species present in 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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	Aceraceae	<i>Acer rubrum</i>	red maple	Native	Tree	–	–
Asterales	Asteraceae	<i>Ageratina jucunda</i>	hammock snakeroot	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Ambrosia artemisiifolia</i>	annual ragweed	Native	Forb/herb	–	–
Polypodiales	Blechnaceae	<i>Anchistea virginica</i>	Virginia chainfern	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Andropogon</i>	bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon cretaceus</i>	purple bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon dealbatus</i>	chalky bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon gyrans</i>	Elliott's bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon tenuispathes</i>	bushy bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon ternarius</i>	splitbeard bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon virginicus</i>	broomsedge bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon virginicus</i> var. <i>decipiens</i>	broomsedge bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Andropogon virginicus</i> var. <i>virginicus</i>	broomsedge bluestem	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Aristida beyrichiana</i>	Beyrich threeawn	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Aristida lanosa</i>	woollysheath threeawn	Native	Graminoid	–	–
Magnoliales	Annonaceae	<i>Asimina incana</i>	woolly pawpaw	Native	Shrub	–	–
Magnoliales	Annonaceae	<i>Asimina parviflora</i>	smallflower pawpaw	Native	Tree, Shrub	–	–
Caryophyllales	Chenopodiaceae	<i>Atriplex mucronata</i>	crested saltbush	Native	Forb/herb, Shrub, Subshrub	–	–
Ericales	Ericaceae	<i>Bejaria racemosa</i>	flyweed	Native	Shrub	–	–
Scrophulariales	Bignoniaceae	<i>Bignonia capreolata</i>	crossvine	Native	Vine	–	–
Urticales	Urticaceae	<i>Boehmeria cylindrica</i>	smallspike false nettle	Native	Forb/herb	–	–
Capparales	Brassicaceae	<i>Cakile harperi</i>	Harper's searocket	Native	Forb/herb	–	–
Lamiales	Verbenaceae	<i>Callicarpa americana</i>	American beautyberry	Native	Shrub	–	–
Scrophulariales	Bignoniaceae	<i>Campsis radicans</i>	trumpet creeper	Native	Vine	–	–
Cyperales	Cyperaceae	<i>Carex</i>	sedge	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Carex dasycarpa</i>	sandywoods sedge	Native	Graminoid	–	Rare; S3
Cyperales	Cyperaceae	<i>Carex floridana</i>	Florida sedge	Native	Graminoid	–	–

¹ Information obtained from the PLANTS database (USDA 2022a)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 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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	Cyperaceae	<i>Carex longii</i>	Long's sedge	Native	Graminoid	–	–
Scrophulariales	Oleaceae	<i>Cartrema americanum</i>	devilwood	Native	Tree, Shrub	–	–
Juglandales	Juglandaceae	<i>Carya glabra</i>	pignut hickory	Native	Tree	–	–
Urticales	Ulmaceae	<i>Celtis laevigata</i>	sugarberry	Native	Shrub, Tree	–	–
Cyperales	Poaceae	<i>Cenchrus tribuloides</i>	sanddune sandbur	Native	Graminoid	–	–
Apiales	Apiaceae	<i>Centella asiatica</i>	erect centella	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Chasmanthium laxum</i>	slender woodoats	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Chasmanthium sessiliflorum</i>	longleaf woodoats	Native	Graminoid	–	–
Caryophyllales	Chenopodiaceae	<i>Chenopodium album</i>	lambquarters	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Cirsium horridulum</i>	yellow thistle	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Cirsium nuttallii</i>	Nuttall's thistle	Native	Forb/herb	–	–
Sapindales	Rutaceae	<i>Citrus xaurantium</i>	sour orange	Non-native	Shrub, Tree	–	–
Euphorbiales	Euphorbiaceae	<i>Cnidoscolus stimulosus</i>	finger rot	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Coleataenia anceps</i> ssp. <i>rhizomata</i>	beaked panicgrass	Native	Graminoid	–	–
Commelinales	Commelinaceae	<i>Commelina erecta</i>	whitemouth dayflower	Native	Forb/herb	–	–
Solanales	Convolvulaceae	<i>Convolvulus limnophilus</i>	hedge false bindweed	Native	Forb/herb, Vine	–	–
Violales	Cistaceae	<i>Crocanthemum corymbosum</i>	pine barren frostweed	Native	Subshrub, Forb/herb	–	–
Fabales	Fabaceae	<i>Crotalaria rotundifolia</i>	rabbitbells	Native	Forb/herb	–	–
Euphorbiales	Euphorbiaceae	<i>Croton punctatus</i>	gulf croton	Native	Subshrub, Forb/herb	–	–
Cyperales	Cyperaceae	<i>Cyperus</i>	flatsedge	Unknown	Graminoid	–	–
Cyperales	Cyperaceae	<i>Cyperus erythrorhizos</i>	redroot flatsedge	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Cyperus odoratus</i> var. <i>odoratus</i>	fragrant flatsedge	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Cyperus retrorsus</i>	pine barren flatsedge	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Cyperus tetragonus</i>	fourangle flatsedge	Native	Graminoid	–	–
Fabales	Fabaceae	<i>Desmodium incanum</i>	zarzabacoa comun	Non-native	Forb/herb, Subshrub	–	–
Fabales	Fabaceae	<i>Desmodium paniculatum</i> var. <i>paniculatum</i>	panickedleaf ticktrefoil	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Dichanthelium</i>	rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium aciculare</i>	needleleaf rosette grass	Native	Graminoid	–	–

¹ Information obtained from the PLANTS database (USDA 2022a)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 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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>Dichanthelium commutatum</i>	variable panicgrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium dichotomum</i>	cypress panicgrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium ensifolium</i>	cypress panicgrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium oligosanthes</i> var. <i>oligosanthes</i>	Heller's rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium portoricense</i>	hemlock rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium scabriusculum</i>	woolly rosette grass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Dichanthelium strigosum</i>	roughhair rosette grass	Native	Graminoid	–	–
Ebenales	Ebenaceae	<i>Diospyros virginiana</i>	common persimmon	Native	Tree	–	–
Cyperales	Poaceae	<i>Distichlis spicata</i>	saltgrass	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Eleocharis robbinsii</i>	Robbins' spikerush	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Eleocharis vivipara</i>	viviparous spikerush	Native	Graminoid	–	–
Asterales	Asteraceae	<i>Elephantopus nudatus</i>	smooth elephantsfoot	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Elephantopus tomentosus</i>	devil's grandmother	Native	Forb/herb	–	–
Orchidales	Orchidaceae	<i>Epidendrum conopseum</i>	green fly orchid	Native	Forb/herb	–	Unusual; S3
Cyperales	Poaceae	<i>Eragrostis elliottii</i>	field lovegrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Eragrostis oxylepis</i>	red lovegrass	Native	Graminoid	–	–
Asterales	Asteraceae	<i>Erechtites hieraciifolius</i>	American burnweed	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Eremochloa ophiuroides</i>	centipede grass	Non-native	Graminoid	–	–
Asterales	Asteraceae	<i>Erigeron pusillus</i>	Canadian horseweed	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Erigeron quercifolius</i>	oakleaf fleabane	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Eupatorium capillifolium</i>	dogfennel	Native	Forb/herb	–	–
Euphorbiales	Euphorbiaceae	<i>Euphorbia bombensis</i>	dixie sandmat	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Eustachys petraea</i>	pinewoods fingergrass	Native	Graminoid	–	–
Scrophulariales	Oleaceae	<i>Forestiera segregata</i> var. <i>segregata</i>	Florida swampprivet	Native	Shrub, Tree	–	Rare; S2
Fabales	Fabaceae	<i>Galactia elliottii</i>	Elliott's milkpea	Native	Forb/herb, Vine	–	–
Fabales	Fabaceae	<i>Galactia volubilis</i>	downy milkpea	Native	Vine, Forb/herb	–	–
Rubiales	Rubiaceae	<i>Galium bermudense</i>	coastal bedstraw	Native	Forb/herb	–	–
Rubiales	Rubiaceae	<i>Galium obtusum</i> var. <i>filifolium</i>	bluntleaf bedstraw	Native	Forb/herb	–	–

¹ Information obtained from the PLANTS database (USDA 2022a)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 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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
Rubiales	Rubiaceae	<i>Galium pilosum</i>	hairy bedstraw	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Gamochaeta purpurea</i>	spoonleaf purple everlasting	Native	Forb/herb	–	–
Ericales	Ericaceae	<i>Gaylussacia tomentosa</i>	hairytwig huckleberry	Native	Shrub	–	–
Gentianales	Loganiaceae	<i>Gelsemium sempervirens</i>	evening trumpetflower	Native	Vine, Shrub	–	–
Asterales	Asteraceae	<i>Heterotheca subaxillaris</i>	camphorweed	Native	Forb/herb	–	–
Rubiales	Rubiaceae	<i>Hexasepalum teres</i>	poorjoe	Native	Forb/herb	–	–
Rubiales	Rubiaceae	<i>Houstonia procumbens</i>	roundleaf bluet	Native	Forb/herb	–	–
Apiales	Apiaceae	<i>Hydrocotyle bonariensis</i>	largeleaf pennywort	Native	Forb/herb	–	–
Apiales	Apiaceae	<i>Hydrocotyle umbellata</i>	manyflower marshpennywort	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Hymenachne hemitomom</i>	maidencane	Native	Graminoid	–	–
Theales	Clusiaceae	<i>Hypericum cistifolium</i>	roundpod St. Johnswort	Native	Shrub, Forb/herb, Subshrub	–	–
Theales	Clusiaceae	<i>Hypericum hypericoides</i>	St. Andrew's cross	Native	Shrub, Subshrub	–	–
Theales	Clusiaceae	<i>Hypericum mutilum</i>	dwarf St. Johnswort	Native	Forb/herb	–	–
Celastrales	Aquifoliaceae	<i>Ilex ambigua</i>	Carolina holly	Native	Tree, Shrub	–	–
Celastrales	Aquifoliaceae	<i>Ilex coriacea</i>	large gallberry	Native	Shrub, Tree	–	–
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	–	–
Solanales	Convolvulaceae	<i>Ipomoea pandurata</i>	man of the earth	Native	Forb/herb, Vine	–	–
Asterales	Asteraceae	<i>Iva frutescens</i> var. <i>frutescens</i>	Jesuit's bark	Native	Subshrub, Forb/herb	–	–
Juncals	Juncaceae	<i>Juncus coriaceus</i>	leathery rush	Native	Graminoid	–	–
Juncals	Juncaceae	<i>Juncus effusus</i> ssp. <i>solutus</i>	lamp rush	Native	Graminoid	–	–
Juncals	Juncaceae	<i>Juncus megacephalus</i>	bighead rush	Native	Graminoid	–	–
Pinales	Cupressaceae	<i>Juniperus [silicicola + virginiana]</i>	eastern redcedar	Native	Tree	–	–
Asterales	Asteraceae	<i>Krigia virginica</i>	Virginia dwarf dandelion	Native	Forb/herb	–	–
Arales	Lemnaceae	<i>Lemna aequinoctialis</i>	lesser duckweed	Native	Forb/herb	–	–
Capparales	Brassicaceae	<i>Lepidium virginicum</i>	Virginia pepperweed	Native	Forb/herb	–	–
Fabales	Fabaceae	<i>Lespedeza hirta</i>	hairy lespedeza	Native	Forb/herb	–	–

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Table A-1 (continued). Vascular plant species present in 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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
Hamamelidales	Hamamelidaceae	<i>Liquidambar styraciflua</i>	sweetgum	Native	Tree	–	–
Myrtales	Onagraceae	<i>Ludwigia leptocarpa</i>	anglestem primrose-willow	Native	Forb/herb, Subshrub	–	–
Lycopodiales	Lycopodiaceae	<i>Lycopodiella appressa</i>	southern bog clubmoss	Native	Forb/herb, Subshrub	–	–
Ericales	Ericaceae	<i>Lyonia ferruginea</i>	rusty staggerbush	Native	Tree, Shrub	–	–
Ericales	Ericaceae	<i>Lyonia lucida</i>	fetterbush lyonia	Native	Shrub	–	–
Magnoliales	Magnoliaceae	<i>Magnolia grandiflora</i>	southern magnolia	Native	Tree	–	–
Magnoliales	Magnoliaceae	<i>Magnolia virginiana</i>	sweetbay	Native	Shrub, Tree	–	–
Sapindales	Meliaceae	<i>Melia azedarach</i>	Chinaberrytree	Non-native	Shrub, Tree	Category 1	–
Cyperales	Poaceae	<i>Melica mutica</i>	twoflower melicgrass	Native	Graminoid	–	–
Asterales	Asteraceae	<i>Mikania scandens</i>	climbing hempvine	Native	Forb/herb, Vine	–	–
Myricales	Myricaceae	<i>Morella cerifera</i>	wax myrtle	Native	Tree, Subshrub, Shrub	–	–
Cyperales	Poaceae	<i>Muhlenbergia sericea</i>	gulfhairawn muhly	Native	Graminoid	–	–
Rhamnales	Vitaceae	<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	muscadine	Native	Vine	–	–
Rhamnales	Vitaceae	<i>Nekemias arborea</i>	peppervine	Native	Shrub, Vine	–	–
Liliales	Liliaceae	<i>Nothoscordum bivalve</i>	crowpoison	Native	Forb/herb	–	–
Cornales	Cornaceae	<i>Nyssa biflora</i>	swamp tupelo	Native	Tree	–	–
Myrtales	Onagraceae	<i>Oenothera humifusa</i>	seabeach evening primrose	Native	Forb/herb, Subshrub	–	–
Cyperales	Poaceae	<i>Oplismenus setarius</i>	basketgrass	Native	Graminoid	–	–
Caryophyllales	Cactaceae	<i>Opuntia drummondii</i>	cockspur pricklypear	Native	Subshrub, Shrub	–	–
Polypodiales	Osmundaceae	<i>Osmundastrum cinnamomeum</i>	cinnamon fern	Native	Forb/herb	–	–
Geraniales	Oxalidaceae	<i>Oxalis articulata</i>	windowbox woodsorrel	Non-native	Forb/herb	–	–
Geraniales	Oxalidaceae	<i>Oxalis corniculata</i>	creeping woodsorrel	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Panicum amarum</i>	bitter panicgrass	Native	Graminoid	–	–
Rhamnales	Vitaceae	<i>Parthenocissus quinquefolia</i>	Virginia creeper	Native	Vine	–	–
Cyperales	Poaceae	<i>Paspalum</i>	crowngrass	Unknown	Graminoid	–	–
Cyperales	Poaceae	<i>Paspalum notatum</i>	bahiagrass	Non-native	Graminoid	Category 2	–
Cyperales	Poaceae	<i>Paspalum setaceum</i>	thin paspalum	Non-native	Graminoid	–	–
Violales	Passifloraceae	<i>Passiflora lutea</i>	yellow passionflower	Native	Forb/herb, Vine	–	–

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Table A-1 (continued). Vascular plant species present in 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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
Gentianales	Asclepiadaceae	<i>Pottalis palustre</i>	gulf coast swallow-wort	Native	Forb/herb, Vine	–	–
Laurales	Lauraceae	<i>Persea borbonia</i>	redbay	Native	Tree, Shrub	–	–
Laurales	Lauraceae	<i>Persea palustris</i>	swamp bay	Native	Shrub, Tree	–	–
Lamiales	Verbenaceae	<i>Phyla nodiflora</i> var. <i>nodiflora</i>	turkey tangle fogfruit	Native	Forb/herb	–	–
Solanales	Solanaceae	<i>Physalis walteri</i>	Walter's groundcherry	Native	Forb/herb	–	–
Caryophyllales	Phytolaccaceae	<i>Phytolacca americana</i>	American pokeweed	Native	Forb/herb	–	–
Pinales	Pinaceae	<i>Pinus elliotii</i>	slash pine	Native	Tree	–	–
Pinales	Pinaceae	<i>Pinus palustris</i>	longleaf pine	Native	Tree	–	–
Pinales	Pinaceae	<i>Pinus serotina</i>	pond pine	Native	Tree	–	–
Pinales	Pinaceae	<i>Pinus taeda</i>	loblolly pine	Native	Tree	–	–
Cyperales	Poaceae	<i>Piptochaetium avenaceum</i>	blackseed speargrass	Native	Graminoid	–	–
Plantaginales	Plantaginaceae	<i>Plantago virginica</i>	Virginia plantain	Native	Forb/herb	–	–
Polypodiales	Polypodiaceae	<i>Pleopeltis michauxiana</i>	resurrection fern	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Pluchea foetida</i>	stinking camphorweed	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Poaceae</i>	grass	Unknown	Graminoid	–	–
Scrophulariales	Buddlejaceae	<i>Polypremum procumbens</i>	juniper leaf	Native	Forb/herb	–	–
Rosales	Rosaceae	<i>Prunus caroliniana</i>	Carolina laurelcherry	Native	Shrub, Tree	–	–
Rosales	Rosaceae	<i>Prunus serotina</i> var. <i>serotina</i>	black cherry	Native	Shrub, Tree	–	–
Asterales	Asteraceae	<i>Pseudognaphalium obtusifolium</i>	rabbit-tobacco	Native	Forb/herb	–	–
Polypodiales	Dennstaedtiaceae	<i>Pteridium pseudocaudatum</i>	western brackenfern	Native	Forb/herb	–	–
Asterales	Asteraceae	<i>Pterocaulon pycnostachyum</i>	dense-spike blackroot	Native	Forb/herb, Subshrub	–	–
Apiales	Apiaceae	<i>Ptilimnium capillaceum</i>	herbwilliam	Native	Forb/herb	–	–
Fagales	Fagaceae	<i>Quercus geminata</i>	sand live oak	Native	Tree, Shrub	–	–
Fagales	Fagaceae	<i>Quercus hemisphaerica</i>	Darlington oak	Native	Tree	–	–
Fagales	Fagaceae	<i>Quercus myrtifolia</i>	myrtle oak	Native	Tree, Shrub	–	–
Fagales	Fagaceae	<i>Quercus nigra</i>	water oak	Native	Tree	–	–
Fagales	Fagaceae	<i>Quercus virginiana</i>	live oak	Native	Tree	–	–
Sapindales	Anacardiaceae	<i>Rhus copallinum</i> var. <i>copallinum</i>	winged sumac	Native	Tree, Shrub	–	–

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Table A-1 (continued). Vascular plant species present in 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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	Cyperaceae	<i>Rhynchospora colorata</i>	starrush whitetop	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Rhynchospora corniculata</i>	shortbristle horned beaksedge	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Rhynchospora fascicularis</i>	fascicled beaksedge	Native	Graminoid	–	–
Rosales	Rosaceae	<i>Rubus</i>	blackberry	Native	Shrub	–	–
Rosales	Rosaceae	<i>Rubus trivialis</i>	southern dewberry	Native	Subshrub, Vine	–	–
Scrophulariales	Acanthaceae	<i>Ruellia caroliniensis</i>	Carolina wild petunia	Native	Forb/herb	–	–
Arecales	Arecaceae	<i>Sabal palmetto</i>	cabbage palmetto	Native	Tree	–	–
Gentianales	Gentianaceae	<i>Sabatia stellaris</i>	rose of Plymouth	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Sacciolepis striata</i>	American cupscale	Native	Graminoid	–	–
Lamiales	Lamiaceae	<i>Salvia coccinea</i>	blood sage	Native	Forb/herb, Subshrub	–	–
Apiales	Apiaceae	<i>Sanicula canadensis</i> var. <i>floridana</i>	Canadian blacksnakeroot	Native	Forb/herb	–	–
Piperales	Saururaceae	<i>Saururus cernuus</i>	lizard's tail	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Schizachyrium scoparium</i> var. <i>scoparium</i>	little bluestem	Native	Graminoid	–	–
Cyperales	Cyperaceae	<i>Scleria triglomerata</i>	whip nutrush	Native	Graminoid	–	–
Lamiales	Lamiaceae	<i>Scutellaria</i>	skullcap	Native	Forb/herb	–	–
Arecales	Arecaceae	<i>Serenoa repens</i>	saw palmetto	Native	Shrub, Tree	–	–
Ebenales	Sapotaceae	<i>Sideroxylon tenax</i>	tough bully	Native	Tree, Shrub	–	–
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 laurifolia</i>	laurel greenbrier	Native	Shrub, Vine	–	–
Liliales	Smilacaceae	<i>Smilax pumila</i>	sarsparilla vine	Native	Subshrub, Vine, Shrub	–	–
Asterales	Asteraceae	<i>Solidago chapmanii</i>	Chapman's goldenrod	Native	Forb/herb	–	–
Cyperales	Poaceae	<i>Spartina patens</i>	saltmeadow cordgrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Sporobolus</i>	dropseed	Native	Graminoid	–	–
Caryophyllales	Caryophyllaceae	<i>Stellaria media</i>	common chickweed	Non-native	Forb/herb	–	–
Ebenales	Symplocaceae	<i>Symplocos tinctoria</i>	common sweetleaf	Native	Shrub, Tree	–	–
Bromeliales	Bromeliaceae	<i>Tillandsia bartramii</i>	Bartram's airplant	Native	Forb/herb	–	S2

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Table A-1 (continued). Vascular plant species present in 56 vegetation monitoring plots within Cumberland Island National Seashore, May–July 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
Bromeliales	Bromeliaceae	<i>Tillandsia recurvata</i>	small ballmoss	Native	Forb/herb	–	S1
Bromeliales	Bromeliaceae	<i>Tillandsia usneoides</i>	Spanish moss	Native	Vine, Forb/herb	–	–
Sapindales	Anacardiaceae	<i>Toxicodendron radicans</i> var. <i>radicans</i>	eastern poison ivy	Native	Shrub, Subshrub, Vine	–	–
Cyperales	Poaceae	<i>Tripsacum dactyloides</i> var. <i>dactyloides</i>	eastern gammagrass	Native	Graminoid	–	–
Cyperales	Poaceae	<i>Uniola paniculata</i>	seaoats	Native	Graminoid	–	–
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 formosum</i>	southern blueberry	Native	Shrub	–	–
Ericales	Ericaceae	<i>Vaccinium fuscatum</i>	black highbush blueberry	Native	Shrub	–	–
Ericales	Ericaceae	<i>Vaccinium myrsinites</i>	shiny blueberry	Native	Shrub	–	–
Ericales	Ericaceae	<i>Vaccinium stamineum</i>	deerberry	Native	Shrub	–	–
Fabales	Fabaceae	<i>Vachellia farnesiana</i>	sweet acacia	Native	Shrub, Tree	–	S1
Violales	Violaceae	<i>Viola sororia</i>	common blue violet	Native	Forb/herb	–	–
Rhamnales	Vitaceae	<i>Vitis aestivalis</i> var. <i>aestivalis</i>	summer grape	Native	Vine	–	–
Rhamnales	Vitaceae	<i>Vitis vulpina</i>	frost grape	Native	Vine	–	–
Liliales	Agavaceae	<i>Yucca aloifolia</i>	aloe yucca	Native	Shrub, Tree	–	–
Liliales	Agavaceae	<i>Yucca filamentosa</i>	Adam's needle	Native	Forb/herb, Shrub, Subshrub	–	–
Sapindales	Rutaceae	<i>Zanthoxylum clava-herculis</i>	Hercules's club	Native	Shrub, Tree	–	–

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Appendix B. Species Diversity, Abundance, and Woody Stem Metrics Summarized by Broadly Defined Habitats at Cumberland Island National Seashore

Table B-1. Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Acer rubrum</i>	25	1	–	–	15	1
<i>Ageratina jucunda</i>	25	2	–	–	13	2
<i>Ambrosia artemisiifolia</i>	50	2	–	–	15	2
<i>Anchistea virginica</i>	50	2	–	–	2	2
<i>Andropogon</i>	–	–	–	–	2	1
<i>Andropogon cretaceus</i>	25	1	–	–	–	–
<i>Andropogon dealbatus</i>	25	1	–	–	–	–
<i>Andropogon gyrans</i>	–	–	–	–	4	2
<i>Andropogon tenuispathus</i>	–	–	50	4	2	2
<i>Andropogon ternarius</i>	50	2	–	–	4	2
<i>Andropogon virginicus</i>	–	–	–	–	15	2
<i>Andropogon virginicus</i> var. <i>decipiens</i>	25	2	–	–	–	–
<i>Andropogon virginicus</i> var. <i>virginicus</i>	–	–	–	–	2	2
<i>Aristida beyrichiana</i>	–	–	–	–	2	1
<i>Aristida lanosa</i>	–	–	–	–	2	1
<i>Asimina incana</i>	50	2	–	–	6	2
<i>Asimina parviflora</i>	–	–	–	–	35	2
<i>Atriplex mucronata</i>	–	–	–	–	2	2
<i>Bejaria racemosa</i>	–	–	–	–	2	3
<i>Bignonia capreolata</i>	–	–	–	–	44	2
<i>Boehmeria cylindrica</i>	–	–	–	–	6	2
<i>Cakile harperi</i>	–	–	100	2	–	–
<i>Callicarpa americana</i>	–	–	25	1	8	3
<i>Campsis radicans</i>	–	–	–	–	2	1
<i>Carex</i>	–	–	–	–	4	3
<i>Carex dasycarpa</i>	–	–	–	–	2	2
<i>Carex floridana</i>	–	–	–	–	4	2
<i>Carex longii</i>	–	–	–	–	4	1
<i>Cartrema americanum</i>	–	–	–	–	19	2
<i>Carya glabra</i>	–	–	–	–	4	6
<i>Celtis laevigata</i>	–	–	–	–	10	5
<i>Cenchrus tribuloides</i>	–	–	100	2	2	1
<i>Centella asiatica</i>	–	–	–	–	13	2
<i>Chasmanthium laxum</i>	–	–	–	–	35	3
<i>Chasmanthium sessiliflorum</i>	–	–	–	–	33	2
<i>Chenopodium album</i>	–	–	–	–	2	1
<i>Cirsium horridulum</i>	–	–	100	2	2	2

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Cirsium nuttallii</i>	–	–	–	–	4	1
<i>Citrus xaurantium</i>	–	–	–	–	2	2
<i>Cnidioscolus stimulosus</i>	25	2	25	1	6	2
<i>Coleataenia anceps</i> ssp. <i>rhizomata</i>	–	–	–	–	8	2
<i>Commelina erecta</i>	–	–	–	–	4	2
<i>Convolvulus limnophilus</i>	–	–	25	1	4	2
<i>Crocanthemum corymbosum</i>	–	–	–	–	13	2
<i>Crotalaria rotundifolia</i>	–	–	–	–	2	1
<i>Croton punctatus</i>	–	–	100	3	–	–
<i>Cyperus</i>	–	–	25	1	2	2
<i>Cyperus erythrorhizos</i>	–	–	25	2	–	–
<i>Cyperus odoratus</i> var. <i>odoratus</i>	25	2	–	–	2	1
<i>Cyperus retrorsus</i>	50	2	–	–	19	2
<i>Cyperus tetragonus</i>	–	–	–	–	2	1
<i>Desmodium incanum</i>	–	–	–	–	2	2
<i>Desmodium paniculatum</i> var. <i>paniculatum</i>	–	–	–	–	10	2
<i>Dichanthelium</i>	–	–	–	–	6	2
<i>Dichanthelium aciculare</i>	25	2	25	2	2	2
<i>Dichanthelium commutatum</i>	75	2	–	–	50	2
<i>Dichanthelium dichotomum</i>	–	–	–	–	15	2
<i>Dichanthelium ensifolium</i>	25	4	–	–	–	–
<i>Dichanthelium oligosanthes</i> var. <i>oligosanthes</i>	–	–	–	–	2	1
<i>Dichanthelium portoricense</i>	75	2	–	–	50	2
<i>Dichanthelium scabriusculum</i>	–	–	–	–	2	2
<i>Dichanthelium strigosum</i>	25	2	–	–	–	–
<i>Diospyros virginiana</i>	–	–	–	–	2	1
<i>Distichlis spicata</i>	–	–	–	–	2	1
<i>Eleocharis robbinsii</i>	–	–	–	–	2	1
<i>Eleocharis vivipara</i>	25	3	–	–	–	–
<i>Elephantopus nudatus</i>	–	–	–	–	10	2
<i>Elephantopus tomentosus</i>	–	–	–	–	2	1
<i>Epidendrum conopseum</i>	–	–	–	–	2	1
<i>Eragrostis elliottii</i>	–	–	50	2	2	1
<i>Eragrostis oxylepis</i>	–	–	100	2	–	–
<i>Erechtites hieraciifolius</i>	25	1	–	–	6	2
<i>Eremochloa ophiuroides</i>	–	–	25	1	2	1
<i>Erigeron pusillus</i>	–	–	100	2	8	2
<i>Erigeron quercifolius</i>	–	–	–	–	2	2
<i>Eupatorium capillifolium</i>	25	1	50	2	8	2
<i>Euphorbia bombensis</i>	–	–	75	2	–	–
<i>Eustachys petraea</i>	–	–	75	2	6	2

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Forestiera segregata</i> var. <i>segregata</i>	–	–	–	–	2	3
<i>Galactia elliottii</i>	25	5	–	–	17	3
<i>Galactia volubilis</i>	–	–	–	–	2	2
<i>Galium bermudense</i>	–	–	50	2	6	2
<i>Galium obtusum</i> var. <i>filifolium</i>	–	–	–	–	2	1
<i>Galium pilosum</i>	–	–	–	–	6	2
<i>Gamochaeta purpurea</i>	–	–	–	–	4	2
<i>Gaylussacia tomentosa</i>	–	–	–	–	4	3
<i>Gelsemium sempervirens</i>	–	–	–	–	33	2
<i>Heterotheca subaxillaris</i>	–	–	100	2	–	–
<i>Hexasepalum teres</i>	–	–	100	2	2	1
<i>Houstonia procumbens</i>	–	–	–	–	2	2
<i>Hydrocotyle bonariensis</i>	–	–	75	3	–	–
<i>Hydrocotyle umbellata</i>	–	–	–	–	2	1
<i>Hymenachne hemitomon</i>	25	2	–	–	–	–
<i>Hypericum cistifolium</i>	25	2	–	–	–	–
<i>Hypericum hypericoides</i>	–	–	–	–	2	2
<i>Hypericum mutilum</i>	–	–	–	–	2	1
<i>Ilex ambigua</i>	–	–	–	–	2	2
<i>Ilex coriacea</i>	25	2	–	–	–	–
<i>Ilex glabra</i>	50	3	–	–	–	–
<i>Ilex opaca</i>	50	2	–	–	58	4
<i>Ilex vomitoria</i>	–	–	–	–	13	5
<i>Ipomoea pandurata</i>	–	–	–	–	2	1
<i>Iva frutescens</i> var. <i>frutescens</i>	–	–	–	–	2	2
<i>Juncus coriaceus</i>	–	–	25	1	4	2
<i>Juncus effusus</i> ssp. <i>solutus</i>	–	–	–	–	4	1
<i>Juncus megacephalus</i>	–	–	–	–	2	1
<i>Juniperus [silicicola + virginiana]</i>	–	–	25	1	19	3
<i>Krigia virginica</i>	–	–	25	1	–	–
<i>Lemna aequinoctialis</i>	–	–	–	–	2	4
<i>Lepidium virginicum</i>	–	–	25	1	2	2
<i>Lespedeza hirta</i>	–	–	–	–	2	2
<i>Liquidambar styraciflua</i>	–	–	–	–	6	4
<i>Ludwigia leptocarpa</i>	25	2	–	–	–	–
<i>Lycopodiella appressa</i>	25	2	–	–	–	–
<i>Lyonia ferruginea</i>	25	2	–	–	65	6
<i>Lyonia lucida</i>	25	4	–	–	2	4
<i>Magnolia grandiflora</i>	–	–	–	–	6	4
<i>Magnolia virginiana</i>	–	–	–	–	2	1
<i>Melia azedarach</i>	–	–	–	–	2	3

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Melica mutica</i>	–	–	–	–	2	1
<i>Mikania scandens</i>	–	–	–	–	8	2
<i>Morella cerifera</i>	75	2	75	5	58	4
<i>Muhlenbergia sericea</i>	–	–	50	3	–	–
<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	50	2	–	–	88	4
<i>Nekemias arborea</i>	–	–	25	2	10	4
<i>Nothoscordum bivalve</i>	–	–	25	2	–	–
<i>Nyssa biflora</i>	–	–	–	–	6	5
<i>Oenothera humifusa</i>	–	–	100	2	–	–
<i>Oplismenus setarius</i>	–	–	–	–	13	3
<i>Opuntia drummondii</i>	–	–	75	2	8	2
<i>Osmundastrum cinnamomeum</i>	25	3	–	–	–	–
<i>Oxalis articulata</i>	–	–	–	–	4	2
<i>Oxalis corniculata</i>	–	–	–	–	2	2
<i>Panicum amarum</i>	–	–	75	2	–	–
<i>Parthenocissus quinquefolia</i>	–	–	–	–	25	2
<i>Paspalum</i>	–	–	25	2	2	2
<i>Paspalum notatum</i>	–	–	–	–	6	2
<i>Paspalum setaceum</i>	25	1	75	2	19	2
<i>Passiflora lutea</i>	–	–	–	–	2	1
<i>Pattalias palustre</i>	–	–	–	–	2	2
<i>Persea borbonia</i>	75	2	–	–	92	4
<i>Persea palustris</i>	25	3	–	–	–	–
<i>Phyla nodiflora</i> var. <i>nodiflora</i>	–	–	50	2	4	1
<i>Physalis walteri</i>	–	–	50	2	6	2
<i>Phytolacca americana</i>	–	–	–	–	2	1
<i>Pinus elliotii</i>	25	1	–	–	29	4
<i>Pinus palustris</i>	50	6	–	–	8	6
<i>Pinus serotina</i>	50	7	–	–	–	–
<i>Pinus taeda</i>	–	–	–	–	17	6
<i>Piptochaetium avenaceum</i>	–	–	–	–	17	2
<i>Plantago virginica</i>	–	–	–	–	2	1
<i>Pleopeltis michauxiana</i>	25	1	25	1	65	2
<i>Pluchea foetida</i>	–	–	–	–	2	2
<i>Poaceae</i>	–	–	–	–	2	1
<i>Polypremum procumbens</i>	–	–	75	2	–	–
<i>Prunus caroliniana</i>	–	–	–	–	27	2
<i>Prunus serotina</i> var. <i>serotina</i>	–	–	–	–	4	2
<i>Pseudognaphalium obtusifolium</i>	–	–	–	–	4	2
<i>Pteridium pseudocaudatum</i>	25	2	–	–	6	2
<i>Pterocaulon pycnostachyum</i>	–	–	–	–	2	1

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Ptilimnium capillaceum</i>	–	–	–	–	4	1
<i>Quercus geminata</i>	25	6	–	–	15	6
<i>Quercus hemisphaerica</i>	50	7	–	–	38	5
<i>Quercus myrtifolia</i>	25	3	–	–	6	5
<i>Quercus nigra</i>	–	–	–	–	13	3
<i>Quercus virginiana</i>	25	6	–	–	96	7
<i>Rhus copallinum</i> var. <i>copallinum</i>	50	2	–	–	2	2
<i>Rhynchospora colorata</i>	–	–	–	–	2	2
<i>Rhynchospora corniculata</i>	25	2	–	–	–	–
<i>Rhynchospora fascicularis</i>	25	3	–	–	–	–
<i>Rubus</i>	25	2	–	–	13	2
<i>Rubus trivialis</i>	25	1	25	1	6	2
<i>Ruellia caroliniensis</i>	–	–	–	–	4	2
<i>Sabal palmetto</i>	25	1	25	2	33	5
<i>Sabatia stellaris</i>	–	–	25	2	–	–
<i>Sacciolepis striata</i>	–	–	–	–	2	1
<i>Salvia coccinea</i>	–	–	–	–	2	1
<i>Sanicula canadensis</i> var. <i>floridana</i>	–	–	–	–	2	2
<i>Saururus cernuus</i>	–	–	–	–	4	2
<i>Schizachyrium scoparium</i> var. <i>scoparium</i>	–	–	–	–	2	1
<i>Scleria triglomerata</i>	25	1	–	–	56	2
<i>Scutellaria</i>	–	–	–	–	2	1
<i>Serenoa repens</i>	100	7	–	–	85	7
<i>Sideroxylon tenax</i>	–	–	50	4	27	2
<i>Smilax auriculata</i>	50	2	100	2	54	2
<i>Smilax bona-nox</i>	–	–	–	–	44	2
<i>Smilax glauca</i>	50	2	–	–	52	2
<i>Smilax laurifolia</i>	25	2	–	–	–	–
<i>Smilax pumila</i>	25	2	–	–	19	2
<i>Solidago chapmanii</i>	–	–	–	–	2	2
<i>Spartina patens</i>	–	–	50	1	4	1
<i>Sporobolus</i>	–	–	–	–	2	2
<i>Stellaria media</i>	–	–	25	1	4	2
<i>Symplocos tinctoria</i>	25	4	–	–	23	5
<i>Tillandsia bartramii</i>	–	–	–	–	4	1
<i>Tillandsia recurvata</i>	–	–	–	–	44	2
<i>Tillandsia usneoides</i>	25	2	–	–	92	4
<i>Toxicodendron radicans</i> var. <i>radicans</i>	–	–	–	–	17	2
<i>Tripsacum dactyloides</i> var. <i>dactyloides</i>	–	–	–	–	2	2
<i>Uniola paniculata</i>	–	–	100	5	–	–
<i>Vaccinium arboreum</i>	50	5	–	–	60	5

Table B-1 (continued). Constancy and average cover class for all vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 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	CPUO Constancy	CPUO Cover	MOU Constancy	MOU Cover	MUFS Constancy	MUFS Cover
<i>Vaccinium elliotii</i>	–	–	–	–	2	4
<i>Vaccinium formosum</i>	25	3	–	–	2	1
<i>Vaccinium fuscatum</i>	25	3	–	–	10	2
<i>Vaccinium myrsinites</i>	25	3	–	–	19	3
<i>Vaccinium stamineum</i>	75	2	–	–	21	2
<i>Vachellia farnesiana</i>	–	–	–	–	2	2
<i>Viola sororia</i>	–	–	–	–	4	2
<i>Vitis aestivalis</i> var. <i>aestivalis</i>	–	–	–	–	4	2
<i>Vitis vulpina</i>	–	–	–	–	2	4
<i>Yucca aloifolia</i>	–	–	25	2	–	–
<i>Yucca filamentosa</i>	–	–	–	–	4	1
<i>Zanthoxylum clava-herculis</i>	–	–	25	2	4	4

Table B-2. Basal area (BA, m²/ha) and density (Den, count/ha) of woody vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 plots).

Species	CPUO Tree BA	CPUO Tree DEN	CPUO Sapling BA	CPUO Sapling Den	CPUO Seedling Den	MOU Tree BA	MOU Tree DEN	MOU Sapling BA	MOU Sapling Den	MOU Seedling Den	MUFS Tree BA	MUFS Tree DEN	MUFS Sapling BA	MUFS Sapling Den	MUFS Seedling Den
<i>Acer rubrum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
<i>Asimina parviflora</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	5	–
<i>Bejaria racemosa</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	3	–
<i>Bignonia capreolata</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.01	86	6094
<i>Cartrema americanum</i>	–	–	–	–	–	–	–	–	–	–	0.01	1	0.00	3	104
<i>Carya glabra</i>	–	–	–	–	–	–	–	–	–	–	0.24	3	–	–	26
<i>Celtis laevigata</i>	–	–	–	–	–	–	–	–	–	–	0.10	1	–	–	391
<i>Citrus xaurantium</i>	–	–	–	–	–	–	–	–	–	–	0.01	1	–	–	–
<i>Forestiera segregata</i> var. <i>segregata</i>	–	–	–	–	–	–	–	–	–	–	0.02	1	–	–	–
<i>Gaylussacia tomentosa</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	3	547
<i>Gelsemium sempervirens</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	70	1146
<i>Ilex ambigua</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	3	–
<i>Ilex glabra</i>	–	–	0.07	281	1563	–	–	–	–	–	–	–	–	–	–
<i>Ilex opaca</i>	–	–	–	–	–	–	–	–	–	–	0.29	8	0.00	8	260
<i>Ilex vomitoria</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.04	174	5182
<i>Iva frutescens</i> var. <i>frutescens</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	3	104
<i>Juniperus [silicicola + virginiana]</i>	–	–	–	–	–	–	–	–	–	–	0.05	2	0.01	31	26
<i>Liquidambar styraciflua</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	8	3203
<i>Lyonia ferruginea</i>	–	–	–	–	–	–	–	–	–	–	0.34	30	0.77	688	911
<i>Lyonia lucida</i>	–	–	0.08	344	625	–	–	–	–	–	–	–	0.01	23	260
<i>Magnolia grandiflora</i>	–	–	–	–	–	–	–	–	–	–	0.10	1	0.00	13	26
<i>Magnolia virginiana</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	26
<i>Melia azedarach</i>	–	–	–	–	–	–	–	–	–	–	0.02	1	–	–	–
<i>Morella cerifera</i>	–	–	0.12	156	625	–	–	0.05	94	–	0.05	4	0.12	305	1302
<i>Muscadinia rotundifolia</i> var. <i>rotundifolia</i>	–	–	0.00	31	–	–	–	–	–	–	–	–	0.11	393	2422
<i>Nekemias arborea</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.01	44	156
<i>Nyssa biflora</i>	–	–	–	–	–	–	–	–	–	–	0.12	1	–	–	–
<i>Parthenocissus quinquefolia</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.01	44	677
<i>Persea borbonia</i>	–	–	0.01	31	938	–	–	–	–	–	0.03	2	0.08	302	3568

Table B-2 (continued). Basal area (BA, m²/ha) and density (Den, count/ha) of woody vascular plant species observed in 56 Southeast Coast Network vegetation monitoring plots. Broad Habitat Type Codes are as follows: CPUO = Coastal Plain Upland Open Woodlands (four plots), MOU = Maritime Open Upland Grasslands (four plots), and MUFS = Maritime Upland Forests and Shrublands (48 plots).

Species	CPUO Tree BA	CPUO Tree DEN	CPUO Sapling BA	CPUO Sapling Den	CPUO Seedling Den	MOU Tree BA	MOU Tree DEN	MOU Sapling BA	MOU Sapling Den	MOU Seedling Den	MUFS Tree BA	MUFS Tree DEN	MUFS Sapling BA	MUFS Sapling Den	MUFS Seedling Den
<i>Persea palustris</i>	–	–	–	–	313	–	–	–	–	–	–	–	–	–	–
<i>Pinus elliotii</i>	–	–	–	–	–	–	–	–	–	–	1.03	13	0.08	107	339
<i>Pinus palustris</i>	5.03	44	0.38	250	625	–	–	–	–	–	0.58	3	–	–	26
<i>Pinus serotina</i>	5.44	425	4.96	1656	–	–	–	–	–	–	–	–	–	–	–
<i>Pinus taeda</i>	–	–	–	–	–	–	–	–	–	–	1.14	14	0.07	81	495
<i>Prunus caroliniana</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	5	339
<i>Quercus geminata</i>	0.42	13	0.07	219	2813	–	–	–	–	–	1.08	26	0.03	36	1641
<i>Quercus hemisphaerica</i>	4.39	31	0.04	125	1563	–	–	–	–	–	0.59	3	0.06	279	2865
<i>Quercus myrtifolia</i>	–	–	–	–	–	–	–	–	–	–	0.01	1	0.07	68	26
<i>Quercus nigra</i>	–	–	–	–	–	–	–	–	–	–	0.10	1	0.01	3	156
<i>Quercus virginiana</i>	1.68	38	–	–	3750	–	–	–	–	–	23.50	85	0.06	133	9505
<i>Rhus copallinum</i> var. <i>copallinum</i>	–	–	0.03	31	1875	–	–	–	–	–	–	–	–	–	26
<i>Sabal palmetto</i>	–	–	–	–	–	–	–	–	–	–	2.94	23	0.06	138	781
<i>Serenoa repens</i>	–	–	0.27	1125	30625	–	–	–	–	–	0.01	1	1.17	4891	15026
<i>Sideroxylon tenax</i>	–	–	–	–	–	–	–	0.37	313	–	–	–	0.00	3	339
<i>Smilax auriculata</i>	–	–	0.01	125	625	–	–	0.01	313	1250	–	–	0.00	99	365
<i>Smilax bona-nox</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	177	3203
<i>Smilax glauca</i>	–	–	0.00	250	–	–	–	–	–	–	–	–	0.01	206	495
<i>Smilax laurifolia</i>	–	–	–	–	1250	–	–	–	–	–	–	–	–	–	–
<i>Smilax pumila</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	52
<i>Symplocos tinctoria</i>	–	–	–	–	938	–	–	–	–	–	0.01	1	0.05	156	729
<i>Toxicodendron radicans</i> var. <i>radicans</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1250
<i>Vaccinium arboreum</i>	–	–	0.32	813	2188	–	–	–	–	–	0.10	9	0.22	391	443
<i>Vaccinium elliotii</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	23	78
<i>Vaccinium formosum</i>	–	–	–	–	313	–	–	–	–	–	–	–	0.00	18	–
<i>Vaccinium fuscatum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Vaccinium myrsinites</i>	–	–	–	–	2188	–	–	–	–	–	–	–	0.00	5	1302
<i>Vaccinium stamineum</i>	–	–	–	–	313	–	–	–	–	–	–	–	0.01	44	156
<i>Vitis vulpina</i>	–	–	–	–	–	–	–	–	–	–	–	–	0.00	3	–
<i>Zanthoxylum clava-herculis</i>	–	–	–	–	–	–	–	–	–	–	0.02	1	–	–	–

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.

National Park Service
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Natural Resource Stewardship and Science

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