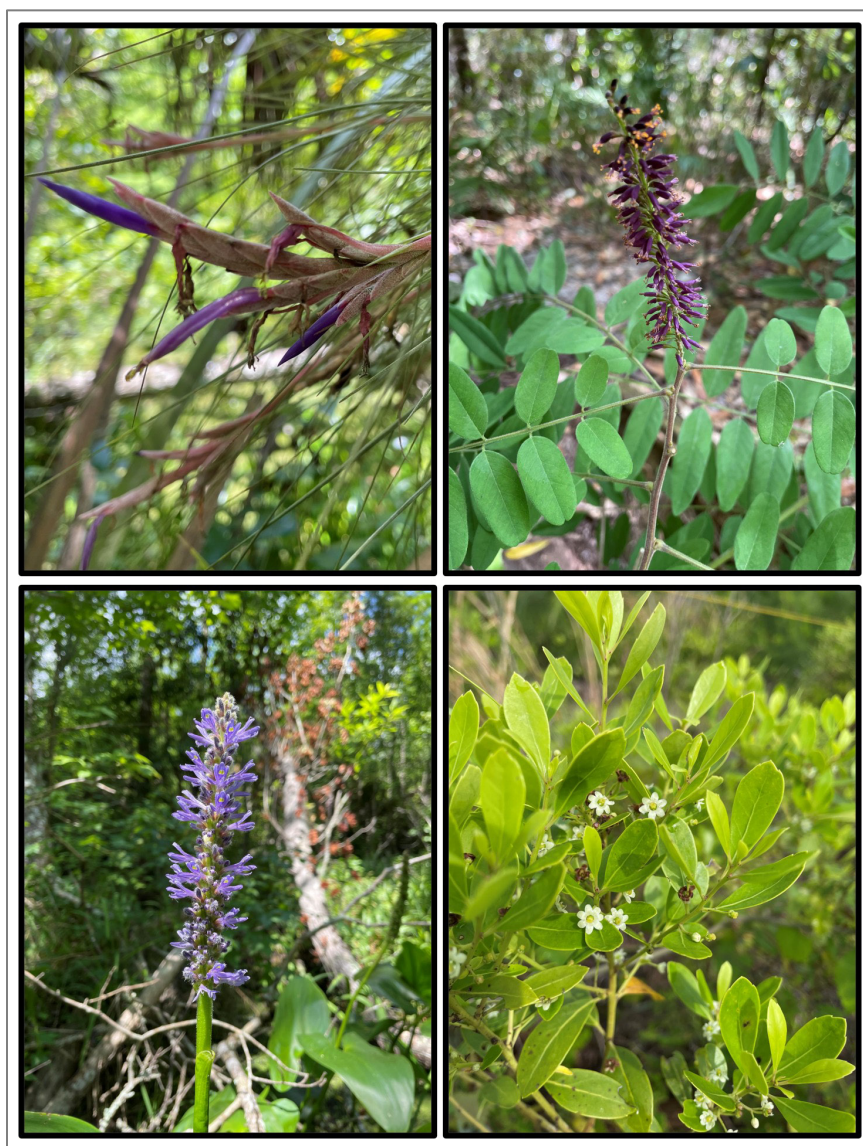




# Terrestrial Vegetation Monitoring at Timucuan Ecological and Historic Preserve

## *2023 Data Summary—Cycle 2 and Newly Established Cycle 1 Plots*



Flowers from some common and not-so-common plants of Timucuan Ecological and Historic Preserve, Duval County, Florida. Clockwise from top left—Bartram's airplant (*Tillandsia bartramii*), tall indigo bush (*Amorpha fruticosa*), little gallberry (*Ilex glabra*), and heartleaf pickerelweed (*Pontederia cordata* var. *cordata*).

NPS / M. FORBES BOYLE

# **Terrestrial Vegetation Monitoring at Timucuan Ecological and Historic Preserve: 2023 Data Summary—Cycle 2 and Newly Established Cycle 1 Plots**

Science Report NPS/SR—2025/344

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## Abstract

Parks within the Southeast Coast Network (SECN) host a diverse assemblage of terrestrial vegetation communities. Determining trends in vegetation over time and identifying threats is vital to understanding the ecological health of ecosystems within SECN parks. The sampling unit for monitoring vegetation within SECN parks is a 20 × 20 meter plot. The current data summary report describes the status of several plot elements from Timucuan Ecological and Historic Preserve in 2023 and represents the second iteration of monitoring. Baseline data were collected in May–June 2019. During 2019, 23 plots were established across three broad habitats of the preserve (nontidal forested wetlands, open upland woodlands, and upland forests) and across three management units (Cedar Point, Theodore Roosevelt, and Thomas Creek). Each of these plots was resampled in 2023. An additional 10 plots were established during the 2023 monitoring effort increasing overall sample size across habitats and management units. Across all 33 plots sampled in 2023, 245 vascular plant taxa were detected. There were 37 species present in the 2023 plots that were not on previous park taxa lists, including two species listed as invasive—downy maiden and narrow sword fern. Basal area of trees increased from 2019 to 2023 in both nontidal forested wetland and upland forest plots but decreased in open upland woodland plots due to heavy tree mortality caused by the Yellow Bluff Wildfire. Widespread threats to vegetation were not observed within plots of both nontidal forested wetland and upland forest and shrubland habitats of Timucuan EHP. Recent fire history events have had a much greater, more profound impact on the vegetation resources within open upland woodland habitat. Open upland woodland plots that were not within the Yellow Bluff Wildfire currently have similar vegetation structure and density to the pre-burn structure and density in Yellow Bluff plots. A wildfire within these stands that have not burned in well over 20 years would have devastating impacts to this ecosystem. Finally, a vegetation health scorecard was developed for each of the preserve’s broad habitat types. Native species diversity scores were rated as “Good” for all monitored habitats. This is a remarkable feature of the vegetation communities within Timucuan EHP. Despite its close proximity to one of the largest metropolitan areas in the eastern U.S., the preserve offers sanctuary and protected space for a diverse assemblage of plant species and their associations in northeastern Florida.

## Acknowledgments

Several people deserve recognition for their support prior to, during, and following fieldwork at Timucuan Ecological and Historic Preserve (TIMU). Steve Kidd (TIMU Chief of Science and Resource Management) met with the field crew prior to fieldwork to go over site logistics and to review the safety plan. Field crew members who assisted with data collection included Steve, Fiona Southwell (TIMU Biological Science Technician), Jules Pace (former TIMU Biological Science Technician), Kayleigh Hendley (Cumberland Island National Seashore Cultural Resource Manager), Abigail Gonzalez (former Southeast Coast Network Coastal Technician), Hanna Rosner-Katz (Florida Natural Areas Inventory, NPS contractor), Alyssa Sanderson (former Southeast Coast Network Scientist in Parks intern), and this report's two authors—Forbes Boyle (Southeast Coast Network Botanist and terrestrial vegetation monitoring protocol lead) and Mallorie Davis (Southeast Coast Network Biological Science Technician). Hanna also assisted with identification of unknown plants. Finally, thanks to Mark Hynds (Southeast Coast Network Editor) for editorial support and development of photopoint array images, which are available in the [supplemental materials](#) accompanying this report.



The 2023 vegetation monitoring field work at Timucuan Ecological and Historic Preserve included support from multiple NPS divisions and partners. Left, field crew members from left to right included Mallorie Davis (SECN, Biotech), Steve Kidd (TIMU, Chief of Science and Resource Management), Forbes Boyle (SECN, Botanist), Jules Pace (TIMU, former Biotech), and Fiona Southwell (TIMU, Biotech). Right, Mallorie Davis and Alyssa Sanderson (SECN, former Scientist in Parks intern).

*CREDITS: LEFT, NPS / MALLORIE DAVIS; AND RIGHT, NPS / M. FORBES BOYLE*

## Summary and Key Findings

The Southeast Coast Network (SECN) conducts long-term terrestrial vegetation monitoring as part of the National Park Service's (NPS) Inventory and Monitoring Program. The vegetation community vital sign is one of the primary-tier resources identified by SECN park managers, and monitoring is conducted at 14 network parks. 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.

2023 marked the second year of conducting this monitoring effort at Timucuan Ecological and Historic Preserve (EHP). From late April to late May, 23 vegetation plots established in 2019 were resampled ("plot revisits," "Cycle 2") and 10 plots were established during this monitoring year ("plot establishment," "Cycle 1"). Data collected in each plot included a list of species present and cover of each species, woody stem seedling/sapling counts and adult tree (greater than 10 centimeters [3.9 in]) diameters at breast height (DBH), overall tree health, observed disturbance, and woody biomass (i.e., fuel load) estimates. For Cycle 1 plots established in 2023, landform and soil data were also collected.

Plot summaries and analyses were stratified across three broadly defined habitats within the preserve, including nontidal forested wetlands, open upland woodlands, and upland forests and shrublands. These habitats represented the dominant terrestrial natural and seminatural vegetation types of the preserve. Plot locations and sample size were allocated across three non-contiguous management units of the preserve—Thomas Creek, Cedar Point, and Theodore Roosevelt. Nontidal forested wetlands included lowland hardwood swamps dominated by red maple (*Acer rubrum*), ash (*Fraxinus* sp.), loblolly bay (*Gordonia lasianthus*), swamp tupelo (*Nyssa biflora*), sweetbay (*Magnolia virginiana* var. *australis*), and other hardwood species. The understory of these forests is typically shrubby and dense. Extensive swamp forests can be found on the southern end of Thomas Creek; elsewhere in the preserve this habitat occurs in smaller, patchy scales either adjacent to small creeks or in lower lying topographies within the upland matrix forest. Nontidal forested wetlands also include the freshwater marsh and shrub zones within Spanish Pond on the northern end of Theodore Roosevelt. Open upland woodlands include open canopy forests and woodlands dominated by pines (slash [*Pinus elliottii*] and longleaf [*Pinus palustris*]) occurring on relatively flat landscapes with poorly drained soils. A variant of this habitat ("sandhills") usually occurs on rolling, complex topography. Mesic to hydric pine woodlands are the dominant upland vegetation type of Thomas Creek, and also occur in patches surrounded by maritime oak forests and wetlands within Cedar Point. The "sandhills" variant of this broadly defined habitat is near the preserve headquarters within the Theodore Roosevelt Unit and in patches on the northern edge of Cedar Point. Finally, the upland forest and shrubland habitat type represents forests (and occasional shrublands) on older, stabilized dune systems of the preserve. Canopies are dominated by live oak (*Quercus virginiana*) and sand laurel oak (*Quercus hemisphaerica*), with an understory of southern red cedar (*Juniperus silicicola*), red bay (*Persea borbonia*), and cabbage palmetto (*Sabal palmetto*). These maritime-influenced forests dominate the upland habitats of both Cedar Point and Theodore Roosevelt. A drier variant of

this broadly defined habitat occurs on deep, relatively sterile sands and is composed of stunted trees such as sand live oak, Chapman oak (*Quercus chapmanii*), and occasional pines; the shrub stratum in these sites is composed of various species such as huckleberries (*Gaylussacia sp.*), saw palmetto, and southern evergreen blueberry (*Vaccinium myrsinites*). Within the preserve, this “sandhill” type of upland forest and shrubland is in scattered areas of the northern portion of Cedar Point and in strands of Theodore Roosevelt.

Noteworthy findings from 2023 include:

- Long-term SECN vegetation plots of Timucuan Ecological and Historic Preserve are in a spatially-balanced pattern across three broad habitat types within three of the preserve’s primary management units—Thomas Creek, Cedar Point, and Theodore Roosevelt. Plot sample size by broad habitat type was as follows:
  - Nontidal forested wetlands: 13 plots
  - Open upland woodlands: 9 plots
  - Upland forests and shrublands: 11 plots
- Photopoints of each plot from 2019 and 2023 are available to view in the [supplemental materials](#) accompanying this report.
- Across all 33 monitoring plots sampled in 2023, 245 vascular plant taxa were detected. Of the 23 monitoring plots established in 2019 and resampled in 2023, 171 vascular plants were detected. Twenty-four species present in 2019 were not detected in 2023; thirty-seven species present in 2023 were not detected in 2019. There were 37 species that were present in the 2023 monitoring plots that were not on previous park taxa lists, including two species listed as invasive by the Florida Invasive Species Council—downy maiden fern (*Christella dentata*) and narrow sword fern (*Nephrolepis cordifolia* var. *cordifolia*).
- The most frequently occurring species across the preserve were muscadine (*Muscadinia rotundifolia* var. *rotundifolia*), saw palmetto (*Serenoa repens*), and dune greenbriar (*Smilax auriculata*); each of these were found in 76% of vegetation plots. Other widespread species included Spanish moss (*Tillandsia usneoides*), common wax-myrtle (*Morella cerifera*), and slash pine. Ninety-three of the 245 plant taxa detected (38% of the total) within these plots were single occurrence records (i.e., only found in one plot).
- There were nine non-native species and three species of unknown nativity observed within these monitoring plots in 2023—5% of the species list. Eight of these species are listed as invasive by the Florida Invasive Species Council. The most frequently occurring invasive species was Chinese tallow (*Triadica sebifera*) which was found in six of the 33 plots (18%). Other invasive species found within these plots included camphortree (*Camphora officinarum*), downy maiden fern, common lantana (*Lantana strigocamara*), primrose-willow (*Ludwigia peruviana*), Japanese climbing fern (*Lygodium japonicum*), narrow sword fern, and water spangles (*Salvinia minima*). Invasive species frequency was low across the preserve, but high in the three plots within Spanish Pond.

- Most species detected in 2023 are common across northern Florida and the Southeastern United States. The one rare species tracked by the state of Florida recorded during this monitoring effort was buckthorn bully (*Sideroxylon lycioides*). This species was also reported within monitoring plots in 2019.
- Average number of species within nontidal forested wetland and upland forest and shrubland plots remained similar to values reported in 2019, and tree species had the highest richness values among other growth forms across most sampling scales. Species richness nearly doubled from 2019 to 2023 within plots located within the preserve's open upland woodland habitat. This was because of the extremely low values recorded in 2019 from open upland woodland plots located within the footprint of the Yellow Bluff Wildfire on the preserve's Thomas Creek Unit. Current species numbers within these three plots are higher than plots within the same habitat type of the Thomas Creek unit that were not burned in 2019.
- The most frequent species recorded in nontidal forested wetland plots included water oak (*Quercus nigra*), swamp tupelo, sweetbay, muscadine, cinnamon fern (*Osmundastrum cinnamomeum*), and Spanish moss; the most frequent species recorded in open upland woodland plots included little gallberry (*Ilex glabra*), saw palmetto, slash pine, southern bracken (*Pteridium pseudocaudatum*), Elliott's milkpea (*Galactia elliotii*), muscadine, and dune greenbriar; and finally, the most frequent species recorded in upland forest and shrubland plots included sand laurel oak (*Quercus hemisphaerica*), Spanish moss, live oak (*Quercus virginiana*), muscadine, red bay (*Persea borbonia*), dune greenbriar, and ball-moss (*Tillandsia recurvata*).
- Basal area is defined as the cross-sectional area of trees at a given height (typically 1.37 meters, or breast height) and is a common metric used to assess woody stem density. Basal area ( $\text{m}^2/\text{ha}$ ) of live trees increased from 2019 to 2023 in both nontidal wetland and upland forest and shrubland plots of the preserve. Basal area of live trees decreased from 2019 to 2023 in open upland woodland plots due to heavy tree mortality caused by the Yellow Bluff Wildfire. Dominant tree-sized species within nontidal forested wetlands included loblolly bay, slash pine, swamp tupelo, and water oak; dominant tree-sized species within open upland woodlands included slash pine and longleaf pine; and dominant tree-sized species within upland forests and shrublands included live oak, cabbage palmetto, sand laurel oak, and pignut hickory (*Carya glabra*).
- Red bay and swamp bay (*Persea palustris*) were once dominant understory trees within upland and wetland forests within the preserve. These species have all but been eliminated from the forest canopy over the past 20 years due to the presence of laurel wilt disease—a fungal pathogen that impacts these bay species and other plants within the Laurel Family. Only one tree-sized individual of red bay was found on SECN vegetation monitoring plots of the preserve in 2023. This individual was in the Theodore Roosevelt unit.
- Regeneration rates of sapling-sized canopy-forming species was low across the preserve. In other National Parks of the eastern U.S., long-term forest monitoring plot data has shown that sapling regeneration failure is primarily caused by excessive browse from white-tailed deer

(*Odocoileus virginianus*). It is unknown whether sapling regeneration rates are impacted on Timucuan EHP due to browsing by white-tailed deer, browsing by other animals (e.g., feral hogs [*Sus scrofa*]), or other factors. It's also unknown whether sapling abundance rates will continue to be low across the preserve over time. Long-term monitoring will be used to assess these trends.

- Although red and swamp bay were mostly absent from the canopy of these monitoring plots in 2023, they were present and, in many cases, abundant within the seedling and sapling stratum of all broad habitat types across the preserve. Long-term monitoring will assess whether these younger individuals survive over time to re-establish within the subcanopy of these forests.
- Widespread disturbances and threats to vegetation resources were not observed within vegetation plots of both nontidal forested wetland and upland forest and shrubland habitats of Timucuan EHP. The most frequent disturbances observed within these plots included windthrow, impacts from historical fire, and impacts from former land use (e.g., timber management, clearcutting). Recent fire history events within the preserve that include the widespread absence of fire, and the occurrence of high severity wildfire, have had a much greater, more profound impact on the vegetation resources within open upland woodland habitat. There were heavy losses of canopy trees in plots in the 2019 Yellow Bluff Wildfire between 2019 and 2023. Prior to 2019, this unit within the preserve had been unburned for long duration. Fire events that occur in sites that have long gone unburned have greater flame lengths which burn into the canopy and higher temperatures that impact the soil and duff strata. Historically, open upland woodlands (i.e., pine “flatwoods”) would burn on a much more frequent time scale (one to three years) and with much less intensity and severity. Open upland woodland plots that were not within the Yellow Bluff Wildfire footprint have similar vegetation structure and density to the pre-burn structure and density in Yellow Bluff plots. A wildfire event within these stands that have not burned in over 20 years would have devastating impacts to this ecosystem.
- A vegetation health scorecard was developed for each of the preserve’s broad habitat types. Growth and expansion of invasive species was one stressor to vegetation resources that occurred across all habitats of the preserve. However, native species diversity scores were rated as “Good” for all monitored habitats. This is a remarkable feature of the vegetation communities within Timucuan Ecological and Historic Preserve. Despite its close proximity to and often shared border with one of the largest metropolitan areas in the eastern U.S., the preserve offers sanctuary and protected space for a diverse assemblage of plant species and their associations in northeastern Florida.
- Vegetation monitoring occurs every four years within each park of the Southeast Coast Network. The next monitoring cycle for Timucuan Ecological and Historic Preserve will be in 2027.

# Project Background

The Southeast Coast Inventory and Monitoring Network (SECN) monitors the status of vegetation and vegetation communities in 14 National Park Service (NPS) parks in the southeastern U.S. (DeVivo et al. 2008). Tracking vegetation condition over time is critical to determining park health and making informed management decisions to protect and preserve this vital park resource for future generations. Plant species and their associations integrate the biological and physical environment, 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. They also provide the backdrop to the natural world for park visitors.

The Southeast Coast Network uses a terrestrial vegetation monitoring approach (Boyle et al. 2019) similar to other Inventory and Monitoring Networks in the NPS Southeast Region, including the Cumberland Piedmont Network (White et al. 2011), Gulf Coast Network (Carlson et al. 2018), and South Florida/Caribbean Network (Whelan et al. 2020). The standard sampling unit for the Southeast Coast Network and these other networks is a  $20 \times 20$  meter ( $65.6 \times 65.6$  ft) vegetation plot and data collected from each plot include a vascular species list, species cover, tree health and abundance, woody species regeneration metrics, and other environmental, abiotic, and disturbance information. Data are synthesized across sampling years to answer the following questions:

- 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?
- What is the relative frequency of woody seedlings, saplings, and subcanopy or canopy species; what are the growth and mortality rates of dominant trees?
- Do observable stressors appear to impact vegetation communities?
- How are forest fuels changing over time?

The current data summary report for Timucuan Ecological and Historic Preserve (Timucuan EHP, “the preserve”) describes the status of these plot elements in 2023 and represents the second iteration of monitoring. Baseline data were collected from 23 of these plots in May–June 2019. Plots were established across three broadly defined habitats of the preserve (nontidal forested wetlands, open upland woodlands, and upland forests and shrublands) and across three management units of the preserve (Cedar Point, Theodore Roosevelt, and Thomas Creek). Each of these 23 plots was resampled in 2023. An additional 10 plots were established during the 2023 monitoring effort to increase overall sample size across habitats and management units. Vegetation, environmental, and disturbance information are summarized below at different scales (e.g., plot, broad habitat type) to provide managers added context of site-scale and landscape-scale conditions that can be used in

combination to make informed decisions. Raw data exports from all sampling years are available at:  
[irma.nps.gov/DataStore/Reference/Profile/2305052](http://irma.nps.gov/DataStore/Reference/Profile/2305052).

# Study Area

## Physical Description

Timucuan EHP covers approximately 18,600 hectares (46,000 acres [ac]) within the city limits of Jacksonville, Duval County, Florida, between the St. Johns and Nassau Rivers. The two rivers form a vast estuarine system dominated by tidally influenced salt marsh and coastal hammock habitat, with 75% of the Preserve made up of tidal wetlands and open water. The Preserve is composed of multiple landowners—federal, state, city parks, and private—and is the largest cooperative park system within the United States. Total area of Timucuan EHP lands under federal ownership is approximately 3,440 hectares (8,500 ac). The Southeast Coast Network conducts long-term vegetation monitoring on three primary management units of the preserve under federal ownership: Cedar Point, Theodore Roosevelt, and Thomas Creek (Figure 1). These units serve as the sampling frame for this project.

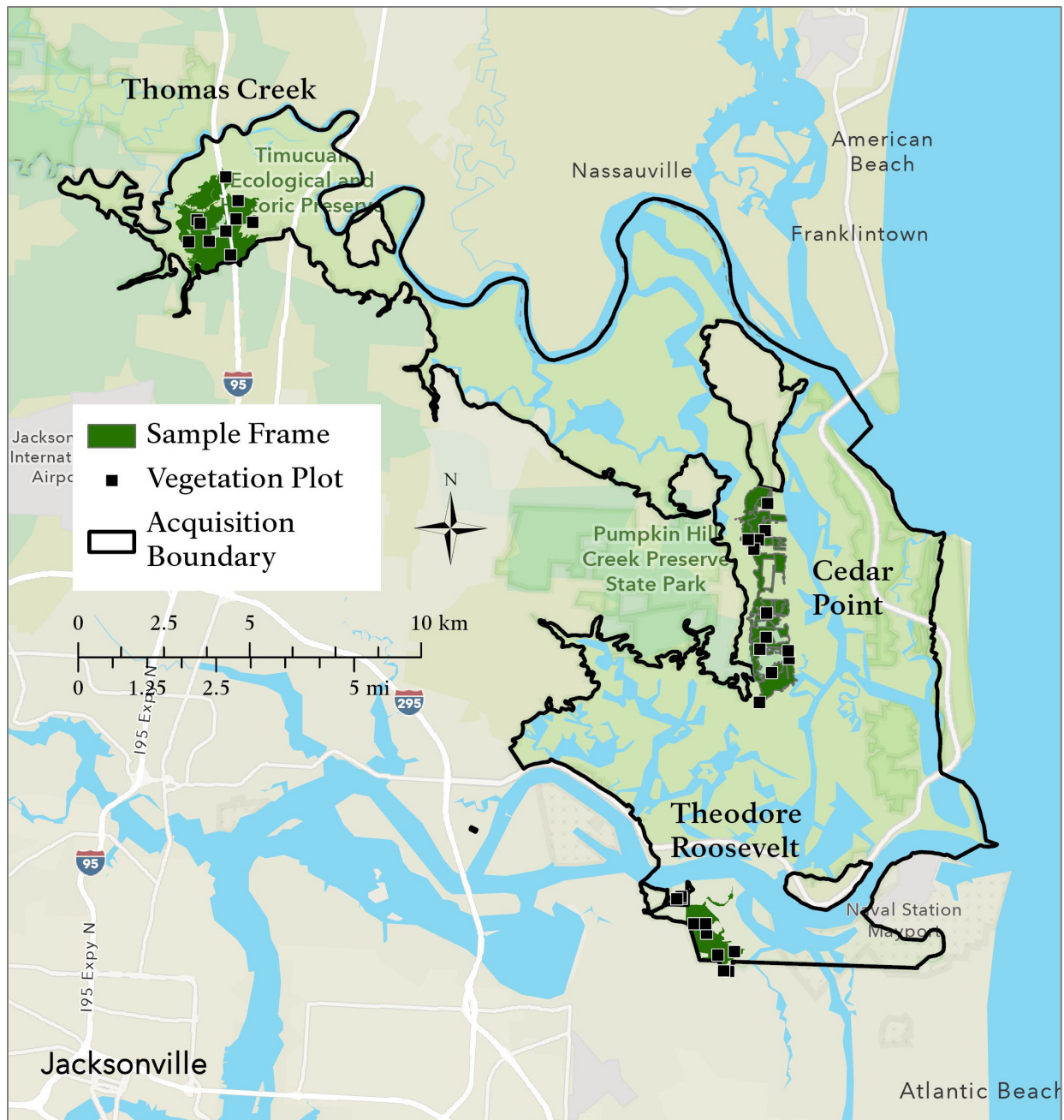


**Figure 1.** Southeast Coast Network's vegetation monitoring sampling frame and plot locations across Timucuan Ecological and Historic Preserve.

*NPS / SECN*

### General Vegetation Features

The preserve falls entirely within U.S. Environmental Protection Agency (EPA) Level III Southern Coastal Plain Ecoregion (Omernik and Griffith 2014) and includes two EPA Level IV Ecoregions—Sea Islands/Coastal Marsh and Sea Island Flatwoods (Griffith et al. 2010). Terrain appears flat within this landscape, although slight elevation changes yield vastly different vegetation communities including swampy lowlands, extensive marshes bordering rivers and estuaries, coastal lagoons, and

higher elevations supporting a variety of natural and semi-natural upland forests and woodlands. Within the Cedar Point and Theodore Roosevelt units of the preserve, there are maritime upland forests dominated by live oak (*Quercus virginiana*), southern red cedar (*Juniperus silicicola*), slash pine (*Pinus elliottii*), and cabbage palmetto (*Sabal palmetto*). The farthest western and northern unit of the preserve is Thomas Creek, which falls near the border of the Sea Island Flatwood Ecoregion. Within this unit, uplands are composed of pine-dominated woodlands occurring across very flat terrain. Most of these forested stands are semi-natural and in previous ownership were used for timber production. Extensive swamp forests can be found on the southern end of Thomas Creek. Elsewhere in the preserve forested wetlands occur in smaller, patchy scales either adjacent to small creeks or in lower lying topographies within the upland matrix forest. Shrubs, small diameter trees, and a variety of freshwater marsh ground cover make up the dominant vegetation community of Spanish Pond on the northern end of the Theodore Roosevelt unit. Although not included in this monitoring effort, the preserve consists of large areas of salt marsh that vary in degrees of salinity but are generally dominated by smooth cordgrass (*Spartina alterniflora*) and needlegrass rush (*Juncus roemerianus*).

The most recent floristic survey of Timucuan EHP occurred in 2005 and reported 480 vascular plant taxa as present within the preserve (Zomlefer et al. 2007). Currently, the NPSpecies (2025) database documents over 530 vascular plant species, subspecies, and varieties as present within the preserve. There are undoubtedly taxa not yet documented for the preserve. Several new-to-park species were discovered in the preserve in 2019 as part of the baseline vegetation monitoring effort conducted by the Southeast Coast Network (Boyle and Rico 2021). Regardless of the species count, Timucuan EHP hosts a diverse flora and plays a crucial role in providing habitat for many rare species, including the state listed incised groove-bur (*Agrimonia incisa*), Bartram's ixia (*Calydorea coelestina*), southern lip fern (*Myriopteris microphylla*), Godfrey's swampprivet (*Forestiera godfreyi*), star anise (*Illicium parviflorum*), Atlantic Coast Florida lantana (*Lantana depressa* var. *floridana*), plume polypody (*Pectuma plumula*), terrestrial peperomia (*Peperomia humilis* var. *humilis*), and silver buckthorn (*Sideroxylon alachuense*) (NPSpecies 2025; FNAI 2025). The preserve provides habitat to several commercially exploited species within Florida, including American royal fern (*Osmunda spectabilis*), cinnamon fern (*Osmundastrum cinnamomeum*), Piedmont azalea (*Rhododendron canescens*), and saw palmetto (*Serenoa repens*) (NPSpecies 2025; FDACS 2024). Furthermore, there are nearly 40 known and mapped U.S. National Vegetation Classification System (USNVCS) vegetation associations described for the preserve (O'Hare et al. 2020). Many of these associations are listed as vulnerable, imperiled, or critically imperiled across their range by NatureServe (2025), including Cabbage Palmetto Hydric Hammock, Northeast Florida Coastal Scrub, and South Atlantic Coastal Plain Dry Longleaf Pine Sandhill.

### **Land Use History and Vegetation Management Issues**

During the past several decades, the areas adjacent to Timucuan EHP have experienced some of the most rapid growth and development in Florida. While the shared border between the park and other conservation-minded organizations within the preserve provides opportunities for landscape-scale collaboration, the wildland-urban interface across most of the preserve has brought in several external stressors impacting vegetation and other ecological resources. Land-use change and other

external stressors adjacent to the park have altered ecosystem function—hydrology (brought on by dredging on the St. Johns River) and seral dynamics (brought on by fire suppression). Fire is a natural ecosystem process within pine-dominated open uplands that historically reduced density of hardwood species, created soil conditions favorable for germination of diagnostic species, increased nutrient turnover in the soil, and increased vigor and reproduction of certain species (Abrahamson and Hartnett 1990). Fire exclusion, on the other hand, increases the density of taller woody shrubs (e.g., saw palmetto, little gallberry (*Ilex glabra*), prevents regeneration of canopy pines, and creates unnaturally high fuel loads that increase fire intensity and severity when sites finally do burn (Heyward 1939; Edmisten 1963; Clabo and Campbell 2020). Like most of the open upland pine ecosystems of Florida and the Southeastern U.S., these communities of Timucuan EHP have experienced alterations of natural fire regimes due to increases in land development and systematic fire exclusion practices. Use of prescribed fire and fire surrogate treatments (e.g., mechanical removal of woody vegetation) can be used to restore and maintain the natural condition of these ecosystems. However, prescribed fire has not been implemented on the preserve since 2009 (from InFORM online data repository of fire occurrence data from 1992 to current [<https://in-form-nifc.hub.arcgis.com>])).

Other stressors to vegetation resources include competition from invasive species and effects of contaminants accrued through the St. Johns River. Invasive plants listed as Category 1 by the Florida Invasive Species Council (FISC 2023) observed in the park during its most recent floristic survey in 2005 include asparagus fern (*Asparagus aethiopicus*), camphortree (*Camphora officinarum*), air potato (*Dioscorea bulbifera*), cat's-claw vine (*Dolichandra unguis-cati*), water-hyacinth (*Eichhornia crassipes*), common lantana (*Lantana strigocamara*), Japanese honeysuckle (*Lonicera japonica*), Japanese climbing fern (*Lygodium japonicum*), and Chinese tallow (*Triadica sebifera*; Zomlefer et al. 2007). Another noted threat to a significant native species within the park is the invasion of an exotic insect—the redbay ambrosia beetle (*Xyleborus glabratus*)—which impacts species within the Lauraceae Family, including red bay (*Persea borbonia*) and swamp bay (*Persea palustris*). The insect and its associated fungal pathogen, laurel wilt (*Raffaelea lauricola*), were discovered in the park in 2005; in less than two years the pathogen killed over 92% of red and swamp bay individuals greater than 7.6 centimeters (3 in) in diameter at breast height (Fraedrich et al. 2008).

# Methods

## Plot Selection

USNVCS vegetation associations were described for Timucuan EHP and used as map units during the latest park-wide vegetation mapping project (O'Hare et al. 2020). Vegetation associations present within the park were then grouped into broader-scale classification types (broad habitat types) by this report's lead author to maintain an adequate sample size of plot distribution across classification units that are useful for park management decisions. While mapped vegetation associations could be incorrect—O'Hare et al. (2020) report an overall accuracy assessment within the overall project as 72%—the cross-walked broadly defined habitats they nest under are typically correct. Three broadly defined habitats were defined for Timucuan EHP—nontidal forested wetlands, open upland woodlands, and upland forests and shrublands. A fourth type—tidal wetlands—is present within the park's administrative boundary but not included in this monitoring effort due to time constraints.

The number of plots within these broad habitat types was determined by a combination of factors. First, sample size of between two and four plots per 100 hectares (247 ac) was targeted for habitats that cover more than 30% of the total area of a park unit's natural and semi-natural vegetation. In habitats that cover less than 30% of the total area, four plots were established. Number of plots by broad habitat type for each unit are as follows:

- Thomas Creek
  - nontidal forested wetlands: 5 plots
  - open upland woodlands: 5 plots
- Cedar Point
  - nontidal forested wetlands: 4 plots
  - open upland woodlands: 4 plots
  - upland forests and shrublands: 5 plots
- Theodore Roosevelt
  - nontidal forested wetlands: 4 plots
  - upland forests and shrublands: 6 plots

Plot locations by management unit are illustrated in Figure 2. Broad habitat type polygons derived from vegetation map data did not always reveal the correct, on-the-ground habitat. This explains why some vegetation plots classified as one type appear to occur in a different mapped type. Plant community classifications are useful models for understanding natural phenomena, but they misleadingly imply hard boundaries between classes. Each vegetation class, type, or association is in fact a spectrum of intergrading groups of plants, with each species responding independently, for the most part, to environmental conditions and chance events. Because of this, plots can have features of more than one class, and some plots are a better match to their assigned class than others. Accepting

that most classification models are an imperfect fit, the class assignments used for this project are based on each plot's dominant class (i.e., >50% of the plot).

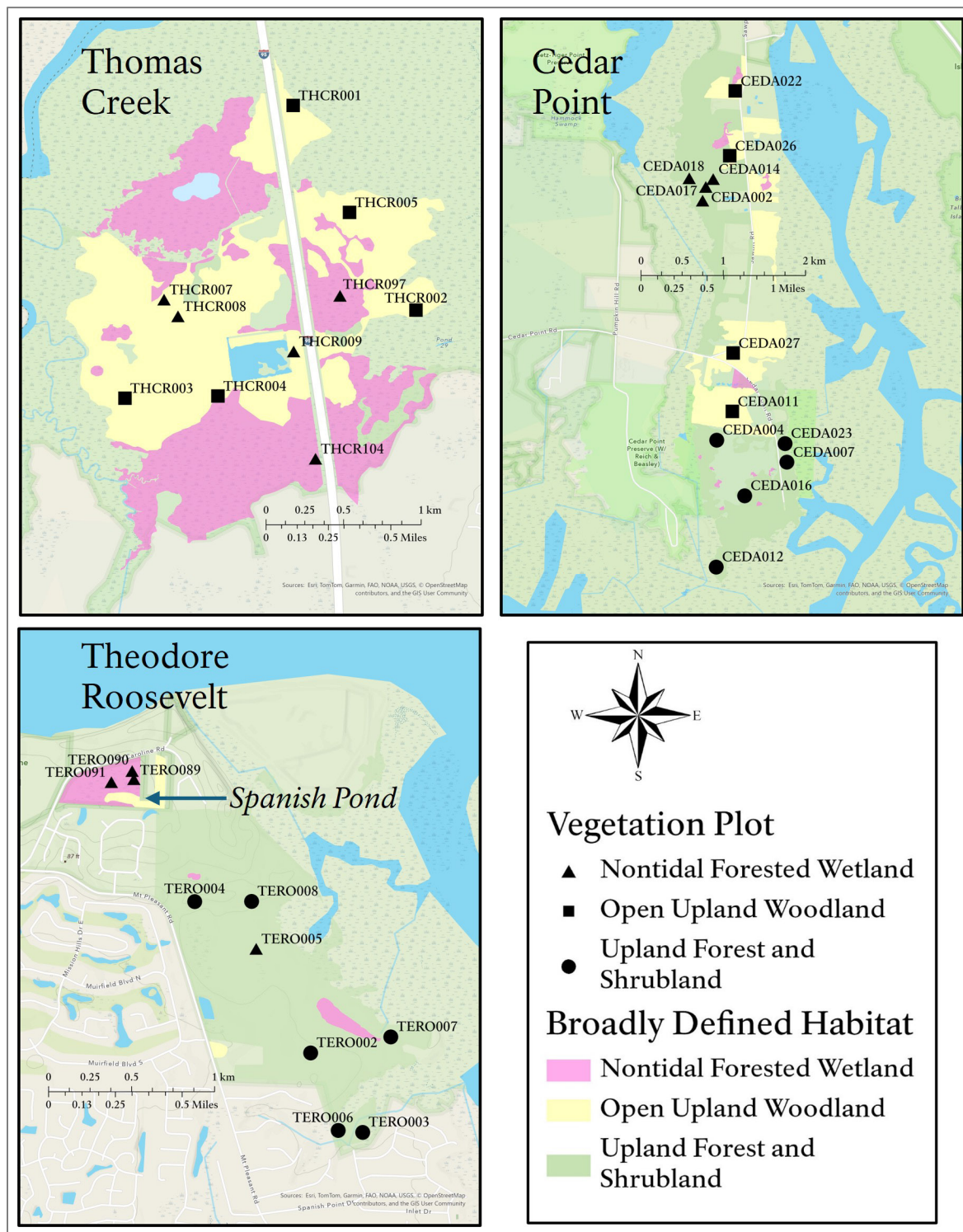


**Figure 2.** Broad habitat types of Timucuan Ecological and Historic Preserve management units and Southeast Coast Network vegetation plot locations.

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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). Plots were selected for sampling based on the order listed within the GRTS output. For a full description of the site selection approach that the Southeast Coast Network (SECN) uses for terrestrial vegetation monitoring, refer to Boyle (2024).

### **Field Methodology**

Vegetation monitoring fieldwork at Timucuan EHP in 2023 began in late April and ended in late May. The vegetation plot layout for this monitoring effort is based upon the plot design used by the Carolina Vegetation Survey (Peet et al. 1998) and the Cumberland Piedmont Network (White et al. 2011). The plot array consists of a  $20 \times 20$  meter ( $65.6 \times 65.6$  ft) bounded square with multiple nested sampling frames ranging from 1 square meter (10.8 square feet [ft<sup>2</sup>]) to 400 square meters (4,305.5 ft<sup>2</sup>), three 25 meter (82.0 ft) fuel transects that cross both inside and outside the bounded square, and three soil sample frames adjacent to the bounded square (Figure 3).

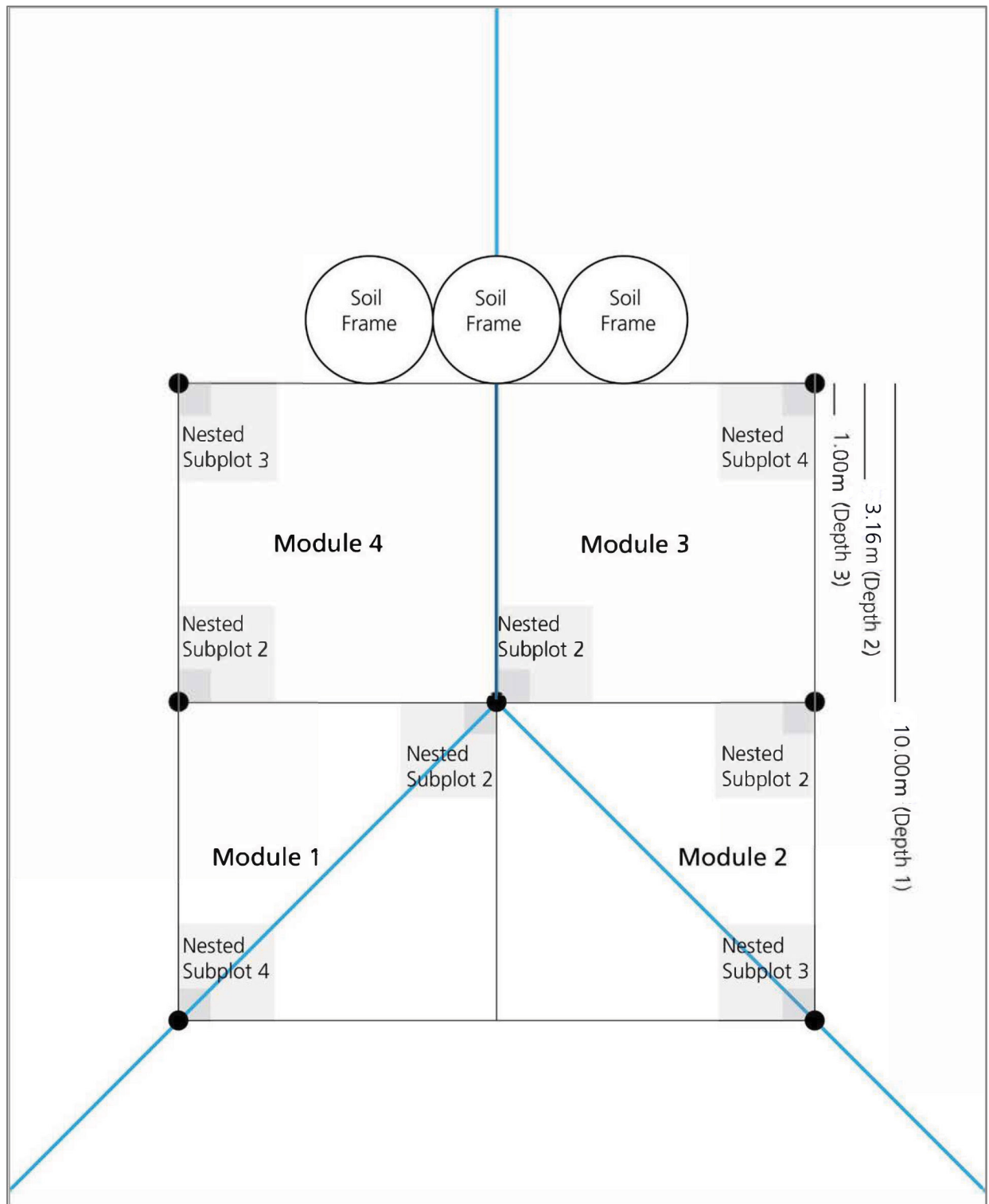


**Figure 3.** The layout of a vegetation monitoring plot for the Southeast Coast Network, which is a modified version of the standard Level 5 Carolina Vegetation Survey plot. Ideal locations of rebar used as permanent structures to monument the plot are represented by black shaded circles. Blue lines represent locations of the three 25-meter (82-foot) fuel transects.

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Vascular plant species lists were compiled at the 1 m<sup>2</sup> and 10 m<sup>2</sup> depths of each nested subplot as well as for each 100 m<sup>2</sup> module. Areal cover of each species present or overhanging each module was recorded using the 10 point cover class scale from Peet et al. (1998). 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. Once the final list was determined, each species was cross-referenced with the USDA Plants Database (USDA 2025) to determine growth form, nativity status, and to provide a unique common name. The species list was also cross-referenced with Florida plant lists to determine the state and federal conservation status (e.g., Endangered, Threatened, Rarity) of each species (FDACS 2024; FNAI 2025) and the list of non-native invasive plants in Florida to determine the degree of invasiveness (FISC 2023).

All woody stems greater than or equal to 10 centimeter (3.9 inches[in]) diameter at breast height (or 1.37 meter [4.5 ft] in height, DBH) were classified as trees. For each living tree within each module, the following values were recorded:

- Species
- DBH
- Presence of insect, disease, or other damages
- Status (live versus dead)
- Crown class
- Vigor
- Dieback

For each standing dead tree within each module, its decay class and height were recorded. Woody stems greater than or equal to 1.37 meters in height and less than 10 centimeters DBH were classified as saplings and tallied by species and diameter class within each 10 m<sup>2</sup> depth of the eight nested subplots. Woody stems less than 1.37 meters in height were classified as seedlings and tallied by species and height class within each 1 m<sup>2</sup> depth of the same nested subplots. Seedlings between 5–15 centimeters height were classified as germinants. Basal area, or the cross-sectional area of an individual tree based on its diameter, was calculated for each tree and sapling species. This metric as well as total counts (density) of woody individuals classified as either trees, saplings, or seedlings were used to determine growth rates and relative dominance of woody species within vegetation plots and broad habitat types.

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

Site characteristics were also measured at each plot, including coverage of standing water, presence and cover of disturbances, canopy cover, and canopy height. Photopoints were also collected from each plot. Additional data were collected at newly established plots (Cycle 1). These include dominant slope, aspect, terrain shape, basic hydrological condition, collection of soil samples from the three soil sample frames, and assignment to one or two USNVCS vegetation association types. These same data were collected in 2019 from revisit plots (Cycle 2) plots.

Finally, sampling lasted an average of 3.7 hours per plot and ranged from two to six hours. A complete description of all field methods is located within this protocol's implementation plan and its associated field standard operating procedures (SOPs; Boyle et al. 2019 and references therein).

## Results

Thirty-three vegetation plots were sampled across Timucuan EHP during this monitoring event in 2023, including 23 plots original established in 2019. Ten plots were established in 2023 to increase the sample size of broad habitat types within each management unit of the preserve. Data are summarized below at the preserve, management unit, broad habitat, and plot scale. Occasionally, 2023 data are compared with data collected within the preserve in 2019. However, trend analysis is not presented within this data summary report. Trend analytics will not be applied to vegetation monitoring data until at a minimum three cycles of sampling have occurred on these plots. Data summaries are provided for multiple elements collected across plots—species richness and cover, tree growth and regeneration metrics, tree health, environmental attributes, observed disturbances, and fuel loads. Collectively, these elements were qualitatively assessed to provide an overall condition scorecard for broad habitat types within the preserve. The scorecard is in the Conclusions section of this report.

### **Environmental Attributes and Broad Habitat Type Descriptions**

The three broad habitat types sampled during this monitoring effort encompassed a wide range of topographic, elevation, and soil moisture and fertility conditions. These environmental differences coupled with a site's disturbance history function to create unique vegetation composition and habitat structure at each plot (Figure 4). All Cycle 2 plots were classified to a USNVCS association in 2019, and all Cycle 1 plots established in 2023 were classified to an association during this current monitoring effort. Brief descriptions of environmental attributes for each broad habitat type are provided below, and summaries of USNVCS associations sampled during this monitoring effort are available in the [supplemental materials](#) accompanying this report.

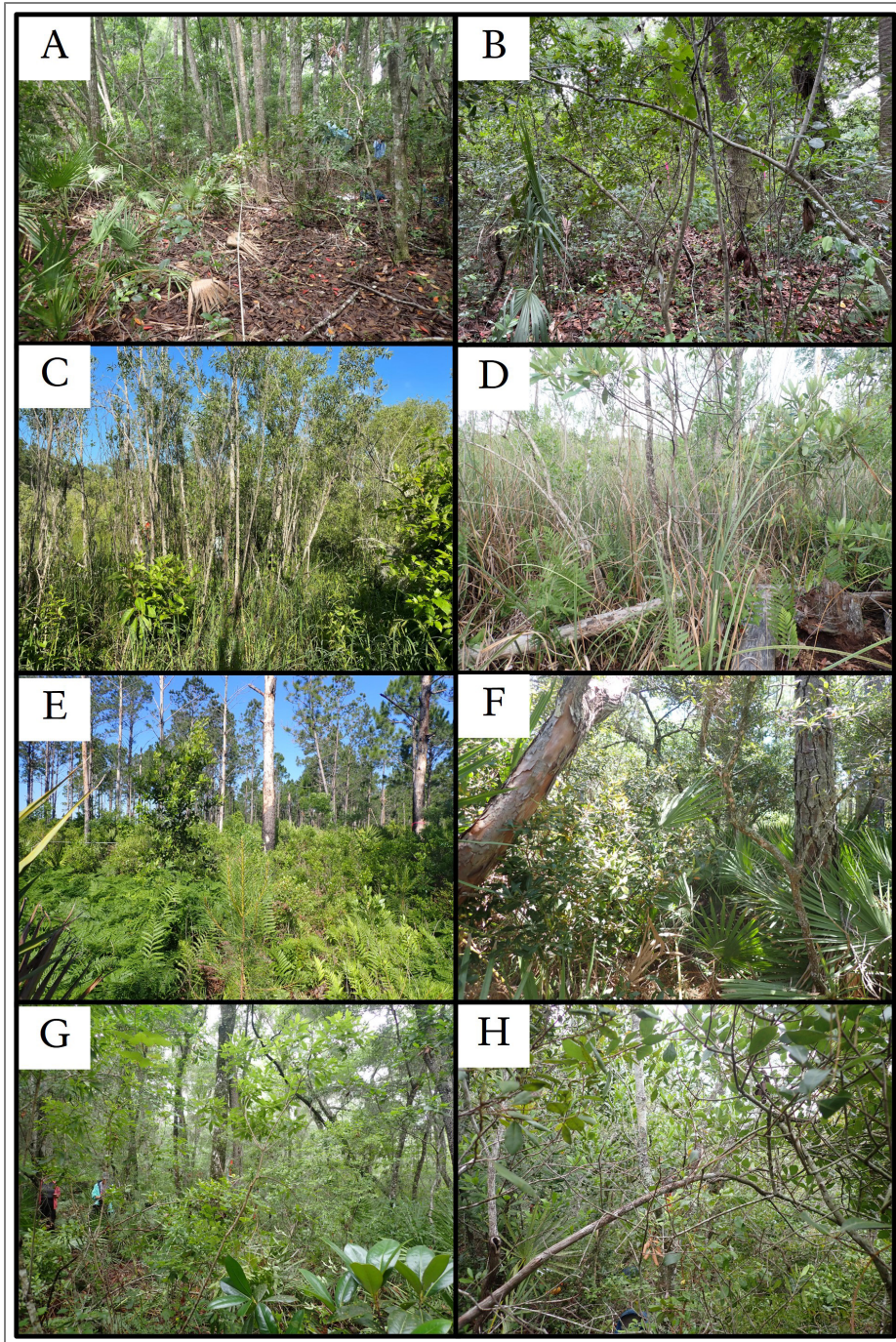


**Figure 4.** Representative photos of the three broad habitat types monitored within Timucuan Ecological and Historic Preserve. U.S. National Vegetation Classification Standard associations sampled within nontidal forested wetlands included Loblolly-bay Swamp Forest (A), Pond Pine-Bay Swamp (B), Central Florida Willow Thicket (C), and recently burned South Atlantic Coastal Nonriverine Swamp Forest (D). Open upland woodland associations included recently burned Slash Pine Flatwoods (E) and Longleaf Pine - Slash Pine Scrubby Flatwoods (F). Associations sampled within upland forest and shrubland habitat included Maritime Live Oak Hammock (G) and a single site example of South Atlantic Coastal Shell Midden Woodland (H).

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### **Nontidal Forested Wetlands**

Seven vegetation plots associated with the preserve's nontidal forested wetlands were established in 2019 and resurveyed during this monitoring effort, including three plots within Cedar Point, one plot within Theodore Roosevelt, and three plots within Thomas Creek. Another six plots were established in 2023 to ensure a minimum of four plots per preserve unit in future monitoring efforts. Three of these newly established plots were in Spanish Pond. Plot photopoints are available in Figures 1–13 in the [supplemental materials](#) accompanying this report. This habitat type includes a broad category of forested wetlands not tidally influenced within the preserve. Lowland hardwood swamps are across the preserve and present in all management units. The canopy of swamp forests is closed. Dominant canopy species include red maple (*Acer rubrum*), ash (*Fraxinus sp.*), loblolly bay (*Gordonia lasianthus*), swamp tupelo (*Nyssa biflora*), southern sweet bay (*Magnolia virginiana* var. *australis*), and others. The understory of these forests is typically shrubby and dense. Extensive swamp forests can be found on the southern end of Thomas Creek; elsewhere in the preserve this habitat occurs in smaller, patchy scales either adjacent to small creeks or in lower lying topographies within the upland matrix forest. Nontidal wetlands also include the freshwater marsh and shrub zones within Spanish Pond on the northern end of the Theodore Roosevelt Unit.

Nontidal forested wetlands occur in closed basins hydrologically controlled by rainfall, slope seepage, or groundwater seepage. Timing of standing water on these sites can vary from perennial to seasonal. All plots were dry (i.e., not submerged) at the time of sampling in both 2019 and 2023, except CEDA018 which was 80% covered in water during this most current monitoring cycle. These wetlands occur on flat or very minor sloping landforms; and soils are typically acidic and can have high levels of organic matter content ([supplemental materials](#)).

### **Open Upland Woodlands**

Six vegetation plots associated with the preserve's open upland woodland habitat were established in 2019 and resurveyed during this latest monitoring effort, including one plot within Cedar Point and five plots within Thomas Creek. Another three plots were established within Cedar Point in 2023 to ensure a minimum of four plots per preserve unit in future monitoring efforts. Plot photopoints are available to view in Figures 14–22 in the [supplemental materials](#) accompanying this report.

Open upland woodlands of Timucuan EHP occur on relatively flat terrains and typically have poorly drained soils. They can develop over a wide spectrum of hydrologic condition based on relatively small changes in elevation and topography—including hydric sites that contain standing water several months during the year, mesic sites (the most common hydrology of open upland woodlands) that are inundated only during periods of high water during the rainy season, and dry sites with well-drained soils (Abrahamson and Hartnett 1990). All plots were dry (i.e., not submerged) at the time of sampling in both 2019 and 2023 ([supplemental materials](#)).

Soil samples collected in 2019 and 2023 from these plots exhibited traits typical of soils from this ecosystem type within Florida (Abrahamson and Hartnett 1990). Soil analysis revealed highly acidic conditions, with pH ranges from 3.7 to 4.4; furthermore, organic matter and extractable nutrient content values were typically low ([supplemental materials](#)).

This habitat type includes open canopy forests and woodlands dominated by pines (slash and longleaf [*Pinus palustris*]). A variant of this habitat (“sandhills”) usually occurs on rolling, complex topography. There is typically very little understory, and the ground cover can be dense with both shrub and herbaceous species. These communities are historically maintained by frequent, low intensity fire. Mesic to hydric pine woodlands are the dominant upland matrix vegetation type of Thomas Creek, and also occur in patches surrounded by maritime oak forests and forested wetlands within Cedar Point. The “sandhills” variant of this broadly defined habitat is near the preserve headquarters within the Theodore Roosevelt Unit and in patches on the northern edge of Cedar Point.

### ***Upland Forests and Shrublands***

Ten vegetation plots associated with the preserve’s upland forest and shrubland habitat were established in 2019 and resurveyed during this latest monitoring effort, including four plots within the Cedar Point and six plots within Theodore Roosevelt. Another plot was established within Cedar Point in 2023 to maximize coverage within this preserve unit in future monitoring efforts. Plot photopoints are available to view in Figures 23–33 in the [supplemental materials](#) accompanying this report.

Maritime upland forests and shrublands of the outer Coastal Plain are on stabilized dunes of barrier islands and ridges and bluffs of mainland settings adjacent to the coast. 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 where they border ocean and dune habitat or salt marsh habitat.

Plots within upland forests and shrublands occurred on the steepest slopes within the park, ranging from 0 to 5.5°, and exhibited concave, flat, and convex terrain shapes ([supplemental materials](#)). Standing water was not observed on any of these sites. Like most soils measured in the park, soils within this habitat were acidic; however, a few plots exhibited rather high pH values—including two plots with alkaline (pH > 7) soils ([supplemental materials](#)). These two plots were on the Cedar Point land parcel and included the single plot classified as the South Atlantic Coastal Shell Midden Woodland. Throughout their range, these rare communities have elevated calcium in the soil, owing to their occurrence on calcareous coastal sands, natural shell deposits, or Native American shell middens.

This broad habitat type represents forests (and occasional shrublands) with canopies dominated by live oak and sand laurel oak (*Quercus hemisphaerica*), with an understory of southern red cedar, red bay, and cabbage palmetto. Trees are typically covered with epiphytic plants like Spanish moss (*Tillandsia usneoides*) and resurrection fern (*Pleopeltis polypodioides*). These maritime oak-dominated forests comprise a substantial portion of the upland habitats within Cedar Point and Theodore Roosevelt. A drier variant of this broadly defined habitat occurs on deep, relatively sterile sands and is composed of stunted trees such as sand live oak (*Quercus geminata*), Chapman oak (*Quercus chapmanii*), and occasional pines; the shrub stratum in these sites is composed of various species such as huckleberries (*Gaylussacia* sp.), saw palmetto, and southern evergreen blueberry

(*Vaccinium myrsinites*). Within the preserve, this “sandhill” type of upland forest and shrubland is in scattered areas of the northern portion of Cedar Point and in strands of the Theodore Roosevelt Unit.

### **Preserve-Scale Species Diversity and Notable Species Information**

Across all 33 monitoring plots sampled in 2023, 245 vascular plant taxa were detected ([supplemental materials](#)). In contrast, the 23 monitoring plots established in 2019 yielded 155 species (Boyle and Rico 2021). Twenty-four species present in 2019 were not detected in 2023. There were 37 species present in the 2023 monitoring plots not on previous park taxa lists ([supplemental materials](#)), including two species listed as invasive by the Florida Invasive Species Council (FISC 2023)—downy maiden fern (*Christella dentata*) and narrow sword fern (*Nephrolepis cordifolia* var. *cordifolia*). These invasive species were observed in monitoring plots in Spanish Pond on the northern end of the Theodore Roosevelt Unit. Another new-to-park species of note also found within Spanish Pond—water-spider orchid (*Habenaria repens*)—is listed as vulnerable (S3) within the state of Florida (NatureServe 2025; Figure 5).



**Figure 5.** This water-spider orchid (*Habenaria repens*) was observed in one of the three newly established vegetation monitoring plots of Spanish Pond. This species is known to occur in a variety of wetlands, including marshes, blackwater swamps, and along banks of rivers and creeks. In Florida, its conservation status is listed as vulnerable (S3; NatureServe 2025).

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Most species detected in 2023 are common across northern Florida and the Southeastern United States. The most frequently occurring were muscadine (*Muscadinia rotundifolia* var. *rotundifolia*), saw palmetto, and dune greenbriar (*Smilax auriculata*); each found in 76% of vegetation plots. Other widespread species included Spanish moss, common wax-myrtle (*Morella cerifera*), and slash pine. Ninety-three of the 245 plant taxa detected (38% of the total) within these plots were single

occurrence records (i.e., only found in one plot). Preserve-wide average species richness at the full-plot scale (400 m<sup>2</sup>) was 32.8 across all plots sampled in 2023. Average richness in 2023 for the 23 plots established in 2019 (Cycle 2) was 32.7; average richness in 2019 for these same plots was 29.1.

The few species rare to either northern Florida or the Southeastern U.S. detected during this monitoring effort include the aforementioned water-spider orchid, green dragon (*Arisaema dracontium*), white ash (*Fraxinus americana*), small-flowered buckthorn (*Sageretia minutiflora*) and tough bully (*Sideroxylon tenax*). Another observed species of note—buckthorn bully (*Sideroxylon lycioides*)—is listed as endangered within Florida. 95% of taxa are categorized as native while the remaining 5% are categorized as non-native or whose nativity status is unknown. Eight of the non-native species are listed as invasive by the Florida Invasive Species Council (FISC 2023) and include the two aforementioned ferns, Chinese tallow, camphortree, common lantana (*Lantana strigocamara*), primrose-willow (*Ludwigia peruviana*), Japanese climbing fern (*Lygodium japonicum*), and water spangles (*Salvinia minima*). Invasive species detections in 2019 across the preserve were low. Larger rates of detection in 2023 were primarily due to elevated numbers of invasive species in newly established Cycle 1 plots within Spanish Pond on the northern end of the Theodore Roosevelt Unit. However, new invasive detections did occur in other areas of the preserve. 2023 presence of invasive species within the 33 SECN vegetation plots of the preserve is provided in [supplemental materials](#).

### **Species Richness and Abundance by Broad Habitat Type**

Average species numbers (i.e., species richness) at the full plot scale (400 m<sup>2</sup>) were similar in 2023 across broad habitat types in Cycle 2 vegetation plots (Figure 6) and were typically similar to values reported from these same plots in 2019 (Figure 7; Boyle and Rico 2021). The most notable differences were observed within open upland woodland plots (see discussion below). Species categorized as trees represented the highest growth form richness value across all habitat types within both sample years (Figure 7). Summaries of species presence and abundance information for each broad habitat type are provided below and within [supplemental materials](#).

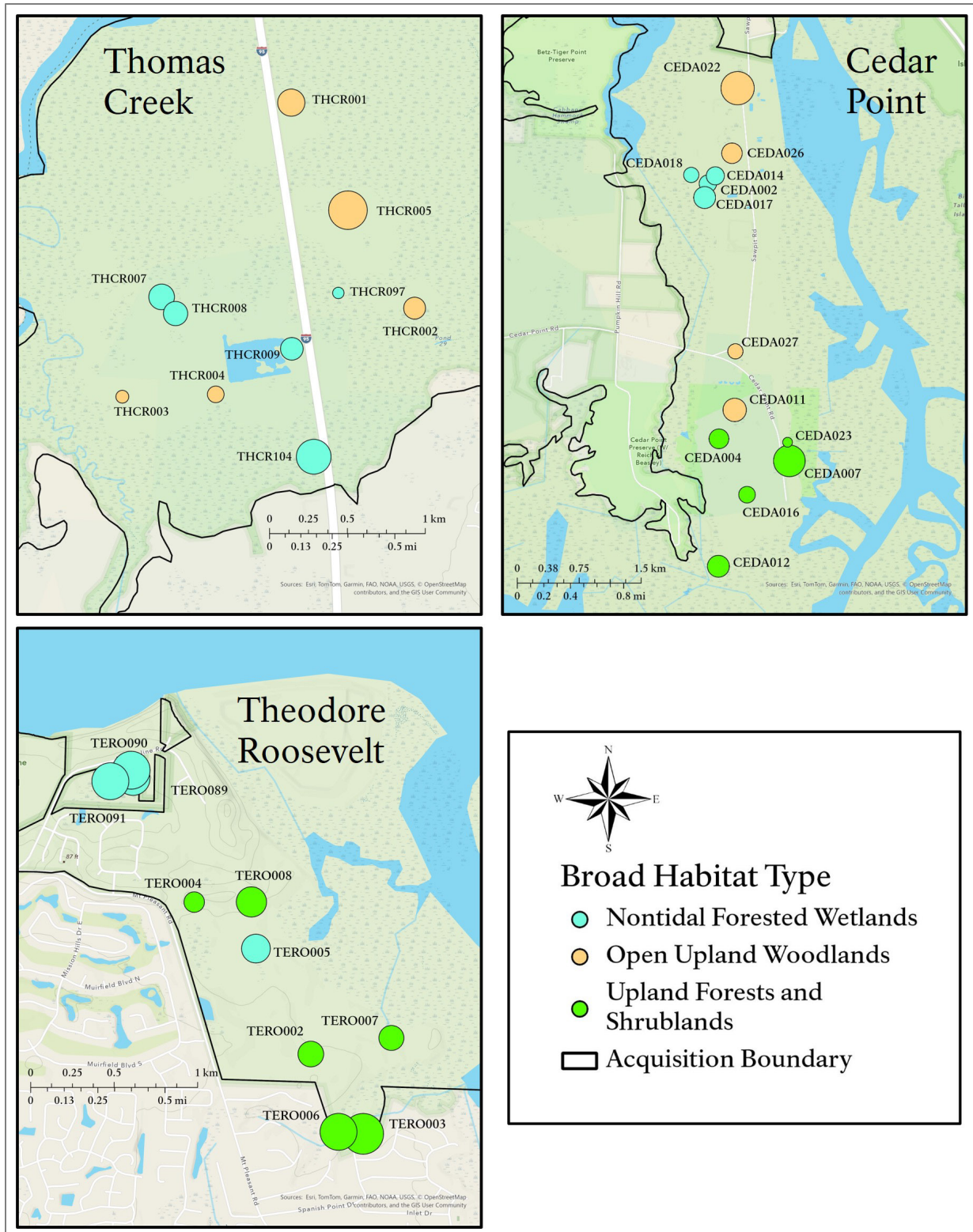


**Figure 6.** Vegetation plots within Timucuan Ecological and Historic Preserve scaled in size by 2023 species richness estimates. Richness values ranged from 13 to 54 species per plot across all broad habitat types.

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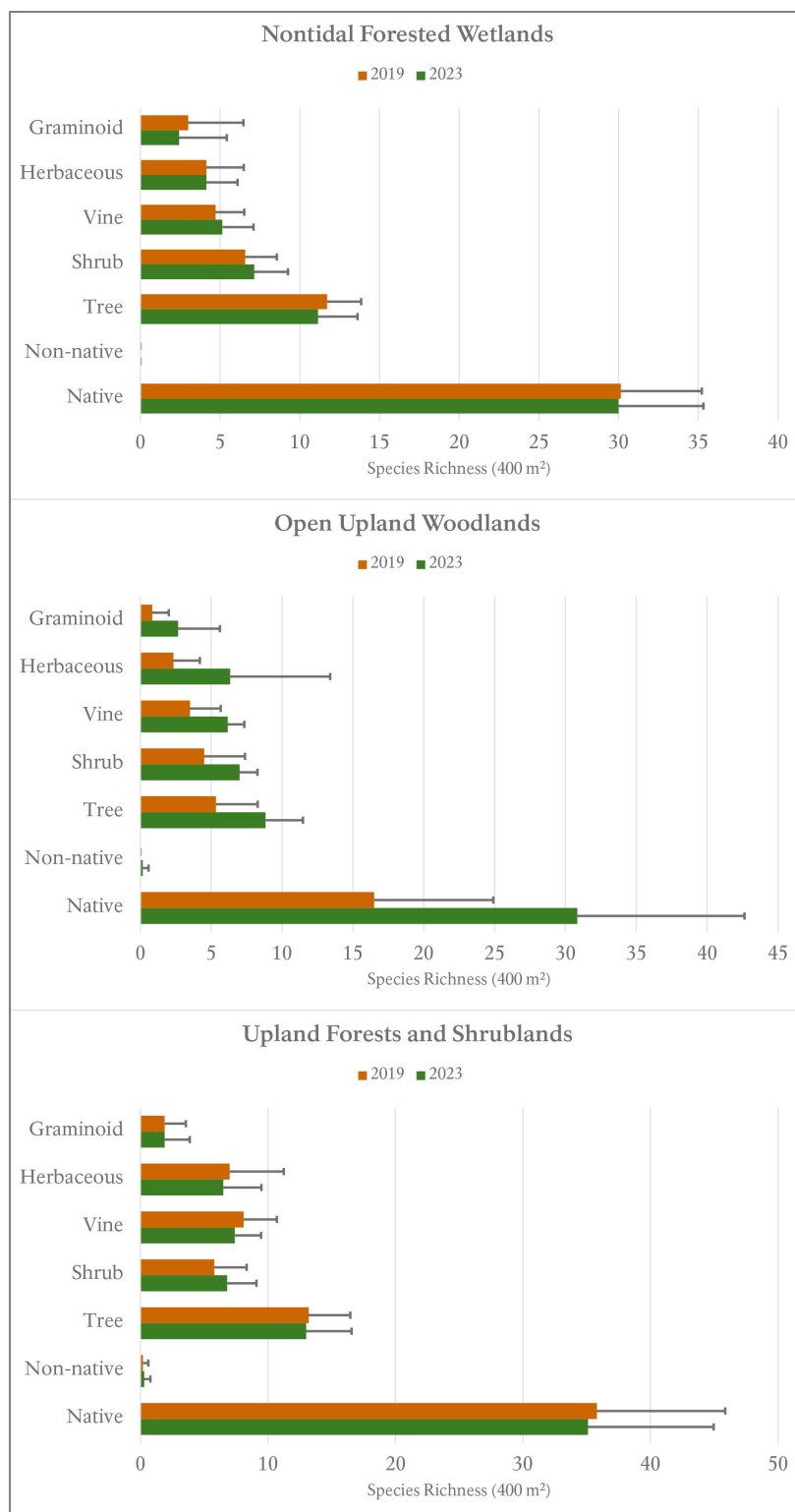


**Figure 7.** Average species richness at the full plot scale (400 m<sup>2</sup>) by growth form and nativity within broad habitat types of Timucuan Ecological and Historic Preserve. Data are summarized for plots monitored in both sampling years only, 2019 and 2023. Error bars represent standard deviation.

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### **Nontidal Forested Wetlands**

During this monitoring year, native species richness ranged from 15 to 46 species per plot within newly established Cycle 1 and revisited Cycle 2 nontidal forested wetland plots of the preserve, with an average of 32.5 (Figures 6 and 7; [supplemental materials](#)). Richness values of most plots hovered around this average, although there was some variation. Plots with higher numbers of native species occurred within the willow thicket habitat of Spanish Pond on the north of the Theodore Roosevelt unit (TERO089, TERO090, and TERO091). These plots had much higher herbaceous and graminoid diversity compared with other nontidal forested wetland plots within the preserve. A high number of native species was also observed in the basin swamp forest plot adjacent to Interstate 95 on the Thomas Creek unit (THCR104). Richness was lowest in the single nontidal forested wetland plot east of Interstate 95 on the Thomas Creek unit (THCR097). This site has experienced high levels of tree mortality owing to multiple wildfire events over past several decades ([supplemental materials](#)) and is dominated by high cover of sawgrass (*Cladium jamaicense*).

Total number of species (i.e., richness) within Cycle 2 nontidal forested wetland plots of Timucuan EHP were similar when comparing 2019 to 2023 monitoring events across most growth forms (trees, shrubs, vines, herbs, and graminoids) and plot spatial scales (400 m<sup>2</sup>, 100 m<sup>2</sup>, 10 m<sup>2</sup>, and 1 m<sup>2</sup>) ([supplemental materials](#); Boyle and Rico 2021). In 2023, native species richness averaged 30.0 for Cycle 2 plots ([supplemental materials](#)). The average richness in 2019 was essentially the same (30.3; Boyle and Rico 2021). Collectively, tree species provided the highest level of diversity across most spatial scales in Cycle 2 plots (Figure 7).

Non-native species were not present in any of the Cycle 2 plots, nor were they present in 2019. However, the additional plots established in 2023 within the Theodore Roosevelt and Thomas Creek units did have non-native species present ([supplemental materials](#)). Plants listed as invasive by the Florida Invasive Species Council (FISC 2023) were frequent, but occurred in low abundance, in the three Spanish Pond plots of the Theodore Roosevelt unit and included downy maiden fern, primrose-willow, Japanese climbing fern, tuberous sword fern, and Chinese tallow; one newly established nontidal forested wetland plot within the Thomas Creek unit (THCR104) had high abundance of the aquatic invasive water spangles.

There were 150 vascular plant taxa observed in the 13 nontidal wetland plots of the preserve during this monitoring effort in 2023. Constancy and average areal cover value of each taxa record from 2023 vegetation plots are summarized by broad habitat type and located in [supplemental materials](#). Constancy is defined as the proportion of plots a certain taxa occurs in and is expressed as a percentage; a species with 100% constancy occurs in all plots of a given broad habitat type. Species with high constancy in nontidal forested wetland plots of the preserve in 2023 are listed below along with their average cover range:

#### Trees

- Swamp tupelo; constancy = 77%, mean cover = 10–25%
- Swamp bay; constancy = 69%, mean cover = 5–10%

- Southern sweet bay; constancy = 69%, mean cover = 2–5%
- Slash pine; constancy = 62%, mean cover = 5–10%
- Water oak (*Quercus nigra*); constancy = 62%, mean cover = 5–10%

#### Shrubs

- Common wax-myrtle; constancy = 85%, mean cover = 2–5%
- Black highbush blueberry (*Vaccinium fuscatum*); constancy = 62%, mean cover = 0–1%

#### Vines

- Muscadine; constancy = 69%, mean cover = 2–5%
- Eastern poison ivy (*Toxicodendron radicans* var. *radicans*); constancy = 69%, mean cover = 1–2%
- Whiteleaf greenbriar (*Smilax glauca*); constancy = 62%, mean cover = 0–1%

#### Herbs/Graminoids

- Spanish moss; constancy = 85%, mean cover = 0–1%
- Cinnamon fern; constancy = 77%, mean cover = 2–5%

#### **Open Upland Woodlands**

Native species richness ranged from 17 to 51 species per plot (average of 30.6) within open upland woodland plots of Timucuan EHP in 2023 (Figures 6 and 7; [supplemental materials](#)). Tree species provided the highest level of richness among species growth forms within these plots at the full plot and modular scale (400 m<sup>2</sup>, 100 m<sup>2</sup>), while at the nested subplot scales (10 m<sup>2</sup>, 1 m<sup>2</sup>) other woody growth forms and herbaceous species were codominant ([supplemental materials](#)). There was considerable variation in richness values among these plots in 2023 ([supplemental materials](#)) and differences among overall richness values between sampling years (Figure 7). Spikes in overall richness between 2019 and 2023 can be contributed to extremely low species observations taken in 2019 from the three open upland woodland plots within the footprint of the Yellow Bluff Wildfire of the Thomas Creek Unit (THCR001, THCR002, and THCR005). In 2019, these plots were sampled less than a month following the wildfire when there was very little ground cover present (Figures 18, 19, and 22 in [supplemental materials](#)). Current species numbers in these plots are higher than open upland woodland plots of Thomas Creek that did not burn in 2019 (THCR003 and THCR004; [supplemental materials](#)). In these unburned plots, an extremely dense and tall shrub stratum of little gallberry is present (Figures 20 and 21 in [supplemental materials](#)). The crowded nature of this species within these plots prevents the establishment of other species within the ground cover and minimizes the ability for canopy species to regenerate.

Non-native species were not present in any of the preserve's open upland woodland plots in 2019 (Boyle and Rico 2021). However, in 2023 Chinese tallow was observed in one of the plots in the Yellow Bluff Wildfire footprint—THCR001 ([supplemental materials](#)). Chinese tallow was also

observed in an open upland woodland plot newly established in 2023 within Cedar Point—CEDA022 ([supplemental materials](#)).

There were 107 vascular plant taxa observed in the nine open upland woodland plots of the preserve during this monitoring effort in 2023. Constancy and average areal cover values of each taxa record from 2023 vegetation plots are summarized by broad habitat type and located in [supplemental materials](#). Species with high constancy in open upland woodland plots of the preserve in 2023 are listed below along with their average cover range:

#### Trees

- Slash pine; constancy = 100%, mean cover = 10–25%

#### Shrubs

- Saw palmetto; constancy = 100%, mean cover = 25–50%
- Little gallberry; constancy = 100%, mean cover = 25–50%
- Black highbush blueberry; constancy = 78%, mean cover = 1–2%
- Common wax-myrtle; constancy = 78%, mean cover = 0–1%
- Southern dwarf huckleberry (*Gaylussacia dumosa*); constancy = 78%, mean cover = 0–1%

#### Vines

- Elliott’s milkpea (*Galactia elliottii*); constancy = 89%, mean cover = 5–10%
- Dune greenbriar; constancy = 89%, mean cover = 1–2%
- Muscadine; constancy = 78%, mean cover = 2–5%
- Whiteleaf greenbriar; constancy = 78%, mean cover = 1–2%

#### Herbs/Graminoids

- Southern bracken (*Pteridium pseudocaudatum*); constancy = 78%, mean cover = 2–5%

#### ***Upland Forests and Shrublands***

Native species richness ranged from 13 to 52 species per plot (average of 33.1) within upland forest and shrubland plots of the preserve in 2023 with tree species providing the highest level of richness among species growth form across all plot spatial scales (Figures 6 and 7; [supplemental materials](#)). Richness was lowest in CEDA023 which was directly adjacent to the marsh of Clapboard Creek on the eastern edge of the Cedar Point Unit. This site has experienced recent flood scour impacting overall ground cover diversity ([supplemental materials](#)).

Total number of species within Cycle 2 upland forest and shrubland plots of Timucuan EHP were similar when comparing 2019 to 2023 monitoring events across all growth forms (trees, shrubs, vines, herbs, and graminoids) and plot spatial scales (400 m<sup>2</sup>, 100 m<sup>2</sup>, 10 m<sup>2</sup>, and 1 m<sup>2</sup>) (Figure 6;

[supplemental materials](#); Boyle and Rico 2021). In 2023, native species richness averaged 35.1 for Cycle 2 plots ([supplemental materials](#)). The average richness in 2019 was essentially the same for these same plots (36.2; Boyle and Rico 2021).

Non-native species frequency and abundance within plots of this broad habitat type in the Cedar Point and Theodore Roosevelt Units was low in 2019 and in 2023. However, new detections of two invasive species—camphortree and common lantana—were observed in upland forest and shrubland plots on the southern end of the Theodore Roosevelt Unit (TERO003 and TERO006; [supplemental materials](#)).

There were 110 total vascular plant taxa observed in the 11 upland forest and shrubland plots of the preserve during this second monitoring effort. Constancy and average areal cover values of each taxa record from 2023 vegetation plots are summarized by broad habitat type and located in [supplemental materials](#). Species with high constancy in these plots of the preserve in 2023 are listed below along with their average cover range:

#### Trees

- Sand laurel oak; constancy = 100%, mean cover = 10–25%
- Live oak; constancy = 91%, mean cover = 25–50%
- Red bay; constancy = 82%, mean cover = 2–5%
- Cabbage palmetto; constancy = 73%, mean cover = 10–25%
- Wild olive (*Cartrema americanum*); constancy = 73%, mean cover = 10–25%
- Pignut hickory (*Carya glabra*); constancy = 73%, mean cover = 5–10%

#### Shrubs

- Saw palmetto; constancy = 82%, mean cover = 10–25%
- Yaupon (*Ilex vomitoria*); constancy = 73%, mean cover = 5–10%
- American beautyberry (*Callicarpa americana*); constancy = 73%, mean cover = 0–1%

#### Vines

- Dune greenbriar; constancy = 91%, mean cover = 1–2%
- Muscadine; constancy = 82%, mean cover = 2–5%
- Saw greenbriar (*Smilax bona-nox*); constancy = 73%, mean cover = 0–1%
- Virginia creeper (*Parthenocissus quinquefolia*); constancy = 73%, mean cover = 0–1%

#### Herbs/Graminoids

- Spanish moss; constancy = 100%, mean cover = 5–10%
- Ball-moss (*Tillandsia recurvata*); constancy = 82%, mean cover = 0–1%

## **Tree Abundance, Health, and Growth Metrics by Broad Habitat Type**

There were 697 live trees present within 33 SECN vegetation plots across Timucuan EHP in 2023, and the total basal area of these live trees was 705 m<sup>2</sup>/ha. Dominant species across the preserve included slash pine, live oak, swamp tupelo, loblolly bay, and cabbage palmetto. There were 34 woody species with a large enough diameter at breast height ( $\geq 10$  cm) to be considered a tree. Eighty-nine dead trees were observed in 2023 across all 33 vegetation plots. Thirty-nine of these were slash pine. Summaries of tree presence, abundance, and health status observed during this monitoring effort are provided below for each broad habitat type and within [supplemental materials](#).

### ***Nontidal Forested Wetlands***

Live tree basal area within nontidal forested wetland plots of Timucuan EHP ranged from 2.8 to 40.5 m<sup>2</sup>/ha with an average of 22.5 m<sup>2</sup>/ha, while live tree density ranged from three to 65 stems/plot ([supplemental materials](#)). Density of live trees was highest in this broad habitat type of the preserve. Live tree abundance was expectably low in the three willow-dominated shrubland plots within Spanish Pond (TERO089, TERO90, and TERO091). Hydrologic patterns and edaphic conditions within Spanish Pond restrict the ability of woody species to grow into large trees except along the edges of this community. Small trees and shrubs that grow within the center of Spanish Pond are adapted to survive during periods of prolonged wet conditions.

Dominant trees, by basal area, within this broad habitat type included native species such as swamp tupelo, slash pine, loblolly bay, and water oak ([supplemental materials](#)); individual plots had varying rates of abundance of these and other canopy-forming species ([supplemental materials](#)). For example, slash pine typically dominated nontidal forested wetlands of Cedar Point but was much less dominant in the other management units of the preserve. Canopy cover was usually above 80% within these plots, but several plots had lower cover (<50%) related to recent disturbance history (e.g., high canopy mortality brought on by wildfire events in THCR097) or edaphic factors impacting canopy formation (TERO089).

Of the 376 trees measured within these plots in 2023, 333 were living (89%), 30 were dead (8%), and 13 had fallen since the previous monitoring effort in 2019 (3%; Table 1). Over half of the dead trees were swamp tupelo, loblolly bay, or water oak. Tree mortality is a natural occurrence within forested vegetation communities, resulting in increased growth of remaining live individual trees and creating canopy gaps for ground cover recruitment of seedlings and other species. Mortality rates observed within this broad habitat type are relatively low and should not be a concern for overall forest health. Furthermore, live trees within this broad habitat type typically exhibited healthy vigor (72% of the total; Table 1).

**Table 1.** Total counts of live, dead, and fallen trees and vigor estimates by species within nontidal forested wetland vegetation plots of Timucuan Ecological and Historic Preserve.

| Species                                          | Grand Total | Status     |           |           | Vigor      |               |                  |                |                   |
|--------------------------------------------------|-------------|------------|-----------|-----------|------------|---------------|------------------|----------------|-------------------|
|                                                  |             | Live       | Dead      | Fallen    | Healthy    | Light Decline | Moderate Decline | Severe Decline | Functionally Dead |
| <i>Acer rubrum</i>                               | 12          | 11         | 1         | 0         | 8          | 1             | 1                | 0              | 1                 |
| <i>Cartrema americanum</i>                       | 1           | 1          | 0         | 0         | 0          | 0             | 1                | 0              | 0                 |
| <i>Cephalanthus occidentalis</i>                 | 5           | 4          | 1         | 0         | 2          | 1             | 1                | 0              | 0                 |
| <i>Fraxinus caroliniana</i>                      | 8           | 5          | 3         | 0         | 2          | 2             | 1                | 0              | 0                 |
| <i>Gordonia lasianthus</i>                       | 95          | 81         | 5         | 9         | 60         | 8             | 12               | 1              | 0                 |
| <i>Ilex cassine</i>                              | 3           | 3          | 0         | 0         | 3          | 0             | 0                | 0              | 0                 |
| <i>Ilex opaca</i>                                | 2           | 2          | 0         | 0         | 2          | 0             | 0                | 0              | 0                 |
| <i>Liquidambar styraciflua</i>                   | 12          | 12         | 0         | 0         | 11         | 0             | 0                | 0              | 1                 |
| <i>Magnolia grandiflora</i>                      | 3           | 3          | 0         | 0         | 3          | 0             | 0                | 0              | 0                 |
| <i>Magnolia virginiana</i> var. <i>australis</i> | 7           | 7          | 0         | 0         | 5          | 0             | 1                | 1              | 0                 |
| <i>Nyssa biflora</i>                             | 100         | 89         | 10        | 1         | 61         | 6             | 21               | 0              | 1                 |
| <i>Persea palustris</i>                          | 2           | 0          | 1         | 1         | 0          | 0             | 0                | 0              | 0                 |
| <i>Pinus elliotii</i>                            | 26          | 24         | 2         | 0         | 22         | 1             | 1                | 0              | 0                 |
| <i>Pinus serotina</i>                            | 3           | 3          | 0         | 0         | 3          | 0             | 0                | 0              | 0                 |
| <i>Pinus taeda</i>                               | 1           | 1          | 0         | 0         | 1          | 0             | 0                | 0              | 0                 |
| <i>Quercus hemisphaerica</i>                     | 3           | 3          | 0         | 0         | 2          | 1             | 0                | 0              | 0                 |
| <i>Quercus laurifolia</i>                        | 8           | 8          | 0         | 0         | 6          | 2             | 0                | 0              | 0                 |
| <i>Quercus nigra</i>                             | 56          | 47         | 7         | 2         | 30         | 10            | 5                | 2              | 0                 |
| <i>Quercus virginiana</i>                        | 2           | 2          | 0         | 0         | 1          | 0             | 1                | 0              | 0                 |
| <i>Sabal palmetto</i>                            | 1           | 1          | 0         | 0         | 1          | 0             | 0                | 0              | 0                 |
| <i>Salix caroliniana</i>                         | 26          | 26         | 0         | 0         | 17         | 4             | 1                | 2              | 2                 |
| <b>Grand Total</b>                               | <b>376</b>  | <b>333</b> | <b>30</b> | <b>13</b> | <b>240</b> | <b>36</b>     | <b>46</b>        | <b>6</b>       | <b>5</b>          |

Only the seven plots established in 2019 within this broad habitat type could be used to assess tree growth. Overall, average basal area of canopy species within these seven plots increased, with oak species exhibiting the slowest growth rate (Figure 8).

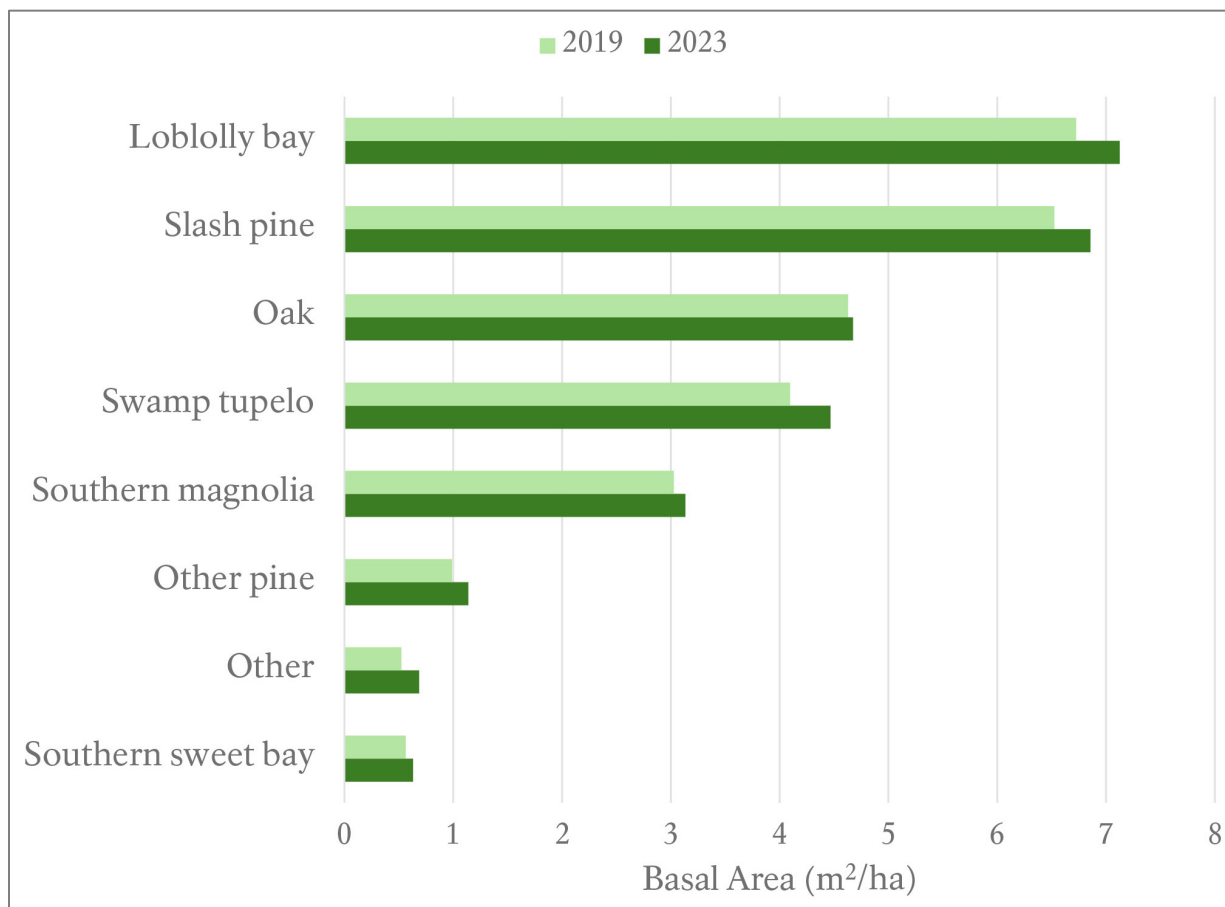


**Figure 8.** Mean basal area of live canopy species within nontidal forested wetland plots of Timucuan Ecological and Historic Preserve sampled in 2019 and 2023. Species in the “Oak” category include sand laurel oak, laurel oak (*Quercus laurifolia*), water oak, and live oak; species in the “Other pine” category include pond pine (*Pinus serotina*) and loblolly pine (*Pinus taeda*); and species in the “Other” category include wild olive, dahoon (*Ilex cassine*), American holly (*Ilex opaca*), sweetgum (*Liquidambar styraciflua*), and cabbage palmetto.

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### **Open Upland Woodlands**

Live tree basal area within open upland woodland plots of the preserve ranged from 0 to 31.9 m²/ha with an average of 14.1 m²/ha and was the lowest among all broad habitat types monitored ([supplemental materials](#)). Natural, healthy stands of this habitat type have widely spaced trees, lower tree densities, and a relatively more open canopy than hardwood-dominated forests of the Southeastern Coastal Plain. Open canopies allow sunlight to penetrate the ground and create suitable conditions for tree regeneration. Ray (2010) suggests maintaining a canopy cover below a 50% threshold is needed to support healthy ground cover conditions within upland pine forests. Within the

preserve's open upland woodland plots, canopy cover ranged from 3 to 83% and was highest within Cedar Creek and the two open upland woodland plots of Thomas Creek west of Interstate 95 ([supplemental materials](#)).

Dominant trees across this broad habitat type of the preserve included slash, pond, and longleaf pine in varying combinations of dominance ([supplemental materials](#)). Open upland woodlands of Cedar Point were dominated by slash and pond pine ([supplemental materials](#)), while open woodlands of Thomas Creek were dominated by slash pine and, in one example (THCR003), longleaf pine ([supplemental materials](#)). Hardwood species like live oak, sweetgum, and loblolly bay were occasionally present in the canopy ([supplemental materials](#)), and their presence illustrates the wide spectrum of intergrading species among broad habitat types within the preserve. Plant communities often do not form clear boundaries and sites can exhibit structure and composition of more than one community type. Species composition within a site is largely a function of edaphic conditions, disturbance events, and random chance.

Of the 209 trees measured within these plots in 2023, 163 were living (78%), 38 were dead (18%), and eight had fallen since the previous monitoring effort in 2019 (4%; Table 2). All the dead trees within this broad habitat type occurred within plots east of Interstate 95 on Thomas Creek. These three plots (THCR001, THCR002, and THCR005) were in the footprint of the 2019 Yellow Bluff Wildfire and have since experienced heavy rates of tree mortality (see discussion below). Elsewhere across the preserve, not only were mortality rates of canopy species nonexistent, but trees experienced healthy vigor (Table 2). There were no trees present in CEDA022 because it had recently been logged by prior owners within this parcel of the preserve ([supplemental materials](#)).

**Table 2.** Total counts of live, dead, and fallen trees and vigor estimates by species within open upland woodland vegetation plots of Timucuan Ecological and Historic Preserve.

| Species                        | Grand Total | Status     |           |          | Vigor      |               |                  |                |                   |
|--------------------------------|-------------|------------|-----------|----------|------------|---------------|------------------|----------------|-------------------|
|                                |             | Live       | Dead      | Fallen   | Healthy    | Light Decline | Moderate Decline | Severe Decline | Functionally Dead |
| <i>Acer rubrum</i>             | 1           | 1          | 0         | 0        | 1          | 0             | 0                | 0              | 0                 |
| <i>Gordonia lasianthus</i>     | 2           | 2          | 0         | 0        | 1          | 1             | 0                | 0              | 0                 |
| <i>Ilex opaca</i>              | 1           | 0          | 1         | 0        | 0          | 0             | 0                | 0              | 0                 |
| <i>Ilex vomitoria</i>          | 1           | 1          | 0         | 0        | 1          | 0             | 0                | 0              | 0                 |
| <i>Liquidambar styraciflua</i> | 5           | 5          | 0         | 0        | 5          | 0             | 0                | 0              | 0                 |
| <i>Lyonia ferruginea</i>       | 3           | 3          | 0         | 0        | 3          | 0             | 0                | 0              | 0                 |
| <i>Persea borbonia</i>         | 1           | 0          | 1         | 0        | 0          | 0             | 0                | 0              | 0                 |
| <i>Pinus elliotii</i>          | 101         | 59         | 36        | 6        | 53         | 5             | 1                | 0              | 0                 |
| <i>Pinus palustris</i>         | 35          | 34         | 0         | 1        | 33         | 1             | 0                | 0              | 0                 |
| <i>Pinus serotina</i>          | 37          | 37         | 0         | 0        | 27         | 4             | 3                | 3              | 0                 |
| <i>Quercus chapmanii</i>       | 4           | 4          | 0         | 0        | 3          | 1             | 0                | 0              | 0                 |
| <i>Quercus geminata</i>        | 3           | 3          | 0         | 0        | 3          | 0             | 0                | 0              | 0                 |
| <i>Quercus hemisphaerica</i>   | 1           | 1          | 0         | 0        | 1          | 0             | 0                | 0              | 0                 |
| <i>Quercus nigra</i>           | 1           | 1          | 0         | 0        | 0          | 1             | 0                | 0              | 0                 |
| <i>Quercus virginiana</i>      | 13          | 12         | 0         | 1        | 5          | 4             | 3                | 0              | 0                 |
| <b>Grand Total</b>             | <b>209</b>  | <b>163</b> | <b>38</b> | <b>8</b> | <b>136</b> | <b>17</b>     | <b>7</b>         | <b>3</b>       | <b>0</b>          |

Only the six plots established in 2019 within this broad habitat type could be used to assess tree growth. Slash pine basal area decreased from 15.1 to 8.9 m<sup>2</sup>/ha from 2019 to 2023 owing to heavy live tree mortality of this species in the Yellow Bluff Wildfire plots (Figure 9). Basal area of other species and slash pine outside of the Yellow Bluff Wildfire plots (not shown) increased between sampling years (Figure 9).

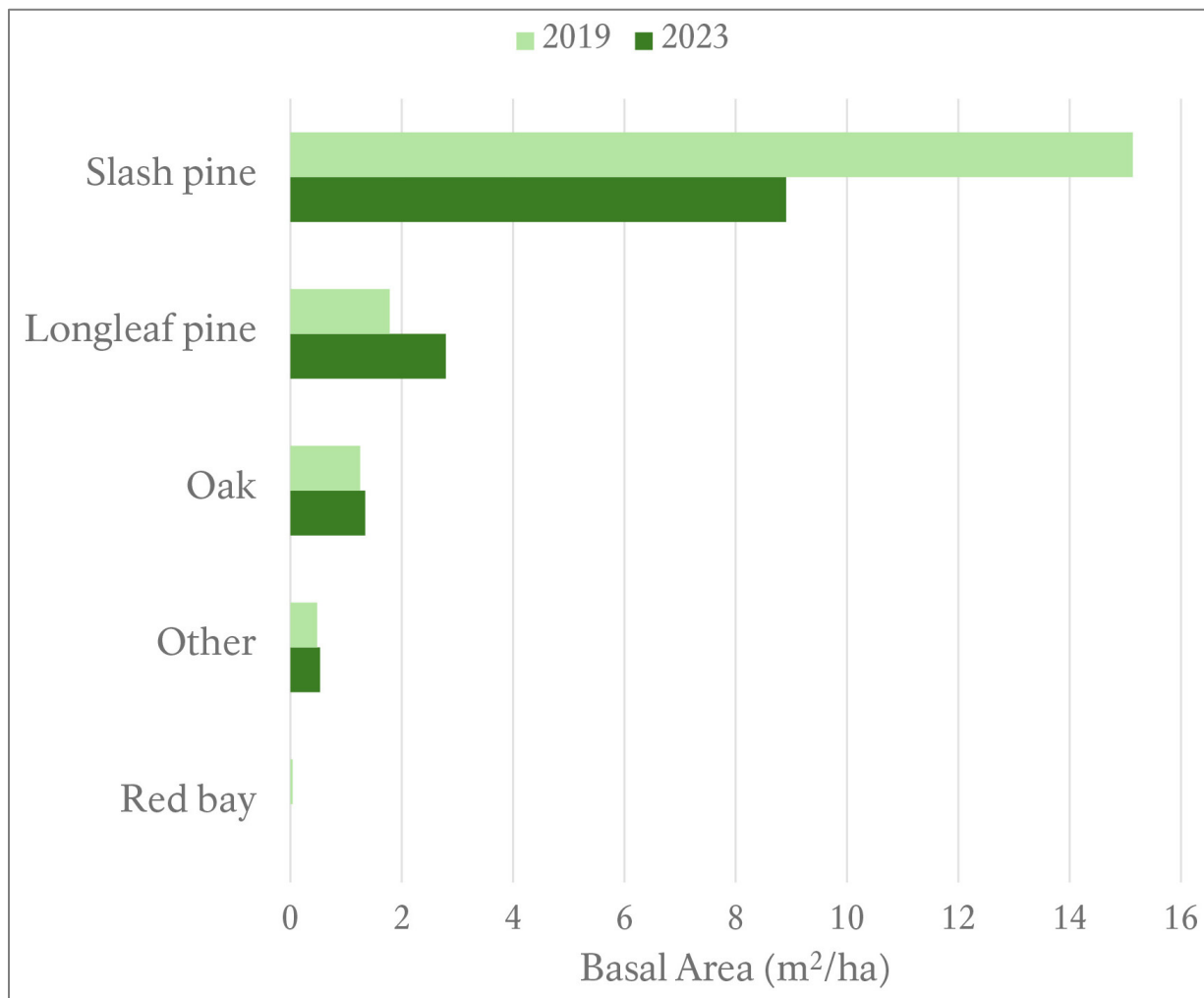


**Figure 9.** Mean basal area of live canopy species within open upland woodland plots of Timucuan Ecological and Historic Preserve sampled in 2019 and 2023. Species in the “Oak” category include sand laurel oak, water oak, and live oak, while species in the “Other” category include red maple, loblolly bay, American holly, yaupon, and sweetgum.

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### ***Upland Forests and Shrublands***

Live tree basal area within upland forest and shrubland plots of Timucuan EHP was highly variable ranging from 3.1 to 59.5 m<sup>2</sup>/ha with an average of 26.0 m<sup>2</sup>/ha ([supplemental materials](#)). Basal area was very low in TERO004 due to the near absence of tree-sized individuals. Low density of trees is expected from this plot; it represents an example of the Northeast Florida Coastal Scrub association

type ([supplemental materials](#)). This community type is typified by low stature with small diameter trees and shrubs. Other upland forest and shrubland plots with lower basal areas were dominated by small- to mid-diameter trees and likely represent sites that have experienced previous disturbance (e.g., CEDA016, TERO003, TERO006, and TERO007). In Cape Hatteras, North Carolina, presence of pines in the canopy with sand laurel oak as a co-dominant rather than live oak suggests the occurrence of previous disturbance events (Bratton and Davidson 1985). In most Timucuan EHP upland forest and shrubland plots with low basal areas, sand laurel oak was typically a canopy dominant or co-dominant.

The most dominant tree within this broad habitat type was live oak, which had an average basal area of 12.0 m<sup>2</sup>/ha; the next most dominant species within these plots was cabbage palmetto, which had an average basal area of 3.5 m<sup>2</sup>/ha ([supplemental materials](#)). Sand laurel oak occurred in relatively high stem densities (77.3 stems/ha) across these plots ([supplemental materials](#)). Other tree species that were present within these plots but occurred in lower abundance included pignut hickory, southern magnolia, sweetgum, slash pine, and others ([supplemental materials](#)).

Most of these plots had closed canopies, with an average canopy cover of greater than 80% ([supplemental materials](#)). A closed canopy is typical of maritime upland forests, although small-scale canopy gaps brought on by localized wind events or other disturbances do occur. The one forested plot with canopy cover less than 80% within the preserve occurred in Cedar Point (CEDA023) and has experienced a high degree of canopy tree die-off from salt-water intrusion ([supplemental materials](#)). Of the 237 trees measured within these plots in 2023, 201 were living (85%), 21 were dead (9%), and 15 had fallen since the previous monitoring effort in 2019 (6%; Table 3). Most live trees measured within these monitoring plots were observed with healthy vigor (Table 3). Nearly half of the dead trees were small diameter southern red cedar individuals on the southeastern edge of Cedar Point in plots CEDA007 and CEDA023. Although salt-water intrusion was observed in CEDA023 (see discussion above) it is not known if this was a factor in elevated southern red cedar mortality rates. Southern red cedar is relatively salt tolerant compared to other maritime tree species (Gilman and Watson 1993). Other causes of mortality in this species can include twig blights and rust diseases.

**Table 3.** Total counts of live, dead, and fallen trees and vigor estimates by species within upland forest and shrubland vegetation plots of Timucuan Ecological and Historic Preserve.

| Species                                     | Grand Total | Status     |           |           | Vigor      |               |                  |                |                   |
|---------------------------------------------|-------------|------------|-----------|-----------|------------|---------------|------------------|----------------|-------------------|
|                                             |             | Live       | Dead      | Fallen    | Healthy    | Light Decline | Moderate Decline | Severe Decline | Functionally Dead |
| <i>Cartrema americanum</i>                  | 7           | 7          | 0         | 0         | 6          | 0             | 1                | 0              | 0                 |
| <i>Carya glabra</i>                         | 13          | 13         | 0         | 0         | 10         | 2             | 1                | 0              | 0                 |
| <i>Celtis laevigata</i>                     | 8           | 8          | 0         | 0         | 8          | 0             | 0                | 0              | 0                 |
| <i>Ilex opaca</i>                           | 1           | 1          | 0         | 0         | 1          | 0             | 0                | 0              | 0                 |
| <i>Juniperus silicicola</i>                 | 13          | 3          | 10        | 0         | 2          | 0             | 1                | 0              | 0                 |
| <i>Liquidambar styraciflua</i>              | 7           | 6          | 1         | 0         | 5          | 1             | 0                | 0              | 0                 |
| <i>Lyonia ferruginea</i>                    | 1           | 1          | 0         | 0         | 1          | 0             | 0                | 0              | 0                 |
| <i>Magnolia grandiflora</i>                 | 12          | 12         | 0         | 0         | 11         | 0             | 0                | 0              | 1                 |
| <i>Morus rubra</i>                          | 1           | 1          | 0         | 0         | 1          | 0             | 0                | 0              | 0                 |
| <i>Persea borbonia</i>                      | 4           | 1          | 2         | 1         | 1          | 0             | 0                | 0              | 0                 |
| <i>Pinus elliotii</i>                       | 9           | 8          | 1         | 0         | 5          | 2             | 1                | 0              | 0                 |
| <i>Prunus caroliniana</i>                   | 9           | 9          | 0         | 0         | 1          | 0             | 0                | 8              | 0                 |
| <i>Prunus serotina</i> var. <i>serotina</i> | 2           | 2          | 0         | 0         | 1          | 1             | 0                | 0              | 0                 |
| <i>Quercus</i>                              | 4           | 0          | 0         | 4         | 0          | 0             | 0                | 0              | 0                 |
| <i>Quercus geminata</i>                     | 9           | 7          | 0         | 2         | 5          | 1             | 0                | 1              | 0                 |
| <i>Quercus hemisphaerica</i>                | 43          | 34         | 6         | 3         | 28         | 2             | 2                | 2              | 0                 |
| <i>Quercus myrtifolia</i>                   | 1           | 1          | 0         | 0         | 0          | 1             | 0                | 0              | 0                 |
| <i>Quercus nigra</i>                        | 20          | 17         | 0         | 3         | 12         | 4             | 1                | 0              | 0                 |
| <i>Quercus virginiana</i>                   | 53          | 51         | 1         | 1         | 33         | 13            | 3                | 2              | 0                 |
| <i>Sabal palmetto</i>                       | 16          | 16         | 0         | 0         | 15         | 1             | 0                | 0              | 0                 |
| <i>Serenoa repens</i>                       | 3           | 3          | 0         | 0         | 3          | 0             | 0                | 0              | 0                 |
| <i>Unknown sp.</i>                          | 1           | 0          | 0         | 1         | 0          | 0             | 0                | 0              | 0                 |
| <b>Grand Total</b>                          | <b>237</b>  | <b>201</b> | <b>21</b> | <b>15</b> | <b>149</b> | <b>28</b>     | <b>10</b>        | <b>13</b>      | <b>1</b>          |

Only the 10 plots established in 2019 within this broad habitat type could be used to assess tree growth. Overall, average basal area of all canopy species within these 10 plots increased, with southern magnolia and sweetgum experiencing the slowest growth (Figure 10).

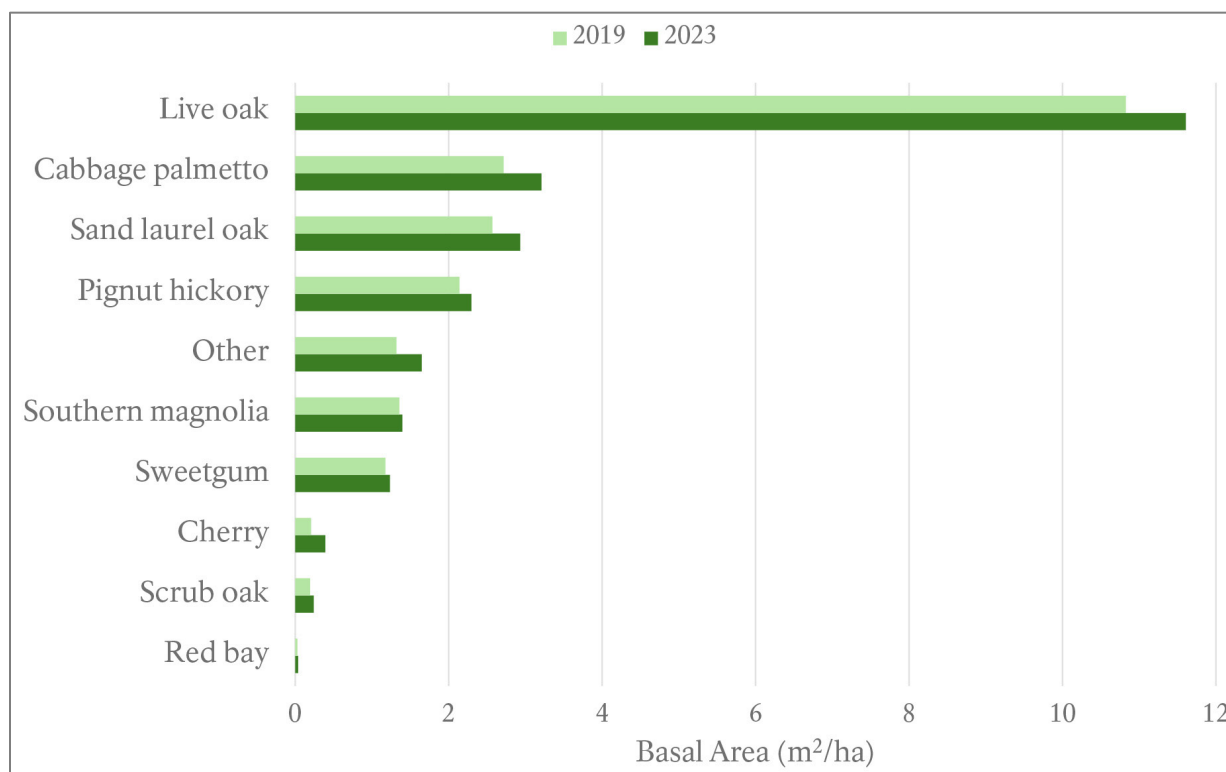


**Figure 10.** Mean basal area of live canopy species within upland forest and shrubland plots of Timucuan Ecological and Historic Preserve sampled in 2019 and 2023. Species in the “Other” category include wild olive, sugarberry (*Celtis laevigata*), American holly, southern red cedar, red mulberry (*Morus rubra*), slash pine, and water oak; species within the “Cherry” category include Carolina laurel cherry (*Prunus caroliniana*) and eastern wild black cherry (*Prunus serotina* var. *serotina*); and species within the “Scrub oak” category include sand live oak and myrtle oak (*Quercus myrtifolia*).

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### Tree and Woody Stem Regeneration Metrics

The sustainability of forests over time is largely dependent upon the composition and abundance of desirable canopy species within a forest’s seedling and sapling strata—collectively, the regeneration stratum. In the eastern United States, natural regeneration is primarily a function of canopy gaps formed by the die-off of older trees (Lorimer and White 2003). Species present in the regeneration stratum of these gaps typically represent the future composition of a forest’s canopy (Yamamoto 2000). Miller and McGill (2019) defined the concept of regeneration debt in eastern forests to describe differences in composition between canopy species and the regeneration stratum that could cause significant shifts in future canopy composition and abundance, and overall canopy loss in extreme situations. Regeneration debt was assessed across 39 national parks in the Mid-Atlantic and Northeast regions of the U.S. from long-term forest monitoring plots over a 12-year period (Miller et

al. 2023). Their study documented imminent or probable failure in regeneration of canopy species across 27 of 39 parks with white-tailed deer (*Odocoileus virginianus*) browse impact as the strongest predictor of regeneration debt.

Regeneration data from 2023 vegetation monitoring plots of Timucuan EHP was highly variable. Sapling basal area ranged from 0.1 to 11.7 m<sup>2</sup>/ha and seedling density ranged from 0 to 60 stems/8 m<sup>2</sup> ([supplemental materials](#)). Across all broad habitat types of all management units within the preserve, sapling abundance of canopy species was low and typically nearing or below the critical threshold value of regeneration success defined for the Mid-Atlantic and Northeast regions of the U.S. in Miller et al. (2023; Figure 11). It is unknown at this time whether impacts to regeneration across the preserve are due to factors described in Miller et al. (2023; e.g., white-tailed deer browse), other regional factors impacting Southeastern forested ecosystems, or represent natural fluctuations in canopy regeneration density. However, long-term monitoring can be used to assess trends in canopy species abundance in the regeneration stratum and determine ancillary stressors that could be impacting these trends.

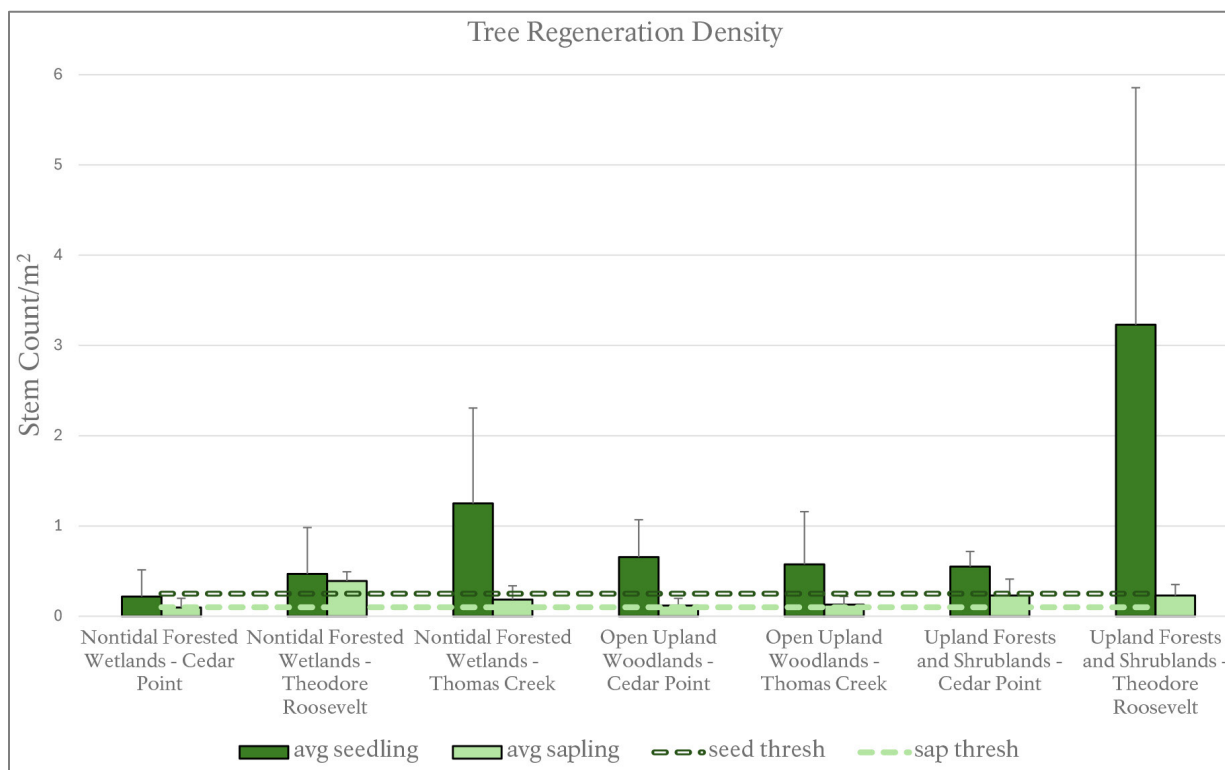


**Figure 11.** Stem density in 2023 by broad habitat type and preserve unit at Timucuan Ecological and Historic Preserve. Sapling counts were collected at the 80 m<sup>2</sup> scale from each plot (sum of eight 10 m<sup>2</sup> nested subplots) and seedling counts, excluding recent germinants (stems 5–15 cm in height), were collected at the 8 m<sup>2</sup> scale from each plot (sum of eight 1 m<sup>2</sup> nested subplots). Values illustrated below include the average count per 1 m<sup>2</sup> of each stratum among plots of the same broad habitat type and preserve unit. Vertical error bars represent standard deviation. The dotted horizontal lines represent the critical threshold for seedling and sapling regeneration debt based on Miller et al. 2023.

Average sapling basal area, sapling density, and seedling density values for all woody species including any tree (canopy or non-canopy-forming), shrub, or liana species across all habitat types are provided in [supplemental materials](#). Frequently occurring saplings observed across all broad habitat types included staggerbush (*Lyonia ferruginea*), water oak, saw palmetto, yaupon, and common wax-myrtle; frequently occurring seedlings observed in all habitat types included saw palmetto, shining fetterbush (*Lyonia lucida*), yaupon, Carolina jessamine (*Gelsemium sempervirens*), muscadine, and common wax-myrtle.

Summaries of sapling, seedling, and germinant abundance observed during this monitoring effort are provided below for each broad habitat type and in [supplemental materials](#).

### **Nontidal Forested Wetlands**

Basal area of canopy and subcanopy saplings within the 13 nontidal forested wetland vegetation plots of Timucuan EHP ranged from 0.1 to 11.7 m<sup>2</sup>/ha and had the highest variation among all habitat types sampled on the preserve during this monitoring effort ([supplemental materials](#)). Dominant sapling species included Carolina willow (*Salix caroliniana*), loblolly bay, swamp tupelo, and sweetgum ([supplemental materials](#)). Seedling density of canopy and subcanopy seedlings ranged from 0 to 21 stems/8 m<sup>2</sup> ([supplemental materials](#)). Dominant seedlings included swamp bay and Carolina willow ([supplemental materials](#)). Other abundant, non-canopy forming, woody species in the sapling and seedling strata of these plots included shining fetterbush, eastern poison ivy, little gallberry, and buttonbush (*Cephalanthus occidentalis*; [supplemental materials](#)). Regeneration values were lowest among nontidal wetland plots of Cedar Point and are below the critical threshold values for regeneration success defined by Miller et al. (2023; Figure 11).

Relative densities of trees and saplings and seedlings within the canopy and subcanopy categories remained relatively similar between sampling years within the seven nontidal forested wetland plots that were sampled in 2019 and 2023 (Figure 12). Although not present in the canopy, presumably due to die-off related to laurel wilt disease (LWD), swamp bay dominated both the seedling and sapling strata of plots within this broadly defined habitat in both 2019 and 2023 (Figure 12).

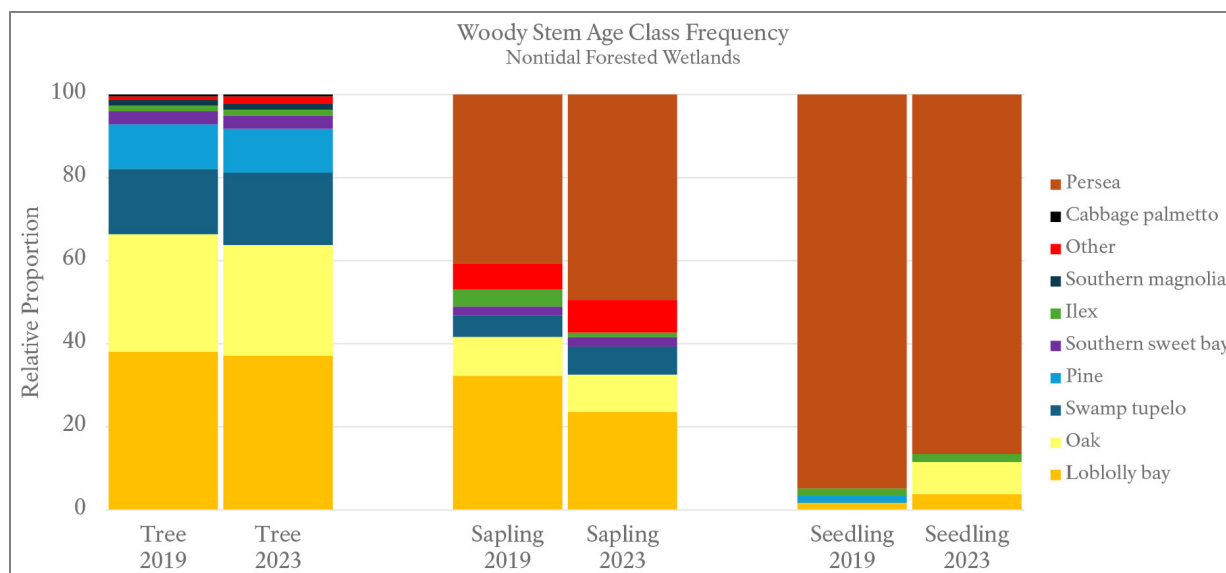


**Figure 12.** Relative proportion of canopy species across tree, sapling, and seedling strata within 2019 Cycle 1 and 2023 Cycle 2 nontidal forested wetland plots of Timucuan Ecological and Historic Preserve. Seedlings excluded recent germinants (stems 5–15 cm in height). Species in the “Persea” category include red bay and swamp bay; species in the “Other” category include red maple, wild olive, and sweetgum; species in the “Ilex” category include dahoon and American holly; species in the “Pine” category include slash pine, pond pine, and loblolly pine; and species in the “Oak” category include laurel oak, water oak, and live oak.

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### Open Upland Woodlands

Basal area of canopy and subcanopy saplings within the nine open upland woodland plots of Timucuan EHP monitored in 2023 ranged from 0.2 to 3.4 m<sup>2</sup>/ha ([supplemental materials](#)). Dominant sapling species included slash pine, sand live oak, and sweetgum ([supplemental materials](#)). Seedling density of canopy and subcanopy seedlings ranged from 0 to 9 stems/8 m<sup>2</sup>. Dominant seedlings included several oak species and slash pine ([supplemental materials](#)). Other abundant, non-canopy forming woody species abundant in the sapling and seedling strata of these plots included little gallberry, saw palmetto, Carolina jessamine, and shining fetterbush ([supplemental materials](#)). Seedling regeneration values were below the critical threshold values for regeneration failure defined by Miller et al. (2023) in open upland woodland plots within both Cedar Point and Thomas Creek (Figure 11).

Relative densities of slash pine decreased in the tree and sapling strata between 2019 and 2023 within the six open upland woodland plots sampled in both monitoring years (Figure 13). As discussed above, open upland woodland plots within the footprint of the 2019 Yellow Bluff Wildfire experienced heavy canopy mortality which explains the decrease of slash pine within the tree age class. Relative density of slash pine also decreased within the sapling age class of these plots but increased in the seedling age class (Figure 13). Tree-sized longleaf pine individuals were only present in a single open upland woodland plot on the eastern end of Thomas Creek (THCR003); within this plot pine regeneration is very low. Collectively, the relative density of sapling-sized swamp bay

stems increased within these plots across the preserve between 2019 and 2023 (Figure 13). Continued monitoring will determine whether swamp (and red) bay can successfully return as a subcanopy co-dominant species within this broad habitat type of the preserve following heavy mortality caused by LWD.

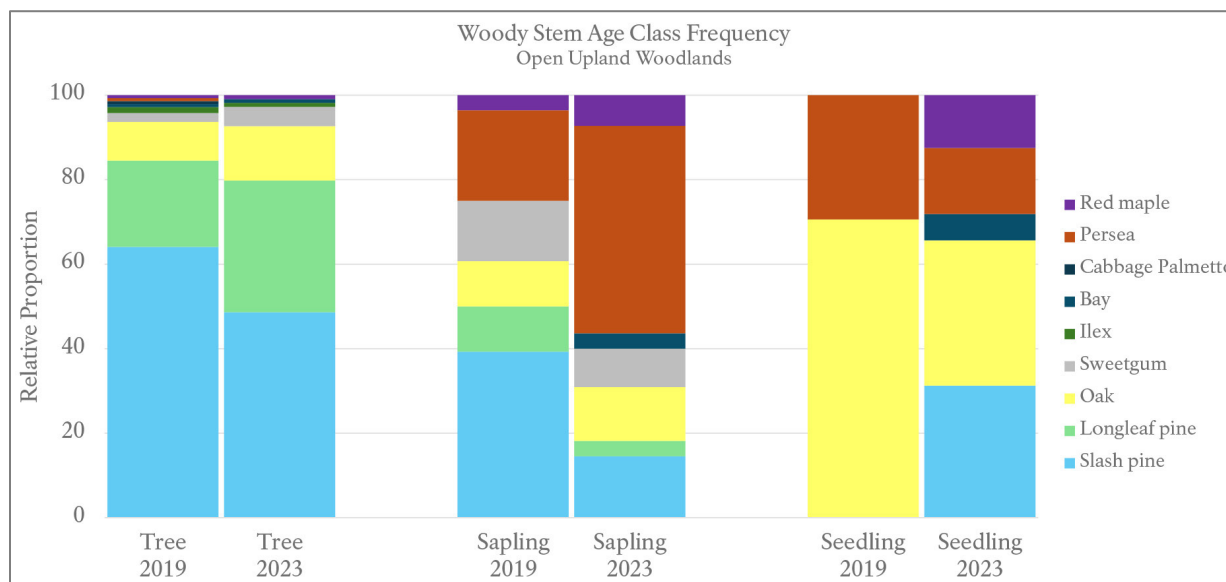


**Figure 13.** Relative proportion of canopy species across tree, sapling, and seedling strata within 2019 Cycle 1 and 2023 Cycle 2 open upland woodland plots of Timucuan Ecological and Historic Preserve. Seedlings excluded recent germinants (stems 5–15 cm in height). Species in the “Persea” category include red bay and swamp bay; species in the “Bay” category include loblolly bay and southern sweet bay; species in the “Ilex” category include American holly and yaupon; and species in the “Oak” category include sand live oak, sand laurel oak, water oak, and live oak.

NPS / SECN

### Upland Forests and Shrublands

Basal area of canopy and subcanopy saplings within the 11 upland forest and shrubland vegetation plots of Timucuan EHP ranged from 0.1 to 9.5 m<sup>2</sup>/ha and had the highest average among all habitat types sampled on the preserve during this monitoring effort ([supplemental materials](#)). Dominant sapling species included staggerbush, wild olive, cabbage palmetto, and live oak ([supplemental materials](#)). Seedling density of canopy and subcanopy seedlings ranged from three to 60 stems/8 m<sup>2</sup> and had the highest average among all habitat types sampled on the preserve during this monitoring effort ([supplemental materials](#)). Dominant seedlings included sand live oak, sand laurel oak, and live oak ([supplemental materials](#)). Other abundant, non-canopy forming, woody species abundant in the sapling and seedling strata of these plots included yaupon, saw palmetto, sparkleberry (*Vaccinium arboreum*), sarsaparilla vine (*Smilax pumila*), and dwarf dangleberry (*Gaylussacia nana*; [supplemental materials](#)). Regeneration density of canopy-forming species within the seedling age-class was very high within upland forest and shrubland plots of the Theodore Roosevelt unit and above the critical regeneration failure threshold in plots of this broad habitat type of Cedar Point

(Figure 11). However, sapling density was low (as noted above) for all broad habitat types across the preserve (Figure 11).

Relative densities of trees and canopy and subcanopy saplings and seedlings remained relatively similar between sampling years for most species within the 10 upland forest and shrubland plots that were sampled in 2019 and 2023, including a stable density of red bay within both the sapling and seedling strata (Figure 14).

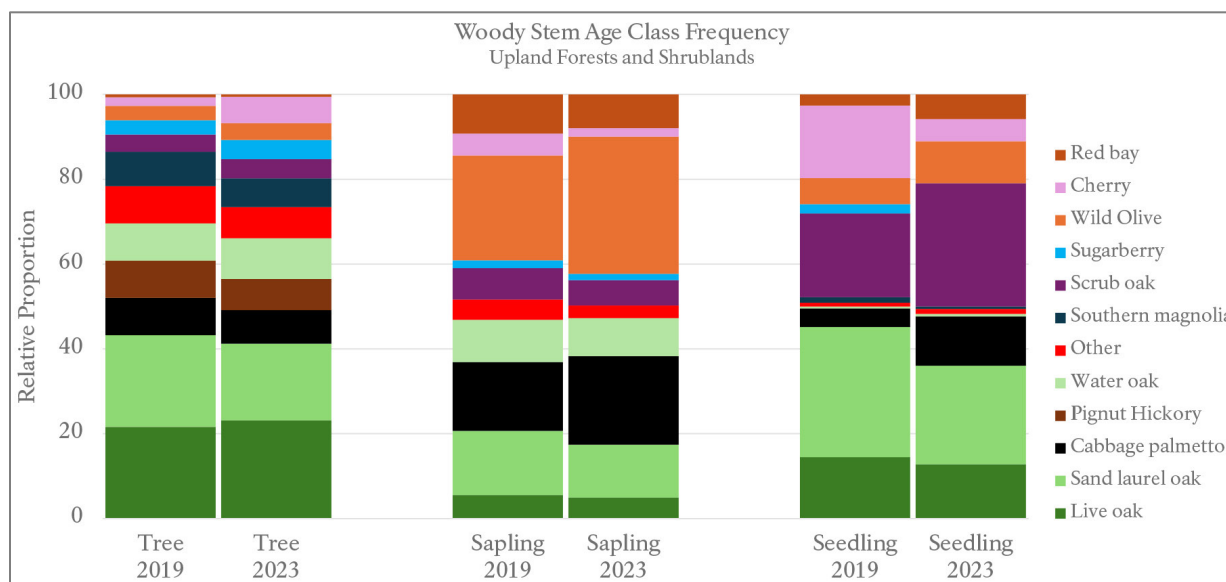


**Figure 14.** Relative proportion of canopy species across tree, sapling, and seedling strata within 2019 Cycle 1 and 2023 Cycle 2 upland forest and shrubland plots of Timucuan Ecological and Historic Preserve. Seedlings excluded recent germinants (stems 5–15 cm in height). Species in the “Cherry” include Carolina laurel cherry and eastern wild black cherry; species in the “Scrub oak” category include sand live oak and myrtle oak; and species in the “Other” category include coastal American hornbeam (*Carpinus caroliniana* var. *caroliniana*), American holly, southern red cedar, sweetgum, staggerbush, red mulberry, and slash pine.

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## Observed Disturbances and Threats

### Nontidal Forested Wetlands

Gaps created by windfall of large canopy trees were observed in four of the 13 nontidal wetland plots of the preserve ([supplemental materials](#)). Wind disturbance within forested wetlands can have a multitude of impacts to these ecosystems depending on the duration and intensity of the wind event. Minor, short-term wind disturbances can snap canopy branches and bring some light to the forest floor while major wind events (e.g., hurricanes and tornados) can cause the catastrophic die-off of the entire canopy (Roberts and Gilliam 2014). Windfall impacts to vegetation observed within nontidal wetland plots of Timucuan EHP were of the smaller-scale. Historical land use activities (e.g., plowing, logging) were observed on three of these wetland plots; however, it is likely that these

activities also occurred in the other plots as well at some point over the past century ([supplemental materials](#)).

Fire is a natural disturbance event that impacts many terrestrial ecosystems in the Southeastern U.S. and is particularly prevalent in Florida and the South Atlantic and Gulf Coastal Plain. Even wetlands can experience fire during times of prolonged drought and when there is an abundance of fuel loads. In forested swamps of Florida, absence of fire or low fire frequency increases the abundance of mixed hardwoods (swamp tupelo, loblolly bay, sweetbay) and slash pine; while species-rich cypress savannas and shrub bogs typically experience higher fire frequency in combination with longer hydroperiods that increase organic matter (Ewel 1990). Evidence of historical fire was observed in one nontidal wetland plot on the Thomas Creek Unit east of Interstate 95 (THCR097; [supplemental materials](#)). This site burned in 2019 during the Yellow Bluff Wildfire and in 2007 during the Halfmoon Wildfire ([supplemental materials](#)). During the previous vegetation mapping project, this site was classified as a Sweetgum – Red Maple-(Swamp Blackgum)/Virginia Chainfern Forest (CEGL007848) (O’Hare et al. 2020). However, this site is currently dominated by sawgrass (*Cladium jamaicense*) and cinnamon fern (*Osmundastrum cinnamomeum*) and lacks a dense canopy as described in the vegetation mapping report (see Figure 12 in [supplemental materials](#)). Repeated high intensity fires over the past several decades have removed most of the canopy trees within this site and increased the amount of coarse woody debris within the ground cover (see Fuel Load Estimates Section below).

### **Open Upland Woodlands**

The only disturbance observed in 2023 but not in 2019 was feral hog activity in a single open upland woodland plot—THCR005 ([supplemental materials](#)). Hogs negatively impact park resources by their destructive behavior of “rooting” the forest floor, “digging” mud wallows, and creating trail networks. Park resources impacted include native vegetation (e.g., reduce tree regeneration, endanger populations of already rare plant species, and spread invasive plants), native wildlife (e.g., increase competition for resources, being eaten, and spread disease), soil (e.g., erosion), wetlands (e.g., increase bacteria waste into waterways), and archaeology sites.

As noted, the three open upland plots (THCR001, THCR002, and THCR005) east of I-95 on the Thomas Creek Unit were impacted by the May/June 2019 Yellow Bluff Wildfire. There was very little ground cover present when these plots were sampled in 2019 (see Figures 18, 19, and 20 in [supplemental materials](#)), and most canopy trees were still alive, although many had red, dying canopy needles and low vigor ratings (Boyle and Rico 2021). Of the 48 live trees counted in these three plots in 2019, only five were alive in 2023—four years post-fire. Pre-fire stand conditions (e.g., an extremely dense and tall shrub stratum) and weather conditions (e.g., high heat, low humidity, localized drought) created an environment for the Yellow Bluff Wildfire to have major impacts to trees within this habitat type. Tree mortality within these plots was likely caused by a combination of factors. In pine woodlands, long intervals between fire events can increase the height and abundance of woody vegetation (Walker and Silletti 2006) and increase the depth of the duff layer along the forest floor (Hood 2010). As Clabo and Campbell (2020) illustrate, heavy tree mortality can occur in long unburned pine stands from flames reaching into the canopy by way of “ladder” fuels (i.e., a

dense, tall shrub stratum) and from fire burning into the soil organic layer killing tree roots. Prior to the 2019 fire, this site had not burned since 2007 during the Halfmoon Wildfire. In pine flatwood habitats, a 12-year gap is long enough to create site condition described above that increases the likelihood of canopy mortality. Ideal fire frequency to maintain healthy conditions of these ecosystems is suggested at one to three years, with increased threats present on sites not burned over 10 years (Clabo and Campbell 2020). It should be noted that other areas of the preserve not within the Yellow Bluff Wildfire footprint but with open upland woodland habitat (e.g., Cedar Point and the Thomas Creek Unit west of I-95) have been long unburned ([supplemental materials](#)) and currently express vegetation structure and organic soil depth conditions that threaten canopy trees should a fire event take place ([supplemental materials](#)). Even plots within the Yellow Bluff Wildfire footprint have significant increases in woody shrub density only four years following the burn, although the threat to carry fire to canopy trees has diminished due to the absence of canopy trees (see Figures 18, 19, and 20 in [supplemental materials](#)).

### ***Upland Forests and Shrublands***

Several disturbances were observed within upland forest and shrubland plots during this monitoring effort, including impacts related to historical fire, former land use (e.g., logging), saltwater intrusion, and windthrow ([supplemental materials](#)). None of these disturbances, however, were widespread.

The impact of laurel wilt disease (LWD) on the preserve's red bay and swamp bay trees was discussed in the 2019 data summary report (Boyle and Rico 2021). According to historical accounts, prior to 2005—the year LWD was discovered on the preserve—red bay was a dominant subcanopy species within Timucuan's maritime upland forests (see Zomlefer et al. 2007). Although red bay was found within these plots in 2019 and 2023 at a high constancy (90%; [supplemental materials](#)), only one live tree-sized individual was encountered. Other individuals were either seedling- or sapling-sized. Continued monitoring of these plots will determine whether this species can persist within the preserve's upland forests and if it will once again inhabit the forest subcanopy.

### **Fuel Load Estimates by Preserve Unit**

The distribution and volume of dead and downed woody debris, duff, litter, and live vegetation is collectively referred to as surface fuel. Surface fuels can be used by managers to predict fire behavior and fire impacts (i.e., fire effects) within terrestrial ecosystems (Lutes et al. 2006). Smaller pieces of dead and downed woody debris are less than 8 centimeters (3.1 in) in diameter and collectively referred to as fine woody debris (FWD). Volume of FWD is generally associated with having a stronger influence on fire behavior since smaller pieces of wood reach ignition temperature quicker than larger pieces. Coarse woody debris (CWD) include pieces of dead and downed woody debris greater than 8 centimeters in diameter and are associated with fire effects to a site since they generally burn longer during all phases of combustion. Litter represents dead grasses, recently fallen leaves, and pine needles, while duff includes decomposed litter material no longer identifiable that is between the litter layer and mineral soil. Like dead and downed woody debris, volume of duff and litter also influences fire behavior and can influence fire effects on a site. Surface fuels can be tallied both by individual class or collectively in order to determine total fuel load—the amount of available flammable material at a given site typically expressed in tons per acre. Fire managers for the National

Park Service in the Southeast have a targeted goal to reduce and maintain fuel loads for non-living fuels below 10 tons/acre for most forested ecosystem types to reduce risk and maintain healthy habitat (Rob Klein, NPS SER Fire Ecologist, personal communication).

Total surface fuel load volume was highly variable among 2023 vegetation monitoring plots of Timucuan EHP, ranging from 7.1 to 313.6 tons/acre. Factors influencing surficial fuel volume at a site can include time since last fire, overall fire history, climate, soil, topography, or other disturbance events besides fire (e.g., ice storms, windfall). Although fuel loads were generally high in nontidal forested wetlands of the preserve, this was mainly due to high volume of duff and occasionally high volume of litter. Duff and organic matter accumulation from decaying leaf litter can be slow, albeit natural, process in forested wetland swamps (i.e., nontidal forested wetlands) of Florida, particularly when there are long hydroperiods and the substrate is acidic (Ewel 1990). During these wet periods, the duff layer typically will not hold fire. However, during periods of prolonged drought fire can carry and burn through dried duff, exposing tree roots and mineral soil (Ewel 1990). Stand replacement fire events are a natural ecosystem process in these wetlands and are a primary reason that a mosaic of open water, marshes, shrub-dominated communities, and swamp forests occur within the same hydrologic basin in northeast Florida and southeast Georgia (Hamilton 1984). Patterns of fuel loads are discussed below within other broad habitat types of each preserve unit.

### ***Cedar Point***

Total fuel loads within Cedar Point in 2023 ranged from 17.0 to 31.3 tons/acre and had relatively low variation among all plots regardless of broad habitat type (Figure 15). Broad habitat types within this unit of the preserve were less clearly defined and integrated with each other more so than in other management unit. This potentially explains why some fuel loads were relatively homogenous among all vegetation plots. Duff and litter biomass had the most influence on fuel load volume within all broad habitat types across this management unit (Figure 15). High fuel loads within open upland woodlands and upland forest and shrublands could threaten these communities should wildfire occur within this management unit. Total fuel loads decreased from 2019 to 2023 within the three nontidal forested wetland plots established in 2019 ([supplemental materials](#)).

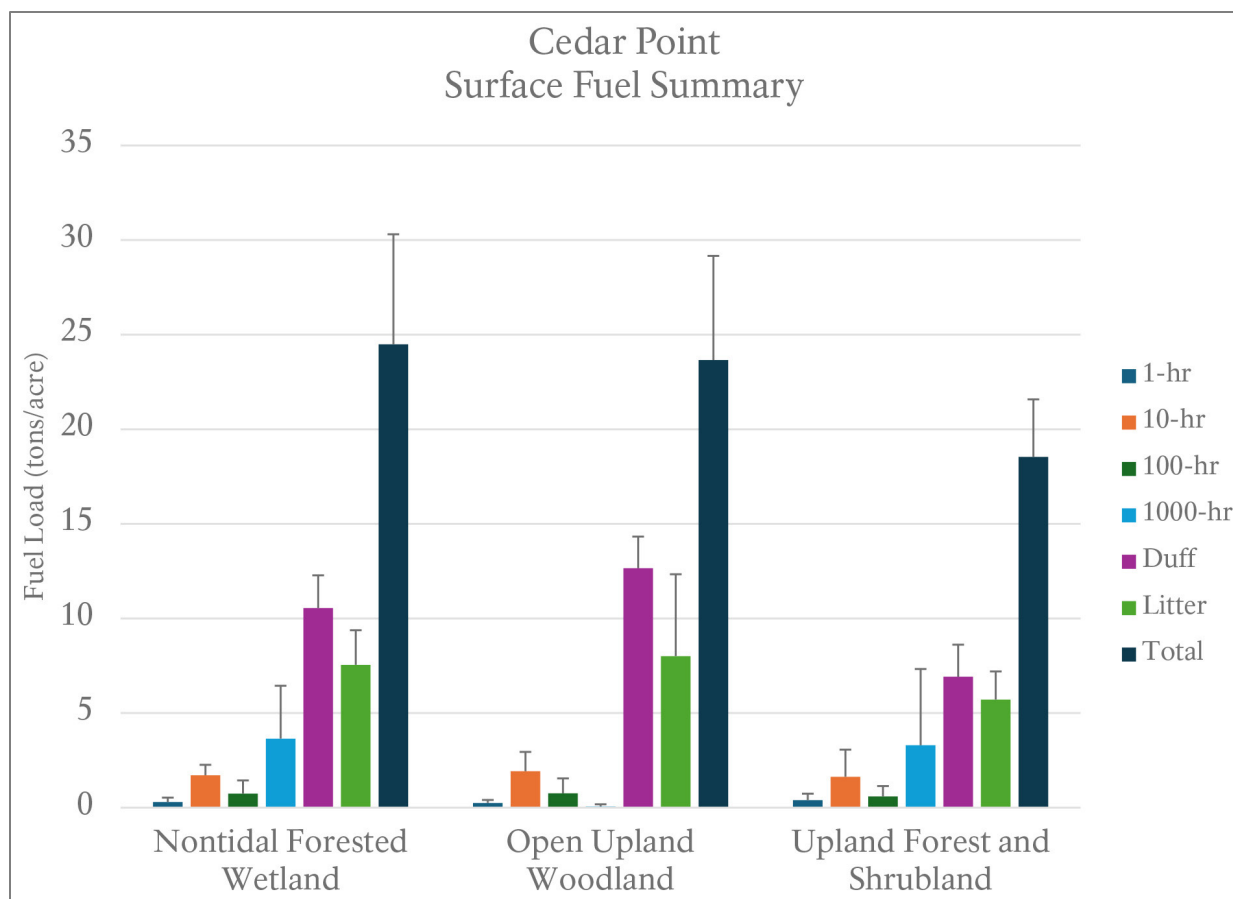


**Figure 15.** 2023 average fuel load values of surface fuel types within 13 Southeast Coast Network vegetation monitoring plots within the Cedar Point unit of Timucuan Ecological and Historic Preserve. Fuel types labeled as 1-hr, 10-hr, and 100-hr (hr = hour) are collectively defined as fine woody debris and represent downed woody material across the forest floor that are less than 8 cm in diameter. The 1-hr category represents woody material 0–0.64 cm in diameter; the 10-hr category represents woody material 0.64–2.54 centimeters in diameter; and the 100-hr category represents woody material 2.54–8 centimeters in diameter. 1000-hr surface fuels are defined as coarse woody debris and represent woody material greater than 8 centimeters in diameter. The Litter category represents dead grasses, recently fallen leaves, and pine needles. The Duff category represents the area below the litter layer and above mineral soil and is composed of litter material no longer identifiable. The Total category is a sum of all surface fuel types. Vertical error bars represent standard deviation.

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### **Theodore Roosevelt**

Total fuel loads within Theodore Roosevelt in 2023 ranged from 7.1 to 46.6 tons/acre and was highest in nontidal forested wetlands due to relatively higher duff biomass within this broad habitat type (Figure 16). Fuel volumes across all surficial fuel categories were similar between upland forest and shrubland plots of this management unit and Cedar Point (Figures 15 and 16). Within both management units, fuel loads were determined by a combination of litter, duff, and 1000-hour surficial fuels (Figures 15 and 16). Finally, overall fuel loads remained relatively similar from 2019

to 2023 across all plots established within this management unit of the preserve in 2019 ([supplemental materials](#)).

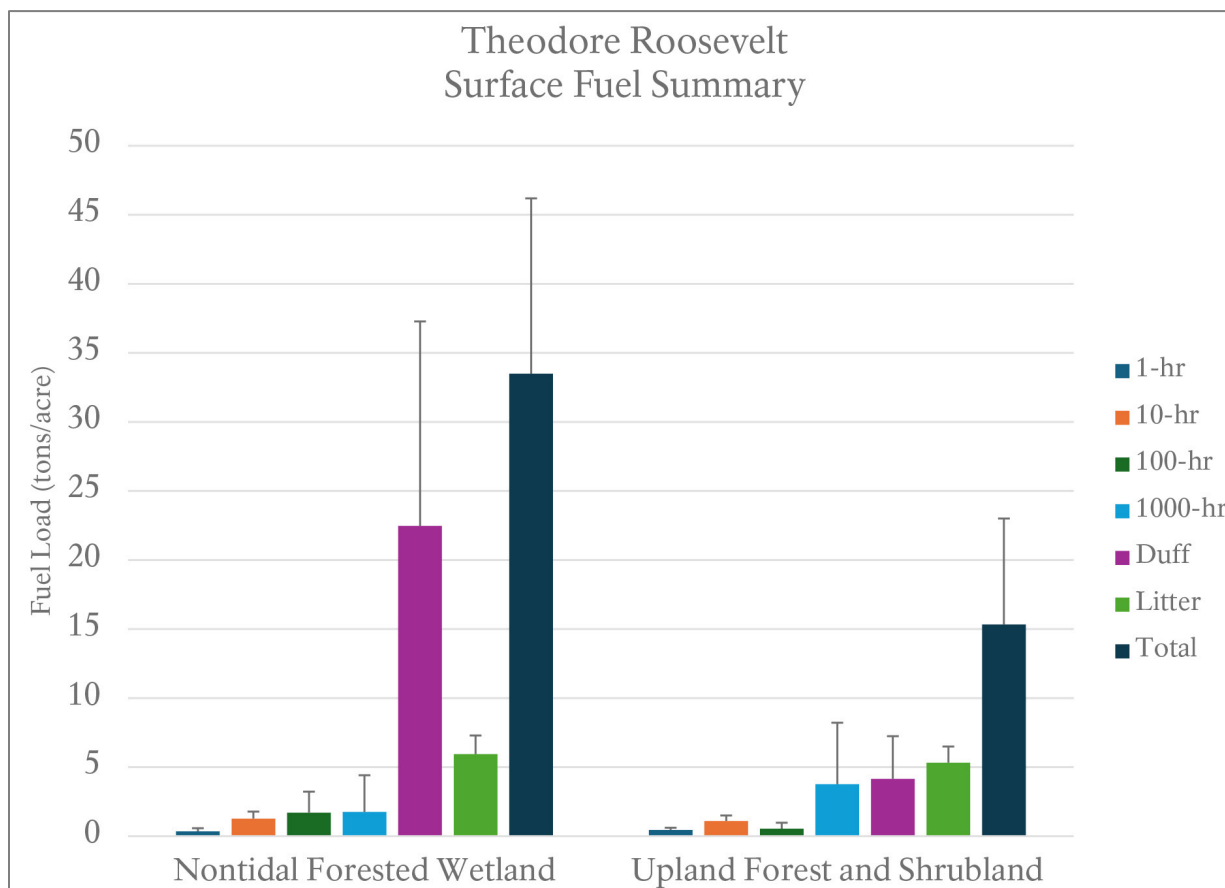


**Figure 16.** 2023 average fuel load values of surface fuel types within 10 Southeast Coast Network vegetation monitoring plots within the Theodore Roosevelt unit of Timucuan Ecological and Historic Preserve. Fuel types labeled as 1-hr, 10-hr, and 100-hr (hr = hour) are collectively defined as fine woody debris and represent downed woody material across the forest floor that are less than 8 centimeters in diameter. The 1-hr category represents woody material 0–0.64 cm in diameter; the 10-hr category represents woody material 0.64–2.54 centimeters in diameter; and the 100-hr category represents woody material 2.54–8 centimeters in diameter. 1000-hr surface fuels are defined as coarse woody debris and represent woody material greater than 8 centimeters in diameter. The Litter category represents dead grasses, recently fallen leaves, and pine needles. The Duff category represents the area below the litter layer and above mineral soil and is composed of litter material no longer identifiable. The Total category is a sum of all surface fuel types. Vertical error bars represent standard deviation.

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### **Thomas Creek**

Total fuel loads within Thomas Creek exhibited extreme variation in 2023 mostly driven by elevated counts of coarse woody debris within THCR005 (Figure 17; [supplemental materials](#)). Total fuel load within this plot was over 300 tons/acre. As discussed above, the Yellow Bluff Wildfire in 2019 caused heavy tree mortality across much of the Thomas Creek unit east of Interstate 95. In

THCR005, these trees have fallen and created a dense volume of woody biomass on the forest floor. Other plots within the fire footprint (THCR001 and THCR002) have standing dead trees that had not fallen in 2023. The level of variation of fuel loads from all other plots within this management unit was also high and ranged from 19.6 to 81.7 tons/acre. Total fuel loads within plots established in 2019 and resampled in 2023 slightly decreased ([supplemental materials](#)).

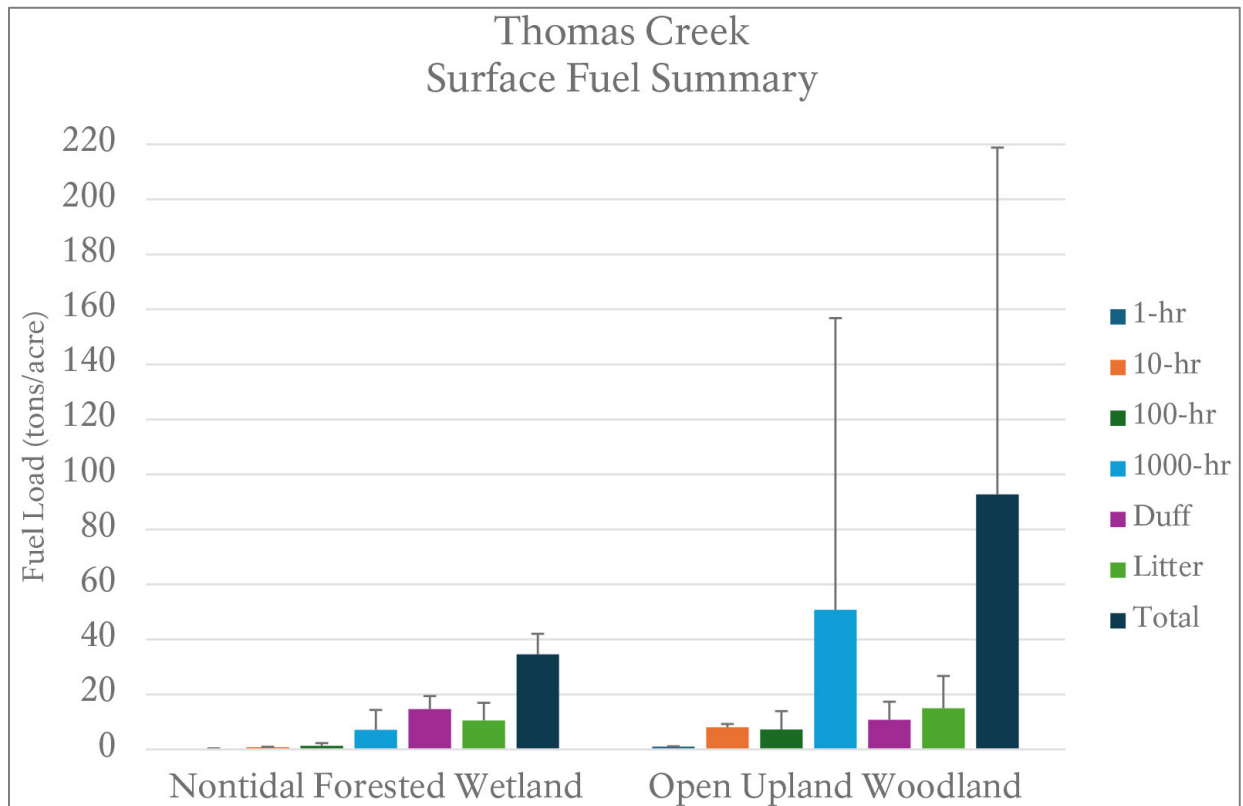


**Figure 17.** 2023 average fuel load values of surface fuel types within 10 Southeast Coast Network vegetation monitoring plots within the Thomas Creek unit of Timucuan Ecological and Historic Preserve. Fuel types labeled as 1-hr, 10-hr, and 100-hr (hr = hour) are collectively defined as fine woody debris and represent downed woody material across the forest floor that are less than 8 centimeters in diameter. The 1-hr category represents woody material 0–0.64 centimeters in diameter; the 10-hr category represents woody material 0.64–2.54 centimeters in diameter; and the 100-hr category represents woody material 2.54–8 centimeters in diameter. 1000-hr surface fuels are defined as coarse woody debris and represent woody material greater than 8 centimeters in diameter. The Litter category represents dead grasses, recently fallen leaves, and pine needles. The Duff category represents the area below the litter layer and above mineral soil and is composed of litter material no longer identifiable. The Total category is a sum of all surface fuel types. Vertical error bars represent standard deviation.

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## Conclusions

A condition scorecard using multiple monitoring elements was developed for each of the broadly defined habitats within each of the three management units at Timucuan EHP (Table 4). Nontidal forested wetland plots from Spanish Pond were reported as a separate habitat type due to their dissimilarity with other forested wetland types across the preserve. A four-point rating system was utilized—Good, Caution, Concern, Significant Concern—to determine overall ecological health. A rating of Significant Concern implies that the habitat is in imminent danger of failing due to a certain category that describes either vegetation condition (e.g., native diversity, tree growth rates, tree recruitment) or threats to native vegetation (e.g., invasive species); a rating of Good implies that the habitat is healthy and stable in relation to those same categories. Finally, it should be noted that ratings were assigned qualitatively using best judgement by this report’s lead author.

**Table 4.** Terrestrial vegetation scorecard for broadly defined habitats of Timucuan Ecological and Historic Preserve management units based on data collected from 2023 monitoring plots.

| Unit               | Broad Habitat Type                      | Native Diversity  | Invasive Species     | Canopy Growth Rate | Canopy Mortality Rate | Canopy Recruitment   | Disturbance/Threats  | Fuel Load            |
|--------------------|-----------------------------------------|-------------------|----------------------|--------------------|-----------------------|----------------------|----------------------|----------------------|
| Cedar Point        | Nontidal Forested Wetlands              | Good <sup>B</sup> | Good <sup>B</sup>    | Good <sup>B</sup>  | Good <sup>B</sup>     | Caution <sup>C</sup> | Good <sup>B</sup>    | Good <sup>B</sup>    |
|                    | Open Upland Woodlands                   | Good <sup>B</sup> | Caution <sup>C</sup> | Good <sup>B</sup>  | Good <sup>B</sup>     | Caution <sup>C</sup> | Concern <sup>D</sup> | Caution <sup>C</sup> |
|                    | Upland Forests and Shrublands           | Good <sup>B</sup> | Caution <sup>C</sup> | Good <sup>B</sup>  | Good <sup>B</sup>     | Good <sup>B</sup>    | Good <sup>B</sup>    | Caution <sup>C</sup> |
| Theodore Roosevelt | Spanish Pond                            | Good <sup>B</sup> | Concern <sup>D</sup> | Good <sup>B</sup>  | Good <sup>B</sup>     | Good <sup>B</sup>    | Good <sup>B</sup>    | Good <sup>B</sup>    |
|                    | Nontidal Forested Wetlands <sup>A</sup> | Good <sup>B</sup> | Good <sup>B</sup>    | Good <sup>B</sup>  | Good <sup>B</sup>     | Good <sup>B</sup>    | Good <sup>B</sup>    | Good <sup>B</sup>    |
|                    | Upland Forests and Shrublands           | Good <sup>B</sup> | Caution <sup>C</sup> | Good <sup>B</sup>  | Good <sup>B</sup>     | Good <sup>B</sup>    | Good <sup>B</sup>    | Good <sup>B</sup>    |
| Thomas Creek       | Nontidal Forested Wetlands              | Good <sup>B</sup> | Caution <sup>C</sup> | Good <sup>B</sup>  | Good <sup>B</sup>     | Good <sup>B</sup>    | Good <sup>B</sup>    | Good <sup>B</sup>    |
|                    | Open Upland Woodlands                   | Good <sup>B</sup> | Caution <sup>C</sup> | Good <sup>B</sup>  | Caution <sup>C</sup>  | Caution <sup>C</sup> | Concern <sup>D</sup> | Caution <sup>C</sup> |

<sup>A</sup> Represents condition based on data collected from 1 vegetation plot.

<sup>B</sup> Shaded green for good.

<sup>C</sup> Shaded yellow for caution.

<sup>D</sup> Shaded red for concern.

### **Nontidal Forested Wetlands**

Overall, this broad habitat type is relatively stable and healthy across Timucuan EHP. As noted above, canopy recruitment within the sapling age-class was low within Cedar Point. It is uncertain what this implies for the future of canopy species regeneration. It is possible that once small-scale canopy gaps form via wind or other disturbance events there will be a growth spurt of seedlings into the sapling stratum. A single nonnative, invasive species—water spangles—was observed within one nontidal forested wetland plot (THCR104) of Thomas Creek ([supplemental materials](#)). This aquatic plant may be abundant within other forested wetlands of Thomas Creek, particularly where standing water is present.

### **Spanish Pond**

The high frequency of invasive plants within the three Spanish Pond plots of the preserve threatens the stability of this ecosystem and can serve as a source for spread of invasive species beyond the borders of this habitat into the surrounding maritime forest of the Theodore Roosevelt unit and Fort Caroline National Memorial.

### **Open Upland Woodlands**

Heavy tree mortality was recorded in plots of this habitat type on the Thomas Creek unit that were within the Yellow Bluff Wildfire footprint. Pine recruitment is present within these sites and these individuals could serve as future canopy trees if they are not outcompeted by other woody species. In 2019, there were no invasive species present in any open upland woodland plot of the preserve. However, Chinese tallow was found in 2023 in both the Thomas Creek and Cedar Point units. The presence of Chinese tallow within plots of this habitat is a reminder that invasive species spread within the preserve is always a possibility. The biggest threat to the stability of open upland woodlands of the preserve is fire exclusion. Except for the area of the Thomas Creek Unit east of Interstate 95, most of the preserve's open upland woodland habitat has not burned in well over 20 to 30 years, if not longer. Without fire, or surrogate treatments that mimic fire, recruitment of the pine canopy will be difficult, species diversity patterns will be altered with loss of certain species that require reoccurring fire, and fuel loads will increase to dangerously high levels that threaten not only the ecosystem but the urban interface surrounding the preserve.

### **Upland Forests and Shrublands**

The maritime oak- and hardwood-dominated forests of Timucuan Ecological and Historic Preserve are relatively healthy and in stable condition. The Invasive Species category was rated as a Concern for this habitat type due to the increased presence of invasive species on plots within both the Cedar Point and Theodore Roosevelt units from 2019 to 2023.

This is the second data summary report from SECN terrestrial vegetation monitoring for Timucuan EHP. Vegetation monitoring using the protocol published in Boyle et al. (2019) began on the preserve in 2019. The third cycle of monitoring is scheduled for spring/summer 2027. After this third monitoring iteration, vegetation diversity and woody stem metrics will be analyzed for trends and changes will be compared with conditions of, and changes in, notable environmental variables, land

use, climate, and resource stressors. Highlights from this current monitoring effort are listed in the Summary and Key Findings section above and not repeated here.

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