



Vegetation Monitoring at Big Thicket National Preserve: Results for 2022

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ON THE COVER: *Liatris pycnostachya* and *Boltonia diffusa* in Turkey Creek unit. Photo by NPS/Jane E. Carlson

Summary and Key Findings

The Gulf Coast Inventory and Monitoring (I&M) Network completed its first round of vegetation monitoring in Big Thicket National Preserve between May and October 2022. Sixty plots were sampled across five of the Preserve's major units: Beech Creek, Big Sandy, Jack Gore Baygall, Lance Rosier, and Turkey Creek. Fifty-six of the plots were selected as a random draw within the entire area or major portions of each unit; these were the primary plots. Four additional plots, called targeted plots, were placed specifically in current or potential longleaf pine (*Pinus palustris*) restoration areas in Big Sandy, Lance Rosier, and Turkey Creek. All 60 plots were first visited during winter months between Dec. 2019 and Feb. 2022 to install plot markers and tag all trees that had a diameter at breast height [DBH] of ≥ 10 cm. Crews returned to sample plots during the growing season of 2022, following the methods published in the protocol "Monitoring Terrestrial Vegetation in Gulf Coast Network Parks", and its 11 standard operating procedure documents (Carlson et al. 2018). In short, all plant species were identified in each 400-meter² (20 x 20 meter) plot, and their coverages and relative frequencies were recorded in nested sampling frames as measures of understory dominance. New tree recruits were tagged, i.e., those reaching ≥ 10 cm DBH since plot establishment, and then all newly and previously tagged trees were measured for DBH and assessed for damage. Juvenile trees were counted within four 10-m² microplots per full plot, divided into classes of seedlings (heights up to 1.36 m) and saplings (heights taller than 1.36 m and DBH < 10 cm). These data served as a baseline for tracking forest health, including tree growth, recruitment, and mortality.

The project's key findings for 2022 were as follows:

- Long-term I&M monitoring plots in Big Thicket National Preserve fell into nine broad vegetation classes. These classes were derived from earlier work by Paul Harcombe and Peter Marks (Harcombe and Marks 1979; Marks and Harcombe 1981), with some adjustments to better match sampled communities. From most to least represented among I&M plots, the classes were Mesic Lower Slope Forest (18 plots), Floodplain Hardwood Forest (13 plots), Wet Flatwood Pine-Hardwood Forest (8 plots), Baygall (6 plots), Wet Pine with Dense Gallberry (4 plots), Dry Upper Slope Pine-Hardwood Forest (4 plots), Wet Flatwood Pine with Savanna Elements (3 plots), Cypress Tupelo Swamp (2 plots), and Dry Upland Pine Savanna or Woodland (2 plots). These classes and their relative frequencies in the I&M sample were broadly representative of the dominant plant communities in the five focal units, given the project's randomized sampling design. The only exceptions were the four targeted plots, which were placed in communities that were relatively rare on the landscape but were nevertheless central to restoration goals. The four targeted plots were evenly divided between the Wet Flatwood Pine with Savanna Elements class [Wet Flatwood Pine] and the Dry Upland Pine Savanna or Woodland class [Dry Upland Pine].
- Across all 56 primary plots sampled in 2022, I&M staff recorded 367 plant taxa. The four targeted plots contributed 78 additional taxa, for a cumulative total of 445. Although no rare species (i.e., on state or federal lists) were recorded during monitoring, several plots were within

Highlights

- The NPS Inventory and Monitoring program completed its first round of vegetation monitoring in Big Thicket National Preserve in summer 2022. The 60 long-term plots captured a surprisingly varied and complete set of the low-elevation forest types known from the southeastern United States, especially those west of the Mississippi River, all packed into a relatively small area in southeastern Texas.
- Most long-term plots represented fairly common communities for Big Thicket that were also widespread in the Southeastern Plains or South Central Plains ecoregions. However, several plots were in rare communities like baygalls or wet flatwoods, which are unique to southeast Texas and western Louisiana. These plots will allow for closer study and monitoring of these unusual types of wetlands.
- Four of the 60 I&M plots were specifically placed in areas of current or future restoration in upland or wet pine savannas. These plots will allow tracking of progress and impacts of management activities in these rich and highly valued areas of the Preserve.

communities listed as rare by Texas Parks and Wildlife Department or as Vulnerable or Imperiled by NatureServe. These rare communities were represented by several plots within the following four classes: Baygall, Wet Flatwood Pine-Hardwood, Wet Flatwood Pine, and Dry Upland Pine.

- The most widely recorded species overall was American holly (*Ilex opaca*), found in 94% of the primary plots. Four additional native species were nearly as widespread, in 82-86% of primary plots: sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), and yaupon (*Ilex vomitoria*). The most widespread species among forbs, vines, and graminoids were cat greenbrier (*Smilax glauca*), muscadine (*Vitis rotundifolia*), and partridgeberry (*Mitchella repens*), all present in 79-80% of primary plots.
- There were 10 non-native species recorded in plots, with only one species, Chinese tallow (*Triadica sebifera*) being fairly widespread, in 55% of primary plots. The next most frequently recorded non-native was Japanese climbing fern (*Lygodium japonicum*), present in 30% of primary plots, followed by Chinese privet (*Ligustrum sinense*) in 14% of primary plots. Overall, at least one non-native species was present in 68% of primary plots. Even though non-natives were often recorded as present in plots, they were never recorded at higher than 5% cover in the understory.
- The Preserve's richest vegetation classes were Dry Upland Pine (71 species per plot; max of 81) and Wet Flatwood Pine (67 species per plot; max of 73). Both classes were central to the Preserve's longleaf pine restoration efforts and had been specifically targeted with two I&M plots each. As expected, both classes had some longleaf pine in the overstory, and both were unusually rich in forbs and graminoids. The Dry Upland Pine class occurred at relatively high elevations within the Preserve on well-drained soils that were sandy or loamy, whereas the Wet Flatwood Pine class had poorly drained soils were typically waterlogged in the winter and drought-prone in the summer and fall. Three of the five plots in either class were located in management areas of Turkey Creek or Big Sandy that received regular prescribed burns and occasionally, additional management actions. The remaining two plots were in the northeast corner of Lance Rosier unit, representing the Preserve's largest tracts of Wet Flatwood Pine. Prescribed fire had not been applied to that area within the last decade, but increased restoration activity was under consideration. This class's partial resilience to fire suppression was contrasted with the Dry Upland Pine, Dry Upper Slope Pine-Hardwood, and Wet Pine with Dense Gallberry classes that, in the absence of frequent fires, were dominated by yaupon, gallberry or other woody plants.
- The majority of plots lacked a pine-dominated overstory and species-rich herbaceous understory, but several classes were still fairly rich. For example, Dry Upper Slope Pine-Hardwood Forest had 52 species per plot on average, and Floodplain Hardwood Forest had 51, which were both well above the Preserve-wide average of 42. Both classes were particularly rich in trees, with per-plot averages of 18 or 20 species and a maximum of 24 or 25. The Baygall class was notable for its relatively high shrub richness and for the presence of several minute forbs that were restricted to baygalls or similar acidic wetland habitats. The most species-poor classes were Wet Pine with Dense Gallberry (23 species) and Mesic Lower Slope Forest (33 species), with the latter being the most common class in the monitored units of the Preserve.
- Each vegetation class featured a fairly distinct group of dominant species in the forest understory, as measured by percent cover and relative frequency in understory microplots. For three of the vegetation classes, the understories were dominated by one or two shrub species that summed to >50% cover. These were Wet Pine with Dense Gallberry, which was dominated by gallberry (*Ilex coriacea*; 54% cover) and swamp titi (*Cyrilla racemiflora*; 34% cover); Dry Upper Slope Pine-Hardwood Forest, which was dominated by yaupon (54% cover); and Baygall, which was dominated by swamp titi (40% cover) and gallberry (30% cover). For the remaining six classes, understory vegetative cover was lower on average, but there was notable variation among plots, particularly within the Mesic Lower Slope and Wet Flatwood Pine-Hardwood classes. Plots with dense, nearly impenetrable understories were examples of the 'thickness' after which Big Thicket was named. For a few vegetation classes in this study, dense understories were consistent with a reference or 'natural' condition for the site

(e.g., Baygalls), but for the fire-adapted communities, they generally were not. In those communities, understories with few to no woody plants featured more of the herbaceous species that were expected in fully restored longleaf pine habitats. For example, a plot in the Solo Tract restoration area had both the lowest woody cover (4%) and the highest richness in forbs and graminoids (65 species total). These values showcase the potential gains of restoration efforts that include both frequent fires and woody plant removal, which are currently underway in several parts of the Preserve.

- Forest health metrics were collected in all 60 plots, with each plot having between 1 and 51 live trees (1,423 total) and between 1 and 221 juvenile trees (2,963 total). Mean stem density was 593 stems per hectare or 24 stems per plot, and mean DBH per plot was 22.3 cm. Relative to other forest-dominated parks in the Gulf Coast Network, Big Thicket had denser trees that were smaller in diameter, based on plot-level averages. The Cypress Tupelo Swamp class stood out as having the highest mean basal area, highest stem density, and second highest DBH. Mean basal area and stem density were also notably high for the Mesic Lower Slope, Floodplain Hardwood, and Wet Flatwood Pine-Hardwood Forest classes. Floodplain Hardwood plots contained the Preserve's highest three DBH values for individual trees, with the largest being a cow oak (*Quercus michauxii*) with a DBH of 100.5 cm in one of the Turkey Creek plots.
- Units were also compared for tree composition and tree metrics. All five units shared four of their top five taxa, which were oaks (*Quercus* spp.), tupelo species (*Nyssa* spp.), loblolly pine, and sweetgum. The dominant oak species across all units were water oak, laurel oak (*Quercus laurifolia*), and white oak (*Quercus alba*). Two additional oak species were dominant in some units but not others. These were Darlington oak (*Quercus hemisphaerica*) in Big Sandy and Beech Creek plots, and post oak (*Quercus stellata*) in Big Sandy plots. Additional unit-by-unit differences emerged when considering the less common tree species. For example, adult beech trees (*Fagus grandifolia*) were recorded in all units except for Turkey Creek, but they were far more frequent in Beech Creek than elsewhere. Additionally, adult shortleaf pine trees (*Pinus echinata*) were in the top four for basal area in Big Sandy, present in low numbers in Jack Gore Baygall, and absent from plots in all other units.
- Comparison of regeneration metrics revealed a mix of juvenile taxa in the understories of most sampled forest types, with the dominant species often differing between juvenile and adult cohorts. For example, the Preserve's two bay species (*Persea* spp.) were notably abundant as juveniles (327 total) but exceedingly rare as adults (one total). These findings provided strong evidence that laurel wilt was impacting the Preserve. This fungal disease, transferred between trees by the invasive redbay ambrosia beetle, was first recorded in Hardin and Jasper counties in 2015. Longleaf pine was another species of particular interest in terms of regeneration. Across the 56 primary plots, only one juvenile longleaf pine was recorded. It was in a plot in the Wet Pine with Dense Gallberry class, which also had six longleaf pine adults. The four targeted plots in Wet Flatwood Pine and Dry Upland Pine increased the total adult count by 25 and the total juvenile count by 12. Even so, eight of those juveniles were in plots that had previously been planted with longleaf seedlings, suggesting that natural regeneration of longleaf was uncommon in most parts of the Preserve. The detection of live longleaf seedlings in restoration areas nevertheless provided evidence of successful establishment, and their continued growth and survival will be tracked over time.
- Overall, the first round of I&M vegetation monitoring on the Preserve supported the concept of a surprisingly varied and complete set of the low-elevation forest types known from the southeastern United States, especially those west of the Mississippi River, all packed into a relatively small area in southeastern Texas. Although the dominant vegetation classes themselves were not particularly rich or rare for the southeast, several of the wetland types were restricted to southeastern Texas and western Louisiana, including specific plant associations within Baygall, Wet Flatwood Pine-Hardwood, and Wet Flatwood Pine classes. As this is the first round of data collection in a long-term study, in-depth interpretation of patterns will benefit from additional rounds of data collection. The next vegetation monitoring event in the Preserve is scheduled for summer 2026, and subsequent events will continue once every four years.

Project Background

The Gulf Coast Inventory and Monitoring (I&M) Network tracks the condition of plant communities in eight National Park Service (NPS) units in the southeast and Texas. The vegetated landscapes in these parks are a foundation to park visitor experiences and provide vital ecosystem and wildlife services. Yet even on NPS protected lands, plant communities are threatened by human activities and environmental change. Monitoring plant communities is therefore essential to understanding park health and making informed management decisions, so that resources may be enjoyed, unimpaired, by future generations.

Throughout the NPS, plant communities and other key natural resources are tracked and assessed scientifically by 32 I&M networks, as part of their Vital Signs monitoring programs. For parks in the Gulf Coast I&M Network, the goals of vegetation monitoring include documenting status and change in (1) richness of native and non-native species; (2) percent cover and frequency of key species or growth forms (e.g., graminoids or shrubs); and (3) the health and regeneration of forests. The network follows a published protocol (Carlson et al. 2018) that is largely consistent with other I&M networks in the eastern U.S. (e.g., Tierney et al. 2016; Boyle et al. 2019).

The current summary report, which is the first for the park, describes the study area, methods, and major findings thus far. It includes species lists, richness summaries, understory percent cover, relative frequency, tree metrics, and regeneration metrics. This report is accompanied by a briefer [web article](#), which essentially presents the Summary and Key Findings section above. All current and past products, as well as data exports, are available at irma.nps.gov/DataStore/Reference/Profile/2247864.

Study Area

Physical Description

Big Thicket National Preserve consists of over 44,000 hectares [ha] (108,726 acres) of protected lands and waters in southeast Texas. The Preserve is centered on the Neches River and its tributaries, and it consists of nine units and several connecting riparian corridors. Six of the Preserve's units are large –over 1,800 ha (4,448 acres)– and collectively cover a large portion of the broad geographic region known

as the Big Thicket. The Gulf Coast I&M Network conducts long-term vegetation monitoring on five of the major units: Beech Creek, Big Sandy, Jack Gore Baygall, Lance Rosier, and Turkey Creek (Figure 1). The only major unit not included is the southernmost Beaumont unit, which is a more recent acquisition for the Preserve and is mainly accessed by boat. The five focal units span three different counties in Texas, ranging in elevation from 8 - 97 meters [m] (26-318 feet) above sea level (Table 1). The lowest elevations within the context of this project are Lance Rosier in the southwest and Jack Gore Baygall to the east along the Neches River. Correspondingly, these units feature the Preserve's largest expanses of bottomland forests, swamps, and other forested wetlands. Turkey Creek, which is a relatively narrow unit running north-south in the center of the Preserve's extent, has the widest range in elevations, landforms, and forest types. The two units in the north, Big Sandy and Beech Creek, encompass higher elevations than the other units, but forested wetlands are still an important part of the landscape. Elevation maps in relation to sampling locations within the five focal units are provided in Appendix A.

Changes in elevation and landform across the Preserve are associated, in part, with four major geologic formations and three U.S. EPA Level IV Ecoregions (Omernik and Griffith 2014, Thornberry-Ehrlich 2018; Figure 1, Table 1). Within the Big Thicket area, the ecoregions and geologic

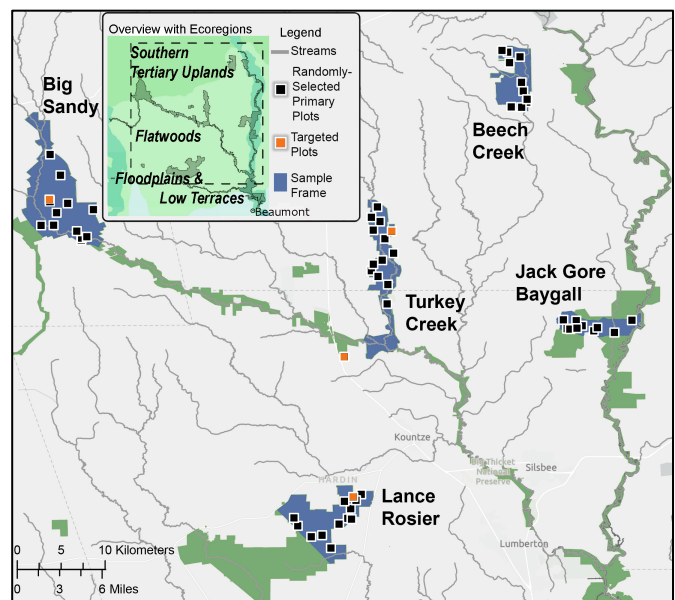


Figure 1. Sampling frame and plots for 2022 monitoring at Big Thicket National Preserve by the Gulf Coast I&M Network.

Table 1. Names and characteristics of the units in Big Thicket National Preserve that are included in the long-term vegetation monitoring program by the Gulf Coast I&M Network. Asterisks indicate total plot counts including one (*) or two (**) nonrandom, targeted plots in addition to the randomly-selected primary plots. The 2022 sampling sequence was scheduled to temporally group broad vegetation classes as well as group plots within the same unit, though spatial proximity often took priority. The October sampling trip focused on plots with savanna elements to facilitate grass identification.

Park Unit	County	Elevation Range in Unit (m)	Year(s) Conveyed for Major Parcels; Most Recent Parcels	Sample Frame Area	Total Plots	EPA Level IV Ecoregion (in South Central Plains)	Sample Dates
Beech Creek (BC)	Tyler	41-69	1976 – 1981; 1994	1819 ha	10	Flatwoods	7/25/202-9/8/2022
Big Sandy (BS)	Polk	42-97	1976 – 1983; 1989	5124 ha	13*	Southern Tertiary Uplands	8/11/2022-10/5/2022
Jack Gore Baygall (JG)	Hardin	8-36	1978; 1982	1077 ha	10	Flatwoods (western half) and Floodplains and Low Terraces	5/9/2022-5/26/2022
Lance Rosier (LR)	Hardin	12-26	1976 – 1980; 1993	3048 ha	13*	Flatwoods	6/8/2022-9/9/2022
Turkey Creek (TC)	Tyler and Hardin	15-47	1977 – 1984; 2005	2796 ha	14**	Flatwoods	5/23/2022-8/10/2022

formations are generally aligned. The northernmost ecoregion, the Southern Tertiary Uplands, roughly follows the Willis formation along its southern boundary. Below that, the Flatwoods ecoregion overlays the Montgomery/Upper Lissie and Bentley/Lower Lissie formations. To the east and west, the Floodplains and Low Terraces ecoregion follows the Neches and Trinity River drainages, with the Deweyville formation underlying the Neches. The Preserve has one more formation that does not align with an ecoregion, the Beaumont formation, but these southernmost areas are outside the scope of this study (see Appendix A for geologic maps). A unit's ecoregion or geologic formation helps explain some of its features, yet landscapes are still quite heterogeneous at smaller scales. Soils, for example, are highly variable: Hardin County alone encompasses 44 distinct soil map units (Wiedenfeld 2006).

General Vegetation Features

Across the five units and the varying landforms within them, the Preserve hosts a wide range of plant communities. These communities include many of the characteristically southeastern forest types at or near their western-most extent, such as beech-magnolia slope forests, longleaf pine uplands, and wet flatwood pine savannas (Bridges and Orzell 1989; Diggs et al. 2006; MacRoberts and MacRoberts 2007). The Preserve also contains a few dry, open areas that feature species more common to the west (e.g. *Dalea phleoides*, *Loeflingia squarrosa* and *Croptilon hookerianum*), though overall, the flora is predominately southeastern with only a few western

elements (MacRoberts and MacRoberts 2007; 2008). Although the status as a biological crossroads is debatable, the Preserve and nearby protected areas remain a critical storehouse of peripheral plant populations at their westernmost biological boundary, including some that are genetically unique or sensitive indicators of environmental change (Diggs et al. 2006).

The Big Thicket region is home to several endemic or near-endemic plant species. Within the Preserve, these include the East Texan endemics of Texas trailing phlox (*Phlox nivalis* ssp. *texensis*), Reverchon's palafoxia (*Palafoxia reverchonii*), and Texas screwstem (*Bartonia texana*). There are also several species with only slightly larger ranges that are restricted to east Texas, western Louisiana, and/or southern Arkansas (e.g., *Thelesperma flavodiscum*, *Silene subciliata*, *Trillium texanum*, and *Liatris tenuis*; see also Bridges and Orwell 1989). Most of these species are herbaceous and associated with sandy soils with an overstory of pines, which were historically mostly longleaf pine (*Pinus palustris*). Indeed, the longleaf pine uplands and wet savannas of the southeast are well known for their unusually high richness and endemism in the herb layer, a fact that helped motivate the North American Coastal Plain's recent designation as the 36th global biodiversity hotspot (Noss et al. 2015).

Big Thicket's impressive flora has, at times, been the subject of intensive study, as evidenced by over 25 publications from the 1970s to late the 2000s. One major outcome of this work was the unit-by-unit species inventory for the

Preserve compiled by Paul Harcombe, including 8,095 specimen records and 1,264 distinct taxa (Harcombe 2007 and references therein). Other major contributors to Big Thicket botany and plant ecology include Geraldine Watson (e.g., Watson 2006), Paul Harcombe's colleagues and students (e.g., Harcombe and Marks 1979; Marks and Harcombe 1981; Streng and Harcombe 1982; Glitzenstein and Harcombe 1988; Lui et al. 1997), Larry Brown (e.g., Brown et al. 2005), Geyata Ajilvsgi (Ajilvsgi 1979), and Michael and Barbara MacRoberts (e.g., MacRoberts and MacRoberts 1998; 2007; 2008).

Land Use History and Management

Extractive and chemical industries are strongly integrated into the southeast Texas landscape. The region was, and continues to be an important source of timber, with logging activity peaking between 1900 and 1930. In response to widespread losses of native forests in the early- to mid-1900s, the Big Thicket National Preserve was created in 1974. This prevented further logging and halted development of new oil and gas infrastructure on park properties, which allowed for partial recovery of native forests. As forests have been left uncut, however, many potentially detrimental human activities have continued. Current land uses adjacent or near-adjacent to the Preserve include a paper mill, landfills, sand mines, oil and gas extraction, pine plantations, agriculture, and increasingly, housing developments. On-park, there are some remaining oil and gas operations by permit, as well as illegal trash dumping, chemical spills, and vegetation clearing. In the areas where I&M monitoring currently takes place, there are many signs of past logging and other human activities, from both the distant and recent past. These are described on a plot-by-plot basis and depicted in historical aerial imagery in Appendix B. In addition to changes inflicted by humans, southeast Texas is frequently impacted by extreme weather events, such as prolonged drought, tornados, and excessive rainfall and flooding, which are often -but not always- associated with hurricanes (e.g., Hurricanes Harvey and Rita).

Current day resource management activities at Big Thicket often aim to restore native habitats and control invasive species. A core restoration goal is to increase the Preserve's footprint of longleaf pine and its associated natural communities. During the logging boom in the early 1900s, longleaf pine trees were harvested and then often replaced

by faster-growing loblolly (*Pinus taeda*) or slash pine (*Pinus elliottii*). Second-generation stands were further diminished by fire suppression, which allowed native hardwood trees and shrubs to encroach into what were historically open pine woodlands (see also Streng and Harcombe 1982, Harcombe et al. 1993, Watson 2006). Restoring longleaf pine communities is a shared goal across much of the southeast. Recommended management activities include frequent prescribed burns (every 2-3 years, including during the growing season), overstory tree thinning, chemical or mechanical removal of woody plants, and planting of longleaf pine (e.g., Drewa et al. 2002; Brockway et al. 2005; Platt et al. 2006; Jose et al. 2006; Harrington 2011). Through a mix of these activities, the park maintains several areas where longleaf pine and/or the expected understory communities are present, and few of these support populations of the federally protected Texas trailing phlox. The park aims to restore even more habitat for another federally protected species, the red cockaded woodpecker (*Leuconotopicus borealis*), which has been absent from the park since 1995 (Conner et al. 2006).

Prescribed fires at Big Thicket National Preserve are conducted by their Fire Management Team, often with support from outside entities. In addition to prescribed burns for habitat restoration, the team manages any wildfires entering the park and conducts fuels reduction treatments and mastication. Of the units monitored in this project, only Turkey Creek and Big Sandy have been treated with prescribed fire in the last decade, and fires in these two units have impacted only a subset of I&M monitoring plots (see Table B1 for prescribed fire history for each plot). Park natural resource managers hope to re-introduce fire into the wet flatwood pine communities in northeastern Lance Rosier Unit as well. Finally, invasive species are managed in Big Thicket most years, either through park-led efforts or in partnership with the regional Invasive Plant Management Team. Currently, invasive plant control efforts focus on Chinese privet (*Ligustrum sinense*), Chinese tallow (*Triadica sebifera*), and golden bamboo (*Phyllostachys aurea*). Invasive feral hogs, which damage understory vegetation and soils in all units (e.g., Chavarria et al. 2007), are targeted through public hunting and trapping permits.

Over time, data from long-term vegetation monitoring plots in Big Thicket National Preserve will help reveal whether

these extensive and varied forests are on a trajectory of recovery or decline, and in either case, how management activities may interact with forest health outcomes.

Methods

Plot Selection

The 56 primary vegetation monitoring plots at Big Thicket were assigned as a random draw of 10-12 points within five focal units. For three of the units —Beech Creek, Turkey Creek, and Big Sandy— the sampling frame was the entire unit except for 50 m boundary buffers around roads, paved areas, buildings, and unit boundaries. For the remaining two units —Lance Rosier and Jack Gore Baygall— there were two types of exclusions: the 50 m boundary buffers as well as larger sections that were deemed prohibitively time-consuming to access and of relatively low priority for long-term monitoring, according to park managers at the time. Figure 1 shows the sampling frames and plot locations within each of the 5 units. In addition to the 56 randomly-selected plots, 4 nonrandom ‘targeted’ plots were sampled in 2022, which were selected within areas of either ongoing or proposed future longleaf pine restoration (Figure 1).

The 60 vegetation monitoring plots covered a wide range of vegetation community types, including regularly flooded swamps, baygalls, beech-magnolia slope forests, wet flatwoods and upland pinelands. The diverse communities sampled were organized into nine broadly-defined vegetation classes, which were a simplified subset of the vegetation communities described in the park’s two major vegetation classification projects (Harcombe and Marks 1979; Ley et al. 2024). The U.S. National Vegetation Classification project by Ley et al. (2024) documented 201 natural vegetation types that were mapped to 46 map classes. Harcombe and Marks (1979) documented and mapped 11 vegetation types in the Preserve (see also Marks and Harcombe 1981), and their maps were later digitized by Gulf Coast Network staff. Watson (2006), Bridges and Orzell (1989), Harcombe et al. (1993), Smith (1996), and Louisiana Natural Heritage Program (2009) also provided descriptions of plant communities that aided in interpretation of current vegetation monitoring data and provided a broader view into the full range of plant communities in the region.

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).

Field Methods

A complete description of field methods can be found in the protocol narrative and 11 Standard Operating Procedure documents (Carlson et al. 2018 and references therein). In short, fieldwork was completed through two types of trips: establishment and sampling. Establishment trips were conducted in December 2019, February 2020, January-March 2021, November-December 2021, and February 2022, and they consisted of finding, evaluating and permanently marking plot midpoints and corners (Figure 2), and then tagging and surveying the location of all trees with a diameter at breast height [DBH] greater than 10 centimeters [cm]. This prepared the plot in advance of the growing season.

Growing season sampling at Big Thicket National Preserve took place between May and October 2022. Fieldwork within each plot consisted of creating species lists at the 1-m², 10-m², 100-m² and 400-m² scales; estimating percent cover of all live plant material <1.5 m tall at the 1-m² quadrat scale (targeting ground layer); estimating percent cover of all live plant materials <5 m tall at the 10-m² microplot scale (targeting shrub layer and below); counting seedlings and saplings within four size classes, each at the 10-m² microplot scale; and measuring DBH and assessing the condition of all trees at the 400-m² full plot scale (see Figure 2 for nested sampling frame locations).

Sampling sequence within the 4-month field season at Big Thicket was organized by both plant community and unit. Fieldwork began in May with the predominately forested, wetter plots in Jack Gore Baygall and progressed through

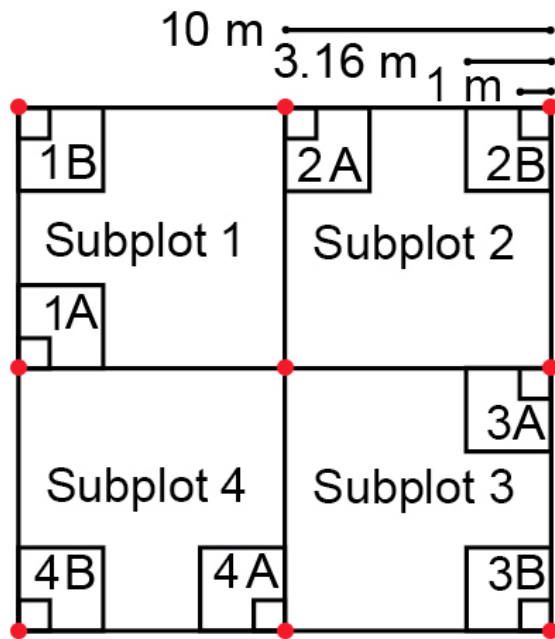


Figure 2. Plot design for long-term vegetation monitoring by the Gulf Coast Network. There are eight 1-m² quadrats (1 x 1 m), eight 10-m² microplots (3.16 x 3.16 m), four 100-m² subplots (10 x 10 m), and one 400-m² plot (20 x 20 m). Red dots show locations of plot markers (fiberglass or rebar stakes).

more mesic forest types to the predominately drier plots of Big Sandy, and then ended with the pine flatwood and upland plots that contained savanna elements, to increase chances that grasses were reproductively mature (see Table 1 for dates). During the mid-summer in particular, logistical constraints required sampling differing communities within the same unit close in time, but in general, plots from the same community were sampled within a five-week span. Three of the 60 plots were sampled twice, at least five days apart, to serve as quality control. Participants included Jane Carlson (network protocol lead and botanist), Jeff Bracewell (network GIS specialist), NPS interns, park biologist Andrew Bennett, and staff from Texas Parks and Wildlife Department (for support during repeat sampling events). Sampling lasted an average of 2.9 hours per plot (range 1.5-9.5 hours).

Results

Broad Vegetation Classes Sampled

The nine vegetation classes sampled for this project encompassed a wide range of forest tree assemblages, understory assemblages, and soil moisture regimes (Figure 3). Strikingly, these differences occurred across relatively

minor elevational changes in a predominately low-elevation landscape. Most classes were fairly widely distributed across the Preserve, with between 4 and 7 classes per unit (Figure 4). Five of the classes were types of wetlands, representing 38% of the randomly-selected plots (21 of 56). To help characterize differences among classes, brief descriptions are provided below, beginning with classes on the lowest landscape positions with frequent to permanent inundation and ending with those in well-drained uplands. Detailed descriptions of each class are in Appendix C, along with information on how these classes relate to the previously-described classifications of Harcombe and Marks (1979) and Ley et al. (2024).

The **Cypress-Tupelo Swamp** class (2 plots) represented communities with soils that were saturated on a nearly permanent basis and a canopy dominated by bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*; Figure 3A). The **Wet Flatwood Pine-Hardwood Forest** class (8 plots) represented several flood-prone communities on broad, mainly flat, low elevation areas away from current major drainages (Figure 3B). Mima mounds, also called pimple mounds, were often a prominent feature, particularly in Lance Rosier. The **Wet Flatwood Pine with Savanna Elements** [Wet Flatwood Pine] class (1 primary plot; 2 targeted plots) represented a relatively rare community at higher elevations than the preceding types but also with poorly-drained soils. Low-permeability soils or subsoil clay layers fostered areas with standing water in winter and drought-prone soils in summer and fall. The pine-dominated canopy (loblolly or longleaf) was typically sparse, and the understory was rich and herbaceous (Figure 3C). The **Wet Pine with Dense Gallberry** class (4 plots) was related to the previous class in that it occupied mid-level landscape positions with poor soil drainage and an overstory of longleaf or loblolly pine. A major difference, however, was the extremely thick gallberry (*Ilex coriacea*), which was presumably favored by relatively high and constant soil moisture and a lack of fire (Figure 3D). The **Baygall** class (6 plots) represented several types of acidic wetland communities occurring in shallow drainages within most forested communities except the major river floodplains. A defining feature was a thick shrub layer of gallberry, Swamp titi (*Cyrilla racemiflora*), and other species below a canopy of

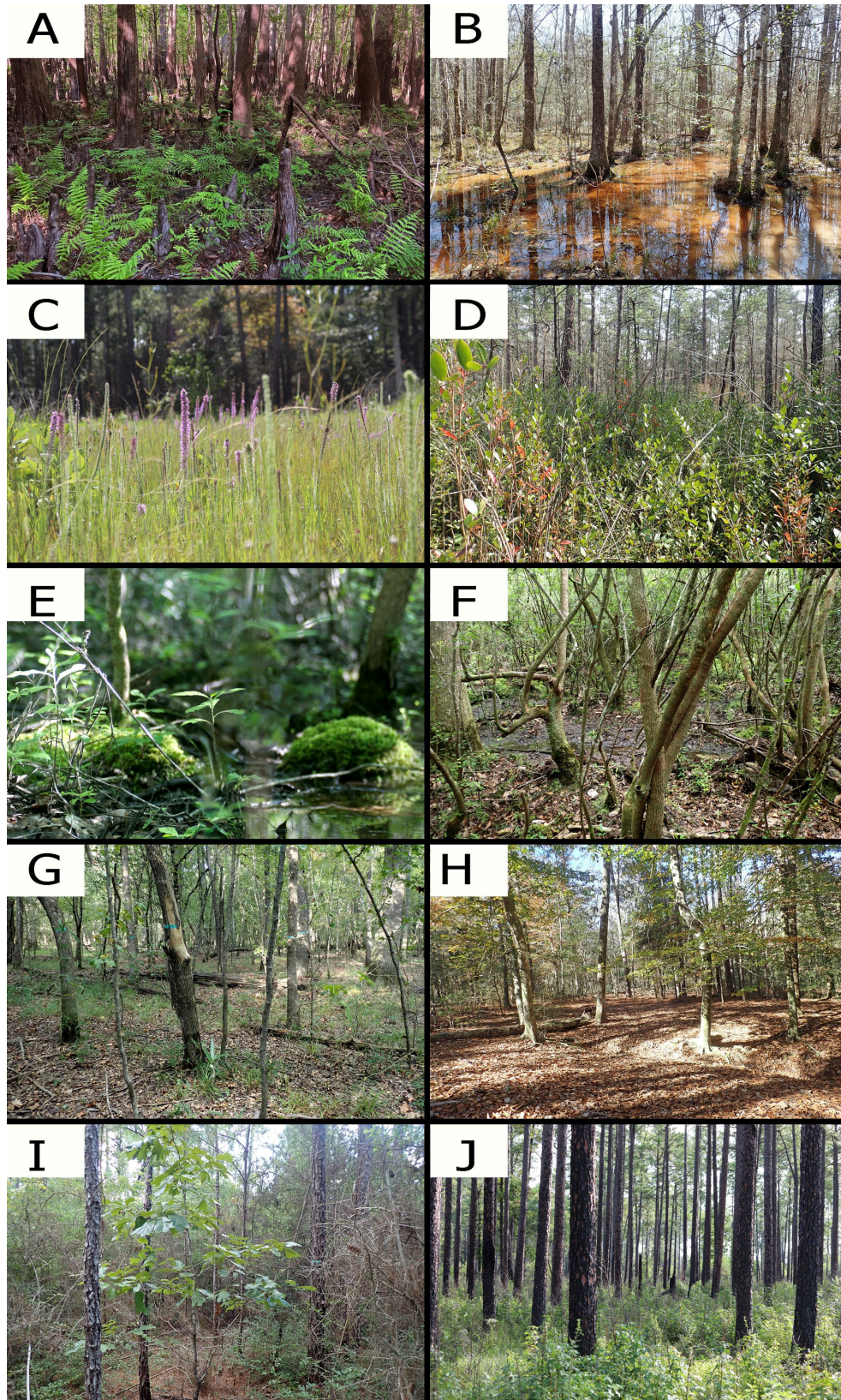
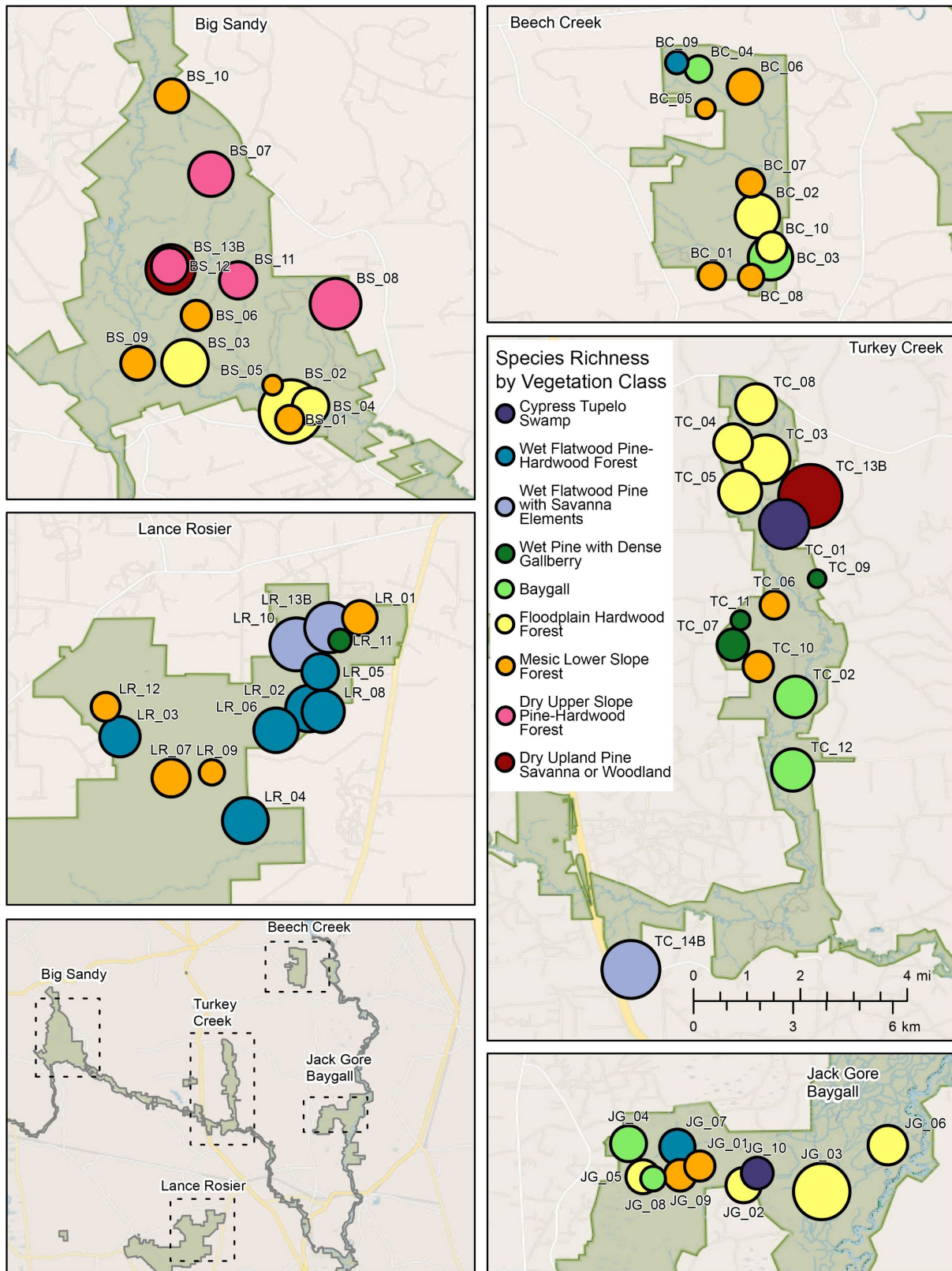


Figure 3. Representative photos of the nine broad vegetation classes sampled at Big Thicket. (A) Cypress-Tupelo Swamp at JG10; (B) Wet Flatwood Pine-Hardwood at LR02 (photo in winter); (C) Wet Flatwood Pine with Savanna Elements in TC14B; (D) Wet Pine with Dense Gallberry in TC07; (E) Baygall in JG04; (F) Baygall in BC03; (G) Floodplain Hardwood Forest in BS04; (H) Mesic Lower Slope Forest in BC06; (I) Dry Upper Slope Pine-Hardwood in BS07; (J) Dry Upland Pine Savanna or Woodland in TC13B.



sweetbay magnolia (*Magnolia virginiana*) and swamp tupelo (*Nyssa biflora*; Figure 3E,F). The **Floodplain Hardwood Forest** class (13 plots) represented communities with a fairly rich assemblage of canopy tree species, all able to withstand occasional flooding, on flat expanses near streams and rivers (Figure 3G). The presence of ironwood (*Carpinus carolinensis*) and/or cow oak (*Quercus michauxii*) with a relatively sparse understory were defining features of the class. The **Mesic Lower Slope Forest** class (18 plots) represented a range of communities on shallow to steep slopes that were dominated by hardwoods or by a combination of hardwoods and loblolly pine. Forests of beech and magnolia were included in this class, as shown in Figure 3H. The **Dry Upper Slope Pine-Hardwood** class (4 plots) represented forests of pines and hardwoods on sandy loam soils of upland slopes. Characteristic trees were shortleaf pine (*Pinus echinata*), loblolly pine and several oak species, including post oak (*Quercus stellata*) and southern red oak (*Quercus falcata*; Figure 3I). The understory generally had extremely dense yaupon (*Ilex vomitoria*). Finally, the **Dry Upland Pine Savanna or Woodland** [Dry Upland Pine] class (2 targeted plots) represented several pine-dominated communities, featuring longleaf pine, loblolly pine, or shortleaf pine with an understory that can be savanna-like if frequently burned (Figure 3J).

Due to the project's randomized sampling design, I&M plots were collectively representative of the dominant plant communities within the five-unit sampling frame. The only exceptions were the four targeted plots, which were in relatively rare communities that nevertheless had high importance to park resource managers. To retain the representative character of the sample for unit-level comparisons, the 56 randomly-selected primary plots were typically summarized separately from the targeted plots. For vegetation class comparisons, however, the targeted plots were included with the 56 primary plots, because targeted plots were in just two classes: Wet Flatwood Pine and Dry Upland Pine.

Preserve-Wide Richness Summaries and Notable Species

Across all 56 primary plots sampled in 2022, I&M staff recorded 367 plant taxa. The four nonrandom targeted plots contributed 78 additional species, for an overall total

of 445 (see Appendix D for full species list). Eighty-eight percent of the total could be identified to genus or species level, leaving 51 taxa as unknown, most often because all individuals were immature. The most species-rich growth form was forbs (i.e., herbaceous, non-graminoid angiosperms plus ferns), with 202 taxa or 45% of the total. Graminoids (grasses, sedges, and rushes) were second most rich (111), followed by trees (60), shrubs (41), then vines (31). Among these richness totals, the most remarkable is for trees, as it places Big Thicket among the top five for park-level tree richness in I&M plots throughout all sampled National Park units in the eastern U.S. (Miller et al. 2023; Boyle 2023; unpublished data).

The single most widespread species in the Big Thicket I&M sample was American holly (*Ilex opaca*), a native, small-statured tree found throughout the eastern United States. It was present in 94% of the primary plots and one targeted plot. The four next most-frequently recorded species were also native and woody, including three trees –sweetgum (*Liquidambar styraciflua*), loblolly pine, water oak (*Quercus nigra*) – and the shrub yaupon. These species were present in 82-86% of the primary plots and 1-4 targeted plots. The most widespread vines were cat greenbrier (*Smilax glauca*; 80% of primary and 2 targeted) and muscadine (*Vitis rotundifolia*; 79% primary and 1 targeted), and the most widespread forb was partridgeberry (*Mitchella repens*; 80% of primary plots). Longleaf woodoats (*Chasmanthium sessiflorum*) and slender woodoats (*Chasmanthium laxum*) were the most widespread graminoids, each at 45-46% of primary plots. Appendix D includes the full species lists for 2022 vegetation monitoring, grouped by growth form, and includes the relative frequency of each species within each unit.

Among the identifiable plants, there were only 10 non-native species found in I&M plots, and no additional non-native species were found in targeted plots. This low percentage of non-natives (2-3%) reflects a minimal contribution of exotics to the sampled flora overall. Even so, 68% of primary plots and one targeted plot had at least one non-native species present. The most widespread non-native was Chinese tallow, being present in 55% of primary plots and 1 targeted plot. This species, along with Chinese privet (14% of plots) and golden bamboo (not recorded),

were previously targeted by Invasive Plant Management Teams, though not in the vicinity of any vegetation monitoring plots. The other relatively widespread non-native was Japanese climbing fern (*Lygodium japonicum*), which was present in 30% of primary plots and one targeted plot. Finally, one non-native species was a new record for the park, Mariana maiden fern (*Macrothelypteris torresiana*). It was found as a few individuals in a single primary plot in northern Turkey Creek. Although a new record for the park and for Tyler County, this species had already been documented nearby outside the park, in Hardin and Liberty Counties.

No rare plant species were recorded in plots during monitoring, based on those listed as Texas Species of Greatest Conservation Need (including federally and state-listed species; Texas Parks and Wildlife Department 2012). Although no individual species were classified as rare, several plots were within Vulnerable or Imperiled plant communities, according to the Texas Parks and Wildlife Department (2012) and Natureserve (<https://explorer.natureserve.org>). These rare communities were represented by plots in the Baygall class, the Wet Flatwood Pine-Hardwood class, the Wet Flatwood Pine class, and the Dry Upland Pine class. See vegetation class descriptions in Appendix C for more details.

Richness Summaries by Unit and Vegetation Class

The five sampled units in the Preserve were fairly similar in average species richness per plot (Table 2), in large part because they each encompassed a mix of vegetation classes (Figure 4). The Preserve-wide mean richness was 42 species per plot, based on the 56 primary plots. Most unit-level averages were close to this overall mean, with the exception of species-poor Beech Creek at 34 species per plot (Table 2). This unit differed from the others in that it had no plots in the top 10% for total richness (i.e., >60 species; Table E1), it had relatively few graminoids and forbs within plots, and it had the lowest overall cumulative species count at 123 (Table 2). A low total count was in part attributable to having two fewer plots than three of the other units. Even so, Jack Gore Baygall also had 10 plots and its mean richness was 41. Even more notable than the low richness of Beech Creek, however, was the

high variation in richness among plots within a given unit (Table 2; Figure 4). Indeed, each Big Thicket unit was found to be extremely heterogeneous in plant communities across its extent, which has been well-demonstrated elsewhere (e.g., Harcombe and Marks 1979; Diggs et al. 2006; Ley et al. 2024). For this reason, vegetation class summaries were more useful for assessing forest condition than were unit level summaries, with one caveat. For some classes, sample sizes were quite small (≤ 3), such that their summarized values could not be considered widely representative.

Two of the nine I&M vegetation classes stood out for their high per-plot richness values (Table 3). These were the wet and dry pine savanna-like communities, mainly represented by nonrandom target plots. The richest class was Dry Upland Pine (2 plots sampled). It had 71 species per plot on average, which included the Preserve's overall highest richness value of 81. This vegetation class was known to be relatively rare on the landscape, occurring in only the Big Sandy and Turkey Creek units (Harcombe and Marks 1979). Both targeted plot locations were selected from areas receiving regular prescribed burns by the Fire Management Team and/or recent brush clearing and plantings (see Table B1 for specific plot history information). The distribution of richness among growth forms in this class revealed an abundance of forbs and graminoids, as well as slightly more shrubs and vines than most other classes (Table 3; plot-level data in Table E1). Distinctive forb species included Georgia frostweed (*Helianthemum georgianum*), slender pinweed (*Lechea tenuifolia*), and arrowhead rattlebox (*Crotalaria sagittalis*).

The second richest class – Wet Flatwood Pine (67 species per plot; 3 plots sampled) – had even higher richness in graminoids and forbs, but it had relatively few shrub, vine, or tree species (Table 3). Notable herbaceous taxa included prairie blazing star (*Liatris pycnostachya*), St Peter's-wort (*Hypericum crux-andreae*), pinewoods rose gentian (*Sabatia gentianoides*), golden colicroot (*Aletris aurea*), grassleaf Barbara's buttons (*Marshallia graminifolia*), arrowfeather threeawn (*Aristida purpurascens*), Muehlenberg's nutrush (*Scleria muehlenbergii*), and plumed beaksedge (*Rhynchospora plumosa*; see Figure C2 for a subset of species's photos). Like the Dry Upland Pine

Table 2. Unit-level richness (*R*) summaries per 400-m² plot in the 2022 I&M sampling in Big Thicket National Preserve. Summaries are for all species recorded in each plot, including those rooted in, overhanging or prostrated across the plot. Sample sizes in the first column are the randomly selected primary plots plus one (*) or two (**) nonrandom targeted plots. All Species Mean *R* includes unidentified species. Values in the final two columns are totals for combined species lists across plots in a unit.

Unit (Number of Plots)	All Species Mean <i>R</i> , Primary Plots	All Species <i>R</i> Std. Dev., Primary	Min. <i>R</i> , Primary Plots	Max. <i>R</i> , Primary Plots	<i>R</i> for Each Target Plot	Total <i>R</i> for 56 Primary Plots	Total <i>R</i> for All 60 Plots
Beech Creek (10)	34	12	19	54	-	123	123
Big Sandy (13*)	46	16	19	80	61	164	191
Jack Gore Baygall (10)	41	12	26	71	-	176	176
Lance Rosier (13*)	45	13	23	66	61	170	192
Turkey Creek (14**)	41	15	16	61	73, 81	173	271
Overall	42	14	16	80	69 (mean)	367	445

Table 3. Class-level richness (*R*) summaries per 400-m² plot in the 2022 I&M sampling at Big Thicket National Preserve. Summaries are for all species recorded in each plot, including those rooted in, overhanging, or prostrated across the plot. All 60 plots are summarized, which includes 4 targeted, non-randomly selected plots. All Species Mean *R* includes unidentified species with unknown nativity status. Values in the final column are totals for combined species lists across plots in a vegetation class.

Broad Vegetation Class (Number of Plots)	All Species Mean <i>R</i>	All Species <i>R</i> Std. Dev.	Non-Native Species Mean <i>R</i>	Forbs Mean <i>R</i>	Graminoids Mean <i>R</i>	Shrubs Mean <i>R</i>	Vines Mean <i>R</i>	Trees Mean <i>R</i>	Total <i>R</i> for All 60 Plots
Cypress Tupelo Swamp (2)	49	18	5	22	10	3	3	12	82
Wet Flatwood Pine-Hardwood Forest (8)	47	11	1	9	11	7	7	14	125
Wet Flatwood Pine with Savanna Elements (3)	67	6	0	33	18	4	3	9	120
Wet Pine with Dense Gallberry (4)	23	9	0	3	3	6	3	9	50
Baygall (6)	42	5	1	9	5	9	7	12	109
Floodplain Hardwood Forest (13)	52	13	2	10	8	7	9	18	194
Mesic Lower Slope Forest (18)	33	7	0	3	3	6	7	15	127
Dry Upper Slope Pine-Hardwood Forest (4)	51	9	1	8	7	8	9	20	105
Dry Upland Pine Savanna or Woodland (2)	71	14	1	28	13	11	9	11	112
Overall (60)	44	15	1	9	7	7	7	14	445

class, this class was known from only a few areas within the Preserve, some of which were being actively managed and restored. The Solo Tract was one such restoration site, within a short walk of the Visitor Center. The targeted plot in that site had the Preserve's third highest richness at 73 species total. The second targeted plot was in a clearing of wet pine savanna near the northeastern corner of Lance Rosier, not far from a randomly located plot in the same class with a much smaller grassy clearing. The northeastern section of Lance Rosier had not been burned in over 10 years, but it was under consideration for increased management activity. Even in the absence prescribed fire, portions of this area likely remained grass-dominated due to sodic soils or a shallow, impermeable

subsurface clay layer that discouraged woody plant encroachment. This class's partial resilience to fire suppression contrasted with the Dry Upland Pine, Dry Upper Slope Pine-Hardwood, and Wet Pine with Dense Gallberry classes that were dominated by yaupon, gallberry or other woody plants in the absence of frequent fires.

Classes with intermediate mean plot-level richness included the Floodplain Hardwood Forest (52 species; 13 plots), Dry Upper Slope Pine-Hardwood Forest (51 species; 4 plots), Wet Flatwood Pine-Hardwood Forest (47 species; 8 plots), and Cypress Tupelo Swamp (49 species; 2 plots). Both the Floodplain Hardwood and Dry Upper Slope Pine-Hardwood were relatively rich in trees, with an average of

18 or 20 species per plot, respectively, and a maximum of 24 or 25. The Preserve's two richest primary plots were in the Floodplain Hardwood class, one in Big Sandy (80 species) and one in Jack Gore Baygall (71 species). The third and fourth richest primary plots were in Dry Upper Slope Pine-Hardwood (63 species) and Cypress Tupelo Swamp (61 species). The latter class was relatively species poor for shrubs, vines, and trees, but it had the third highest richness for forbs. Forb species in this class included lizard's tail (*Saururus cernuus*), dollarweed (*Hydrocotyle verticillata*), and redvine (*Brunnichia ovata*).

The most species-poor classes were Wet Pine with Dense Gallberry (23 species; 4 plots), Mesic Lower Slope Forest (33 species; 18 plots), and Baygall (42 species; 6 plots). The first two classes had particularly low richness in forbs and graminoids (Table 3). Low richness in the Dense Gallberry class was likely associated with its extremely thick shrub layer (see next section); it also had low richness in trees and vines. The Mesic Lower Slope class was the dominant vegetation class in the Preserve, and although it represented a range of forested communities, ground cover tended to be sparse throughout, whether beneath minimal shrubs or dense gallberry and/or yaupon. The Baygall class differed from the other two species-poor classes with its relatively high shrub richness, although like the others, it had relatively few graminoid species. The forb species recorded in baygalls, though not particularly numerous, included several of the class's characteristic diminutive plants, including nodding nixie (*Apteria aphylla*) and northern bluethread (*Burmanna bilfora*; Figure C4).

Understory Percent Cover and Relative Frequency by Vegetation Class

To determine which species dominated the understory of each forested site, coverage and frequency values were estimated within 10-m² nested subplots. Percent cover was averaged across the four 10-m² corner microplots per full 400-m² plot, based on all foliage up to 5 m above ground level. Relative frequency was calculated as the percent occupancy out of all eight 10-m² microplots per full plot for all species rooted in or overhanging the microplot, from ground level through tree canopies.

Frequency and cover estimates revealed that very few species had >50% mean coverage in the understory of plots

within vegetation classes (Figure 5, blue bars), but up to 16 species had ≥50% relative frequency among microplots (Figure 5, green bars). The top five most-frequent species (≥90% of microplots) were swamp titi for Baygall; yaupon for Dry Upper Slope Pine-Hardwood; gallberry for Wet Pine with Dense Gallberry; and beautyberry (*Callicarpa americana*) and yaupon for Dry Upland Pine Savanna or Woodland. The species with the highest percent cover values were gallberry in the Wet Pine with Dense Gallberry class (54%) and yaupon in the Dry Upper Slope Pine-Hardwood class (54%). No other individual species had >50% cover within a class, but two shrub species within the Baygall class combined to an average of 70%. For the remaining six classes, understory vegetative cover was lower on average, but there was notable variation among plots, particularly within the mesic lower slope and wet flatwood pine-hardwood classes.

Plots with dense, nearly impenetrable understories were examples of the 'thickness' after which Big Thicket was named. Understory density was quantified as the summed percent cover across all woody species in each microplot (heights <5 m, excluding vines) and then averaged across the four microplots per plot (inset text in Figure 5A-I). For a few classes, dense understories were consistent with a reference or 'natural' condition (e.g., Baygalls), but for the fire-adapted communities targeted for longleaf pine restoration, they generally were not (e.g., communities in Wet Flatwood Pine, Wet Pine with Dense Gallberry, Dry Upper Slope Pine-Hardwood, and Dry Upland Pine). In those communities, plots with the thickest understories had the lowest richness values for graminoids and forbs (Figure 5J), i.e., they lacked the rich herbaceous understories that were expected in fully restored longleaf pine habitats. Within this spectrum of plots, the Solo Tract plot stood out as having the most recent prescribed fire and restoration work (see Table B1), extremely low woody cover (4%) and the highest richness in forbs and graminoids (65 total). The other two plots in Wet Flatwood Pine—in northeast Lance Rosier—were less rich and more shrub encroached, e.g., 50% and 72% woody understory cover. These differences between actively managed and unmanaged areas reflect the potential gains of combined restoration efforts, which are currently underway in several parts of the Preserve.

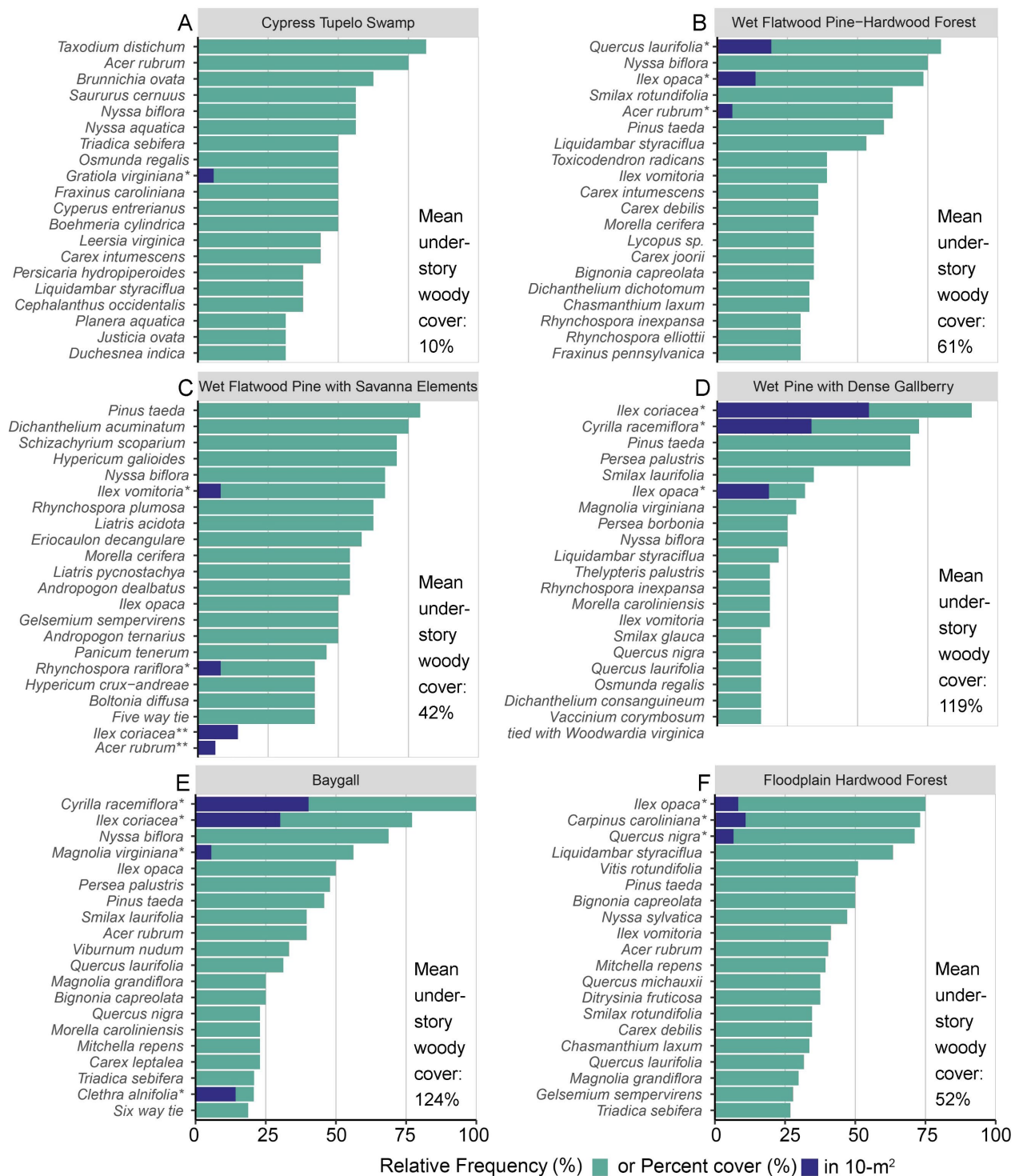


Figure 5. Relative frequency of the top 20 plant species (green bars) and percent cover for all species above >5.0% (blue bars) at Big Thicket. Relative frequency values are calculated as the percent occupancy of eight 10-m² microplots per 20 x 20 plot, and then averaged over all 20 x 20 plots in each class. Percent cover is the per-species average within four microplots per full plot, estimated as polygons around foliage and stems projected vertically downward. Mean understory woody cover is the sum percent cover for all woody species in a microplot excluding woody vines, then averaged for the full plot. Values can exceed 100% due to overlapping plants. Species in the top 20 for frequency that also have >5.0% cover are indicated with an asterisk (*). Species with >5.0% mean cover that are not among the top 20 are included at the end of each list and indicated with two asterisks (**). The six-way tie is *Carex debilis*, *Gelsemium sempervirens*, *Liquidambar styraciflua*, *Rhododendron oblongifolium*, *Woodwardia areolata*, and *Carex jorii*. The five-way tie is *Hyptis alata*, *Liquidambar styraciflua*, *Persea borbonia*, *Pluchea rosea*, and *Rhynchospora gracilentia*.

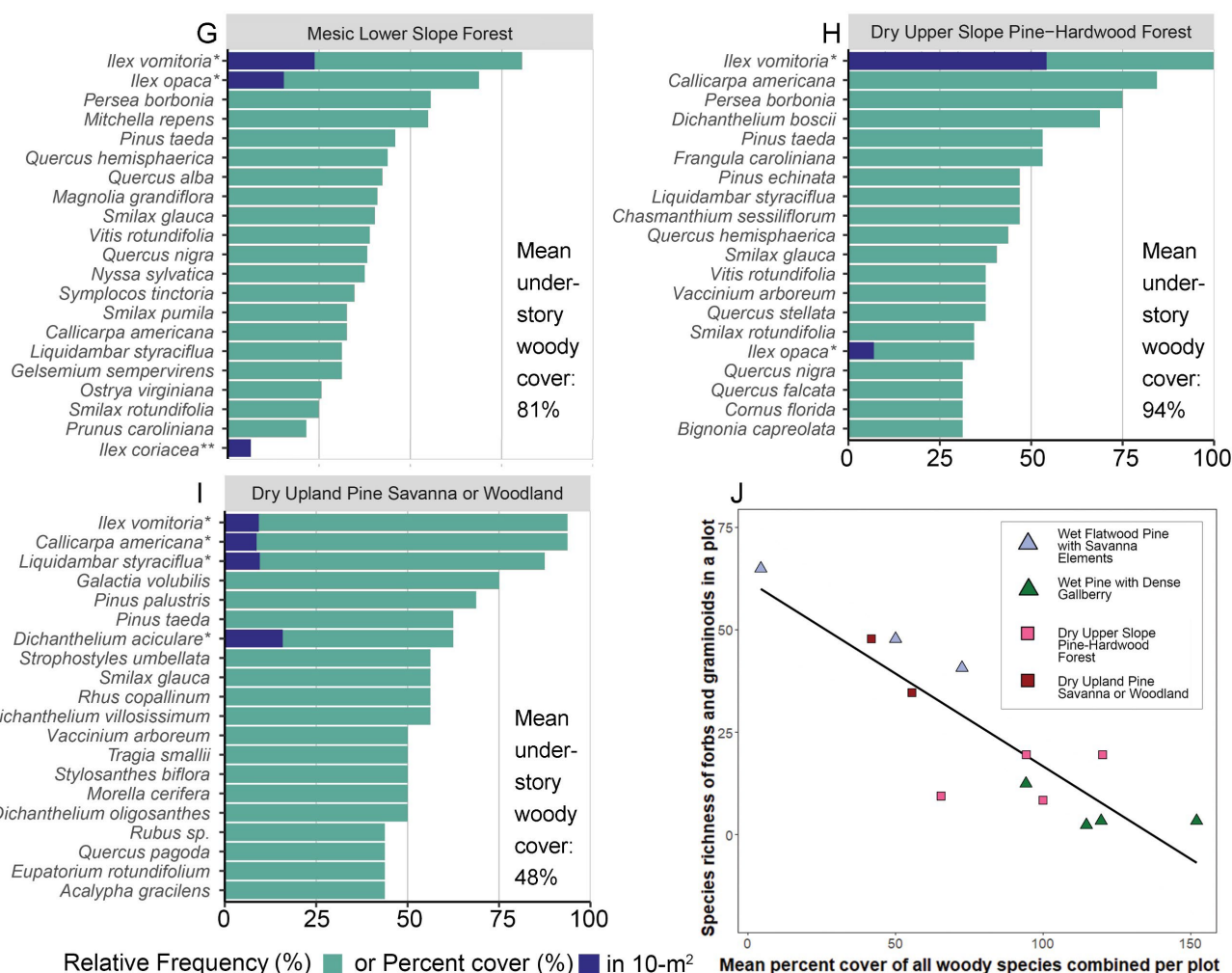


Figure 5 continued. (G-I) Relative frequency of the top 20 plant species (green bars) and percent cover for all species above >5.0% (blue bars) at Big Thicket. Relative frequency values are calculated as the percent occupancy of eight 10-m² microplots per 20 x 20 plot, and then averaged over all 20 x 20 plots in each class. Percent cover is the per-species average within four microplots per full plot, estimated as polygons around foliage and stems projected vertically downward. Mean understory woody cover is the sum percent cover for all woody species in a microplot (<5m tall) excluding woody vines, then averaged for the full plot. Values can exceed 100% due to overlapping plants. Species in the top 20 for frequency that also have >5.0% cover are indicated with an asterisk (*). Species with >5.0% mean cover that are not among the top 20 are included at the end of each list and indicated with two asterisks (**). (J) Species richness of forbs and graminoids relation to percent cover of woody species in the four broad vegetation classes that are the main candidates for longleaf pine restoration in Big Thicket (each color is a different class). The line is a least squares regression line.

Tree and Regeneration Metrics

Forest health metrics were recorded in all 56 primary and 4 targeted plots in 2022. Each plot had 1-51 live trees (1,423 total), based on the criteria of trees having a DBH of ≥10 cm. Focal metrics recorded in each plot included tree location, status (alive, dead, leaning), DBH and structural damage (i.e., large dead branches or broken top; advanced decay; results not shown). Seedlings and saplings were also counted into different sizes classes in four 10-m² microplots per full plot (2,963 counted total, 1-221 per

plot). These classes were combined into juvenile tree density, from which recent germinants were excluded due to high year-to-year fluctuations (Carlson et al. 2018). Results were summarized at the unit level, since these metrics provided a useful snapshot of unit-to-unit differences, as well as the more ecologically-relevant level of vegetation classes. Among the suite of standard tree measurements recorded in each plot, basal area was used in reporting as a key measure of tree dominance.

Tree Composition by Unit

Units differed slightly in terms of which species or taxa had the top value for basal area, but most units had the same four taxa at or near the top (Figure 6). These taxa were oaks (*Quercus* spp.), tupelo species (*Nyssa* spp.), loblolly pine, and sweetgum. The dominant oak species across all units were water oak, laurel oak (*Quercus laurifolia*), and white oak (*Quercus alba*). Two additional oak species were dominant in some units but not others. These were Darlington oak (*Quercus hemisphaerica*) in Big Sandy and

Beech Creek, and post oak (*Quercus stellata*) in Big Sandy plots. Additional unit-by-unit differences emerged when considering the less common tree species that were nevertheless still within the top 15 taxa across all I&M plots in the Preserve. For example, adult beech trees (*Fagus grandifolia*) were recorded in all units except for Turkey Creek, but they were far more numerous in Beech Creek than elsewhere. Additionally, adult shortleaf pine trees (*Pinus echinata*) were in the top four for basal area in Big Sandy plots, infrequent in Jack Gore Baygall plots, and absent from plots in all other units (Figure 6, Figure 7).

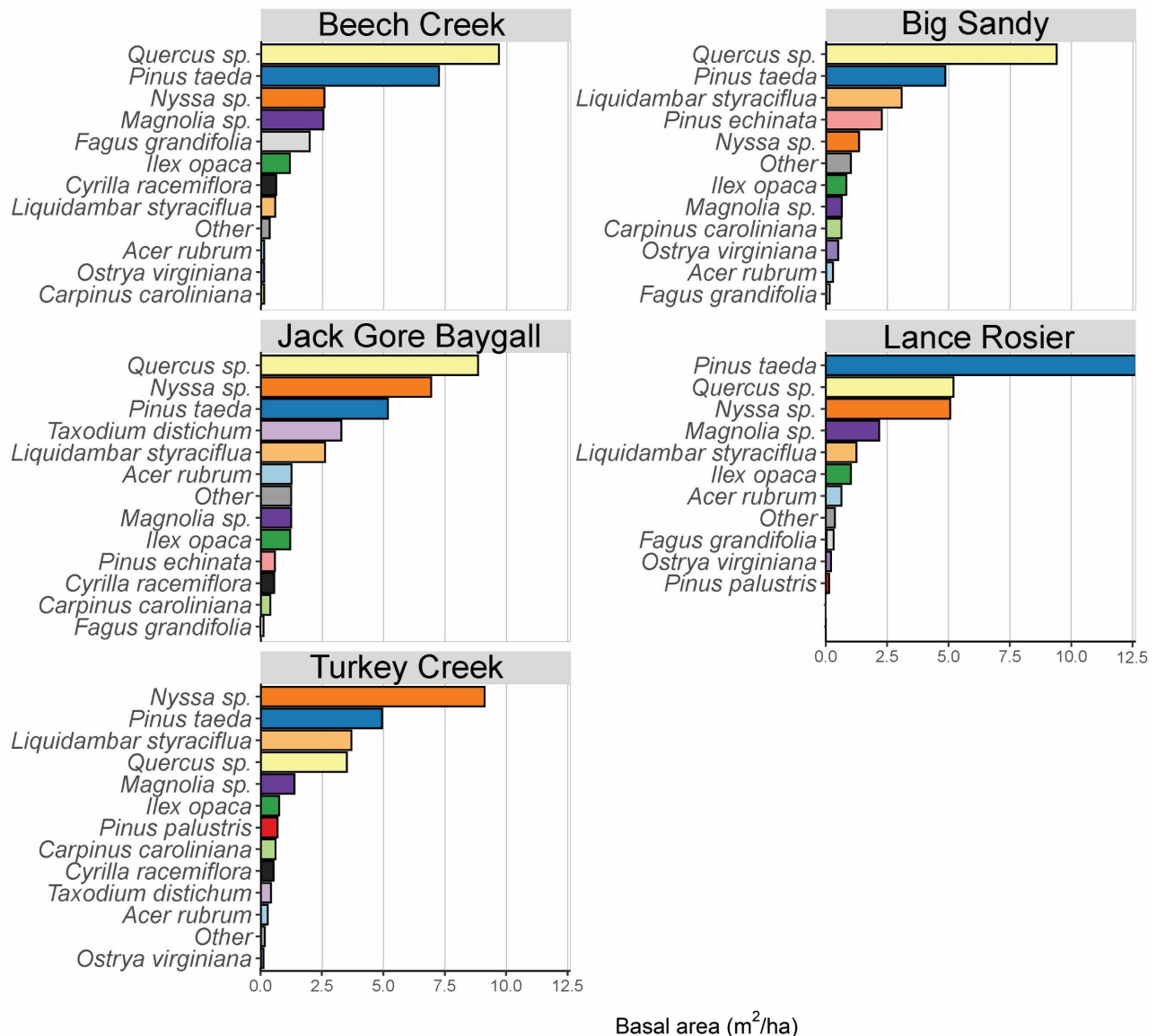


Figure 6. Basal area by tree taxon for the five sampling units in Big Thicket National Preserve, based on the 56 randomly-selected primary plots. The 'other' category consists of *Fraxinus* spp., *Prunus* spp., *Crataegus* spp., *Carya* spp., *Persea* spp., *Triadica sebifera*, *Planera aquatica*, *Chionanthus virginicus*, *Cornus florida*, *Symplocos tinctoria*, *Ulmus* spp., and *Vaccinium arboreum*. Each taxon's color is consistent between Figures 6-8.

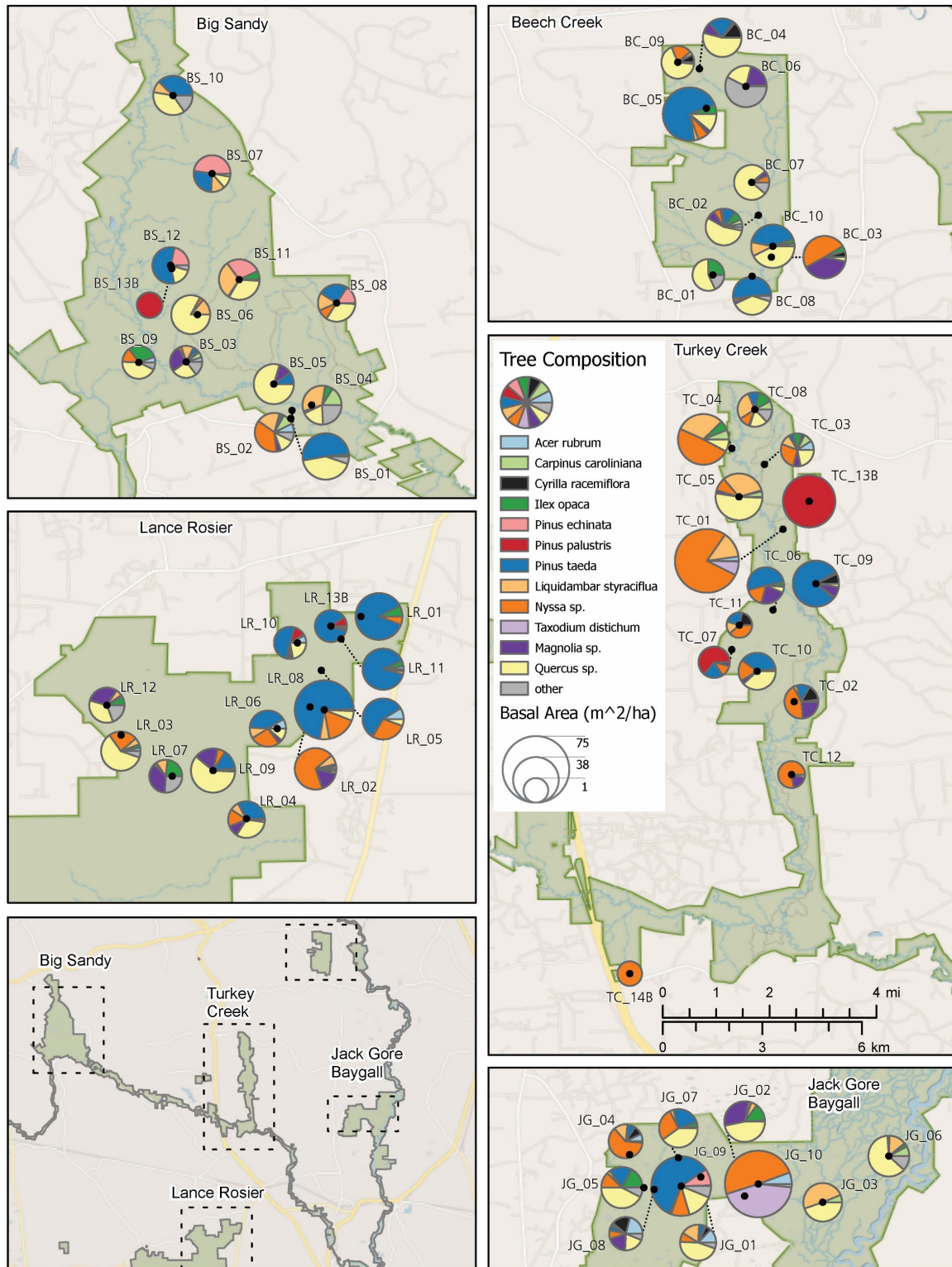


Figure 7. Total basal area and percent composition among species for I&M monitoring plots in Big Thicket National Preserve. Point size is scaled to the mean basal area per plot, and pie charts depict the proportion of basal area belonging to each taxonomic group. Species in the 'other' class include *Fraxinus* spp., *Prunus* spp., *Crataegus* spp., *Carya* spp., *Persea* spp., *Triadica sebifera*, *Planera aquatica*, *Chionanthus virginicus*, *Cornus florida*, *Persea borbonia*, *Symplocos tinctoria*, *Ulmus* spp., *Vaccinium arboreum*, *Ostrya virginiana*, and *Fagus grandifolia*. Each taxa's color is consistent between Figures 6-8.

Tree Metrics by Unit

Averaged over all 56 primary plots, the mean basal area was 28 m²/ha, meaning that at DBH height, tree stems took up a cross-sectional area of 28 m² within each hectare (10,000 m²). Jack Gore Baygall unit stood out as particularly high for mean basal area and stem counts (Table 4), though this was mostly due to just two plots. Cypress-Tupelo Swamp plot JG10 had the Preserve's highest basal area value at 75.2 m²/ha (Figure 7; Table E2). It also had the Preserve's highest stem count of 52 stems (or 1275 stems per ha), though the mean DBH was only 24.1 cm. Mesic Lower Slope plot JG09 had the second highest basal area at 62.8 m²/ha, driven in this case by a relatively high mean DBH of 32.0 cm, including seven relatively large loblolly trees ranging from 44 to 57 cm DBH. Besides high basal area and stem density at Jack Gore Baygall, there were two other notable adult tree metrics by unit. First, Lance Rosier had the second highest stems per hectare among units, which had much to do with high stem density in the Wet Flatwood Pine-Hardwood class, which was barely represented outside that unit (see following sections). Second, Big Sandy had an average of 15 more standing dead trees per ha than the next highest unit for mortality, although this amounted to only about half an additional dead tree per plot (Table 4).

Tree Composition by Vegetation Class

Each of the nine different vegetation classes featured a different suite of dominant tree taxa (Figure 8), as was generally expected based on class definitions. For example, the Cypress Tupelo Swamp was dominated by tupelo species and bald cypress, and the Dry Upland Pine class

was dominated by longleaf pine. For four classes, loblolly had the highest or second highest mean basal area. This group included Wet Flatwood Pine, which in a pristine condition would be expected to have a greater dominance of longleaf pine. As mentioned previously, areas that were repeatedly logged prior to NPS ownership were often replanted in loblolly or slash pine, which has likely slowed longleaf recovery in those areas. Prescribed fire may be necessary to help favor recruitment of adult longleaf over loblolly in this relatively rare but highly valued vegetation class.

Tree Metrics by Vegetation Class

When key tree metrics were compared among vegetation classes, mean values ranged widely (Table 5). Cypress Tupelo Swamp class stood out as having the highest mean basal area (72.7 m²/ha) and stem density (988 stems/ha), and the second highest DBH (28.1 cm). Mean basal area values were also high for the Mesic Lower Slope, Floodplain Hardwood, and Wet Flatwood Pine-Hardwood classes (27.7-29.3 m²/ha), which were the three best-represented classes in the Preserve. Wet Flatwood Pine-Hardwood also had the second highest value for stem density (794 stems/ha), followed by Floodplain Hardwood Forest (646 stems/ha). Although Floodplain Hardwood plots were not remarkable for DBH on average, they did contain the Preserve's three highest values for individual trees. The largest was a cow oak (*Quercus michauxii*) with a DBH of 100.5 cm in TC05, followed by a laurel oak with a DBH of 72.7 cm in JG06, and a southern magnolia with DBH 67.2 cm in JG02.

Table 4. Mean tree and regeneration metrics for primary plots within each unit from 2022 sampling in Big Thicket National Preserve. Adult tree data were collected for all trees ≥10cm DBH in the 400-m² plot, and regeneration data (seedling and sapling densities) were collected in a 40-m² area of the plot (four 10-m² microplots). Recent germinants were those 5 to 15 cm tall; seedlings were 16 to 137 cm tall, and saplings were 1-10 cm DBH. Total juvenile densities were based on the sum of seedling and sapling classes, excluding recent germinants. These summaries only include data for the 56 randomly-selected primary plots.

Unit (Number of Plots)	Basal Area (m ² /ha)	Basal Area (m ² /ha) Std. Dev.	Live Tree Stems /ha	Standing Dead Trees /ha	Canopy Height (m)	Canopy Closure	Mean DBH (cm)	Recent Germinant Density /m ²	Seedling Density /m ²	Sapling Density /m ²	Total Juvenile Tree Density /m ²
BC (10)	27.1	11.2	575	33	22.1	94	21.7	1.06	0.38	0.19	0.56
BS (12)	25.0	6.5	533	48	24.5	94	22.2	0.62	0.54	0.12	0.65
JG (10)	33.4	19.6	763	25	22.7	92	20.4	0.75	0.39	0.17	0.56
LR (12)	29.1	12.9	696	31	20.6	93	21.2	0.56	0.39	0.19	0.59
TC (12)	26.1	19.5	535	21	20.7	87	21.1	0.53	0.37	0.10	0.48
Overall (56)	28.0	14.8	617	32	22.1	92	21.3	0.69	0.41	0.15	0.57

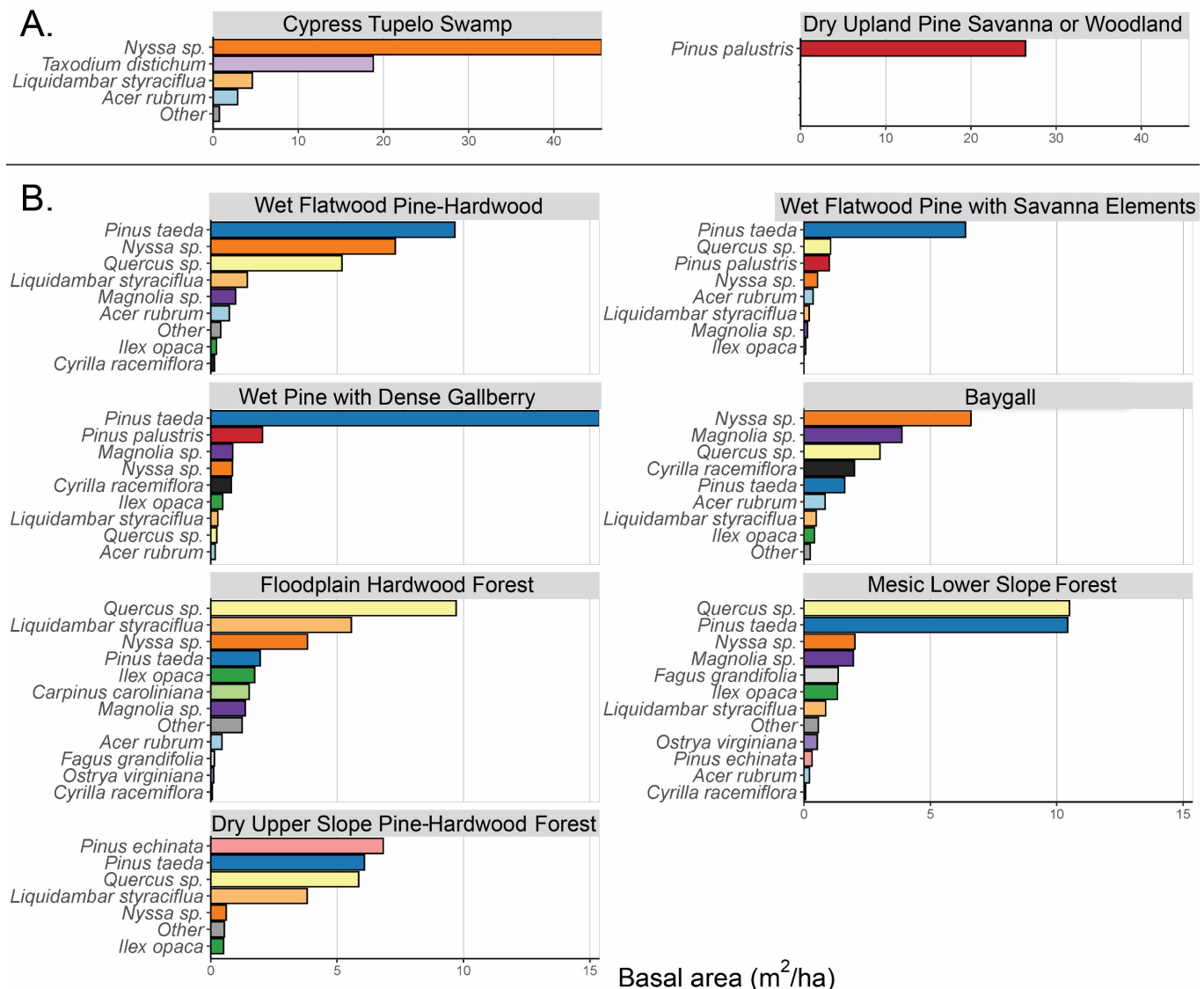


Figure 8. Basal area by tree taxa for the nine vegetation classes at Big Thicket National Preserve. (A) The two classes with the highest basal area; note the different x-axis scale; (B) The remaining seven classes. The 'other' category consists of *Fraxinus* spp., *Prunus* spp., *Crataegus* spp., *Carya* spp., *Persea* spp., *Triadica sebifera*, *Planera aquatica*, *Chionanthus virginicus*, *Cornus florida*, *Symplocos tinctoria*, *Ulmus* spp., and *Vaccinium arboreum*. Each taxa's color is consistent between Figures 6-8.

Although the best-represented classes in the Preserve generally had many trees per plot, two classes were characterized by notably low tree densities. Wet Flatwood Pine had very few trees overall, and Dry Upland Pine had extreme variation in tree metrics among its two plots. Overall for plots in the Preserve, trees were not particularly large, nor basal area very high, reflecting the regrowth status of all the monitored forest stands.

Tree Metric Comparisons with Other Protected Areas

Tree metrics from 400-m² vegetation monitoring plots in other protected areas in Louisiana and Texas were obtained to serve as a reference for Big Thicket I&M plots in 2022. There were comparable data for three of the vegetation classes sampled in Big Thicket: Mesic Lower Slope Forest, Floodplain Hardwood Forest, and Cypress Tupelo Swamp. For the Mesic Slope Forest, there was a privately-owned forest nearby called Wier Woods, which

had not been logged since 1917 and was the subject of a long-term study in the 1980s and 1990s (Glitzenstein et al. 1986; Harcombe et al. 2002). Mean basal area and DBH were both higher in Wier Woods than in Big Thicket I&M plots (basal area: 31.4 vs 28.7 m²/ha; DBH: 30.0 vs 22.9 cm), but Wier Woods stem density was lower (370 vs 556 stems per ha; all comparisons using only stems ≥10 cm DBH). The remaining two vegetation classes were both compared with I&M plot data from 2021 sampling in the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, LA, which was not apparently logged since before 1936 (Carlson 2022). For four Cypress Tupelo Swamp plots in the Barataria Preserve, the mean basal area was lower than in Big Thicket (61.5 vs 72.7 m²/ha), the mean DBH was higher (32.3 vs 28.2 cm), and the mean stem density was lower (700 vs. 988 stems per ha). Finally, the five bottomland deciduous forest plots sampled in the Barataria Preserve in 2021 were considered comparable to Floodplain Hardwood Forest plots in Big Thicket. For the Barataria Preserve, the mean basal area was slightly higher

than in Big Thicket (29.0 vs 27.7 m²/ha), DBH was higher (27.7 vs 20.2 cm), and stem density was lower (350 vs 646 stems per ha; Table 5). In sum, Big Thicket had higher stem densities and lower DBH for all three comparisons with plots in similar vegetation classes elsewhere. This generally suggests that stands are relatively young in Big Thicket, although other factors are also likely involved. With very small sample sizes for some classes (i.e., Cypress-Tupelo Swamp) and without statistical tests, conclusions are tentative at best. They nevertheless serve to put Big Thicket tree metrics into some context.

Seedlings and Saplings by Vegetation Class

Comparison of regeneration metrics revealed a mix of juvenile taxa in the understories of most sampled forest types. Although the dominant species often differed between juvenile and adult cohorts, the top two adult tree taxa had juvenile representatives in all but two vegetation classes (Figure 9). The exceptions were Wet Pine with Gallberry class, for which tupelo species made up 9% of adult stems but were absent as juveniles; and the

Table 5. Mean tree and regeneration metrics for plots within each vegetation class from 2022 sampling in Big Thicket National Preserve. Adult tree data were collected for all trees ≥10cm DBH in the 400-m² plot, and regeneration data (seedling and sapling densities) were collected in a 40-m² area of the plot (four 10-m² microplots). Recent germinants were those 5 to 15 cm tall; seedlings were 16 to 137 cm tall, and saplings were 1-10 cm DBH. Total juvenile densities were based on the sum of seedling and sapling classes, excluding recent germinants. All 60 plots, including the four targeted plots, are included in these summaries.

Broad Vegetation Class (Number of Plots)	Basal Area (m ² /ha)	Basal Area (m ² /ha) Std. Dev.	Live Tree Stems /ha	Standing Dead Trees /ha	Canopy Height (m)	Canopy Closure	DBH (cm)	Recent Germ-inant Density /m ²	Seedling Density /m ²	Sapling Density /m ²	Total Juvenile Tree Density /m ²
Cypress Tupelo Swamp (2)	72.7	3.6	988	38	28.1	95	28.2	0.65	0.14	0.05	0.19
Wet Flatwood Pine-Hardwood Forest (8)	29.3	14.0	794	22	20.8	91	20.0	0.64	0.48	0.21	0.68
Wet Flatwood Pine with Savanna Elements (3)	9.8	7.6	350	0	15.1	49	19.5	0.19	0.36	0.17	0.53
Wet Pine with Dense Gallberry (4)	21.1	16.5	506	50	20.1	85	19.2	0.24	0.61	0.09	0.70
Baygall (6)	19.1	9.3	542	42	17.5	85	19.8	0.73	0.32	0.11	0.43
Floodplain Hardwood Forest (13)	27.7	9.3	646	19	22.4	94	20.2	0.75	0.34	0.21	0.55
Mesic Lower Slope Forest (18)	28.7	13.1	556	33	23.5	95	22.9	0.85	0.43	0.13	0.56
Dry Upper Slope Pine-Hardwood Forest (4)	24.2	3.4	488	56	24.2	89	22.9	0.38	0.45	0.11	0.56
Dry Upland Pine Savanna or Woodland (2)	26.4	33.2	288	20	30.0	32	35.9	0.16	1.25	0.05	1.30
Overall (60)	27.2	15.1	593	30	22.1	88	21.8	0.65	0.43	0.15	0.58

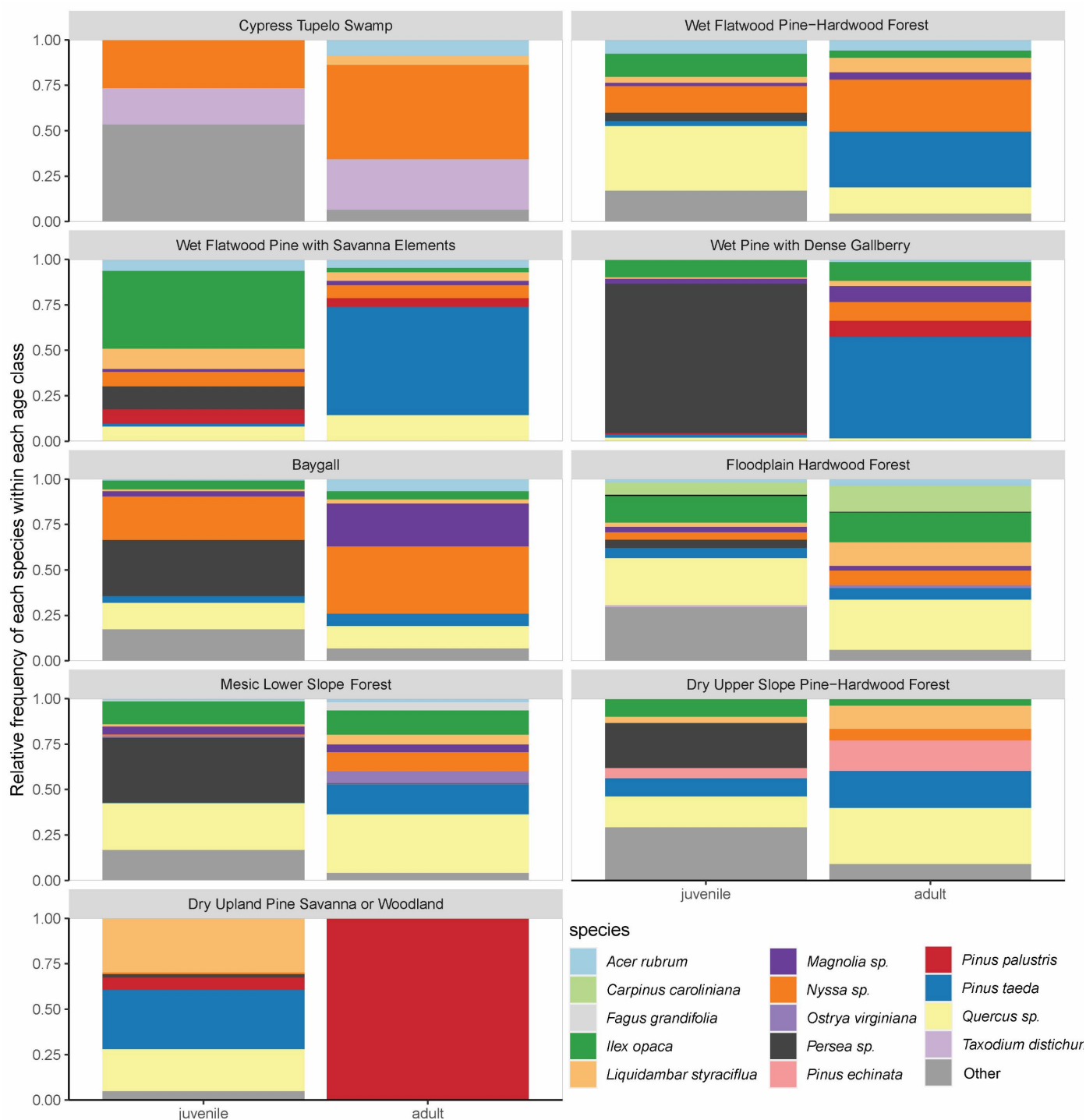


Figure 9. Relative proportion of juvenile and adult trees by stem counts for I&M plots at Big Thicket National Preserve. Juveniles were all seedlings greater than 15 cm tall plus all saplings; recent germinants were excluded. *Cyrilla racemiflora* was excluded from this figure because juveniles of this species were not counted. It was classified as a shrub for most methods, except for that stems > 10cm DBH were tagged and counted with the trees. Species in the 'other' class include *Fraxinus* spp., *Prunus* spp., *Crataegus* spp., *Carya* spp., *Triadica sebifera*, *Planera aquatica*, *Chionanthus virginicus*, *Cornus florida*, *Symplocos tinctoria*, *Ulmus* spp., and *Vaccinium arboreum*. Taxa color are the same as in Figures 6-8 except that *Persea* spp. in Figure 9 uses the same color as *Cyrilla racemiflora* in Figures 6-8.

Mesic Lower Slope class, for which loblolly pine made up 17% of adult stems but were absent as juveniles. In both of those classes, the lack of regeneration in those taxa was not necessarily a cause for concern, given that neither species were defining for their classes. For some plots in the Mesic Lower Slope in particular, adult loblolly trees may be relics of past pine plantations (e.g., see Figure B1 of Beech Creek).

The Preserve's nine vegetation classes not only differed in the composition of juvenile tree taxa, but they also varied widely in their densities (Table 5, Figure 10). The highest density of juvenile trees (i.e., seedlings plus saplings) was 1.3 per m² for the Dry Upland Pine class. The majority of juvenile stems in this class did not belong to the canopy dominant of longleaf pine (7% of juvenile stems), but were instead predominately loblolly or sweetgum (62%). These non-target species were not expected to grow into the canopy due to regular prescribed fires, although resprouters like sweetgum will likely remain as juveniles despite regular

burns. The next highest class in terms of juvenile density was Wet Pine with Dense Gallberry, due to a single plot with 76 juvenile individuals of bay species (*Persea* spp.). Both of the top two classes for juvenile tree density had unusually large numbers of seedlings, which as a group, were considered less predictive of future canopy composition than saplings. For sapling densities alone, the top two classes were Flatwood Pine-Hardwood and Floodplain Hardwood Forests (Table 5, Figure 10).

Among all tree species recorded in the Preserve, the bay tree (*Persea* spp.) stood out for its high juvenile densities and near absence as adults. A bay species was present in 80% of all plots, with 327 juveniles counted overall, as compared to only one adult. Juvenile bay densities were particularly high in classes Wet Pine with Dense Gallberry, Wet Flatwood Pine, Dry Upland Pine, and Wet Flatwood Pine-Hardwood (Figure 9). The extreme rarity of adult bay trees was most

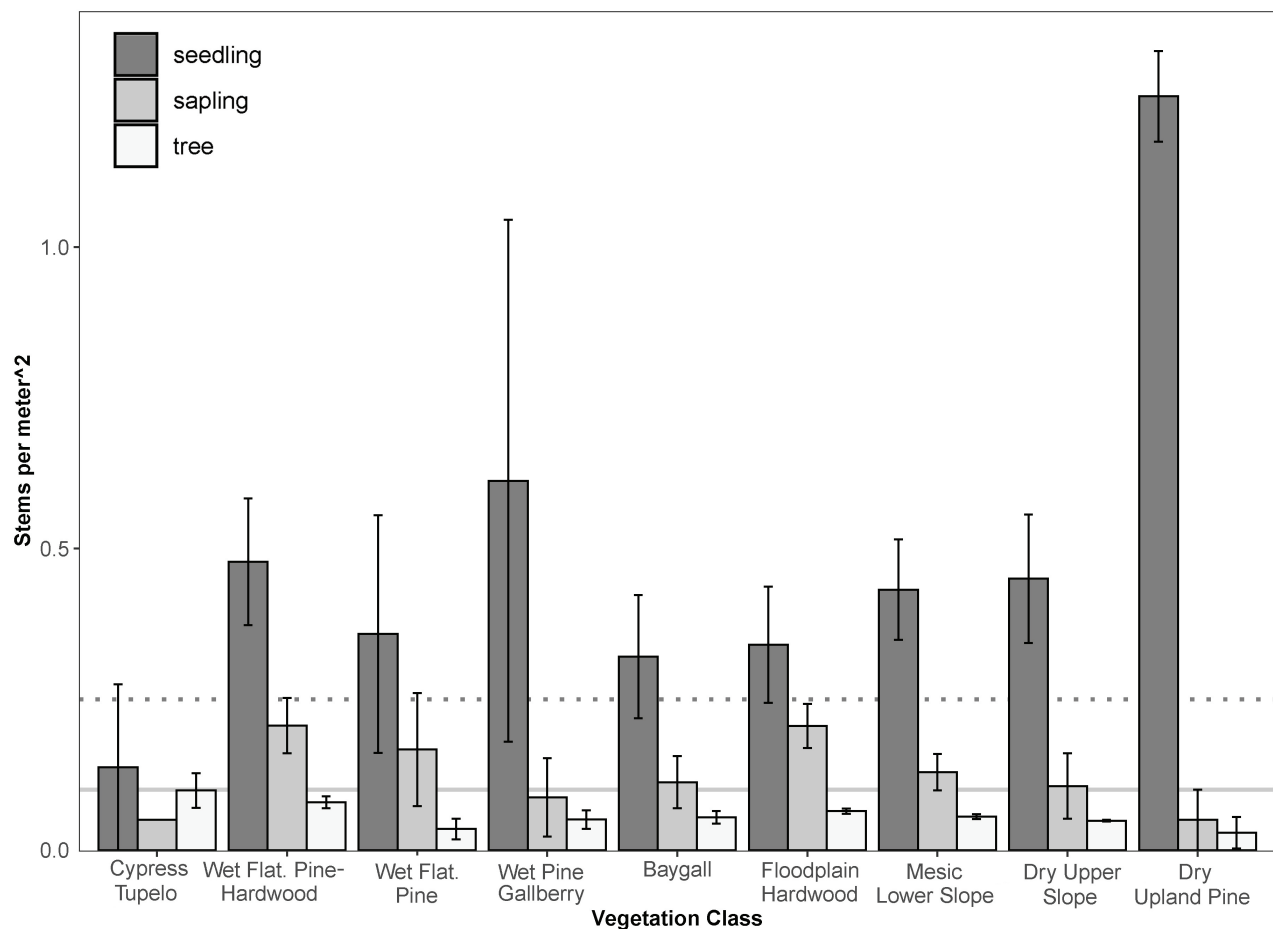


Figure 10. Stem density by tree age class for the nine broad vegetation classes at Big Thicket National Preserve. Plot-level data were collected at the full 400-m² for trees and in four 10-m² microplots for seedlings and saplings. Recent germinants are not included. Bars are averages $\pm$ 1 standard deviation. The dotted horizontal line is the critical threshold for seedling regeneration debt, and the solid grey line is the critical threshold for sapling regeneration debt, based on Miller et al. (2023).

likely due to laurel wilt, a disease caused by a fungal pathogen and transmitted by the invasive redbay ambrosia beetle. This disease was first detected in Hardin County and Jasper counties in 2015 and was already a known problem in much of the southeastern region (Olatinwo et al. 2021).

Regeneration of longleaf pine was of particular interest to park resource management, because of their focus on restoring these communities within the Preserve. To supplement presumed natural regeneration in stands with frequent fire, the Preserve has been conducting restoration plantings for over a decade within focal areas of Big Sandy and Turkey Creek. In the I&M sample, these supplemental plantings may have been the main source of juvenile longleaf individuals. Across the 56 primary plots, all of which were outside of restoration planting areas, there was only one juvenile longleaf pine recorded: a sapling in TC07. The four targeted, non-random plots increased the total by 12, but eight of these juveniles were within restoration planting areas. Plot BS13B was in an area planted in 2021, and TC14B was in an area planted in 2019 and early 2022. The detection of live longleaf seedlings in restoration areas provided evidence of successful establishment, and their continued growth and survival will be tracked over time.

Regeneration Metric Comparisons with Other Studies

Seedling and sapling densities at Big Thicket can be put into a broader context using metrics from a forest health study in National Park units in the eastern U.S. (Miller et al. 2023). The focus was on forest regeneration debt, i.e., insufficient juvenile trees in the understory to replace existing canopy trees. The authors considered regeneration to be critically low when sapling densities were <0.1 per m^2 or seedling densities were <0.25 per m^2 . Above the critical threshold was 'caution', which was set at <0.159 saplings per m^2 or <1.99 seedlings per m^2 . Seedling or sapling densities above the caution thresholds were considered acceptable. Recognizing that values were not scaled for southeastern forests, all vegetation classes in Big Thicket were above the critical thresholds except for Cypress Tupelo Swamp and two classes that were not technically forests (Figure 10). Three vegetation classes had sufficient densities to reach the acceptable level: Floodplain Hardwood, Wet Flatwood Pine-Hardwood, and unexpectedly for its class, Wet Flatwood Pine. This suggests that although some classes are slightly low for juvenile tree densities, nearly all sampled forest types were above the critical mark.

Although the low juvenile tree counts in Cypress-Tupelo Swamp provided evidence for critical levels of regeneration debt there, two caveats should be considered. First, with only two plots sampled in that class, patterns cannot be interpreted as widely representative. Second, seedling establishment in Cypress-Tupelo Swamps differs from most forest classes, in that it typically requires dry-down periods caused by prolonged drought (Visser and Sasser 1995). As such, baseline regeneration in these swamps may be low with episodic pulses. Indeed, no saplings were recorded in any of the Cypress-Tupelo Swamp plots in Barataria Preserve, although these areas were also impounded by levees (Carlson 2022). In Congaree National Park, which has less-disrupted hydrology, three of four Cypress-Tupelo Swamp plots in had sapling densities from 0.01-0.05 per m^2 , which was much lower than other sampled communities in the park and on par with the Big Thicket plots in that class. Only one of the four plots in Congaree was above the critical threshold, with an estimated 0.29 saplings per m^2 (Boyle 2022).

In the eastern temperate forests studied by Miller et al. (2023), critical regeneration shortfalls were often associated with an overabundance of white-tailed deer. In Big Thicket, deer do not appear to have major impacts on juvenile trees, but other threats exist. For example, feral hogs are abundant in the Preserve, and they may adversely impact regeneration by consuming seeds, roots, seedlings, and saplings, including of longleaf pine (Fern et al. 2020). Of all 56 primary plots, 30% had some groundcover disturbance attributed to feral hogs. The unit with the highest frequency of disturbance was Big Sandy (75% of primary plots) followed by Lance Rosier (42%), Turkey Creek (17%), and then Beech Creek (10%). See Table B1 for estimated feral hog impacts per plot.

Conclusions

This is first I&M vegetation monitoring report for the Big Thicket National Preserve, and its intent is to provide a wide breadth of findings and data summaries from the 2022 sampling season. Major results and highlights from 2022 are listed in the Summary and Key Findings section, and they are not repeated here. An overarching theme was the large number of unique and distinct vegetation classes sampled within Preserve, many of which were forested wetlands and some of which included globally rare communities. Differences within and among classes must

be viewed in context with the geography and land use histories described in the introduction, as well as with past and future restoration efforts. After at least three rounds of data collection, the first I&M vegetation monitoring trend report will explore cross-plot differences and impacts of restoration in greater depth.

The next vegetation monitoring event in the Preserve is scheduled for summer 2026, and subsequent events will continue once every four years. As data accumulate for each of the 56 primary and 4 targeted monitoring plots, it will be possible to determine the ways in which plot community composition and structure are changing over time and potentially identify key drivers in these processes.

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Literature Cited

- Ajilvsgi, G. 1979. Wild flowers of the Big Thicket, East Texas, and western Louisiana. Texas A&M Univ. Press, College Station.
- Boyle, M. F. 2023. Terrestrial vegetation monitoring at Congaree National Park: 2021 data summary. Natural Resource Data Series NPS/SECN/NRDS—2023/1396. National Park Service, Fort Collins, Colorado.
- Boyle, M. F., M. B. Gregory, M. W. Byrne, P. Capece, and S. Corbett. 2019. Terrestrial vegetation monitoring in Southeast Coast Network parks: Protocol implementation plan. Natural Resource Report NPS/SECN/NRR—2019/1930. National Park Service, Fort Collins, Colorado.
- Bridges, E.L., and S.L. Orwell 1989. Longleaf pine communities of the West Gulf Coastal Plain. *Natural Areas Journal* Vol. 9, No. 4, pp. 246-26
- Brockway, D.G., K. W. Outcalt, D. J. Tomczak, and E. E. Johnson. 2005. Restoration of longleaf pine ecosystems. United States Forest Service. Southern Research Station, Asheville, NC. www.fs.usda.gov/research/treesearch/20672
- Brown, L. E., B.R. MacRoberts, M.H. MacRoberts, P.A. Harcombe, W.W. Pruess, I.S. Elsik, and D. Johnson. 2005. Annotated checklist of the vascular flora of the Turkey Creek Unit of the Big Thicket National Preserve, Tyler and Hardin counties, Texas. SIDA:1807-11827.
- Carlson, J.E., 2022. Vegetation Monitoring at Barataria Preserve, Louisiana: 2021 Report. Gulf Coast I&M Network, National Park Service, Lafayette, Louisiana. [//irma.nps.gov/DataStore/Reference/Profile/2293834](https://irma.nps.gov/DataStore/Reference/Profile/2293834)
- Carlson, J.E., J. Bracewell, W. Granger, and M. Segura. 2018. Monitoring vegetation in Gulf Coast Network parks: Protocol implementation plan. Natural Resource Report NPS/GULN/NRR—2018/1746. National Park Service, Fort Collins, Colorado.
- Conner, R.N., D. Saenz, and D.C. Rudolph. 2006. Population trends of red-cockaded woodpeckers in Texas. *Bull. Texas. Ornith. Soc.* 39 (2):42-48.
- Chavarria, P. M., R. R. Lopez, G. Bowser, and N. J. Silvy. 2007. A landscape-level survey of feral hog impacts to natural resources of the Big Thicket National Preserve. *Human-Wildlife Conflicts* 1(2): 199-204.
- Diggs, G. M., B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon. 2006. Illustrated flora of East Texas, Volume 1. Botanical Research Institute of Texas (BRIT) Press. Fort Worth, Texas.
- Drewa, P.B., W.J. Platt, and E.B. Moser. 2002. Fire effects on resprouting of shrubs in headwaters of southeastern longleaf pine savannas. *Ecology*. 83:755-767.
- Fern, M.P., J. B Armstrong, R.J. Barlow, and J.S. Kush. 2020. Ecological factors influencing wild pig damage to planted pine and hardwood seedlings. *Human-Wildlife Interactions* 14: 228-238.
- Glitzenstein, J.S., P.A. Harcombe, and D.R. Streng. 1986. Disturbance, succession, and maintenance of species diversity in an East Texas forest. *Ecological Monographs* 56: 243-258.
- Glitzenstein, J.S., and P.A. Harcombe. 1988. The effects of the December 1983 tornado on forest vegetation of the Big Thicket, southeast Texas, U.S.A. *Forest Ecology and Management* 25: 269-290.
- Harrington, T.B. 2011. Overstory and understory relationships in longleaf pine plantations 14 years after thinning and woody control. *Canadian Journal of Forest Research*. 41: 2301-2314.
- Harcombe, P.A., 2007. A vascular plant survey for Big Thicket National Preserve. Unpublished report: U.S. Park Service, Santa Fe, New Mexico. <https://irma.nps.gov/DataStore/Reference/Profile/64952>

- Harcombe, P.A., C.J. Bill, M. Fulton, J.S. Glitzenstien, P.L. Marks and I.S. Elisk. 2002. Stand dynamics over 18 years in a southern mixed hardwood forest, Texas, USA. *Journal of Ecology* 90: 947-957.
- Harcombe, P.A., J.S. Glitzenstien, R.G. Knox, S.L. Orzell, and E.L. Bridges. 1993. Vegetation of the longleaf pine region of the West Gulf Coastal Plain. *Proc. Ann. Tall Timbers Fire Ecol. Conf.* 18:83-103.
- Harcombe, P.A., and P.L. Marks. 1979. Forest vegetation of the Big Thicket National Preserve. Unpublished report: U.S. Park Service, Santa Fe, New Mexico.
- Jose, S., E.J. Jokela and D. L. Miller (eds). 2006. The longleaf pine ecosystem: ecology, silviculture and restoration. Springer series on environmental management. Springer, NY.
- Ley, M., T. Baldvins, H. Pilkington, D. Jones and K. Anderson. 2024. Vegetation classification and mapping project: Big Thicket National Preserve. Natural Resource Report NPS/BITH/NRR—2024/2621. National Park Service, Fort Collins, Colorado.
- Louisiana Natural Heritage Program. 2009. The natural communities of Louisiana. Louisiana Dept. Wildlife & Fisheries, Baton Rouge, Louisiana.
- Liu, C.X., P. A. Harcombe, and R.G. Knox. 1997. Effects of prescribed fire on the composition of woody plant communities in southeastern Texas. *Journal of Vegetation Science* 8(4):495-504
- MacRoberts, B.R., and M.H. MacRoberts. 1998. Floristics of wetland pine savannas in the Big Thicket National Preserve, southeastern Texas. *Phytologia* 85: 40-50.
- MacRoberts, M. H., and B.R. MacRoberts. 2007. Phytogeography of the Big Thicket, east Texas. *Journal of the Botanical Research Institute of Texas*, 1149-1155. <https://www.jstor.org/stable/41971544>
- MacRoberts, M. H., and B.R. MacRoberts 2008. The Big Thicket of Texas as floristically unique habitat. *Journal of the Botanical Research Institute of Texas* 2: 665-671.
- Marks, P.L. and P.A. Harcombe. 1981. Forest vegetation of the Big Thicket, southeast Texas. *Ecological Monographs* 51:287-305.
- Miller, K.M., S.J. Perles, J. Schmit, E.R. Matthews, A.S. Weed, J.A. Comiskey, M.R. Marshall, P. Nelson, and N.A. Fisichelli. 2023. Overabundant deer and invasive plants drive widespread regeneration debt in eastern United States national parks. *Ecological Applications*. eap.2837:1-24
- Noss, R.F., W.J. Platt, B.A. Sorrie, A.S. Weakley, D.B. Means, J. Costanza, and R.K. Peet. 2015. How global biodiversity hotspots may go unrecognized: lessons from the North American Coastal Plain. *Diversity and Distributions*: 21: 236-244.
- Olatinwo, R.O., S.W. Fraedrich, A.E. Mayfield 2021. Laurel wilt: current and potential impacts and possibilities for prevention and management. *Forests* 12(2): 181.
- Omernik, J.M., and G.E. Griffith. 2014. Ecoregions of the conterminous United States: evolution of a hierarchical spatial framework. *Environmental Management* 54(6):1249-1266
- Platt, W.J., S.M. Carr, M. Reilly, J. Fahr. 2006. Pine savanna overstorey influences on ground-cover biodiversity. *Appl. Veg. Sci.* 9:37-50.
- Smith, L. M. 1996. The rare and sensitive natural wetland plant communities of interior Louisiana. Louisiana Natural Heritage Program, Baton Rouge, Louisiana.
- Streng, D.R., and P.A. Harcombe. 1982. Why don't East Texas savannas grow up to forest? *The American Midland Naturalist* 108: 278-294.
- Texas Parks and Wildlife Department. 2012. Texas Conservation Action Plan 2012 – 2016: Western Gulf Coastal Plain Handbook. Editor, W. Connally, Texas Conservation Action Plan Coordinator. Austin, Texas. https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/sgcn.phtml
- Thornberry-Ehrlich, T.L. 2018. Big Thicket National Preserve: Geologic resources inventory report. Natural Resource Report. NPS/NRSS/GRD/NRR—2018/1779. National Park Service. Fort Collins, Colorado.
- Tierney, G., B. Mitchell, K. Miller, J. Comiskey, A. Kozlowski, and D. Faber-Langendoen. 2016. Northeast Temperate Network Long-Term Forest Monitoring Protocol: 2016 revision. Natural Resource Report NPS/NETN/NRR—2016/1184. National Park Service, Fort Collins, Colorado.
- Visser, J.M., and C.E. Sasser. Changes in tree species composition, structure and growth in a bald cypress-water tupelo swamp forest, 1980-1990. *Forest Ecology and Management* 72: 119-129.
- Watson, G.E. 2006. Big Thicket plant ecology: an introduction, third edition. University of North Texas Press, Denton, Texas.
- Wiedenfeld, J. 2006. Soil Survey of Hardin County, Texas. U.S. Department of Agriculture, Natural Resources Conservation Service. 346 pp.

Appendix A: Maps of Elevation and Geologic Formations

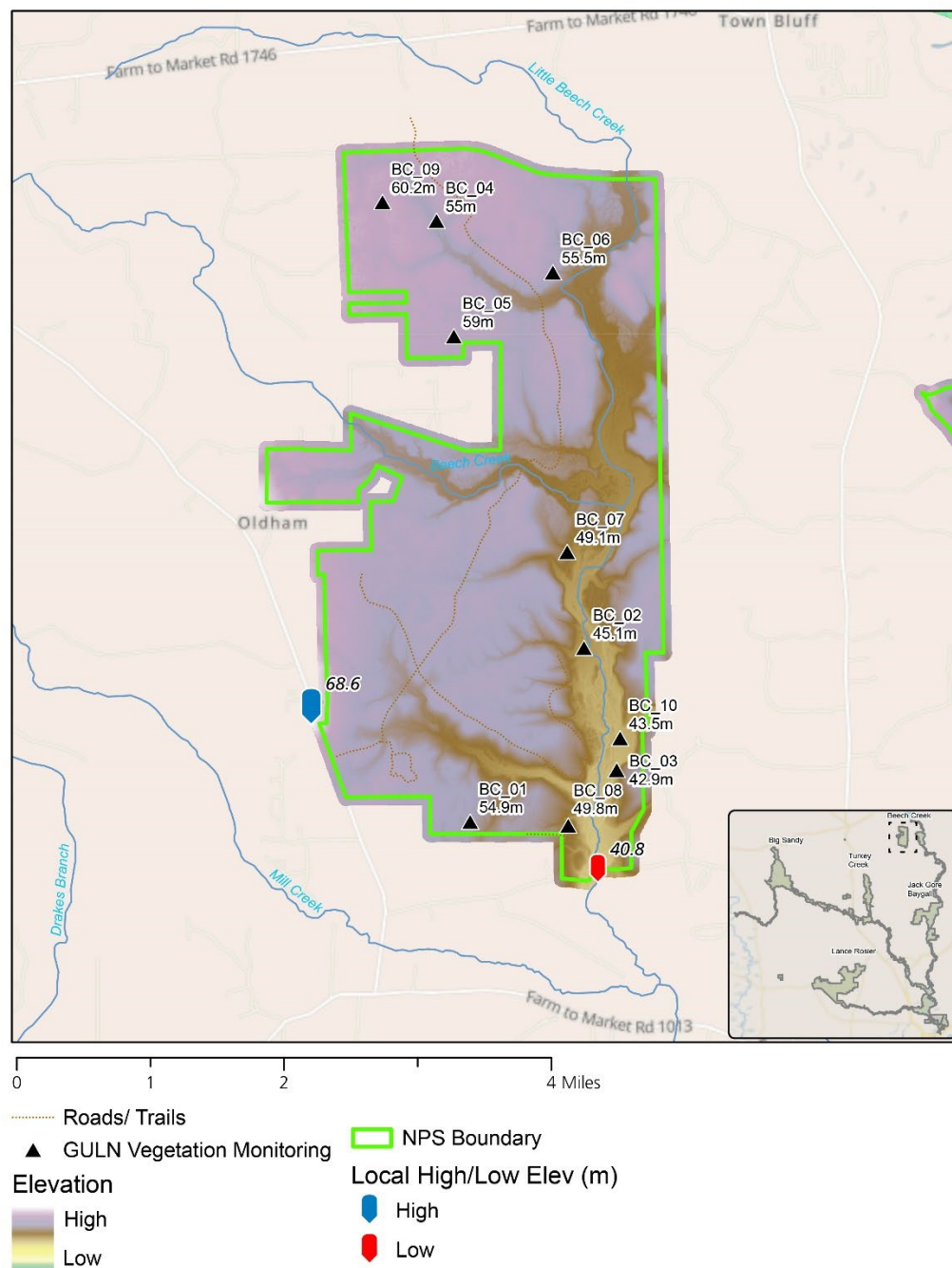


Figure A1. Beech Creek digital elevation model from the 2017 lidar. Plot elevations are included with the plot ID label. The local maximum and minimum elevation within the map extent are indicated with blue and red markers.

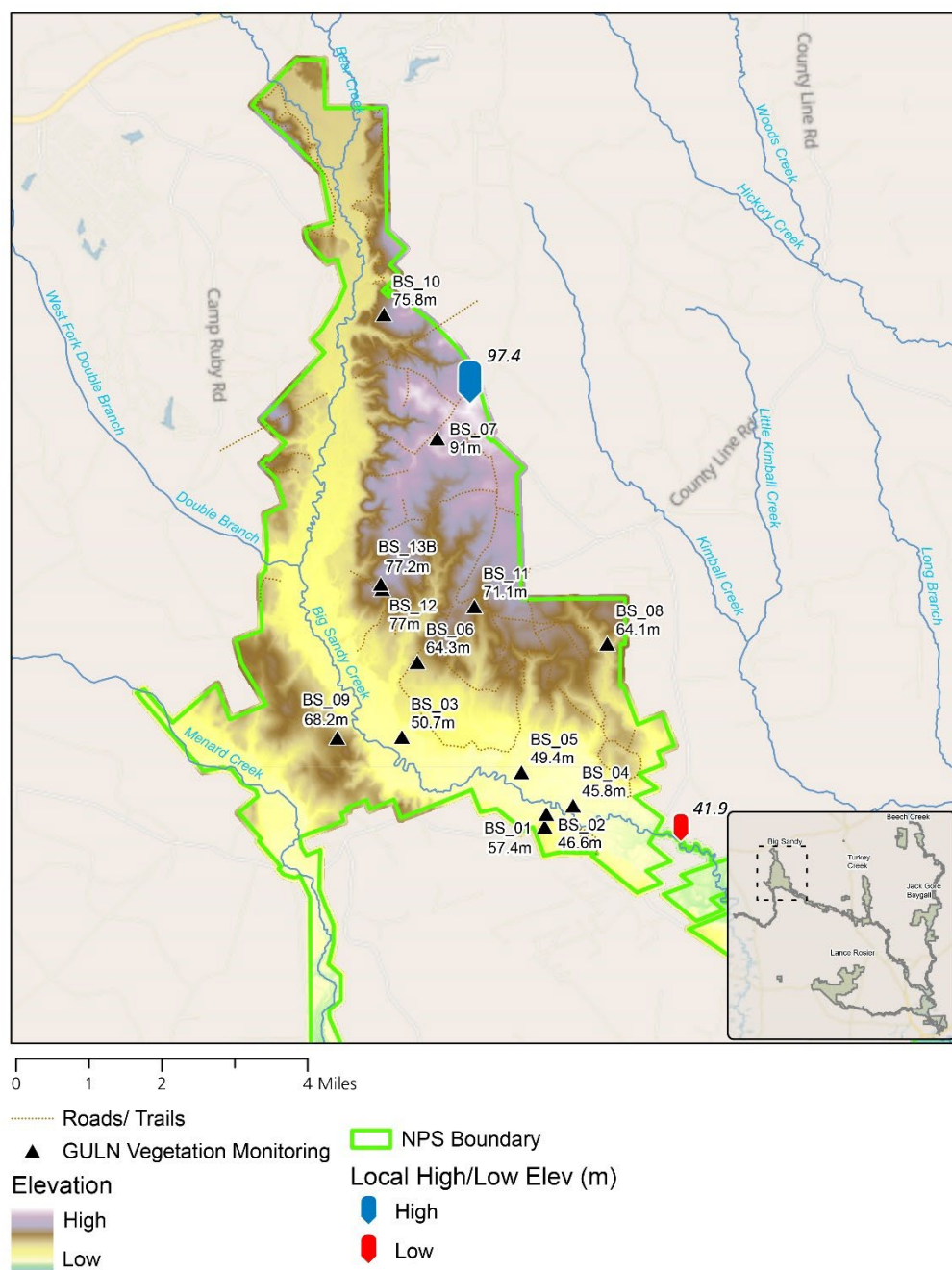


Figure A2. Big Sandy digital elevation model from the 2017 lidar. Plot elevations are included with the plot ID label. The local maximum and minimum elevation within the map extent are indicated with blue and red markers.

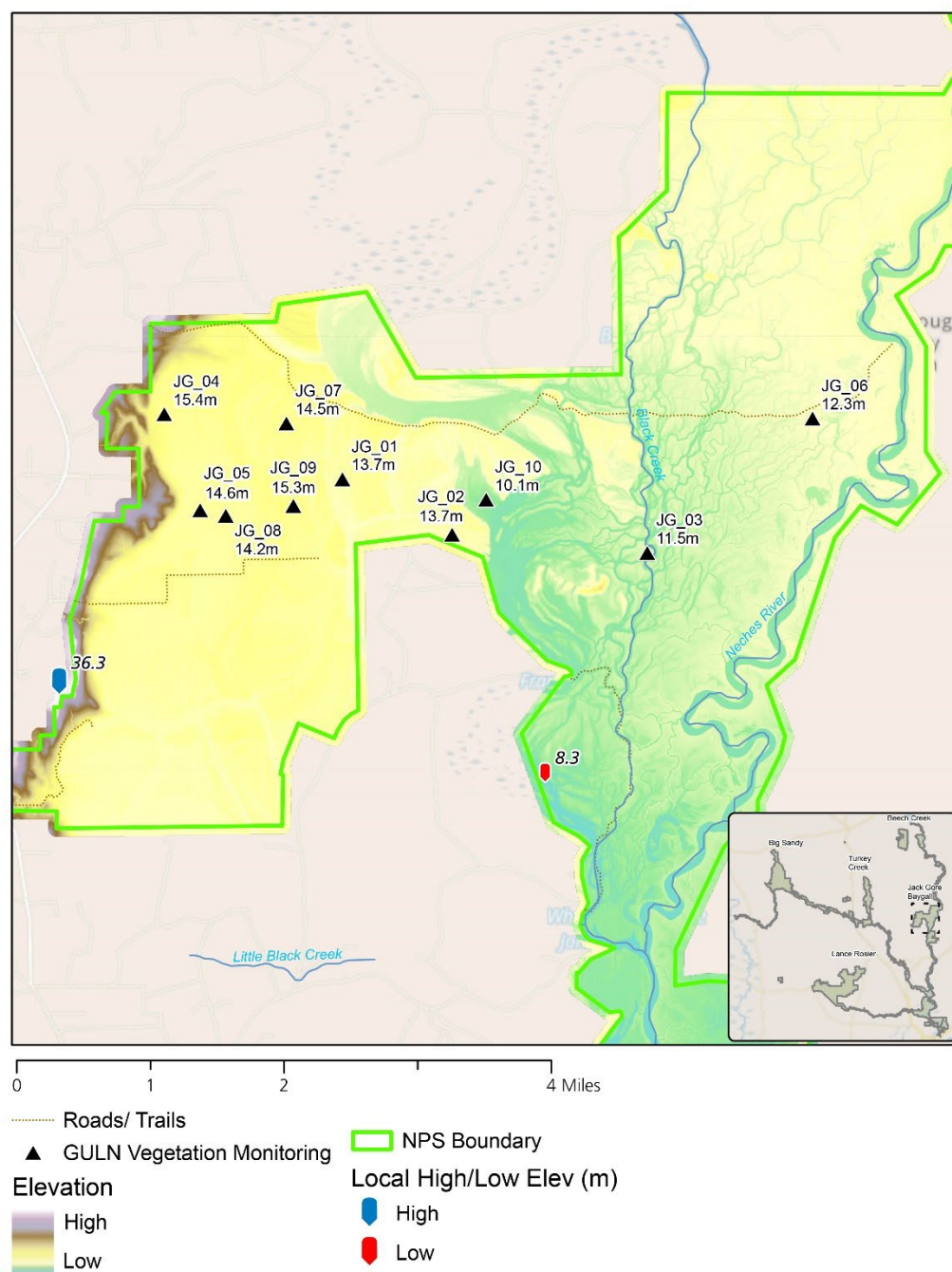


Figure A3. Jack Gore Baygall digital elevation model from the 2017 lidar. Plot elevations are included with the plot ID label. The local maximum and minimum elevation within the map extent are indicated with blue and red markers.

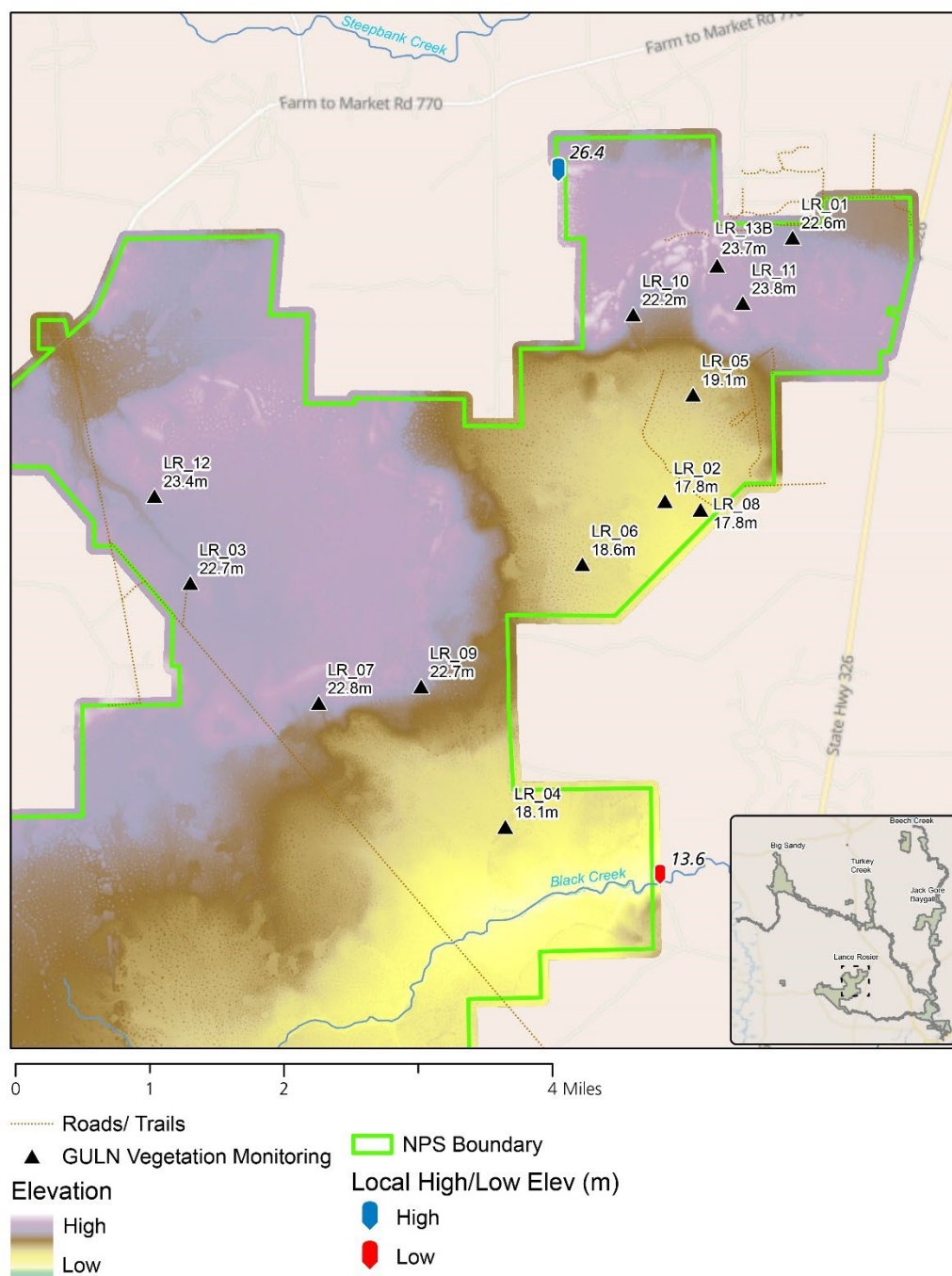


Figure A4. Lance Rosier digital elevation model from the 2017 lidar. Plot elevations are included with the plot ID label. The local maximum and minimum elevation within the map extent are indicated with blue and red markers. The actual minimum elevation for Lance Rosier unit (12 m a.s.l.) is outside the current map extent, where Little Pine Island Bayou leaves the unit near its southernmost point.

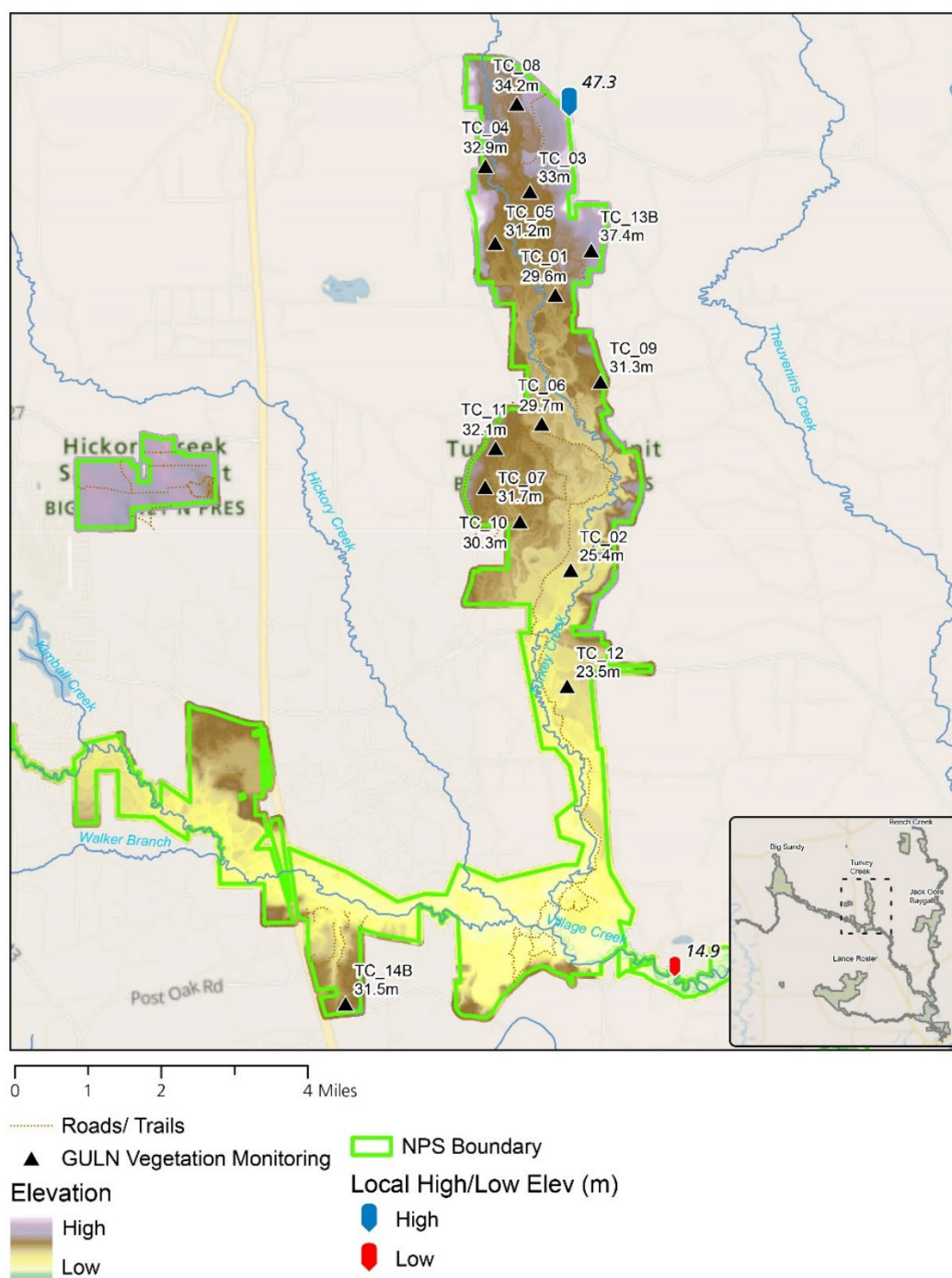


Figure A5. Turkey Creek digital elevation model from the 2017 lidar. Plot elevations are included with the plot ID label. The local maximum and minimum elevation within the map extent are indicated with blue and red markers.

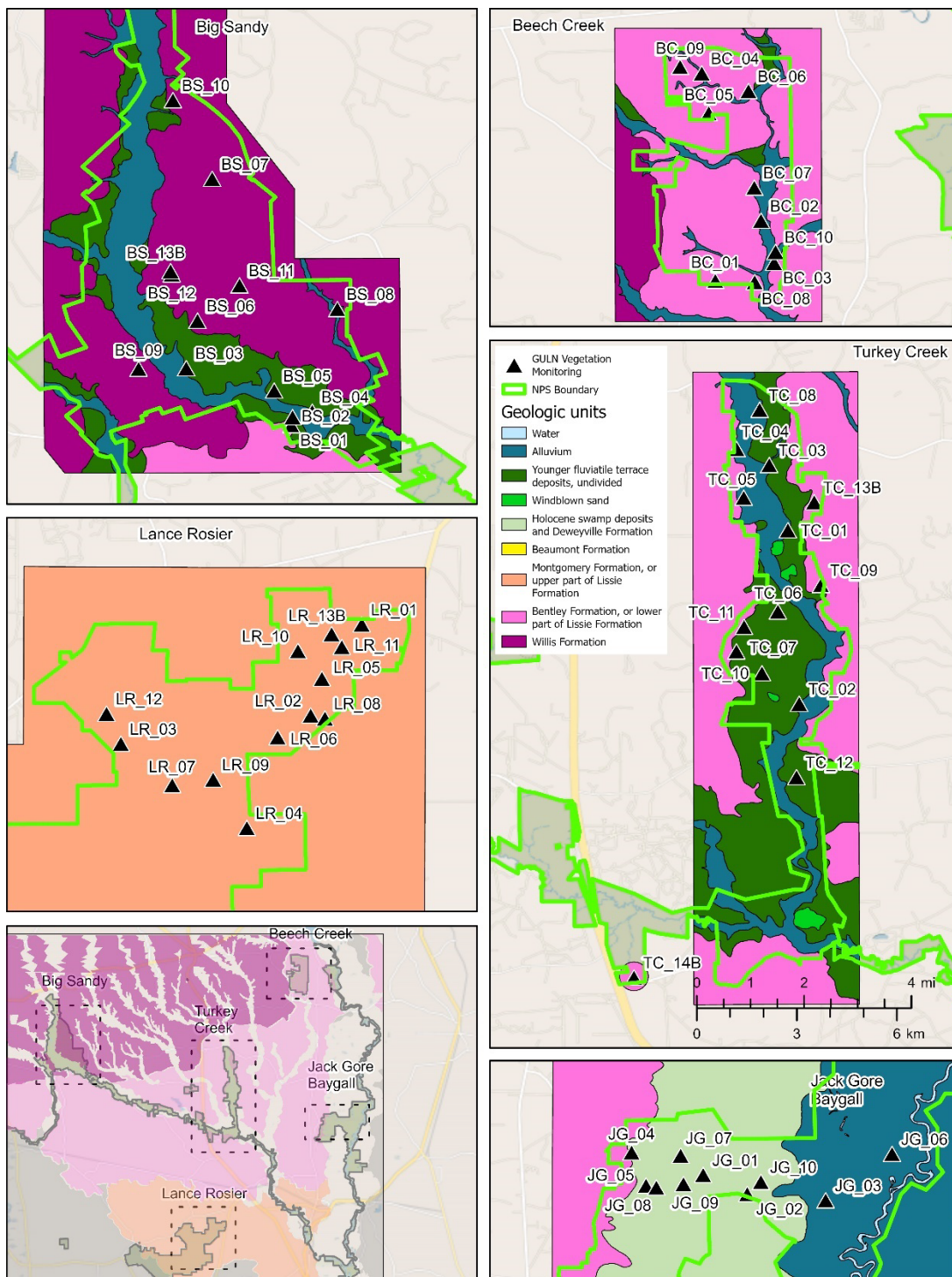


Figure A6. The Geologic Formations of each of the five focal units at Big Thicket, from 'Big Thicket National Preserve: Geologic resources inventory report' by Thornberry-Ehrlich, 2018. The inset to the bottom left includes just four of the Formations: purple for Willis, pink for Bentley/Lower Lissie, orange for Montgomery/Upper Lissie, and grey for Beaumont.

Appendix B: Land Use History and Table of Plot Characteristics

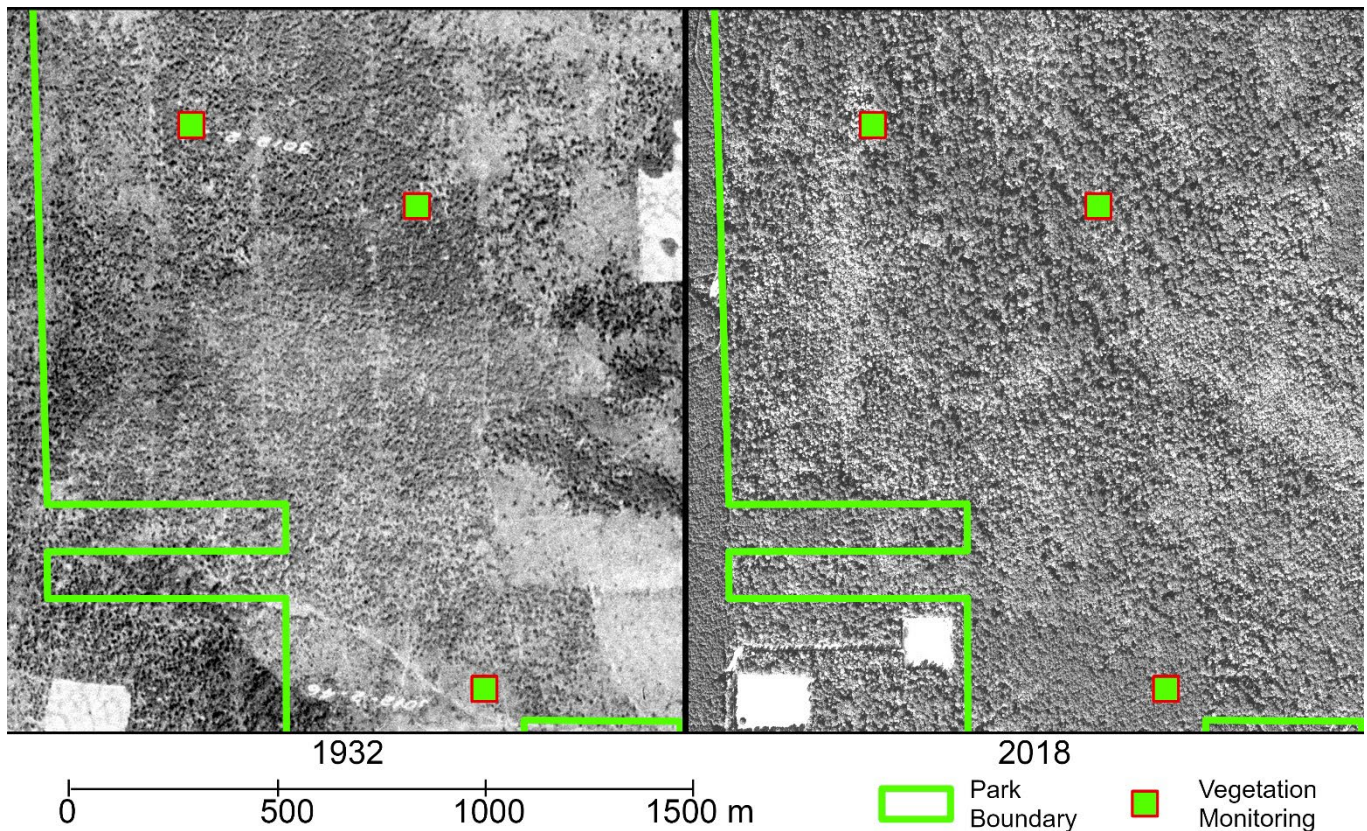


Figure B1. Aerial imagery of the northwest corner of the Beech Creek Unit in 1932 (left) and 2018 (right). Three of the I&M plots sampled in 2022 are shown (left to right, BC09, BC04, and BC05). Vertical logging roads through a pine plantation are visible in 1932, whereas in 2018, the forest appears more mixed, and past roads are no longer visible. Of the three plots, the southernmost appeared to have been more recently replanted in pine, and it still had many larger pine trees in the plot in 2022 (see Table B1 for details).

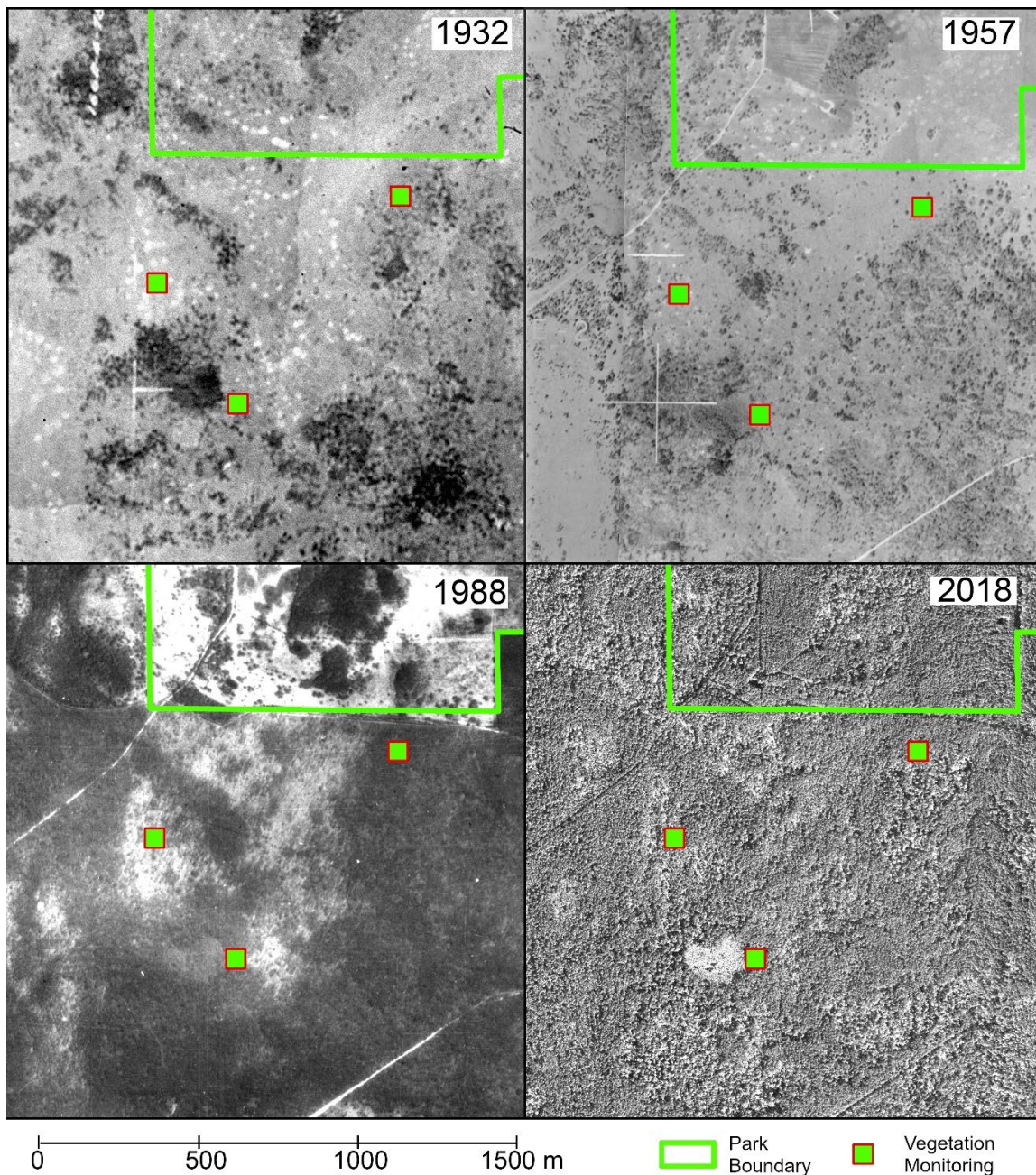


Figure B2. Aerial imagery of northeastern Lance Rosier unit in 1932 (top left), 1957 (top right), 1988 (bottom left), and 2018 (bottom right). Three of the I&M plots sampled in 2022 are shown (left to right, LR13B, LR11, and LR01). The area appeared to have been logged in 1932 and 1957, but throughout the time sequence, there are clear patches of wet pine savanna, falling in the broad vegetation class of Wet Flatwood Pine with Savanna Elements. These areas are visible as sparse canopy (especially in 1988) and exposed sandy surfaces of mima mounds (white spots in cleared areas, especially in 1932).

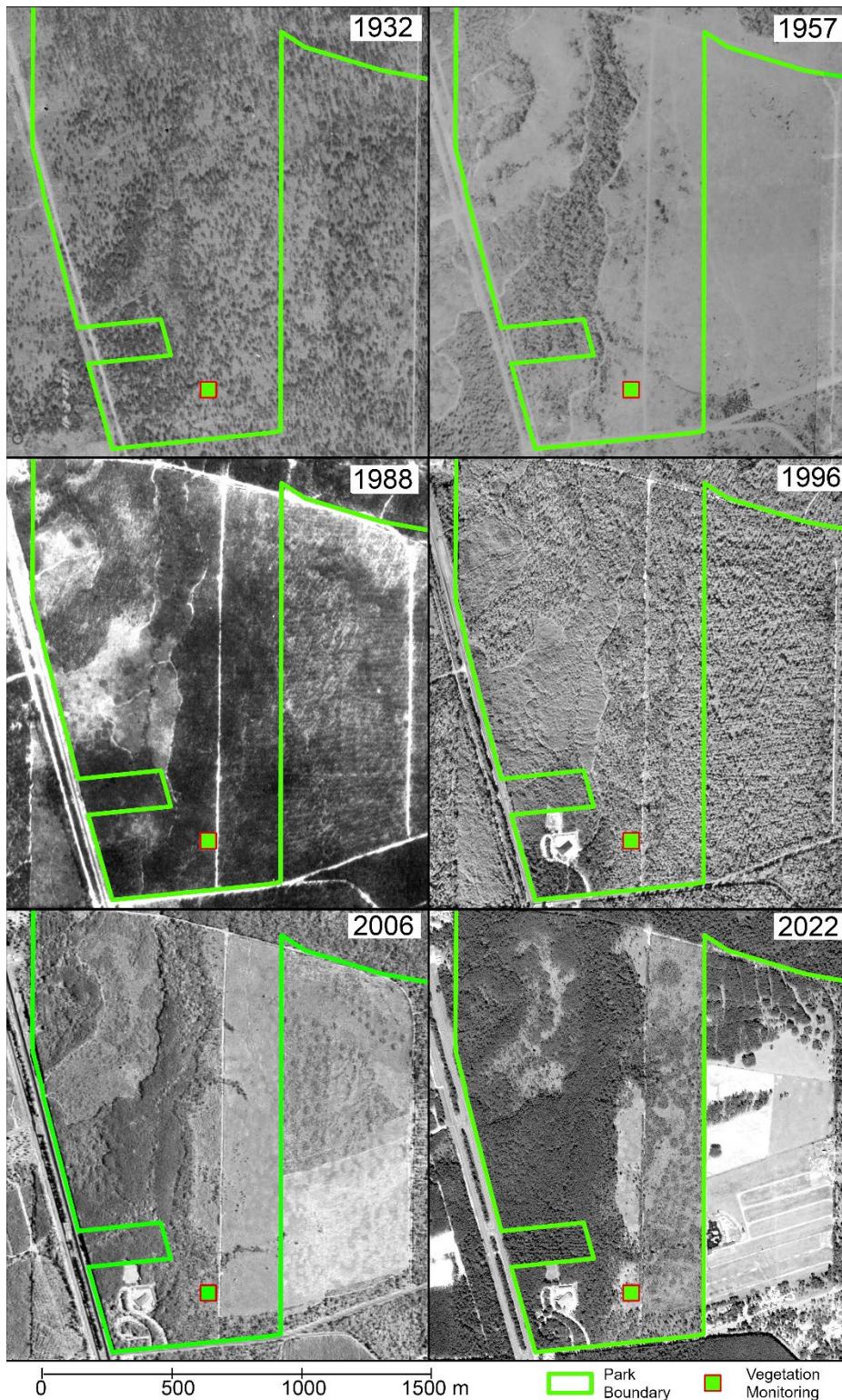


Figure B3. Aerial imagery of southern Solo Tract (and plot TC14B) in 1932 (top left), 1957 (top right), 1988 (mid left), 1996 (mid right), 2006 (bottom left) and 2022 (bottom right). This area was conveyed to the park in 2005, and the area has seen dramatic change from apparently undisturbed, to cleared, to plantation, to cleared again in 2006. The first prescribed burn occurred in 2022.

Table B1. Broad vegetation classes, ecological site descriptions (<https://edit.jornada.nmsu.edu>) and disturbance history of the Gulf Coast I&M Network's 60 long-term vegetation monitoring plots in Big Thicket National Preserve. An asterisk (*) marks the Plot ID each of the four targeted plots. For Vegetation Class, Flat. = Flatwood; other classes are shortened versions of full names in Table 3. Fire History includes any prescribed fires or wildfires between January 2006-May 2021, based on an ArcGIS online feature service published by the NPS fire program, as well as additional fire reporting from the Preserve's 2004 Fire Management Plan. The Big Thicket Fire Management team began prescribed burning in 1982. Disturbance History includes information recorded on-site as well as identified remotely using Lidar DEM and aerial imagery. Dates for imagery used included Oct. 1932, Oct. 1957, May 1988/Oct1990; 1996; 2006; 2015 and 2022. Even for plots with no available evidence of past disturbance, all areas were likely clear-cut or selectively logged for one or two cycles prior to NPS acquisition. Disturbance by feral hogs was also recorded in each plot as the estimated percent of the plot's ground surface that was damaged. Values between 0.1 and 9% were recorded as <10%.

Plot ID, Vegetation Class	Ecological Site Description from NRCS, as Defined by Soil Type	Fire History	Disturbance or Restoration History	Feral Hog Damage Detected
BC_01, Mesic Lower Slope	Well Drained Loamy Upland	-	30 m from a historic road. Site appeared flat and historically disturbed. Evidence of logging roads nearby and apparently plantation in 1932; no sign of clearcuts over time but increasingly filled in with mixed forest	-
BC_02, Floodplain Hardwood	Well Drained Bottomland	-	Evidence of logging roads nearby and apparently plantation in 1932; no sign of clearcuts over time but increasingly filled in with mixed forest	-
BC_03, Baygall	Well Drained Bottomland	-	Same as BC_02	-
BC_04, Baygall	Well Drained Bottomland	-	Clearly in a pine plantation in 1932; less plantation-like in 1957, possibly recovering mixed forest	-
BC_05, Mesic Lower Slope	Seasonally Wet Loamy Upland	-	Clearly in a pine plantation in 1932; tall loblolly pine; still apparently pine plantation in 1957; still predominately pine in 2008 to present	-
BC_06, Mesic Lower Slope	Loamy Upland	-	Plot is 40 m outside a clearing in 1932; no apparent impacts to the plot through to present	<10%
BC_07, Mesic Lower Slope	Well Drained Loamy Upland	-	Same as BC_02	-
BC_08, Mesic Lower Slope	Well Drained Loamy Upland	-	Same as BC_02	-
BC_09, Wet Flat. Pine-Hardwood	Depressional	-	Clearly in a pine plantation in 1932; less plantation-like in 1957, possibly recovering mixed forest	-
BC_10, Floodplain Hardwood	Well Drained Bottomland	-	Same as BC_02	-
BS_01, Mesic Lower Slope	Well Drained Loamy Upland	-	-	-
BS_02, Floodplain Hardwood	Well Drained Bottomland	-	Possible partial logging evident in 1932; no additional signs of logging in 1957 onward	<10%
BS_03, Floodplain Hardwood	Well Drained Bottomland	-	-	<10%
BS_04, Floodplain Hardwood	Well Drained Bottomland	-	-	-
BS_05, Mesic Lower Slope	Southern Sandy Loam Upland	-	Plot is on the forested edge of an apparent logging clearing in 1932; no sign of logging from 1957 onward.	-

Plot ID, Vegetation Class	Ecological Site Description from NRCS, as Defined by Soil Type	Fire History	Disturbance or Restoration History	Feral Hog Damage Detected
BS_06, Mesic Lower Slope	Southern Sandy Loam Upland	No treatment history or evidence of past fires, but plot is 60 m from burn unit that was last burned in 2021	Evidence of clearing in 1932; no signs of additional logging in 1957 onward.	<10%
BS_07, Dry Upper Slope	Southern Sandy Loam Upland	Burned 2004, 2008, and March 2021. In earlier years, there were 4 controlled burns between 1983 and 2004. The 2021 fire did not burn very well. Burns scars evident but plot is currently overgrown.	Evidence of past logging, possibly selective logging, in 1932; relatively unchanged in the 1957; canopy fills in but remains fairly sparse through to present day	<10%
BS_08, Dry Upper Slope	Southern Sandy Loam Upland	Burned unit in 2009 and March 2021, but no evidence of fire in plot	No evidence of thinning in the 1932; appears thinned in the 1957	<10%
BS_09, Mesic Lower Slope	Southern Sandy Loam Upland	Burned unit in 2009 and March 2021, but no evidence of fire in plot	Plot is on the forested edge of an apparent logging road in the 1932; no sign of logging in 1957 onward.	>25%
BS_10, Mesic Lower Slope	Southern Sandy Loam Upland	Burned 2007, 2012, 2014 and Feb. 2021. In earlier years, there were 6 controlled burns between 1983 and 2004. Evidence of 2021 burn on fiberglass stakes.	Just south of a clearcut in 1932; in 1957, the clearing extended to the south as partial thinning in the plot; fully regrown in 1996. Plot appears fairly flat	<10%
BS_11, Dry Upper Slope	Southern Sandy Loam Upland	Burned unit in 2009 and March 2021, but no evidence of fire in plot	Evidence of thinned trees in 1932; no additional logging evidence	<10%
BS_12, Dry Upper Slope	Southern Sandy Loam Upland	Burned 2004, 2008, and March 2021. In earlier years, there were 4 controlled burns between 1983 and 2004. Many dead tops of yaupon from 2021 fire, but many are re-sprouting from the base and are ~ 1 m tall.	Evidence of partial clearing in 1932; no apparent clearcuts in 1957; currently adjacent to a longleaf restoration area containing plot BS_13B	-
BS_13B*, Dry Upland Pine	Southern Sandy Loam Upland	Burned 2004, 2008, Oct 2020 and March 2021. In earlier years, there were 4 controlled burns between 1983 and 2004. The recent fires killed many (50-60%) of the existing adult longleaf pines in the restoration clearing.	Evidence of clearing in 1932; no apparent clearcuts in 1957; 1988/90 imagery shows the area as a pine plantation; site of a pine beetle kill in the 1990s; the canopy cover remained relatively sparse up through August 2020, when additional trees were cut and woody plants were mechanically cleared; planted with longleaf seedlings in 2021	-
JG_01, Mesic Lower Slope	Terrace 60% depressional 40%	-	-	-
JG_02, Floodplain Hardwood	Terrace 60% depressional 40%	-	-	-
JG_03, Floodplain Hardwood	Poorly Drained Clayey Bottomland	-	-	-
JG_04, Baygall	Terrace	-	Barbed wire through one tree in plot	-
JG_05, Floodplain Hardwood	Terrace 60% depressional 40%	-	-	-
JG_06, Floodplain Hardwood	Poorly Drained Clayey Bottomland	-	-	-
JG_07, Wet Flat. Pine-Hardwood	Terrace 60% depressional 40%	-	-	-
JG_08, Baygall	Swamp	-	-	-
JG_09, Mesic Lower Slope	Terrace	-	-	-
JG_10, Cypress Tupelo	Swamp	-	-	-
LR_01, Mesic Lower Slope	Poorly Drained Loamy Upland	Prescribed fire in 1986. In the area south of Little Rock Road, additional fires have	Cleared pre-1937; likely again before 1957; no additional clearing apparent. Some pine plantations	-

Plot ID, Vegetation Class	Ecological Site Description from NRCS, as Defined by Soil Type	Fire History	Disturbance or Restoration History	Feral Hog Damage Detected
		been applied: three times between 1983 and 2004, as well as in Dec. 2010.	nearby within the unit prior to conveyance, between Little Rock and Fire Tower Roads	
LR_02, Wet Flat. Pine-Hardwood	Poorly Drained Loamy Upland	-	-	<10%
LR_03, Wet Flat. Pine-Hardwood	Depressional	-	-	-
LR_04, Wet Flat. Pine-Hardwood	Poorly Drained Loamy Upland	-	In a historic cleared N-S right of way in 1932 and 1957; In the Lidar, the apparent clearing path is 20 m west of plot center.	<10%
LR_05, Wet Flat. Pine-Hardwood	Sodic Flats	Prescribed fire in 2004; additional fires were applied three times between 1983 and 2004.	Same as LR_01	<10%
LR_06, Wet Flat. Pine-Hardwood	Poorly Drained Loamy Upland	-	-	-
LR_07, Mesic Lower Slope	Poorly Drained Loamy Upland	-	-	-
LR_08, Wet Flat. Pine-Hardwood	Poorly Drained Loamy Upland	-	-	<10%
LR_09, Mesic Lower Slope	Seasonally Wet Loamy Upland	-	-	<10%
LR_10, Wet Flat. Pine Savanna	Poorly Drained Loamy Upland	Same as LR_01	Same as LR_01	-
LR_11, Wet Pine Gallberry	Seasonally Wet Loamy Upland	Same as LR_01	Same as LR_01	-
LR_12, Mesic Lower Slope	Poorly Drained Loamy Upland	-	-	-
LR_13B*, Wet Flat. Pine Savanna	Sodic Flats	Same as LR_01	Same as LR_01	-
TC_01, Cypress Tupelo	Well Drained Bottomland	-	-	25%
TC_02, Baygall	Terrace	-	-	-
TC_03, Floodplain Hardwood	Well Drained Bottomland	Burned unit in 2003, 2010 and 2022, but no evidence of fire in plot. In earlier years, there were 2 controlled burns between 1980 and 2003	Not apparently thinned in 1932; thinned in 1957	<10%
TC_04, Floodplain Hardwood	Well Drained Bottomland	-	Not apparently thinned in 1932; thinned in 1957	-
TC_05, Floodplain Hardwood	Well Drained Bottomland	-	-	-
TC_06, Mesic Lower Slope	Terrace	-	-	-
TC_07, Wet Pine Gallberry	Terrace	Prescribed fire in 2014, 2016 and 2020. Evidence of 2020 burn on fiberglass stakes, but regrown gallberry is 5 - 6 ft tall. In earlier years, there were 2 controlled burns between 1980 and 2003	Most trees apparently cut in 1932; still relatively clear in 1957; Evidence of remnants of a pine plantation in 1996; Fire data says mastication was conducted in 2012 through this area. No apparent impacts to the plot, but about 100m to the east, there was a clearing in the 1930s; recovering in the 1950s; planted in slash pine prior to NPS ownership; the park thinned the pine and started burning in 2003; recent mastication in 2022.	-
TC_08, Floodplain Hardwood	Well Drained Loamy Upland	Burned unit in 2010 and 2022, but no evidence of fire in plot. In earlier years, there were 2 controlled burns between 1980 and 2003		-
TC_09, Wet Pine Gallberry	Well Drained Loamy Upland	In earlier years, there was 1 controlled burn between 1980 and 2003	-	-
TC_10, Mesic Lower Slope	Terrace	-	-	-

Plot ID, Vegetation Class	Ecological Site Description from NRCS, as Defined by Soil Type	Fire History	Disturbance or Restoration History	Feral Hog Damage Detected
TC_11, Wet Pine Gallberry	Terrace	Prescribed fire in 2020, but unlikely to have penetrated the extremely dense gallberry thicket	Most trees apparently cut in 1932; apparently recovered in 1957; Evidence of remnants of a pine plantation in 1996	-
TC_12, Baygall	Terrace	-	-	-
TC_13B*, Dry Upland Pine	Seasonally Wet Loamy Upland	Prescribed fire in 2006, 2010, 2013, 2017, 2020, 2021 and Feb 2022. In earlier years, there were 8-9 controlled burns between 1980 and 2003	Some evidence of partial clearing in the area in the 1932; less so in the 1957; no evidence of additional clearings. No known longleaf plantings, but longleaf regeneration was favored through frequent fires	-
TC_14B*, Wet Flat. Pine Savanna	Poorly Drained Loamy Upland (but more likely Sodic Flats, mapped 70 m away)	Prescribed fire burned through the plot in Feb. 2022.	Appeared intact in 1932 imagery; cleared by 1957; planted in slash or loblolly by 1995; harvested prior to conveyance to park in 2005; mastication in 2006, 2013 and 2018. Planted with longleaf pine in 2019 and spring 2022.	-

Appendix C: Broad Vegetation Class Descriptions

The nine broad vegetation classes used for I&M plots in Big Thicket National Preserve are described below, along with their relationships with the communities of Harcombe and Marks (1979), the U.S. National Vegetation Classification [USNVC] associations of Ley et al. (2024) and other relevant references. Descriptions are organized in the same order as the main text, beginning with community types on the lowest landscape positions with frequent to permanent inundation and ending with those in uplands. For five of the nine classes, descriptions are brief. Additional details for those classes can be found within the cited references or Watson (2006). A more comprehensive review is provided for four classes, due to the presence of rare plants and/or their importance to future or current restoration projects. These classes are 3. Wet Flatwood Pine with Savanna Elements, 4. Wet Pine with Dense Gallberry, 5. Baygall, and 9. Dry Upland Pine Savanna or Woodland.

1. Cypress Tupelo Swamp

The Cypress Tupelo Swamp class has a canopy dominated by bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). Soils are typically mucky silty clay or mucky silt loam (USDA NRCS 2023a). The forest floor is often below water with many emergent cypress knees, and in the Neches floodplain, these swamps are occasionally subject to extreme flood pulses (>3.6 m [12 feet]). In Harcombe and Marks (1979), this class was called Swamp Cypress Tupelo Forest, which aligns with the USNVC association of Southern Coastal Plain Bald-Cypress - Tupelo Swamp Forest (CEGL007422; Ley et al. 2024). This broad vegetation class was represented by only two plots in this study, one in Jack Gore Baygall and the other in Turkey Creek. Other swamp types that were not sampled for this project included communities dominated by swamp tupelo (*Nyssa biflora*, often with water tupelo) in depressions or drainages, in some cases with abundant loblolly pine (*Pinus taeda*).

2. Wet Flatwood Pine Hardwood Forest

The Wet Flatwood Pine-Hardwood Forest class includes several communities that occur on loamy soils with occasional to prolonged inundation, and most notably, they do not occur in floodplains. Instead, these communities occupy broad, mainly flat, low elevation areas away from current major drainages. Mima mounds, also called pimple mounds, are a prominent feature of these communities (Figure C1). Within the park, these occur mainly in Lance Rosier, on both the Montgomery and Beaumont formations (see Figure A6 for a geological map of the Preserve). Elsewhere within the park, Wet Flatwood Pine-Hardwood communities occupy small flat depressions as well. Loblolly pine is a characteristic species of this class, although it sometimes only occurs as seedlings or saplings. When present in the canopy, loblolly trees are associated with slightly higher elevation features such as mima mounds, in an assemblage with southern magnolia (*Magnolia grandiflora*), American holly (*Ilex opaca*) and other mesic lower slope forest species. The wetter areas with sparse to no loblolly in the canopy are instead dominated by laurel oak (*Quercus laurifolia*) and swamp tupelo (e.g., LR02, LR03, and BC09). Sweetgum (*Liquidambar styraciflua*) is often present but not dominant. The understory tends to be open and free of dense shrubs, often with patches of tall sedges (e.g. *Rhynchospora elliotii*). When shrubs are present, they tend to be wax myrtle (*Morella cerifera*), possumhaw (*Viburnum nudum*), or yaupon (*Ilex vomitoria*).

This class did not have a one-to-one match with any previously described communities, but it overlapped with several. In Harcombe and Marks (1979), the most similar communities to this class were their Flatland Hardwood Forest (for sites without loblolly) and their Lower Slope Hardwood Pine Forest (for sites with loblolly). This class also had much in common with Bridges and Orzell's (1989) Upland Depression Swamps of the flat Bentley and Montgomery formations. In Ley et al. (2024), related associations included Upper West Gulf Coastal Plain Laurel Oak Flatwoods Forest (CEGL007961), Upper West Gulf Wet Flatwoods Forest (CEGL007871), and West Gulf Coastal Plain Pine - Oak Nonriverine Flatwoods (CEGL007069). Several of these associations were listed as imperiled (G2) by NatureServe. The eight I&M plots in this

vegetation class included six plots in Lance Rosier, one in Jack Gore Baygall, and one in a forested depression in Beech Creek.

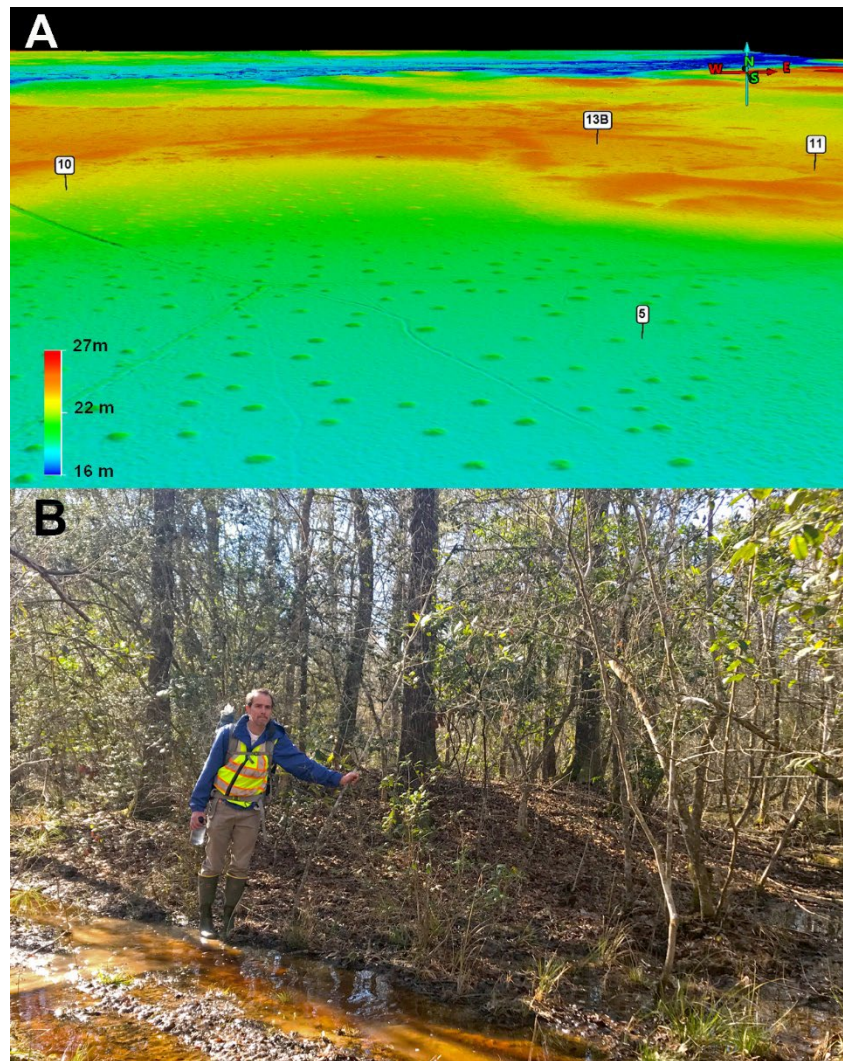


Figure C1. (A) Oblique view of bare earth digital elevation model from 2017 lidar in Lance Rosier unit. Numbers in white boxes are the locations of several LR plots in that unit. The mima mounds are the green-colored half spheres that are especially abundant in the bottom half of the image; (B) Crew member standing next to a mima mound along the UTV path that passes south of plot LR05.

3. Wet Flatwood Pine with Savanna Elements

General Description and Characteristic Species The Wet Flatwood Pine with Savanna Elements class describes a community typified by a sparse overstory of longleaf pine (*Pinus palustris*) or loblolly pine and an open, rich, herbaceous understory. This community occurs on poorly-drained sandy or silty loam surface soils with a highly fluctuating water table. Through a combination of soil characteristics and landscape position, these sites have prolonged periods of inundation coupled with seasonal dry outs (Bridges and Orzell 1989; Smith 1996). The presence sodic soils and/or near-surface clay layers, also called a fragipan, restrict connectivity between surface soil and groundwater, creating waterlogged conditions in the winter and early spring but contrastingly drought-prone soils in the growing season, i.e., late spring, summer and fall. The savanna-like appearance comes from the thick layer of various graminoid and forb species (e.g., Figure C2), which can tolerate these conditions, and an absence of most shrubs and trees, which cannot.



Figure C2. Plant species of the vegetation class Wet Pine Flatwoods with Savanna Elements: (A) Pinehill bluestem, *Schizachyrium scoparium* var. *divergens* (B) Wetland white bluestem, *Andropogon dealbatus*, which was recently split from *Andropogon capillipes* and *A. virginicus* var. *glaucus*. (C) winter-blooming dwarf butterwort, *Pinguicula pumila*; (D) pinewoods rose gentian, *Sabatia gentianoides*; (E) longleaf milkweed, *Asclepias longifolia*; (F) grassleaf Barbara's buttons, *Marshallia graminifolia*; (G) Muehlenberg's nutrush, *Scleria muehlenbergii*; and (H) view into a wet pine savanna with golden colicroot (*Aletris aurea*), saltmarsh umbrellasedge (*Fuirena breviseta*), tenangle pipewort (*Eriocaulon decangulare*), clustered bushmint (*Hyptis alata*), and yelloweyed grass (*Xyris* sp.).

The list of characteristic species is long, including beaksedges (*Rhynchospora* spp.), panicgrasses (*Dichanthelium* spp.), bluestems (*Andropogon* spp.), little bluestem (*Schizachrium scoparium*), arrowfeather threeawn (*Aristida purpurascens*), milkworts (*Polygala* spp.), blazing stars (*Liatris* spp.), meadow-beautys (*Rhexia* spp.), St. Peter's-wort (*Hypericum crux-andreae*), golden colicroot (*Aletris aurea*), longleaf milkweed (*Asclepias longifolia*), smallhead doll's daisy (*Boltonia diffusa*), and grassleaf Barbara's buttons (*Marshallia graminifolia*). The wettest portions are populated by moisture-loving species like pipeworts (*Eriocaulon* sp.), yellow-eyed grasses (*Xyris* sp.), clubmoss (*Lycopodiella appressa*) and sundews (*Drosera* sp.). In the winter, dwarf butterwort plants (*Pinguicula pumila*) also bloom there. Figure C2 includes photos of a small subset of the above species. The wet flatwood pine savanna community in southeast Texas occurs as part of a matrix of mima mounds, flatwoods, and small depressions. Bridges and Orzell (1989) and Harcombe et al. (1993) highlight mima mounds as distinctive features of this western variant of wet flatwood pine savanna, because mima mounds do not occur in eastern wet flatwood pine savannas. Another contrast is that naturally occurring pale pitcher plants (*Sarracenia alata*) are absent from the western variant, but are abundant in wet flatwood pine savannas east of the Mississippi River. Bridges and Orzell (1989) claimed that Hickory Creek Savannah unit and northern Lance Rosier unit were the only known protected examples of western wet flatwood pine savanna at the time, and both had unnatural, introduced pitcher plant populations (see also Watson 2006).

Locations within the Big Thicket In the pre-settlement landscape of eastern Texas, western wet flatwood pine savannas would have been most abundant on the Montgomery formation, with some on the flat Bentley (Harcombe et al. 1993). Today, these communities are rare in both formations, and those that exist are no further north than the Hickory Creek Savannah Unit. In the hillier landscapes further north in Texas and western Louisiana, there are other herbaceous-dominated wetland communities with sparse pine and similar floras, which are embedded in pine forests that are more upland in character (Harcombe et al. 1993). These sites are most often called hillside seepage bogs, and unlike western wet flatwood pine savannas, they often have natural pitcher plant populations. The park has one well-known example of a seepage bog: the herbaceous wetland in northern Turkey Creek unit that is the focal point of the Pitcher Plant trail (unsampled by I&M but studied previously by DESCO 2015). This community occurs within a flat depression with an impermeable clay layer beneath, and it is located downslope of upland pine communities that have well-drained, sandy soils (DESCO 2015; Figure C3).

The I&M plots in Wet Flatwood Pine with Savanna Elements plots were in Lance Rosier (2 plots) and the Solo Tract of Turkey Creek (1 plot). One Lance Rosier plot was a targeted plot in a relatively large natural clearing, placed there specifically to represent that community, and the other was a randomly-selected primary plot in a nearby shrub-encroached area that still contained some wet pine savanna species. The plot in the Solo Tract was another targeted plot, placed in an area of active restoration and regular prescribed burns. All three plots were on or near sodic soils, i.e., soils with higher salts and increased bioturbation (e.g., crawfish chimneys; USDA NRCS 2023b) in addition having poor drainage and a highly fluctuating water table. In the absence of fire, this combination of features likely helped prevent shrub encroachment (Streng and Harcombe 1982). Wet Pine Flatwoods have been documented in Big Thicket on other soil types as well, including poorly drained loamy upland soils (USDA NRCS 2023c) and seasonally wet loamy upland soils (USDA NRCS 2023d). Wet Flatwood Pine with Savanna Elements were apparently even rarer on these soil types, however, most likely because of their increased susceptibility to invasion by gallberry (*Ilex coriacea*), swamp titi (*Cyrilla racemiflora*), yaupon, and other shrubs without regular fire.

Previously Described Classifications This project's Wet Flatwood Pine with Savanna Elements class matched well with previous descriptions of the community type. It was called Wet Pine Savanna by Harcombe and Marks (1979) and the western variant of Longleaf Pine Flatwoods Savanna by Smith (1996). Its geographic range is restricted to the Intermediate Terraces geologic formation in western Louisiana and to the Montgomery and Bentley formations in Texas (Harcombe et al. 1993). In the USNVC mapping project in Big Thicket, all known locations of Wet Flatwood Pine with Savanna Elements were

classified as the ruderal associations of West Gulf Coastal Plain Ruderal Slash Pine Wet Woodland (CEGL007157), *Morella cerifera* - *Ilex vomitoria* wet meadow shrubland (NPSBITH022), and *Pinus taeda* - *Nyssa biflora* - *Magnolia virginiana* / *Andropogon glomeratus* Wet Woodland (NPSBITH026; Ley et al. 2024). Based on I&M field data, some sites should have been classified as Western Wet Longleaf Pine Savanna (CEGL007802), even though longleaf pine was less dominant than loblolly pine in much of the overstory. This USNVC association is listed as imperiled (G2) by NatureServe and is among the rare plant communities listed in Texas (Texas Parks and Wildlife Department 2012). The absence of this association in Ley et al. (2024) was most likely due to the requirement of longleaf dominance, the lack of fire in the two years prior to their fieldwork, and also presumably because many local extents were below their minimum mapping area.



Figure C3. The rich herbaceous community in the hillside seepage depression bog along the Pitcher plant trail. This community was not sampled by Ley et al. (2024) for the Big Thicket National Vegetation Classification Map. The USNVC association that best matches this community on the park is West Gulf Coastal Plain Seepage Bog (CEGL004175).

4. Wet Pine with Dense Gallberry

General Description and Characteristic Species The Wet Pine with Dense Gallberry class is related to the previous class in that it occupies mid-level landscape positions with poor soil drainage and dense to sparse pines in the overstory, including longleaf. A major difference, however, is the extremely thick gallberry, which is presumably favored by a more constant supply of soil moisture than the Wet Flatwood Pine with Savanna Elements class. Dense gallberry sites may debatably contain small areas of true baygall or acid depression swamps at their core, but much of their shrub density is presumably a consequence of fire suppression. Reintroduction of near-annual fire could potentially restore some of the open savanna character by reducing gallberry from all but the wettest portions. Gallberry burns readily but also quickly resprouts

after fire (Watson 1986). With such high gallberry densities already present, mechanical or chemical treatment measures may be required for site restoration, in addition to fire.

Locations within the Big Thicket Since this class represents a fire-suppressed state of pine-dominated communities that are higher in (local) elevation than wet flatwoods pine but lower than dry upland pine, this class may be expected in the vicinity of those two vegetation classes. In this study, the Wet Pine with Dense Gallberry class was represented by four plots. The three of this study's plots were in Turkey Creek, all of which had dense swamp titi as well as dense gallberry. There was one additional plot in Lance Rosier, north of Little Rock Road, which had dense gallberry but lacked swamp titi.

Previously Described Classifications In Harcombe and Marks (1979), this community was nested within Wetland Pine Savanna, although not in its most representative state. Ley et al. (2024) included it as West Gulf Coastal Plain Ruderal Longleaf Pine Flatwoods, Fire-Suppressed Phase (CEGL007162) and the park specials of Wet Flatwood Woodland (NPSBITH009) and *Morella cerifera* – *Ilex coriacea* – *Baccharis halimifolia* Wet Scrub Shrubland (NPSBITH023).

5. Baygall

General Description and Characteristic Species The term Baygall is a local name for several types of wetland communities in the Big Thicket region that occur on poorly drained, highly acidic organic soils (Watson 2006, Harcombe and Marks 1979). A defining feature is their thick shrub layer of a mix of several characteristic species, under sparse or closed tree canopies. Dominant species typically include the 'bay' and 'gall' namesake plants of sweetbay magnolia (*Magnolia virginiana*) and gallberry. Swamp titi is also almost always present in Big Thicket examples, as is swamp tupelo. Other frequently-encountered shrubs include wax myrtle (*Morella cerifera*), southern bayberry (*Morella caroliniensis*), Texas azalea (*Rhododendron oblongifolium*), coastal sweet pepperbush (*Clethra alnifolia*), Virginia sweetspire (*Itea virginica*), and possumhaw. Beneath the dense, intertwined shrub branches, soils are heavily saturated or inundated in tea-colored water. In the wettest portions, groundcover vegetation is mainly found on small hillocks that support sphagnum, other moss species, ferns, and small-statured forbs. Depending on the community, notable forbs include orchids (*Platanthera* sp.), nodding nixie (*Apteria aphylla*), northern bluethead (*Burmannia biflora*) and the globally rare Texas screwstem (*Bartonia texana*; Figure C4).

Characteristic baygall shrub and tree species also occur outside baygalls in other plant communities of Big Thicket, but without the same assemblages or landscape features. Areas adjacent to wet flatwood pine, hillside seepage bogs, and upland pine communities can appear baygall-like if fire is suppressed and gallberry, sweetbay magnolia and other woody plants are allowed to grow tall. These baygall-like zones have been seen in the Hickory Creek Savannah Unit and along the eastern and western edges of the midsection of Turkey Creek Unit. Baygalls and their surrounding forest communities can be differentiated from these fire-suppressed communities in that baygalls do not have pine in the overstory, and they generally do not burn (Watson 2006). Other Big Thicket vegetation classes that share some species with Baygalls are the Mesic Lower Slope class (e.g., wax myrtle and gallberry), the Wet Flatwood Pine-Hardwood class (e.g., swamp titi, wax myrtle, sphagnum, sedges, and possumhaw), and the Floodplain Hardwood class (e.g., swamp titi, sedges and wax myrtle).

Types and Locations within the Big Thicket Region Baygall wetland communities are found in many of the low landscape positions of Big Thicket -although not in the lowest elevation floodplains or flatwoods-, as well as in more upland areas. Based on their relative elevations and surrounding landforms, two main types of Big Thicket baygalls emerge: bottomland baygalls and headwater seep baygalls. The species compositions of these two types are similar, but differences in landscape position influence their spatial extent and adjacent communities. Bottomland baygalls are at the lowest positions in the local landscape, including oxbows and sloughs of upper floodplain terraces. There, they can be fairly extensive or exist as bands along more permanently inundated tupelo swamps, e.g., those in southeastern Jack Gore Baygall. Headwater baygalls,

in contrast, occur as narrow to wide bands at the bases of more upland slopes, often at the transition from slope forest to stream floodplain forests. They are fed by hillside seeps and can develop into broad, braided drainages under the forest canopy. In more northern settings, hillside seeps are not necessarily colonized by trees and understory baygall species but may instead be associated with pitcher plants and other herbaceous species of hillside seepage bogs. Such communities are typically imbedded in upland pine or pine-hardwood forests (e.g., pitcher plant trail in northern Turkey Creek).

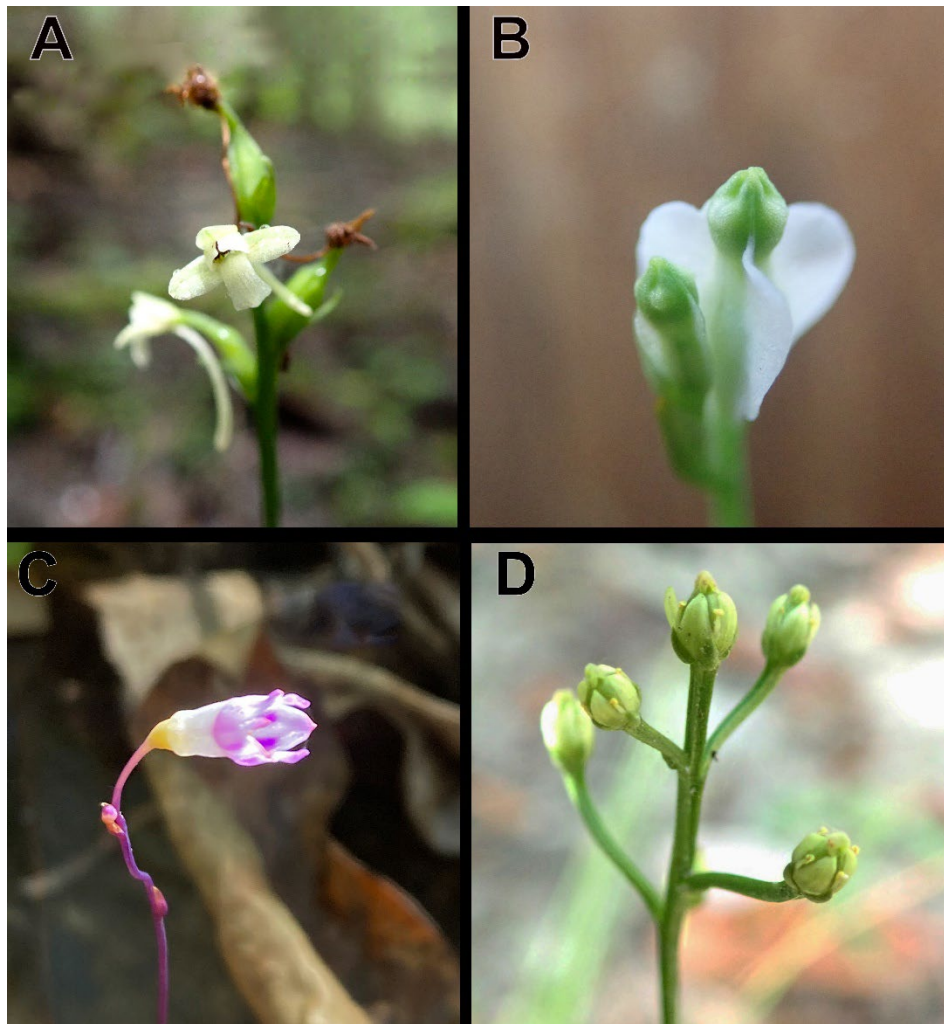


Figure C4. Several small or minute plant species found in Big Thicket baygalls. (A) Little club spur orchid (*Platanthera clavellata*); (B) Northern bluethread (*Burmannia biflora*); (C) Nodding nixie (*Apteris aphylla*), which also occurs in low areas of slope forest; and (D) Texas screwstem (*Bartonia texana*).

Baygalls of one type or the other were found within most of the units and broad vegetation classes sampled for this project. Bottomland baygalls were in Jack Gore Baygall (JG08) and southern Turkey Creek (TC12). Headwater seep baygalls were in Turkey Creek (TC02), Jack Gore Baygall (JG04), Beech Creek (BC03 and BC04), and Big Sandy (e.g., outside of plot but adjacent to BS02). Several other plots captured small portions of baygalls or had baygalls nearby. The only classes sampled for this project that did not have baygalls imbedded within them were the deep cypress tupelo swamps of the Neches River floodplain and the wet flatwoods of Lance Rosier. Within Lance Rosier flatwoods, the lowest landscape positions visited by I&M or USNVC crews were tupelo depression swamps rather than shrub-rich baygalls, although shrubs could be present

along their borders. Previous authors have written of vast baygalls in Lance Rosier unit, either on the Montgomery Formation as it approaches the Beaumont Formation (Watson 2006) or at the headwaters of Black Creek and westward (Harcombe and Marks 1979). But as the latter source explained, much of these expanses were characterized by swamp tupelo, laurel oak and sweetbay magnolia canopies with understories that were relatively free of shrubs, although shrubs may be dense along their margins. In this project, these communities were classified as tupelo depression swamps (not sampled), Wet Pine with Dense Gallberry or Wet Flatwood Pine-Hardwood Forest, even when sphagnum and swamp titi were occasionally present. The phenomenon of baygalls being rare in or absent from wet flatwood communities has also been documented in western Louisiana (Smith 1996).

Previously Described Classifications Baygall communities in southeast Texas have been referred to as wetland baygall shrub thickets (Harcombe and Marks 1979), semi-evergreen broadleaf acid seep forests (Bridges and Orzell 1989), wet creek bottoms (Brooks et al. 1993), and acid bog-baygalls (Watson 2006). In Louisiana, similar communities are called forested seeps and bayhead swamps (Louisiana Natural Heritage Program 2009; Smith 1996). These two Louisiana-defined communities are found in both flatwoods and uplands of eastern Louisiana, but in western Louisiana, they are mostly restricted to the hilly landscapes of the southern tertiary uplands ecoregion, such as in Kisatchie National Forest, where swamp titi and gallberry tend to be less common. In the tertiary uplands ecoregions of southeast Texas, these two species are also often rare or absent in baygalls (Brooks et al. 1993). In such cases, the best matching USNVC classification is West Gulf Coastal Plain Forested Seep, northern type (CEGL007904). The majority of baygalls at Big Thicket were more closely aligned with the southern type of West Gulf Coastal Plain Forested Seep (CEGL00747). This USNVC association is listed as vulnerable (G3) by NatureServe and is among the rare plant communities listed in Texas (Texas Parks and Wildlife Department 2012). Ley et al. (2024) used both the northern and southern forested seep types in the USNVC project for Big Thicket, and they also used West Gulf Coastal Plain Seepage Slope Shrub Thicket (CEGL003530) and a park-special called *Cyrilla racemiflora* seepage bog shrubland (NPSBITH018). Unfortunately, many known baygalls were missed in the USNVC mapping effort, likely due to small baygall sizes and aerial-view similarity between baygall canopy trees and those of neighboring communities.

6. Floodplain Hardwood Forest

The Floodplain Hardwood Forest class has a fairly rich assemblage of canopy tree species, all able to withstand occasional flooding, on flat expanses near streams and rivers. Soils are typically well drained to somewhat poorly drained, some with sandy sediments and loamy alluvium and others with clay horizons (USDA NRCS 2023a). The characteristic group of tree species includes the defining species of ironwood (*Carpinus carolinensis*) and/or cow oak (*Quercus michauxii*), along with water oak (*Quercus nigra*), black gum (*Nyssa sylvatica*), American holly (*Ilex opaca*), sweetgum (*Liquidambar styraciflua*), and red maple (*Acer rubrum*). Other bottomland oak species can be present and even common, depending on the specific community type (e.g., *Quercus phellos*, *Quercus pagoda*, *Quercus lyrata*, and *Quercus laurifolia*). Floodplain hardwood communities on the drier end of the spectrum increasingly resemble mesic slope forests in composition, with occasional individuals of species such as white oak (*Quercus alba*), southern magnolia (*Magnolia grandiflora*), American beech (*Fagus grandifolia*), and hop hornbeam (*Ostrya virginiana*). Loblolly pine also becomes increasingly abundant in the drier floodplain sites. The shrub layer tends to be sparse, although yaupon and/or sebastian bush (*Ditrysinia fruticosa*) are often present. Swamp titi can also occur in this class, most often in transition zones with baygalls. The ground layer is a mix of leaf litter and graminoids in varying proportions, with woodoats (*Chasmanthium* spp.), panicgrasses (*Dichanthelium* spp.) and sedges (*Carex* spp.) most likely to occur there. Big Thicket also includes floodplain forests with loblolly as a dominant

overstory species and/or with dwarf palmetto (*Sabal minor*) in understory, but these community types were not represented among I&M plots. Only one Floodplain Hardwood I&M plot had loblolly as 30-40% of canopy trees (BC10).

The Floodplain Hardwood Forest class aligned well with two communities of Harcombe and Marks (1979), but there was less alignment with the USNVC groupings (Ley et al. 2024). Harcombe and Marks (1979) used the term Floodplain Hardwood Forest for the wetter end of the spectrum near the Neches River and larger streams, and they used Floodplain Hardwood Pine Forest at the drier end of the spectrum by smaller drainages. In both cases, they considered ironwood a defining species. In the USNVC project, there were two map classes covering floodplain forests (*Quercus* spp. mixed hardwood floodplain forest and Mixed Hardwoods- *Pinus taeda* floodplain forest), together encompassing 16 USNVC associations (Ley et al. 2024). The 13 Floodplain Hardwood plots in this study spanned a broad subset of those associations, including West Gulf Coastal Plain Swamp Chestnut Oak Small Stream Bottomland Forest (CEGL007901), West Gulf Coastal Plain Mixed Oak Bottomland Forest (CEGL007906), West Gulf Coastal Plain Water Oak - Sweetgum Floodplain Forest (CEGL007984). Several I&M plots in the Floodplain Hardwood class were not a good match with any floodplain USNVC associations used for Big Thicket, although there were some partial matches (e.g., with CEGL007910, CEGL007370). Four of the five units had plots in the Floodplain Hardwood Forest class, with the only exception being Lance Rosier.

7. Mesic Lower Slope Forest

Forested communities on shallow to steep slopes that are dominated by hardwoods or by a combination of hardwoods and loblolly pine make up the Mesic Lower Slope Forest class. Based on its species composition, this class is more strongly associated with moister lower slopes than drier upper slopes, but there is considerable overlap with both upslope and downslope communities. Soil types are generally loamy upland, sandy loam upland, or terrace (USDA NRCS 2023a). Characteristic canopy tree species include white oak, southern red oak (*Quercus falcata*), American beech, American holly, and southern magnolia. These communities also often feature the widespread species of sweetgum, black gum, loblolly, water oak, and darlington oak (*Quercus hemisphaerica*). The shrub layer is typically dense, often with yaupon or gallberry, except for some beech or pine dominated communities that have open understories. Beautyberry (*Callicarpa americana*) and farkleberry (*Vaccinium arboreum*) are also frequent in this class, and even swamp titi occurs occasionally, often adjacent to headwater baygalls. Species richness tends to be low in these communities, likely in part due to the paucity of groundcover. The most common forb is partridgeberry (*Mitchella repens*), and the most common graminoids are panicgrasses and woodoats. The Mesic Lower Slope Forest class is the most dominant class in Big Thicket, though this may be due in part to fire suppression as well as its natural abundance. It was by far the most common class in the I&M sample, with 18 plots distributed across all five units. Big Thicket also includes numerous mesic slope forest communities that were not represented among I&M plots, including some northern types with abundant southern sugar maple (*Acer floridanum*). Several locally rare species, such as trilliums (*Trillium* sp.) and the Carolina lily (*Lilium michauxii*) are found in the beech-magnolia-loblolly communities (Watson 2006) that are nested within this broad vegetation class.

This broad vegetation class aligned fairly well with the Lower Slope Hardwood Pine of Harcombe and Marks (1979), with a few exceptions. One exception was that Harcombe and Marks (1979) placed mima mound assemblages in their Lower Slope Hardwood Pine group, whereas this study placed those small-scale assemblages with the Hardwood Flatwood class. Another exception was that a few plots in this class had more similarity with the Mid Slope Oak Pine class of Harcombe and Marks (1979), due to the presence of southern red oak (JG09, TC10). Comparisons with the USNVC project provided fewer clear alignments. The relevant map classes were Mixed Hardwood Mesic Slope Forest and *Pinus taeda* Mixed Hardwood Slope and Small Stream Forest, which together encompassed 10 associations. Those represented within the sample of 18 I&M plots included West Gulf Coastal Plain Mesic Loblolly Pine - Mixed Hardwood Forest (CEGL007525), West Gulf Coastal Plain

Dry-Mesic White Oak Forest (CEGL008413), and Texas Upper West Gulf Coastal Plain Hardwood Slope Forest (CEGL007959). As for the Floodplain Hardwood class, the observed plot compositions were rarely a complete match to one of the USNVC associations used by Ley et al. (2024) for Big Thicket.

8. Dry Upper Slope Pine Hardwood

The Dry Upper Slope Pine Hardwood class is found on sandy loam soils of upland slopes. The presence of hardwoods as a regular but not-necessarily-dominant feature of the canopy differentiates this class from true uplands that are nearly exclusively pine. The defining species are post oak (*Quercus stellata*) and shortleaf pine (*Pinus echinata*), though loblolly can be as abundant as shortleaf. Other mesic to upland oak species are also common, such as white oak and southern red oak. In the mid-story and understory, flowering dogwood (*Cornus florida*) and beautyberry are expected, but the dominant species is yaupon, which is often extremely thick. At the highest sites within this class, increased burn frequencies may shift these communities more towards upland pine, by reducing yaupon density. This class was represented in four I&M plots that were all in Big Sandy, although it may occur in more upland portions of all sampled units except for Lance Rosier.

Harcombe and Marks (1979) used two different groupings for upper slope communities: Upper Slope Pine Oak Forest and Mid Slope Oak Pine Forest. They were differentiated by the mid slope forest having a greater proportion of hardwoods and some differences in dominant species. Their upper slope community was a close match for three of the four I&M plots (BS07, BS11, BS13B), and the fourth I&M plot was more aligned with the mid slope community (BS08). Several USNVC associations were good matches for the sampled communities. These were West Gulf Coastal Plain Dry Loblolly Pine - Hardwood Forest (CEGL007528), West Gulf Coastal Plain Upland Loblolly Pine - Post Oak Woodland (CEGL002112), and West Gulf Coastal Plain Shortleaf Pine - Loblolly Pine - Mixed Oak Forest (CEGL004713; Ley et al. 2024).

9. Dry Upland Pine Savanna or Woodland

General Description and Characteristic Species The Dry Upland Pine Savanna or Woodland class represents several pine-dominated communities on the highest natural elevations of Big Thicket. In the most widespread examples, the overstory is relatively sparse, featuring longleaf pine in its most intact state, though loblolly or shortleaf may be present to dominant in Big Thicket examples as well. Soils can be sandy or loamy with good drainage. Fire is essential to maintaining the savanna-like character of the understory, which is expected to have little bluestem (*Schizachrium scoparium*), bluestem species (*Andropogon* spp.), and a relatively high proportion of pea family members. The most important shrubs are beautyberry, yaupon, and winged sumac (*Rhus copallinum*). The driest sites in this class are on deep, nutrient-poor sands – sandhills –, which are habitat for the area’s most xerophytic plant species. These sandhill or dry upland pine communities house many plant species found nowhere else in the park (e.g., *Gymnopogon ambiguus*, *Crotalaria sagittalis*, *Dalea phleoides*, *Alophia drummondii*, *Eriogonum longifolium*, *Opuntia humifusa*, *Loeflingia squarrosa*, *Silene subciliata*, *Echinacea sanguinea*, *Palafoxia reverchonii*, *Selaginella arenicola* ssp. *ridellii*, and *Aristida desmantha*; MacRoberts and MacRoberts 2007; Harcombe 2007). Some of these species are shown in Figure C5. Upland pine communities are home to the federally-listed Texas trailing phlox (*Phlox nivalis* spp. *texensis*), which is completely restricted to Big Thicket and a few other areas in the surrounding counties. These areas are also key habitats for red cockaded woodpeckers (*Leuconotopicus borealis*), which are targeted for reintroduction into Big Thicket.

Locations within the Big Thicket Upland pine savanna communities in Big Thicket are primarily in the Big Sandy and northern Turkey Creek units. These communities are often associated with sandy, rolling hills topography, which is more a feature of landscapes directly to the north, such as in Angelina and Sabine National Forest. Sandhill communities are more patchy and less predictable on the landscape, with a few even as far south as Jack Gore Baygall. The best-known example of

sandhill in the park is on the Sandhill Loop trail in southern Turkey Creek unit. Outside the Big Thicket region, upland longleaf pine communities are distributed across the North American coastal plain, although with a much-reduced footprint relative to before European settlement (Harcombe et al. 1993, Noss et al. 2015). The extant upland longleaf pine communities consist of several variants, with those in western Louisiana and eastern Texas known as the West Gulf Coastal Plain variant. Although these communities are relatively rare in the flatwood ecoregion, where most of Big Thicket lies, they become more frequent to the north in both Texas and Louisiana, in the southern tertiary uplands and tertiary uplands ecoregion. The two I&M plots in this class were nonrandomly-selected targeted plots, with one placed in northern Turkey Creek and the other in Big Sandy. Neither were on the deep sands associated with sandhill in Big Thicket.

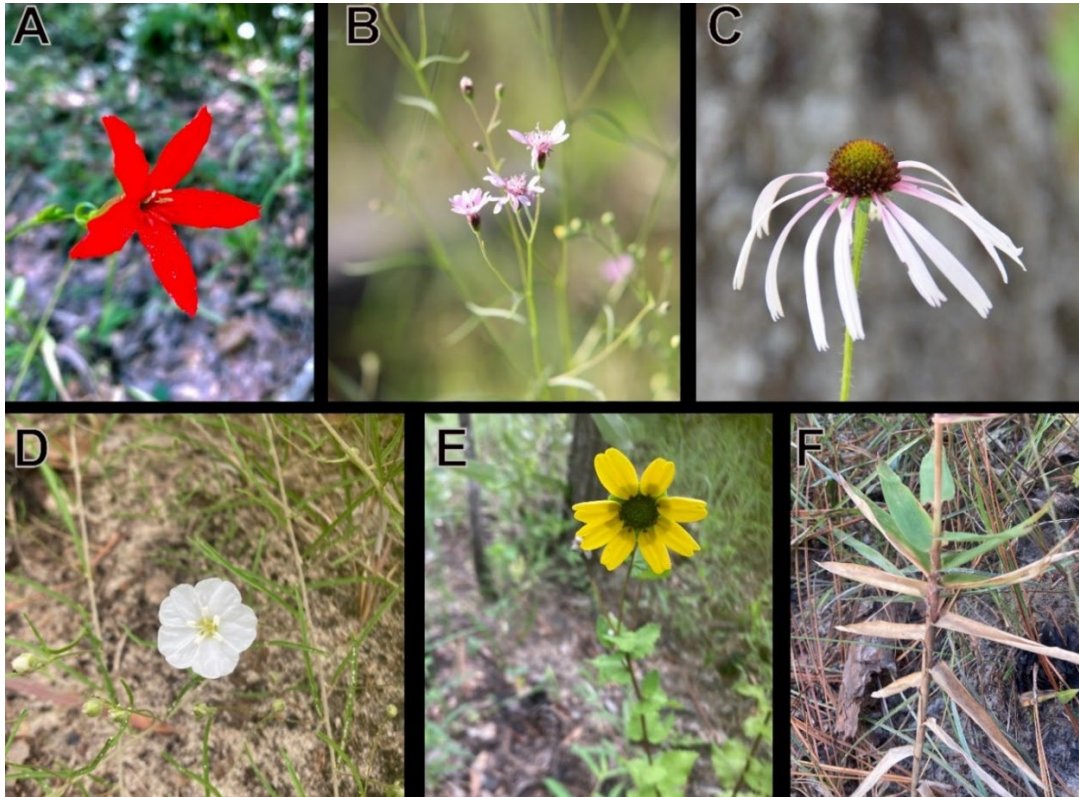


Figure C5. A selection of plants associated with the Dry Upland Pine Savanna or Woodland class, including sandhill habitats. (A) scarlet catchfly (*Silene subciliata*); (B) Reverchon's Palafox (*Palafoxia reverchonii*); (C) Sanguine purple coneflower (*Echinacea sanguinea*, synonym of *Echinacea pallida* var. *sanguinea*); (D) Pickering's daisy (*Stylisma pickeringii*); (E) Soft greeneyes (*Berlandiera pumila*); and (F) Bearded skeletongrass (*Gymnopogon ambiguus*). None of these species were recorded in plots, but were photographed by I&M crews within the Preserve.

Previously Described Classifications The Dry Upland Pine Savanna or Woodland class aligned well with the Upland Pine vegetation type of Harcombe and Marks (1979). The driest sites on deep sands in Big Thicket were classified by Harcombe and Marks (1979) as Sandhill Pine; these communities were not captured in any I&M plots. There was less alignment between the current class and the associations used in the USNVC project. Ley et al. (2024) used three different associations for the Dry Upland Pine Savanna and Woodland class: West Gulf Coastal Plain Upland Loblolly Pine - Post Oak Woodland (CEGL002112; listed as imperiled by Natureserve), the ruderal woodland association of West Gulf Coastal Plain Longleaf - Mixed Pine - Sweetgum Forest (CEGL003609), and a park special of *Pinus* spp. (*taeda*, *echinata*, *elliotti*, *palustris*) Regenerating Woodland and Shrubland (BITH016). The intact upland pine communities known to exist at

Big Thicket were absent from the USNVC project, potentially due to minimum mapping areas or because prescribed fires had not been recent enough prior to their sampling. One of the two I&M plots in this class was fairly ruderal in nature, due to its recently initiated restoration effort (BS13B), but the other (TC13B) more closely aligned with West Gulf Coastal Plain Mesic Upland Longleaf Pine Woodland (CEGL003571). This association is listed as imperiled by Natureserve and is among the rare plant communities listed in Texas (Texas Parks and Wildlife Department 2012). I&M crews also identified several areas that appeared to align with the following sandhill associations that were also not recognized by Ley et al. (2024): West Gulf Coastal Plain Xeric Longleaf Pine Sandhill (CEGL003602; listed as imperiled by Natureserve) and Western Upland Longleaf Pine Forest, Stream Terrace Sandy Woodland Type (CEGL003580; listed as critically imperiled [G1] by Natureserve).

Literature Cited for Vegetation Class Descriptions

- Bridges, E.L., and S.L. Orzell. 1989. Longleaf pine communities of the West Gulf Coastal Plain. *Natural Areas Journal* 9: 246-263.
- Brooks, A.R., E.S. Nixon, and J.A. Neal. 1993. Woody vegetation of wet creek bottom communities in eastern Texas. *Castanea* 58: 185-196. <http://www.jstor.org/stable/4033642>
- DESCO Environmental Consultants, LP. 2015. Ecological survey of a pitcher plant bog, Turkey Creek unit Big Thicket National Preserve, Tyler County, Texas. DESCO Environmental Consultants, Magnolia, Texas.
- Harcombe, P.A., 2007. A vascular plant survey for Big Thicket national preserve. Unpublished report: U.S. Park Service, Santa Fe, New Mexico. <https://irma.nps.gov/DataStore/Reference/Profile/649520>
- Harcombe, P.A., J.S. Glitzenstein, R.G. Knox, S.L. Orzell, and E.L. Bridges. 1993. Vegetation of the longleaf pine region of the West Gulf Coastal Plain. *Proc. Ann. Tall Timbers Fire Ecol. Conf.* 18:83-103.
- Harcombe, P.A., and P.L. Marks. 1979. Forest vegetation of the Big Thicket National Preserve. Unpublished report: U.S. Park Service, Santa Fe, New Mexico. <https://irma.nps.gov/DataStore/DownloadFile/152344>
- Ley, M., T. Baldvins, H. Pilkington, D. Jones and K. Anderson. 2024. Vegetation classification and mapping project: Big Thicket National Preserve. Natural Resource Report NPS/BITH/NRR—2024/2621. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2299254>
- Louisiana Natural Heritage Program. 2009. The natural communities of Louisiana. Louisiana Dept. Wildlife & Fisheries, Baton Rouge, Louisiana.
- MacRoberts, M. H., and B.R. MacRoberts. 2007. Phytogeography of the Big Thicket, east Texas. *Journal of the Botanical Research Institute of Texas*, 1149-1155. <https://www.jstor.org/stable/41971544>
- Noss, R.F., W.J. Platt, B.A. Sorrie, A.S. Weakley, D.B. Means, J. Costanza, and R.K. Peet. 2015. How global biodiversity hotspots may go unrecognized: lessons from the North American Coastal Plain. *Diversity and Distributions*: 21: 236-244.
- Smith, L. M. 1996. The rare and sensitive natural wetland plant communities of interior Louisiana. Louisiana Natural Heritage Program, Baton Rouge, Louisiana.

- Streng, D. R., and P. A. Harcombe. 1982. Why don't East Texas savannas grow up to forests? *American Midland Naturalist* 108: 278–294.
- Texas Parks and Wildlife Department. 2012. Texas Conservation Action Plan 2012 – 2016: Western Gulf Coastal Plain Handbook. Editor, Wendy Connally, Texas Conservation Action Plan Coordinator. Austin, Texas.
- USDA NRCS. 2023a. The Ecosystem Dynamics Interpretive Tool (EDIT). <https://edit.jornada.nmsu.edu>. Accessed February 2024.
- USDA NRCS. 2023b. Ecological site F152BY002TX: Sodic Flats.
<https://edit.jornada.nmsu.edu/catalogs/esd/152B/F152BY002TX> Accessed February 2024.
- USDA NRCS. 2023c. Ecological site F152BY007TX: Poorly Drained Loamy Upland.
<https://edit.jornada.nmsu.edu/catalogs/esd/152B/F152BY007TX>. Accessed February 2024.
- USDA NRCS. 2023d. Ecological site F152BY005TX: Seasonally Wet Loamy Upland.
<https://edit.jornada.nmsu.edu/catalogs/esd/152B/F152BY005TX>. Accessed February 2024.
- Watson, G.E. 2006. Big Thicket plant ecology: an introduction, third edition. University of North Texas Press, Denton, Texas.
- Watson, G. E. 1986. Influence of fire on the longleaf pine - bluestem range in the Big Thicket region. Pp. 181-185 In: D.L. Kulhavy and R.N. Conner, eds. *Wilderness and natural areas in the eastern United States: a management challenge*. Stephen F. Austin University, Nacogdoches, Texas.
https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/sgcn.phtml

Appendix D: Plant Species List

Table D1. List of plant species from 2022 vegetation monitoring in Big Thicket National Preserve. Frequency [Freq.] values for each species were calculated as the number of 400-m² plots where a species was recorded, divided by the total plots sampled in that unit or overall for the park. Color coding is grey for 1-10%, light teal for 11-25%, and dark teal for 26-100%. For two *Nyssa* species on this list, the taxonomic determination was based primarily on habitat, because leaf morphological characteristics were deemed unreliable for positive identification in the field. These were *Nyssa sylvatica* versus *Nyssa biflora*, with the former assigned to plants in drier habitats (typically with wider, irregularly toothed leaves), and the latter to plants in swampy or semi-swampy situations, often with trees having fluted bases. *Persea borbonia* and *Persea palustris* also had vegetative characteristics that overlapped in the field, and determinations were often based on habitat as well. The project botanist was Jane Carlson with occasional support from Texas botanist Jason Singhurst. The following taxonomic references were used: “Illustrated Flora of East Texas, Volume 1: Monocots” by Diggs et al. (2006), “Shinners & Mahler’s Illustrated Flora of North Central Texas” by Diggs et al. (1999), “Trees, Shrubs and Woody Vines of East Texas” by Nixon (2000), “Guide to Texas Grasses” by Shaw and Montgomery (2012), and “Manual of the Vascular Plants of Texas” by Correll and Johnston (1979), among others. Accepted scientific names were based on the United States Department of Agriculture Natural Resource Conservation Service’s PLANTS database (<https://plants.usda.gov/>), with the exception of *Andropogon dealbatus*, which was recently split from *Andropogon capillipes*, based on “Flora of the Southeastern United States” by Weakly et al. (2022).

Growth Form	Family	Scientific Name	Common Name	Nativity	Freq. in BC Plots (% of 10)	Freq. in BS Plots (% of 13)	Freq. in JG Plots (% of 10)	Freq. in LR Plots (% of 13)	Freq. in TC Plots (% of 14)	Freq. overall (% of 60)
Forb	Acanthaceae	<i>Justicia ovata</i>	looseflower water-willow	Native	10	8	20	31	7	15
Forb	Alismataceae	<i>Echinodorus cordifolius</i>	burhead	Native	-	-	10	-	-	2
Forb	Alismataceae	<i>Sagittaria latifolia</i>	broadleaf arrowhead	Native	-	-	10	-	-	2
Forb	Anacardiaceae	<i>Toxicodendron pubescens</i>	Atlantic poison oak	Native	-	-	-	-	7	2
Forb	Apiaceae	<i>Centella erecta</i>	spadeleaf	Native	-	8	-	38	7	12
Forb	Apiaceae	<i>Eryngium integrifolium</i>	blueflower eryngo	Native	-	-	-	8	-	2
Forb	Apiaceae	<i>Eryngium yuccifolium</i>	button eryngo	Native	-	8	-	8	-	3
Forb	Apiaceae	<i>Hydrocotyle verticillata</i>	dollarweed	Native	10	-	20	-	7	7
Forb	Apiaceae	<i>Oxypolis filiformis</i>	water cowbane	Native	-	-	-	8	-	2
Forb	Apiaceae	<i>Ptilimnium costatum</i>	ribbed mock bishopweed	Native	-	-	-	-	7	2
Forb	Apiaceae	<i>Sanicula canadensis</i>	Canada blacksnakeroot	Native	-	-	10	-	-	2
Forb	Apiaceae	<i>Sanicula sp.</i>	blacksnakeroot	Native	-	23	-	-	-	5
Forb	Araceae	<i>Arisaema triphyllum</i>	Jack in the pulpit	Native	20	8	-	8	14	10
Forb	Aristolochiaceae	<i>Aristolochia reticulata</i>	Texas dutchman's pipe	Native	-	23	-	-	7	7
Forb	Aristolochiaceae	<i>Aristolochia serpentaria</i>	Virginia snakeroot	Native	20	15	30	-	-	12
Forb	Asclepiadaceae	<i>Asclepias longifolia</i>	longleaf milkweed	Native	-	-	-	8	7	3
Forb	Asteraceae	<i>Acmella oppositifolia</i>	creeping spotflower	Native	-	-	10	-	-	2
Forb	Asteraceae	<i>Amphiachyris dracunculoides</i>	common broomweed	Native	-	8	-	-	-	2
Forb	Asteraceae	<i>Arnoglossum ovatum</i>	ovateleaf Indian plantain	Native	-	-	-	8	7	3

Growth Form	Family	Scientific Name	Common Name	Nativity	Freq. in BC Plots (% of 10)	Freq. in BS Plots (% of 13)	Freq. in JG Plots (% of 10)	Freq. in LR Plots (% of 13)	Freq. in TC Plots (% of 14)	Freq. overall (% of 60)
Forb	Asteraceae	<i>Arnoglossum sp.</i>	Indian plantain	Native	-	-	-	15	-	3
Forb	Asteraceae	<i>Bidens frondosa</i>	devil's beggartick	Native	-	-	10	-	-	2
Forb	Asteraceae	<i>Boltonia diffusa</i>	smallhead doll's daisy	Native	-	-	-	8	7	3
Forb	Asteraceae	<i>Conoclinium coelestinum</i>	blue mistflower	Native	-	-	10	-	-	2
Forb	Asteraceae	<i>Conyza canadensis</i>	Canada horseweed	Native	-	8	10	-	-	3
Forb	Asteraceae	<i>Coreopsis linifolia</i>	Texas tickseed	Native	-	-	-	15	7	5
Forb	Asteraceae	<i>Coreopsis tinctoria</i>	plains coreopsis	Native	-	-	-	8	7	3
Forb	Asteraceae	<i>Elephantopus carolinianus</i>	Carolina elephantsfoot	Native	-	8	-	-	-	2
Forb	Asteraceae	<i>Elephantopus sp.</i>	elephantsfoot	Native	-	15	-	8	21	10
Forb	Asteraceae	<i>Elephantopus tomentosus</i>	common elephantsfoot	Native	-	8	-	-	7	3
Forb	Asteraceae	<i>Erechtites hieraciifolius</i>	American burnweed	Native	20	-	-	-	21	8
Forb	Asteraceae	<i>Eupatorium capillifolium</i>	dogfennel	Native	10	8	20	8	7	10
Forb	Asteraceae	<i>Eupatorium leucolepis</i>	white-bracted thoroughwort	Native	-	-	-	15	14	7
Forb	Asteraceae	<i>Eupatorium rotundifolium</i>	roundleaf thoroughwort	Native	-	-	-	-	14	3
Forb	Asteraceae	<i>Eupatorium semiserratum</i>	smallflower thoroughwort	Native	-	-	-	8	-	2
Forb	Asteraceae	<i>Eupatorium serotinum</i>	late boneset	Native	-	-	20	-	-	3
Forb	Asteraceae	<i>Helenium drummondii</i>	fringed sneezeweed	Native	-	-	-	-	7	2
Forb	Asteraceae	<i>Helianthus angustifolius</i>	narrowleaf sunflower	Native	-	-	-	8	7	3
Forb	Asteraceae	<i>Liatris acidota</i>	sharp blazing star	Native	-	-	-	15	7	5
Forb	Asteraceae	<i>Liatris pycnostachya</i>	prairie blazing star	Native	-	-	-	15	14	7
Forb	Asteraceae	<i>Marshallia graminifolia</i>	grassleaf Barbara's buttons	Native	-	-	-	8	7	3
Forb	Asteraceae	<i>Pityopsis graminifolia</i>	narrowleaf silkgrass	Native	-	-	-	-	14	3
Forb	Asteraceae	<i>Pluchea rosea</i>	rosy camphorweed	Native	-	8	-	15	7	7
Forb	Asteraceae	<i>Pluchea sp.</i>	camphorweed	Native	-	-	10	31	14	12
Forb	Asteraceae	<i>Prenanthes barbata</i>	barbed rattlesnakeroot	Native	-	-	10	-	-	2
Forb	Asteraceae	<i>Solidago sp.</i>	goldenrod	Native	-	8	-	-	7	3
Forb	Asteraceae	<i>Symphyotrichum sp.</i>	heath aster	Native	-	-	10	-	7	3
Forb	Asteraceae	<i>Vernonia texana</i>	Texas ironweed	Native	-	-	-	-	7	2
Forb	Blechnaceae	<i>Woodwardia areolata</i>	netted chainfern	Native	30	8	20	-	21	15
Forb	Blechnaceae	<i>Woodwardia virginica</i>	Virginia chainfern	Native	-	-	-	-	21	5

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Forb	Buddlejaceae	<i>Polypremum procumbens</i>	juniper leaf	Native	-	8	-	-	7	3
Forb	Burmanniaceae	<i>Apteria aphylla</i>	nodding nixie	Native	20	8	-	-	-	5
Forb	Burmanniaceae	<i>Burmannia biflora</i>	northern bluethread	Native	10	-	-	-	7	3
Forb	Campanulaceae	<i>Lobelia cardinalis</i>	cardinalflower	Native	-	8	-	-	-	2
Forb	Campanulaceae	<i>Lobelia flaccidifolia</i>	foldear lobelia	Native	-	-	-	15	-	3
Forb	Campanulaceae	<i>Lobelia puberula</i>	downy lobelia	Native	-	-	-	-	7	2
Forb	Cistaceae	<i>Helianthemum georgianum</i>	Georgia frostweed	Native	-	8	-	-	-	2
Forb	Cistaceae	<i>Lechea tenuifolia</i>	narrowleaf pinweed	Native	-	8	-	-	-	2
Forb	Clusiaceae	<i>Hypericum crux-andreae</i>	St. Peter's-wort	Native	-	-	-	15	14	7
Forb	Clusiaceae	<i>Hypericum galioides</i>	bedstraw St. John's-wort	Native	-	-	-	15	7	5
Forb	Clusiaceae	<i>Hypericum gentianoides</i>	orangegrass	Native	-	8	-	-	-	2
Forb	Clusiaceae	<i>Hypericum hypericoides</i>	St. Andrew's cross	Native	40	31	20	54	29	35
Forb	Clusiaceae	<i>Hypericum mutilum</i>	dwarf St. Johnswort	Native	10	-	10	-	7	5
Forb	Clusiaceae	<i>Hypericum sp.</i>	St. Johnswort	Native	-	-	-	-	7	2
Forb	Clusiaceae	<i>Triadenum walteri</i>	greater marsh St. Johnswort	Native	20	8	20	23	21	18
Forb	Dennstaedtiaceae	<i>Pteridium aquilinum</i>	bracken fern	Native	-	-	-	8	29	8
Forb	Droseraceae	<i>Drosera capillaris</i>	pink sundew	Native	-	-	-	-	7	2
Forb	Droseraceae	<i>Drosera sp.</i>	sundews	Native	-	-	-	8	-	2
Forb	Dryopteridaceae	<i>Onoclea sensibilis</i>	sensitive fern	Native	-	-	-	-	7	2
Forb	Dryopteridaceae	<i>Polystichum acrostichoides</i>	Christmas fern	Native	-	8	-	8	-	3
Forb	Euphorbiaceae	<i>Acalypha gracilens</i>	slender threeseed mercury	Native	-	8	-	-	7	3
Forb	Euphorbiaceae	<i>Acalypha rhomboidea</i>	common threeseed mercury	Native	-	-	-	-	7	2
Forb	Euphorbiaceae	<i>Acalypha virginica</i>	Virginia threeseed mercury	Native	-	-	10	-	-	2
Forb	Euphorbiaceae	<i>Croton argyranthemus</i>	healing croton	Native	-	8	-	-	-	2
Forb	Euphorbiaceae	<i>Croton capitatus</i>	hogweed	Native	-	8	-	-	-	2
Forb	Euphorbiaceae	<i>Croton glandulosus</i>	sand croton	Native	-	8	-	-	7	3
Forb	Euphorbiaceae	<i>Euphorbia corollata</i>	flowering spurge	Native	-	15	-	8	7	7
Forb	Euphorbiaceae	<i>Stillingia sylvatica</i>	queen's-delight	Native	-	-	-	-	7	2
Forb	Euphorbiaceae	<i>Tragia smallii</i>	Small's noseburn	Native	-	-	-	-	7	2

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Forb	Euphorbiaceae	<i>Tragia urticifolia</i>	nettleleaf noseburn	Native	-	-	-	-	7	2
Forb	Fabaceae	<i>Baptisia bracteata</i>	cream wild indigo	Native	-	-	-	-	7	2
Forb	Fabaceae	<i>Crotalaria sagittalis</i>	arrow crotalaria	Native	-	8	-	-	7	3
Forb	Fabaceae	<i>Desmodium ciliare</i>	hairy small-leaf ticktrefoil	Native	-	-	-	-	7	2
Forb	Fabaceae	<i>Desmodium sp.</i>	tickclover	Native	-	8	-	-	-	2
Forb	Fabaceae	<i>Erythrina herbacea</i>	eastern coralbean	Native	-	23	10	-	-	7
Forb	Fabaceae	<i>Mimosa hystricina</i>	catclaw sensitive briar	Native	-	-	-	8	-	2
Forb	Fabaceae	<i>Stylosanthes biflora</i>	endbeak pencilflower	Native	-	15	-	-	7	5
Forb	Gentianaceae	<i>Sabatia gentianoides</i>	pinewoods rose gentian	Native	-	-	-	8	7	3
Forb	Haloragaceae	<i>Proserpinaca palustris</i>	marsh mermaidweed	Native	10	-	-	-	-	2
Forb	Hypoxidaceae	<i>Hypoxis sp.</i>	curtis's stargrass	Native	-	8	-	-	14	5
Forb	Lamiaceae	<i>Hyptis alata</i>	clustered bushmint	Native	-	-	-	15	14	7
Forb	Lamiaceae	<i>Lycopus rubellus</i>	taperleaf bugleweed	Native	-	-	20	-	7	5
Forb	Lamiaceae	<i>Lycopus sp.</i>	waterhorehound	Native	10	-	-	46	7	13
Forb	Lamiaceae	<i>Lycopus virginicus</i>	Virginia bugleweed	Native	-	15	-	-	-	3
Forb	Lamiaceae	<i>Perilla frutescens</i>	beefsteak mint	Non-Native	-	-	-	-	7	2
Forb	Lamiaceae	<i>Pycnanthemum tenuifolium</i>	narrowleaf mountainmint	Native	-	8	-	-	-	2
Forb	Lamiaceae	<i>Salvia azurea</i>	azure blue sage	Native	-	8	-	-	-	2
Forb	Lamiaceae	<i>Scutellaria cardiophylla</i>	gulf skullcap	Native	-	8	-	-	-	2
Forb	Lamiaceae	<i>Scutellaria integrifolia</i>	helmet skullcap	Native	-	8	-	15	-	5
Forb	Liliaceae	<i>Aletris aurea</i>	golden colicroot	Native	-	-	-	15	7	5
Forb	Liliaceae	<i>Hymenocallis sp.</i>	spiderlily	Native	10	-	20	-	-	5
Forb	Linaceae	<i>Linum medium</i>	stiff yellow flax	Native	-	-	-	8	-	2
Forb	Linaceae	<i>Linum striatum</i>	ridged yellow flax	Native	-	-	-	-	7	2
Forb	Loganiaceae	<i>Mitreola petiolata</i>	lax hornpod	Native	10	-	10	15	-	7
Forb	Loganiaceae	<i>Mitreola sessilifolia</i>	swamp hornpod	Native	-	-	-	15	7	5
Forb	Lycopodiaceae	<i>Lycopodiella appressa</i>	southern bog clubmoss	Native	-	-	-	15	14	7
Forb	Malvaceae	<i>Hibiscus moscheutos</i>	common rose-mallow	Native	-	-	-	15	-	3
Forb	Malvaceae	<i>Malvaviscus arboreus</i>	turk's cap	Native	-	15	-	-	-	3
Forb	Melastomataceae	<i>Rhexia lutea</i>	yellow meadow-beauty	Native	-	-	-	8	7	3

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Forb	Melastomataceae	<i>Rhexia mariana</i>	Maryland meadow-beauty	Native	10	-	-	23	7	8
Forb	Melastomataceae	<i>Rhexia petiolata</i>	fringed meadow-beauty	Native	-	-	-	-	7	2
Forb	Onagraceae	<i>Ludwigia alternifolia</i>	bushy seedbox	Native	-	-	10	-	-	2
Forb	Onagraceae	<i>Ludwigia glandulosa</i>	creeping seedbox	Native	-	-	-	8	-	2
Forb	Onagraceae	<i>Ludwigia linearis</i>	narrowleaf primrose-willow	Native	-	-	-	8	7	3
Forb	Onagraceae	<i>Ludwigia palustris</i>	marsh primrose-willow	Native	-	-	20	-	-	3
Forb	Onagraceae	<i>Ludwigia pilosa</i>	hairy primrose-willow	Native	-	-	10	38	7	12
Forb	Onagraceae	<i>Ludwigia sp.</i>	primrose-willow	Native	-	-	10	-	-	2
Forb	Ophioglossaceae	<i>Botrychium bitermum</i>	southern grape fern	Native	-	54	20	8	29	23
Forb	Ophioglossaceae	<i>Botrychium sp.</i>	grape fern	Native	10	-	-	-	-	2
Forb	Orchidaceae	<i>Platanthera clavellata</i>	little club spur orchid	Native	10	-	-	-	-	2
Forb	Orchidaceae	<i>Platanthera sp.</i>	bog orchid	Native	-	-	10	-	-	2
Forb	Orobanchaceae	<i>Epifagus virginiana</i>	beechdrops	Native	10	-	-	-	-	2
Forb	Osmundaceae	<i>Osmunda cinnamomea</i>	cinnamon fern	Native	-	-	-	-	21	5
Forb	Osmundaceae	<i>Osmunda regalis</i>	royal fern	Native	10	-	20	8	43	17
Forb	Oxalidaceae	<i>Oxalis dillenii</i>	Dillen's oxalis	Native	-	8	10	-	14	7
Forb	Oxalidaceae	<i>Oxalis sp.</i>	wood sorrel	Unknown	-	-	10	-	7	3
Forb	Phyllanthaceae	<i>Phyllanthus urinaria</i>	chamber bitter	Non-Native	-	-	-	-	7	2
Forb	Phytolaccaceae	<i>Phytolacca americana</i>	American pokeweed	Native	-	8	10	-	-	3
Forb	Plantaginaceae	<i>Gratiola brevifolia</i>	sticky hedgehyssop	Native	-	-	-	15	-	3
Forb	Plantaginaceae	<i>Gratiola pilosa</i>	shaggy hedgehyssop	Native	-	-	-	-	7	2
Forb	Plantaginaceae	<i>Mecardonia acuminata</i>	axilflower	Native	10	-	-	31	7	10
Forb	Plantaginaceae	<i>Mecardonia procumbens</i>	baby jumpup	Native	10	-	-	-	-	2
Forb	Plantaginaceae	<i>Micranthemum umbrosum</i>	shade mudflower	Native	-	-	10	-	-	2
Forb	Polygalaceae	<i>Polygala cruciata</i>	drumheads	Native	-	-	-	8	-	2
Forb	Polygalaceae	<i>Polygala mariana</i>	Maryland milkwort	Native	-	-	-	-	14	3
Forb	Polygalaceae	<i>Polygala ramosa</i>	low pinebarren milkwort	Native	-	-	-	-	7	2
Forb	Polygonaceae	<i>Persicaria hydropiperoides</i>	Swamp smartweed	Native	-	-	-	-	7	2
Forb	Polygonaceae	<i>Persicaria sp.</i>	Smartweed	Native	10	-	-	-	-	2

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Forb	Polygonaceae	<i>Persicaria virginiana</i>	jumpseed	Native	-	8	-	-	7	3
Forb	Polypodiaceae	<i>Pleopeltis polypodioides</i>	resurrection fern	Native	10	23	20	-	29	17
Forb	Primulaceae	<i>Lysimachia radicans</i>	trailing yellow loosestrife	Native	-	-	20	-	7	5
Forb	Primulaceae	<i>Samolus valerandi</i>	seaside brookweed	Native	-	-	-	-	7	2
Forb	Rosaceae	<i>Duchesnea indica</i>	India mock-strawberry	Non-Native	-	-	10	-	7	3
Forb	Rubiaceae	<i>Diodia teres</i>	poorjoe	Native	-	-	-	15	-	3
Forb	Rubiaceae	<i>Diodia virginiana</i>	buttonweed	Native	-	-	10	8	7	5
Forb	Rubiaceae	<i>Galium obtusum</i>	bluntleaf bedstraw	Native	-	-	10	-	-	2
Forb	Rubiaceae	<i>Galium tinctorium</i>	dye bedstraw	Native	-	-	10	-	-	2
Forb	Rubiaceae	<i>Galium uniflorum</i>	oneflower bedstraw	Native	-	23	-	-	-	5
Forb	Rubiaceae	<i>Mitchella repens</i>	partridgeberry	Native	90	77	90	54	71	75
Forb	Rubiaceae	<i>Oldenlandia boscii</i>	Bosc's mille grains	Native	-	-	-	8	-	2
Forb	Rubiaceae	<i>Oldenlandia uniflora</i>	clustered mille grains	Native	-	8	-	-	-	2
Forb	Rubiaceae	<i>Stenaria nigricans</i>	prairie bluets	Native	-	-	-	-	14	3
Forb	Saururaceae	<i>Saururus cernuus</i>	lizard's tail	Native	10	-	10	-	7	5
Forb	Scrophulariaceae	<i>Agalinis viridis</i>	green false foxglove	Native	-	-	-	15	7	5
Forb	Scrophulariaceae	<i>Gratiola virginiana</i>	roundfruit hedgehyssop	Native	-	-	20	8	-	5
Forb	Scrophulariaceae	<i>Scoparia dulcis</i>	licorice weed	Native	30	-	-	-	-	5
Forb	Solanaceae	<i>Solanum pseudocapsicum</i>	Jerusalem cherry	Non-Native	-	-	-	-	7	2
Forb	Solanaceae	<i>Solanum ptychanthum</i>	American nightshade	Native	-	-	10	-	-	2
Forb	Thelypteridaceae	<i>Macrothelypteris torresiana</i>	mariana maiden fern	Non-Native	-	-	-	-	7	2
Forb	Thelypteridaceae	<i>Thelypteris kunthii</i>	Kunth's maiden fern	Native	-	-	-	-	7	2
Forb	Thelypteridaceae	<i>Thelypteris palustris</i>	eastern marsh fern	Native	-	-	10	-	7	3
Forb	Unknown	unknown forb 20220907	unknown forb	Unknown	10	-	-	-	-	2
Forb	Unknown	unknownherb_01_20220511	unknown forb	Unknown	-	-	10	-	-	2
Forb	Unknown	unknownherb_01_20220512	unknown forb	Unknown	-	-	10	-	-	2
Forb	Unknown	unknownherb_01_20220525	unknown forb	Unknown	-	-	10	-	-	2
Forb	Unknown	unknownherb_01_20220526	unknown forb	Unknown	-	-	10	-	-	2
Forb	Unknown	unknownherb_01_20220606	unknown forb	Unknown	-	-	-	-	7	2
Forb	Unknown	unknownherb_01_20220607	unknown forb	Unknown	-	-	-	-	7	2

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Forb	Unknown	<i>unknownherb_01_20220609</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_01_20220628</i>	unknown forb	Unknown	-	-	-	15	-	3
Forb	Unknown	<i>unknownherb_01_20220629</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_01_20220711</i>	unknown forb	Unknown	-	-	-	-	7	2
Forb	Unknown	<i>unknownherb_01_20220727</i>	unknown forb	Unknown	10	-	-	-	-	2
Forb	Unknown	<i>unknownherb_01_20220808</i>	unknown forb	Unknown	-	-	-	-	7	2
Forb	Unknown	<i>unknownherb_01_20220810</i>	unknown forb	Unknown	-	-	-	8	7	3
Forb	Unknown	<i>unknownherb_01_20220811</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_01_20220812</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_01_20220909</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_01_20220919</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_01_20220920</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_01_20221004</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_02_20220525</i>	unknown forb	Unknown	-	-	10	-	7	3
Forb	Unknown	<i>unknownherb_02_20220609</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_02_20220629</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_02_20220810</i>	unknown forb	Unknown	-	-	-	-	7	2
Forb	Unknown	<i>unknownherb_02_20220812</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_02_20220919</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_03_20220609</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Unknown	<i>unknownherb_03_20220919</i>	unknown forb	Unknown	-	8	-	-	-	2
Forb	Unknown	<i>unknownherb_04_20220609</i>	unknown forb	Unknown	-	-	-	8	-	2
Forb	Urticaceae	<i>Boehmeria cylindrica</i>	false nettle	Native	10	8	20	-	29	13
Forb	Verbenaceae	<i>Glandularia canadensis</i>	rose mock vervain	Native	-	8	-	-	-	2
Forb	Violaceae	<i>Viola palmata</i>	early blue violet	Native	-	8	10	8	7	7
Forb	Violaceae	<i>Viola primulifolia</i>	violet	Native	10	15	-	-	-	5
Forb	Violaceae	<i>Viola sp. cf sororia</i>	common blue violet	Native	-	15	20	-	21	12
Forb	Xyridaceae	<i>Xyris caroliniana</i>	Carolina yelloweyed grass	Native	-	-	-	-	7	2
Forb	Xyridaceae	<i>Xyris laxifolia</i>	irisleaf yelloweyed grass	Native	-	-	-	8	-	2

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Forb	Xyridaceae	<i>Xyris</i> sp.	yelloweyed grass	Native	-	-	20	38	14	15
Forb	Xyridaceae	<i>Xyris</i> sp. cf <i>difformis</i>	yellow-eyed grass	Native	10	-	-	8	-	3
Graminoid	Cyperaceae	<i>Carex abscondita</i>	hidden-fruit caric-sedge	Native	-	15	-	-	21	8
Graminoid	Cyperaceae	<i>Carex basiantha</i>	Willdenow's sedge	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Carex complanata</i>	blue sedge	Native	-	-	30	23	-	10
Graminoid	Cyperaceae	<i>Carex debilis</i>	white edge sedge	Native	10	23	30	38	43	30
Graminoid	Cyperaceae	<i>Carex digitalis</i>	slender wood sedge	Native	10	-	-	-	21	7
Graminoid	Cyperaceae	<i>Carex glaucescens</i>	clustered sedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Carex intumescens</i>	greater bladder sedge	Native	-	23	10	38	29	22
Graminoid	Cyperaceae	<i>Carex jorii</i> (including <i>Carex</i> sp. <i>glaucescens</i> or <i>jorii</i>)	cypress swamp sedge	Native	20	23	10	69	29	32
Graminoid	Cyperaceae	<i>Carex leptalea</i>	bristlestalked sedge	Native	20	8	10	-	7	8
Graminoid	Cyperaceae	<i>Carex lonchocarpa</i>	southern long sedge	Native	-	-	10	-	7	3
Graminoid	Cyperaceae	<i>Carex louisianica</i>	Louisiana sedge	Native	-	-	-	15	7	5
Graminoid	Cyperaceae	<i>Carex lupulina</i>	hop sedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Carex planispicata</i>	flat-spiked sedge	Native	-	-	-	8	-	2
Graminoid	Cyperaceae	<i>Carex reniformis</i>	kidneyshape sedge	Native	-	8	-	-	-	2
Graminoid	Cyperaceae	<i>Carex</i> sp.	sedge	Native	20	15	-	-	-	7
Graminoid	Cyperaceae	<i>Carex tribuloides</i>	blunt broom sedge	Native	-	-	10	-	7	3
Graminoid	Cyperaceae	<i>Cyperus entrerianus</i>	woodrush flatsedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Cyperus haspan</i>	haspan flatsedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Cyperus virens</i>	green flatsedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Eleocharis baldwinii</i>	Baldwin's spikerush	Native	-	-	-	8	-	2
Graminoid	Cyperaceae	<i>Eleocharis tuberculosa</i>	conecup spikerush	Native	-	-	10	8	-	3
Graminoid	Cyperaceae	<i>Fuirena breviseta</i>	saltmarsh umbrellasedge	Native	-	-	-	8	7	3
Graminoid	Cyperaceae	<i>Fuirena bushii</i>	Bush's umbrellasedge	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Rhynchospora cephalantha</i>	bunched beaksedge	Native	-	-	-	8	-	2
Graminoid	Cyperaceae	<i>Rhynchospora chalarocephala</i>	loosehead beaksedge	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Rhynchospora corniculata</i>	shortbristle horned beaksedge	Native	10	-	-	8	-	3

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Graminoid	Cyperaceae	<i>Rhynchospora elliottii</i>	Elliott's beaksedge	Native	-	-	-	38	7	10
Graminoid	Cyperaceae	<i>Rhynchospora fascicularis</i>	fascicled beaksedge	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Rhynchospora globularis</i>	globe beakrush	Native	-	8	-	-	-	2
Graminoid	Cyperaceae	<i>Rhynchospora glomerata</i>	clustered beaksedge	Native	10	-	-	31	14	12
Graminoid	Cyperaceae	<i>Rhynchospora gracilentia</i>	slender beaksedge	Native	-	-	-	23	14	8
Graminoid	Cyperaceae	<i>Rhynchospora inexpansa</i>	nodding beaksedge	Native	10	-	10	62	21	22
Graminoid	Cyperaceae	<i>Rhynchospora macrostachya</i>	tall horned beaksedge	Native	-	-	10	-	-	2
Graminoid	Cyperaceae	<i>Rhynchospora mixta</i>	mingled beaksedge	Native	10	15	-	15	14	12
Graminoid	Cyperaceae	<i>Rhynchospora plumosa</i>	plumed beaksedge	Native	-	-	-	8	7	3
Graminoid	Cyperaceae	<i>Rhynchospora rariflora</i>	fewflower beaksedge	Native	-	-	-	23	7	7
Graminoid	Cyperaceae	<i>Rhynchospora recognita</i> (including <i>R. sp. cf. recognita</i>)	globe beaksedge	Native	-	-	-	31	7	8
Graminoid	Cyperaceae	<i>Scleria ciliata</i>	fringed nutrush	Native	-	8	-	-	7	3
Graminoid	Cyperaceae	<i>Scleria georgiana</i>	slenderfruit nutrush	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Scleria muehlenbergii</i>	Muehlenberg's nutrush	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Scleria oligantha</i>	littlehead nutrush	Native	10	15	10	15	7	12
Graminoid	Cyperaceae	<i>Scleria pauciflora</i>	fewflower nutrush	Native	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>Scleria sp.</i>	nutrush	Native	-	23	-	15	21	13
Graminoid	Cyperaceae	<i>Scleria triglomerata</i>	whip nutrush	Native	-	23	40	23	36	25
Graminoid	Cyperaceae	<i>unknownsedge_01_20220524</i>	unknown sedge	Unknown	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220607</i>	unknown sedge	Unknown	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220725</i>	unknown sedge	Unknown	10	-	-	-	-	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220727</i>	unknown sedge	Unknown	10	-	-	-	-	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220808</i>	unknown sedge	Unknown	-	-	-	-	7	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220811</i>	unknown sedge	Unknown	-	8	-	-	-	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220908</i>	unknown sedge	Unknown	10	-	-	-	-	2
Graminoid	Cyperaceae	<i>unknownsedge_01_20220919</i>	unknown sedge	Unknown	-	31	-	-	-	7
Graminoid	Eriocaulaceae	<i>Eriocaulon decangulare</i>	tenangle pipewort	Native	-	-	-	23	7	7
Graminoid	Juncaceae	<i>Juncus coriaceus</i>	leathery rush	Native	10	8	-	-	7	5
Graminoid	Juncaceae	<i>Juncus effusus</i>	common rush	Native	-	-	-	8	-	2

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Graminoid	Juncaceae	<i>Juncus repens</i>	lesser creeping rush	Native	10	-	-	-	-	2
Graminoid	Juncaceae	<i>Juncus tenuis</i>	field rush	Native	-	-	-	-	7	2
Graminoid	Juncaceae	<i>Juncus validus</i>	roundhead rush	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Andropogon dealbatus</i>	wetland white bluestem	Native	-	-	-	15	7	5
Graminoid	Poaceae	<i>Andropogon gyrans</i>	Elliott's bluestem	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Andropogon sp.</i>	bluestem	Native	-	8	-	31	7	10
Graminoid	Poaceae	<i>Andropogon ternarius</i>	splitbeard bluestem	Native	-	-	-	8	7	3
Graminoid	Poaceae	<i>Andropogon virginicus</i>	broom sedge	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Aristida palustris</i>	longleaf threeawn	Native	-	-	-	15	-	3
Graminoid	Poaceae	<i>Aristida purpurascens</i>	arrowfeather threeawn	Native	-	8	-	15	14	8
Graminoid	Poaceae	<i>Arundinaria gigantea</i>	giant cane	Native	-	8	-	-	14	5
Graminoid	Poaceae	<i>Chasmanthium latifolium</i>	inland sea oats	Native	-	-	-	-	14	3
Graminoid	Poaceae	<i>Chasmanthium laxum</i>	slender woodoats	Native	40	69	10	69	14	42
Graminoid	Poaceae	<i>Chasmanthium sessiliflorum</i>	longleaf woodoats	Native	20	62	30	62	36	43
Graminoid	Poaceae	<i>Coelorachis cylindrica</i>	Carolina jointail	Native	-	-	-	8	-	2
Graminoid	Poaceae	<i>Dichanthelium aciculare</i>	narrow-leaved panicgrass	Native	-	23	-	8	14	10
Graminoid	Poaceae	<i>Dichanthelium acuminatum</i>	hairy panicgrass	Native	-	-	30	23	21	15
Graminoid	Poaceae	<i>Dichanthelium boscii</i>	Bosc's panicgrass	Native	40	54	20	8	21	28
Graminoid	Poaceae	<i>Dichanthelium commutatum</i> (including <i>D. sp. boscii</i> or <i>commutatum</i>)	variable panicgrass	Native	-	23	20	23	36	22
Graminoid	Poaceae	<i>Dichanthelium consanguineum</i>	blood panicgrass	Native	-	-	-	8	7	3
Graminoid	Poaceae	<i>Dichanthelium dichotomum</i>	cypress panicgrass	Native	20	38	-	46	29	28
Graminoid	Poaceae	<i>Dichanthelium oligosanthes</i>	few-flower panicgrass	Native	-	15	-	-	-	3
Graminoid	Poaceae	<i>Dichanthelium scabriusculum</i>	woolly rosette grass	Native	-	-	-	23	-	5
Graminoid	Poaceae	<i>Dichanthelium scoparium</i>	velvet panicum	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Dichanthelium sp.</i>	rosette grass	Native	10	38	-	8	-	12
Graminoid	Poaceae	<i>Dichanthelium villosissimum</i>	whitehair rosette grass	Native	-	15	-	-	7	5
Graminoid	Poaceae	<i>Leersia oryzoides</i>	rice cut grass	Native	-	8	-	-	-	2
Graminoid	Poaceae	<i>Leersia virginica</i>	white grass	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Oplismenus hirtellus</i>	wavyleaf basketgrass	Native	10	-	20	-	21	10

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Graminoid	Poaceae	<i>Panicum anceps</i>	beaked panicgrass	Native	10	-	-	-	14	5
Graminoid	Poaceae	<i>Panicum rigidulum</i>	redtop panicgrass	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Panicum tenerum</i>	bluejoint panicgrass	Native	-	-	-	8	7	3
Graminoid	Poaceae	<i>Panicum verrucosum</i>	warty panicgrass	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Panicum virgatum</i>	switchgrass	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Paspalum floridanum</i>	Florida paspalum	Native	-	-	-	8	7	3
Graminoid	Poaceae	<i>Paspalum minus</i>	mat paspalum	Native	-	-	-	8	7	3
Graminoid	Poaceae	<i>Paspalum plicatulum</i>	brownseed paspalum	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Paspalum setaceum</i>	fringeleaf paspalum	Native	-	8	-	-	-	2
Graminoid	Poaceae	<i>Saccharum baldwinii</i>	narrow plumegrass	Native	-	-	-	15	7	5
Graminoid	Poaceae	<i>Schizachyrium scoparium</i>	little bluestem	Native	-	15	-	15	29	13
Graminoid	Poaceae	<i>Schizachyrium tenerum</i>	slender bluestem	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>Tridens ambiguus</i>	pine barren fluffgrass	Native	-	-	-	-	7	2
Graminoid	Poaceae	<i>unknowngrass_01_20220509</i>	unknown grass	Unknown	-	-	-	8	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220511</i>	unknown grass	Unknown	-	-	10	-	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220525</i>	unknown grass	Unknown	-	-	10	-	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220608</i>	unknown grass	Unknown	-	-	10	-	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220609</i>	unknown grass	Unknown	-	-	-	8	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220629</i>	unknown grass	Unknown	-	-	-	15	-	3
Graminoid	Poaceae	<i>unknowngrass_01_20220711</i>	unknown grass	Unknown	-	-	-	-	7	2
Graminoid	Poaceae	<i>unknowngrass_01_20220810</i>	unknown grass	Unknown	-	-	-	-	7	2
Graminoid	Poaceae	<i>unknowngrass_01_20220909</i>	unknown grass	Unknown	-	-	-	8	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20220922</i>	unknown grass	Unknown	-	8	-	-	-	2
Graminoid	Poaceae	<i>unknowngrass_01_20221004</i>	unknown grass	Unknown	-	8	-	-	-	2
Graminoid	Poaceae	<i>unknowngrass_01_2022812</i>	unknown grass	Unknown	-	-	-	8	-	2
Graminoid	Poaceae	<i>unknowngrass_02_20220609</i>	unknown grass	Unknown	-	-	-	8	-	2
Graminoid	Poaceae	<i>unknowngrass_02_20220810</i>	unknown grass	Unknown	-	-	-	-	7	2
Graminoid	Poaceae	<i>unknowngrass_20220907</i>	unknown grass	Unknown	10	-	-	-	-	2
Shrub	Anacardiaceae	<i>Rhus copallinum</i>	winged sumac	Native	-	31	10	-	14	12
Shrub	Annonaceae	<i>Asimina parviflora</i>	smallflower pawpaw	Native	20	62	10	8	21	25

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Shrub	Aquifoliaceae	<i>Ilex coriacea</i>	large gallberry	Native	50	-	20	46	57	35
Shrub	Aquifoliaceae	<i>Ilex decidua</i>	Deciduous holly	Native	-	31	50	-	-	15
Shrub	Aquifoliaceae	<i>Ilex longipes</i>	Georgia holly	Native	-	8	-	-	14	5
Shrub	Aquifoliaceae	<i>Ilex vomitoria</i>	yaupon	Native	80	100	60	100	71	83
Shrub	Araliaceae	<i>Aralia spinosa</i>	Devil's walkingstick	Native	-	-	10	-	-	2
Shrub	Arecaceae	<i>Sabal minor</i>	dwarf palmetto	Native	-	8	20	15	-	8
Shrub	Asteraceae	<i>Baccharis halimifolia</i>	eastern baccharis	Native	-	8	-	-	7	3
Shrub	Berberidaceae	<i>Nandina domestica</i>	nandina	Non-Native	-	8	-	-	-	2
Shrub	Betulaceae	<i>Alnus serrulata</i>	brook-side alder	Native	10	-	-	-	-	2
Shrub	Caprifoliaceae	<i>Viburnum acerifolium</i>	mapleleaf viburnum	Native	-	-	10	-	-	2
Shrub	Caprifoliaceae	<i>Viburnum dentatum</i>	arrowwood	Native	20	23	30	38	7	23
Shrub	Caprifoliaceae	<i>Viburnum nudum</i>	possumhaw	Native	20	8	20	38	21	22
Shrub	Caprifoliaceae	<i>Viburnum rufidulum</i>	black-haw	Native	-	8	10	-	-	3
Shrub	Celastraceae	<i>Euonymus americanus</i>	American strawberry-bush	Native	-	15	-	-	-	3
Shrub	Clethraceae	<i>Clethra alnifolia</i>	coastal sweet pepperbush	Native	-	-	20	-	7	5
Shrub	Cornaceae	<i>Cornus foemina</i>	English dogwood	Native	-	-	10	8	-	3
Shrub	Cyrillaceae	<i>Cyrilla racemiflora</i>	swamp cyrilla	Native	50	8	50	8	64	35
Shrub	Ericaceae	<i>Lyonia ligustrina</i>	maleberry	Native	10	-	-	-	14	5
Shrub	Ericaceae	<i>Rhododendron canescens</i>	mountain azalea	Native	20	-	10	8	14	10
Shrub	Ericaceae	<i>Rhododendron oblongifolium</i>	Texas azalea	Native	-	8	10	-	36	12
Shrub	Ericaceae	<i>Vaccinium arboreum</i>	sparkleberry	Native	50	85	20	38	29	45
Shrub	Ericaceae	<i>Vaccinium corymbosum</i>	highbush blueberry	Native	20	15	-	15	43	20
Shrub	Ericaceae	<i>Vaccinium elliotii</i>	Elliott's blueberry	Native	30	38	40	38	36	37
Shrub	Ericaceae	<i>Vaccinium stamineum</i>	deerberry	Native	-	15	10	-	7	7
Shrub	Euphorbiaceae	<i>Ditrysinia fruticosa</i>	Gulf Sebastian-bush	Native	40	31	-	-	50	25
Shrub	Fabaceae	<i>Cercis canadensis</i>	eastern redbud	Native	-	8	-	-	-	2
Shrub	Grossulariaceae	<i>Itea virginica</i>	Virginia sweetspire	Native	20	8	10	15	-	10
Shrub	Hamamelidaceae	<i>Hamamelis virginiana</i>	American witchhazel	Native	30	15	-	-	14	12
Shrub	Myricaceae	<i>Morella caroliniensis</i>	evergreen bayberry	Native	10	8	10	-	29	12
Shrub	Myricaceae	<i>Morella cerifera</i>	wax myrtle	Native	30	38	30	85	57	50

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Shrub	Oleaceae	<i>Forestiera acuminata</i>	eastern swampprivet	Native	-	-	10	-	7	3
Shrub	Oleaceae	<i>Ligustrum sinense</i>	Chinese ligustrum	Non-Native	10	23	10	-	21	13
Shrub	Rosaceae	<i>Prunus umbellata</i>	flatwood plum	Native	-	-	-	8	-	2
Shrub	Rubiaceae	<i>Cephalanthus occidentalis</i>	buttonbush	Native	-	8	10	38	14	15
Shrub	Rutaceae	<i>Zanthoxylum clava-herculis</i>	Hercules' club	Native	-	8	-	8	-	3
Shrub	Sapotaceae	<i>Sideroxylon lanuginosum</i>	coma	Native	-	8	-	-	-	2
Shrub	Styracaceae	<i>Styrax americanus</i>	American snowbell	Native	-	-	10	-	7	3
Shrub	Verbenaceae	<i>Callicarpa americana</i>	American beautyberry	Native	50	92	40	31	43	52
Tree	Aquifoliaceae	<i>Ilex opaca</i>	American holly	Native	100	92	90	100	71	90
Tree	Betulaceae	<i>Carpinus caroliniana</i>	American hornbeam	Native	40	23	20	-	36	23
Tree	Betulaceae	<i>Ostrya virginiana</i>	eastern hophornbeam	Native	30	31	-	15	14	18
Tree	Cannabaceae	<i>Celtis laevigata</i>	southern hackberry	Native	-	8	-	-	-	2
Tree	Cornaceae	<i>Cornus florida</i>	flowering dogwood	Native	-	54	-	8	-	13
Tree	Cornaceae	<i>Nyssa aquatica</i>	water tupelo	Native	10	-	10	-	14	7
Tree	Cornaceae	<i>Nyssa biflora</i> (including <i>Nyssa</i> sp. <i>biflora</i> or <i>sylvatica</i>)	swamp tupelo	Native	40	31	50	69	64	52
Tree	Cornaceae	<i>Nyssa sylvatica</i>	black gum	Native	70	77	60	46	50	60
Tree	Cupressaceae	<i>Juniperus virginiana</i>	eastern red cedar	Native	-	15	-	-	7	5
Tree	Cupressaceae	<i>Taxodium distichum</i>	bald cypress	Native	-	15	30	-	7	10
Tree	Ebenaceae	<i>Diospyros virginiana</i>	common persimmon	Native	10	-	10	15	7	8
Tree	Euphorbiaceae	<i>Triadica sebifera</i>	Chinese tallow	Non-Native	50	38	80	62	43	53
Tree	Fabaceae	<i>Gleditsia triacanthos</i>	common honeylocust	Native	-	-	10	-	-	2
Tree	Fagaceae	<i>Castanea pumila</i>	chinkapin	Native	-	-	10	8	7	5
Tree	Fagaceae	<i>Fagus grandifolia</i>	American beech	Native	70	38	10	8	14	27
Tree	Fagaceae	<i>Quercus alba</i>	eastern white oak	Native	70	54	40	38	29	45
Tree	Fagaceae	<i>Quercus falcata</i>	southern red oak	Native	10	46	10	15	21	22
Tree	Fagaceae	<i>Quercus hemisphaerica</i>	Darlington oak	Native	40	69	40	15	36	40
Tree	Fagaceae	<i>Quercus laurifolia</i>	laurel oak	Native	70	31	70	69	50	57
Tree	Fagaceae	<i>Quercus lyrata</i>	overcup oak	Native	-	8	10	-	-	3
Tree	Fagaceae	<i>Quercus marilandica</i>	blackjack oak	Native	-	23	-	-	-	5
Tree	Fagaceae	<i>Quercus michauxii</i>	swamp chestnut oak	Native	30	23	50	23	29	30

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Tree	Fagaceae	<i>Quercus muehlenbergii</i>	chinkapin oak	Native	-	-	-	-	7	2
Tree	Fagaceae	<i>Quercus nigra</i>	water oak	Native	70	77	90	85	79	80
Tree	Fagaceae	<i>Quercus pagoda</i>	cherrybark oak	Native	-	23	30	31	21	22
Tree	Fagaceae	<i>Quercus phellos</i>	willow oak	Native	-	23	40	-	14	15
Tree	Fagaceae	<i>Quercus sp.</i>	Oak seedling	Native	40	31	30	8	21	25
Tree	Fagaceae	<i>Quercus stellata</i>	post oak	Native	-	38	-	-	7	10
Tree	Hamamelidaceae	<i>Liquidambar styraciflua</i>	sweetgum	Native	60	92	90	100	86	87
Tree	Juglandaceae	<i>Carya cordiformis</i>	bitternut hickory	Native	-	8	-	-	7	3
Tree	Juglandaceae	<i>Carya glabra</i>	pignut hickory	Native	-	-	10	8	7	5
Tree	Juglandaceae	<i>Carya ovata</i>	shagbark hickory	Native	-	-	-	-	7	2
Tree	Juglandaceae	<i>Carya sp. cf texana</i>	hickory	Native	-	8	-	-	-	2
Tree	Juglandaceae	<i>Carya tomentosa</i>	mockernut hickory	Native	-	31	20	15	-	13
Tree	Lauraceae	<i>Persea borbonia</i>	redbay	Native	30	92	-	62	57	52
Tree	Lauraceae	<i>Persea palustris</i>	swamp bay	Native	30	-	70	38	57	38
Tree	Lauraceae	<i>Sassafras albidum</i>	sassafras	Native	-	31	10	-	7	10
Tree	Magnoliaceae	<i>Magnolia grandiflora</i>	southern magnolia	Native	90	54	50	46	43	55
Tree	Magnoliaceae	<i>Magnolia virginiana</i>	sweetbay magnolia	Native	50	46	50	77	71	60
Tree	Moraceae	<i>Morus rubra</i>	red mulberry	Native	-	-	30	-	7	7
Tree	Oleaceae	<i>Chionanthus virginicus</i>	fringetree	Native	10	-	10	-	-	3
Tree	Oleaceae	<i>Fraxinus americana</i>	white ash	Native	-	23	-	-	-	5
Tree	Oleaceae	<i>Fraxinus caroliniana</i>	Carolina ash	Native	10	-	20	-	7	7
Tree	Oleaceae	<i>Fraxinus pennsylvanica</i>	green ash	Native	30	23	50	46	14	32
Tree	Pinaceae	<i>Pinus echinata</i>	shortleaf pine	Native	-	31	10	-	-	8
Tree	Pinaceae	<i>Pinus palustris</i>	longleaf pine	Native	-	15	-	8	21	10
Tree	Pinaceae	<i>Pinus taeda</i>	loblolly pine	Native	80	85	90	92	86	87
Tree	Rhamnaceae	<i>Frangula caroliniana</i>	Carolina buckthorn	Native	10	38	10	8	-	13
Tree	Rosaceae	<i>Crataegus marshallii</i>	parsley hawthorn	Native	10	31	10	-	-	10
Tree	Rosaceae	<i>Crataegus sp.</i>	hawthorn	Native	20	-	10	31	7	13
Tree	Rosaceae	<i>Crataegus spathulata</i>	littlehip hawthorn	Native	-	8	-	-	-	2
Tree	Rosaceae	<i>Prunus caroliniana</i>	carolina laurel cherry	Native	30	54	10	8	7	22
Tree	Rosaceae	<i>Prunus serotina</i>	black cherry	Native	-	23	20	15	7	13
Tree	Sapindaceae	<i>Acer floridanum</i>	Florida maple	Native	-	8	-	-	-	2
Tree	Sapindaceae	<i>Acer rubrum</i>	red maple	Native	70	54	90	92	64	73

Growth Form	Family	Scientific Name	Common Name	Nativity	Freq. in BC Plots (% of 10)	Freq. in BS Plots (% of 13)	Freq. in JG Plots (% of 10)	Freq. in LR Plots (% of 13)	Freq. in TC Plots (% of 14)	Freq. overall (% of 60)
Tree	Styracaceae	<i>Halesia diptera</i>	twowing silverbell	Native	10	-	-	-	14	5
Tree	Symplocaceae	<i>Symplocos tinctoria</i>	common sweetleaf	Native	60	23	60	77	50	53
Tree	Ulmaceae	<i>Planera aquatica</i>	planertree	Native	-	-	10	-	7	3
Tree	Ulmaceae	<i>Ulmus alata</i>	winged elm	Native	20	31	-	-	21	15
Tree	Ulmaceae	<i>Ulmus americana</i>	American elm	Native	-	-	20	-	-	3
Vine	Anacardiaceae	<i>Toxicodendron radicans</i>	eastern poison ivy	Native	20	46	40	77	50	48
Vine	Apocynaceae	<i>Matelea gonocarpus</i>	angularfruit milkvine	Native	-	-	10	-	-	2
Vine	Apocynaceae	<i>Trachelospermum difforme</i>	climbing dogbane	Native	-	-	20	-	-	3
Vine	Asteraceae	<i>Mikania scandens</i>	climbing hempvine	Native	-	-	20	-	7	5
Vine	Bignoniaceae	<i>Bignonia capreolata</i>	cross vine	Native	60	62	70	62	43	58
Vine	Bignoniaceae	<i>Campsis radicans</i>	common trumpet-creeper	Native	-	8	20	15	-	8
Vine	Caprifoliaceae	<i>Lonicera japonica</i>	Japanese honeysuckle	Non-Native	-	-	-	-	7	2
Vine	Cucurbitaceae	<i>Cayaponia quinqueloba</i>	fivelobe cucumber	Native	-	-	10	-	-	2
Vine	Cuscutaceae	<i>Cuscuta sp.</i>	dodder	Native	-	-	-	-	7	2
Vine	Dioscoreaceae	<i>Dioscorea villosa</i>	wild yam	Native	-	8	-	-	-	2
Vine	Fabaceae	<i>Centrosema virginianum</i>	butterflypea	Native	-	8	-	-	-	2
Vine	Fabaceae	<i>Galactia volubilis</i>	downy milkpea	Native	-	15	-	-	7	5
Vine	Fabaceae	<i>Rhynchosia latifolia</i>	broadleaf snoutbean	Native	-	-	-	-	7	2
Vine	Fabaceae	<i>Strophostyles umbellata</i>	perennial wildbean	Native	-	8	-	-	7	3
Vine	Fabaceae	<i>Wisteria frutescens</i>	American wisteria	Native	10	8	10	-	-	5
Vine	Loganiaceae	<i>Gelsemium sempervirens</i>	Carolina jessamine	Native	80	85	60	69	43	67
Vine	Lygodiaceae	<i>Lygodium japonicum</i>	Japanese climbing fern	Non-Native	20	31	30	23	43	30
Vine	Passifloraceae	<i>Passiflora lutea</i>	passion flower	Native	-	38	-	8	7	12
Vine	Polygonaceae	<i>Brunnichia ovata</i>	Redvine	Native	-	-	20	-	14	7
Vine	Rhamnaceae	<i>Berchemia scandens</i>	Alabama supplejack	Native	10	31	10	23	-	15
Vine	Rosaceae	<i>Rubus argutus</i>	prickly Florida blackberry	Native	10	15	-	31	7	13
Vine	Rosaceae	<i>Rubus sp.</i>	brambleberry	Native	20	15	40	31	43	30
Vine	Rosaceae	<i>Rubus trivialis</i>	dewberry	Native	-	-	10	-	-	2
Vine	Smilacaceae	<i>Smilax bona-nox</i>	saw greenbrier	Native	-	31	10	-	7	10
Vine	Smilacaceae	<i>Smilax glauca</i>	cat greenbrier	Native	80	92	90	54	79	78
Vine	Smilacaceae	<i>Smilax laurifolia</i>	laurel greenbrier	Native	30	15	30	62	50	38

Growth Form	Family	Scientific Name	Common Name	Nativity	Freq. in BC Plots (% of 10)	Freq. in BS Plots (% of 13)	Freq. in JG Plots (% of 10)	Freq. in LR Plots (% of 13)	Freq. in TC Plots (% of 14)	Freq. overall (% of 60)
Vine	Smilacaceae	<i>Smilax pumila</i>	sarsaparilla vine	Native	40	62	40	38	29	42
Vine	Smilacaceae	<i>Smilax rotundifolia</i>	common greenbrier	Native	80	77	70	77	57	72
Vine	Smilacaceae	<i>Smilax smallii</i>	lance-leaf greenbrier	Native	40	62	20	38	21	37
Vine	Vitaceae	<i>Nekemias arborea</i>	peppervine	Native	-	-	20	-	-	3
Vine	Vitaceae	<i>Parthenocissus quinquefolia</i>	Virginia creeper	Native	30	38	40	8	29	28
Vine	Vitaceae	<i>Vitis aestivalis</i>	summer grape	Native	-	23	20	8	14	13
Vine	Vitaceae	<i>Vitis cinerea</i>	winter grape	Native	-	-	10	-	-	2
Vine	Vitaceae	<i>Vitis palmata</i>	catbird grape	Native	-	8	-	-	-	2
Vine	Vitaceae	<i>Vitis rotundifolia</i>	muscadine	Native	80	85	90	69	57	75

Appendix E: Plot-Level Summaries for Richness and Tree Metrics

Table E1. Species richness (*R*) of 400-m² plots from 2022 sampling at Big Thicket National Preserve. Richness counts were based on all taxa, including those that were fully identified, identified only to genus, or unidentified, which may slightly inflate counts. Plants were counted if they were within the three-dimensional volume of the plot, from ground level through the canopy, including those rooted in, overhanging, or prostrate across plots. The forb growth form includes all herbaceous non-graminoid angiosperms plus ferns. Totals in the All Species *R* column includes natives, non-natives and unidentified species with unknown nativity status. The last column is the average richness of eight 1-m² quadrats per plot, counting all plants from ground level through the canopy. Cumulative values represent combined species lists across plots within units or across all plots. Plot IDs with "B" are the four non-random, targeted plots.

Plot ID, Vegetation Class	All Species <i>R</i> 400-m ²	Non-Native <i>R</i> 400-m ²	Forb <i>R</i> 400-m ²	Graminoid <i>R</i> 400-m ²	Shrub <i>R</i> 400-m ²	Vine <i>R</i> 400-m ²	Tree <i>R</i> 400-m ²	All Species Mean <i>R</i> 1-m ²
BC_01, Mesic Lower Slope	30	1	4	1	4	11	10	6
BC_02, Floodplain Hardwood	54	1	9	13	7	7	18	8
BC_03, Baygall	54	1	18	5	10	7	14	7
BC_04, Baygall	29	1	4	1	7	6	11	6
BC_05, Mesic Lower Slope	19	0	1	0	2	2	14	6
BC_06, Mesic Lower Slope	41	2	7	4	6	8	16	5
BC_07, Mesic Lower Slope	31	0	1	2	8	5	15	7
BC_08, Mesic Lower Slope	27	0	2	1	5	6	13	6
BC_09, Wet Flat. Pine-Hardwood	23	1	5	4	3	2	9	3
BC_10, Floodplain Hardwood	34	1	2	3	7	5	17	5
Beech Creek All Plots Mean	34	1	5	3	6	6	14	6
Beech Creek All Plots Cumulative	123	3	33	23	20	14	33	-
BS_01, Mesic Lower Slope	31	0	2	1	4	10	14	13
BS_02, Floodplain Hardwood	80	3	21	12	15	11	21	9
BS_03, Floodplain Hardwood	57	2	5	10	9	9	24	7
BS_04, Floodplain Hardwood	43	2	4	11	5	8	15	4
BS_05, Mesic Lower Slope	19	0	0	0	5	4	10	7
BS_06, Mesic Lower Slope	34	0	2	5	5	9	13	6
BS_07, Dry Upper Slope	54	0	11	8	10	9	16	11
BS_08, Dry Upper Slope	63	2	13	7	7	11	25	8
BS_09, Mesic Lower Slope	39	1	3	6	7	8	15	6
BS_10, Mesic Lower Slope	39	0	4	4	5	9	17	7
BS_11, Dry Upper Slope	44	2	4	5	7	8	20	5
BS_12, Dry Upper Slope	43	1	3	7	7	8	18	8
BS_13B, Dry Upland Pine	61	0	24	10	10	7	10	13
Big Sandy Primary Plots Mean	46	1	6	6	7	9	17	7
Big Sandy Primary Plots Cumulative	164	4	41	29	27	22	45	-
Big Sandy All Plots Cumulative	191	4	60	33	30	23	45	-
JG_01, Mesic Lower Slope	34	1	1	3	7	5	18	7
JG_02, Floodplain Hardwood	41	2	2	2	8	10	19	9
JG_03, Floodplain Hardwood	71	3	30	6	4	13	18	10
JG_04, Baygall	42	1	7	2	10	8	15	6
JG_05, Floodplain Hardwood	39	1	3	9	5	7	15	6
JG_06, Floodplain Hardwood	47	2	15	3	3	11	15	5
JG_07, Wet Flat. Pine-Hardwood	41	1	4	5	10	6	16	6
JG_08, Baygall	26	1	4	4	3	5	10	4
JG_09, Mesic Lower Slope	36	0	3	3	6	7	17	7
JG_10, Cypress Tupelo	36	1	18	3	3	1	11	7
Jack Gore Baygall All Plots Mean	41	1	9	4	6	7	15	7
Jack Gore Baygall All Plots Cumulative	176	4	57	26	28	22	43	-
LR_01, Mesic Lower Slope	40	0	5	12	5	5	13	6
LR_02, Wet Flat. Pine-Hardwood	57	1	15	17	6	6	13	9

Plot ID, Vegetation Class	All Species <i>R</i> 400-m ²	Non- Native <i>R</i> 400-m ²	Forb <i>R</i> 400-m ²	Graminoid <i>R</i> 400-m ²	Shrub <i>R</i> 400-m ²	Vine <i>R</i> 400-m ²	Tree <i>R</i> 400- m ²	All Species Mean <i>R</i> 1-m ²
LR_03, Wet Flat. Pine-Hardwood	48	1	7	8	11	8	14	7
LR_04, Wet Flat. Pine-Hardwood	56	2	7	14	9	8	18	7
LR_05, Wet Flat. Pine-Hardwood	43	1	10	10	5	6	12	9
LR_06, Wet Flat. Pine-Hardwood	54	1	14	11	5	8	16	11
LR_07, Mesic Lower Slope	45	2	7	6	6	10	16	8
LR_08, Wet Flat. Pine-Hardwood	51	1	11	15	4	8	13	6
LR_09, Mesic Lower Slope	27	0	1	2	5	4	15	5
LR_10, Wet Flat. Pine Savanna	66	1	29	12	6	6	13	8
LR_11, Wet Pine Gallberry	23	0	1	2	4	6	10	4
LR_12, Mesic Lower Slope	32	1	1	3	6	9	13	5
LR_13B, Wet Flat. Pine Savanna	61	0	30	18	3	2	8	10
Lance Rosier Primary Plots Mean	45	1	9	6	7	7	14	7
Lance Rosier Primary Plots Cumulative	170	2	62	41	19	16	32	-
Lance Rosier All Plots Cumulative	192	2	173	74	50	19	33	-
TC_01, Cypress Tupelo	61	8	26	16	3	4	12	7
TC_02, Baygall	50	0	10	5	12	8	15	6
TC_03, Floodplain Hardwood	60	2	9	9	11	9	22	11
TC_04, Floodplain Hardwood	46	4	9	10	4	9	14	7
TC_05, Floodplain Hardwood	52	2	10	11	5	9	17	8
TC_06, Mesic Lower Slope	31	0	2	2	8	3	16	5
TC_07, Wet Pine Gallberry	36	0	4	9	8	3	12	6
TC_08, Floodplain Hardwood	49	3	5	5	10	9	20	6
TC_09, Wet Pine Gallberry	16	0	4	0	3	2	7	4
TC_10, Mesic Lower Slope	34	0	1	3	11	3	16	7
TC_11, Wet Pine Gallberry	18	0	3	1	7	1	6	3
TC_12, Baygall	50	1	13	11	10	7	9	9
TC_13B, Dry Upland Pine	81	1	32	15	11	11	12	12
TC_14B, Wet Flat. Pine Savanna	73	0	40	25	2	1	5	15
Turkey Creek Primary Plots Mean	41	2	8	7	8	6	14	7
Turkey Creek Primary Plots Cumulative	173	9	50	41	25	16	41	-
Turkey Creek All Plots Cumulative	271	9	110	70	27	19	45	-
All Preserve Primary Plots Mean	42	1	7	6	7	7	15	7
All Preserve Primary Plots Cumulative	367	10	155	83	39	30	60	-
All Preserve All Plots Cumulative	445	10	202	111	41	31	60	-

Table E2. Tree and regeneration metrics from each Gulf Coast Network vegetation monitoring plot in Big Thicket National Preserve. Adult tree data were collected for all trees ≥ 10 cm DBH in the 400-m² plot, and regeneration data (seedling and sapling densities) were collected in a 40-m² area of the plot (four 10-m² microplots). Plot IDs with "B" are the four non-random, targeted plots. Total juvenile tree counts exclude recent germinants (see main text for more details). *Only one live tree in plot.

Plot ID, Vegetation Class	Basal Area (m ² /ha)	Live Tree Stems /ha	Standing Dead Trees /ha	Mean Max. Height	Canopy Closure	Mean DBH (cm)	Recent Germinant Density /m ²	Seedling Density /m ²	Sapling Density /m ²	Total Juvenile Tree Density /m ²
BC_01, Mesic Lower Slope	13.6	425	0	16.7	95	17.3	3.95	1.13	0.45	1.58
BC_02, Floodplain Hardwood	22.4	650	75	20.7	94	17.9	0.95	0.48	0.20	0.68
BC_03, Baygall	32.6	800	25	18.0	95	20.7	0.85	0.43	0.05	0.48
BC_04, Baygall	25.6	650	75	28.7	96	18.9	0.35	0.4	0.03	0.43
BC_05, Mesic Lower Slope	52.0	1075	50	30.0	92	22.8	0.08	0.00	0.10	0.10
BC_06, Mesic Lower Slope	30.7	475	25	21.3	95	27.6	0.18	0.13	0.03	0.15
BC_07, Mesic Lower Slope	19.5	400	0	17.0	96	22.6	0.40	0.3	0.28	0.58
BC_08, Mesic Lower Slope	24.8	450	25	22.0	95	21.9	3.43	0.38	0.35	0.73
BC_09, Wet Flat. Pine-Hardwood	15.4	350	50	24.3	86	21.5	0.30	0.38	0.03	0.40
BC_10, Floodplain Hardwood	34.2	475	0	22.3	96	25.7	0.15	0.15	0.38	0.53
BS_01, Mesic Lower Slope	39.4	425	75	33.7	97	30.0	0.85	0.23	0.03	0.25
BS_02, Floodplain Hardwood	26.3	700	0	21.3	97	19.9	0.58	0.7	0.40	1.10
BS_03, Floodplain Hardwood	14.2	475	25	20.0	93	17.3	0.50	0.45	0.10	0.55
BS_04, Floodplain Hardwood	26.3	650	25	23.0	95	20.8	0.10	0.03	0.15	0.18
BS_05, Mesic Lower Slope	28.2	625	50	21.0	97	22.5	0.65	1.28	0.13	1.40
BS_06, Mesic Lower Slope	26.2	425	50	27.3	97	26.0	0.23	0.45	0.00	0.45
BS_07, Dry Upper Slope	22.4	500	0	19.7	82	21.9	0.30	0.48	0.13	0.60
BS_08, Dry Upper Slope	23.5	475	125	26.0	92	22.2	0.75	0.53	0.25	0.78
BS_09, Mesic Lower Slope	15.6	525	25	21.3	96	17.5	1.40	0.63	0.10	0.73
BS_10, Mesic Lower Slope	27.1	625	100	29.3	97	20.9	1.60	0.88	0.10	0.98
BS_11, Dry Upper Slope	29.2	450	0	29.0	96	26.2	0.40	0.65	0.05	0.70
BS_12, Dry Upper Slope	21.9	525	100	22.3	87	21.4	0.05	0.15	0.00	0.15
BS_13B, Dry Upland Pine*	2.9	25	50	29.0	7	38.5	0.20	1.33	0.00	1.33
JG_01, Mesic Lower Slope	21.1	825	0	20.3	92	17.1	0.48	0.45	0.30	0.75
JG_02, Floodplain Hardwood	29.3	500	0	23.0	93	22.5	1.58	0.63	0.23	0.85
JG_03, Floodplain Hardwood	25.7	700	125	22.0	90	18.0	1.15	1.18	0.05	1.23
JG_04, Baygall	17.4	425	25	20.0	94	20.6	1.85	0.05	0.00	0.05
JG_05, Floodplain Hardwood	30.4	800	0	25.3	95	19.3	0.33	0.05	0.28	0.33
JG_06, Floodplain Hardwood	29.7	975	0	22.0	96	16.5	0.48	0.13	0.30	0.43
JG_07, Wet Flat. Pine-Hardwood	25.5	825	0	15.8	86	17.7	0.48	0.93	0.13	1.05
JG_08, Baygall	16.5	675	50	16.0	91	16.3	0.10	0.10	0.25	0.35
JG_09, Mesic Lower Slope	62.8	625	25	38.7	92	32.0	0.05	0.10	0.10	0.20
JG_10, Cypress Tupelo	75.2	1275	25	24.3	92	24.1	1.05	0.28	0.05	0.33
LR_01, Mesic Lower Slope	40.1	625	100	27.7	93	24.6	0.43	0.45	0.10	0.55
LR_02, Wet Flat. Pine-Hardwood	30.9	850	25	20.3	94	20.1	0.45	0.20	0.40	0.6
LR_03, Wet Flat. Pine-Hardwood	27	675	25	22.3	93	19.7	0.35	0.75	0.33	1.08

Plot ID, Vegetation Class	Basal Area (m ² /ha)	Live Tree Stems /ha	Standing Dead Trees /ha	Mean Max. Height	Canopy Closure	Mean DBH (cm)	Recent Germinant Density /m ²	Seedling Density /m ²	Sapling Density /m ²	Total Juvenile Tree Density /m ²
LR_04, Wet Flat. Pine-Hardwood	22.2	525	25	21.0	92	21.0	1.25	0.68	0.08	0.75
LR_05, Wet Flat. Pine-Hardwood	30.1	1275	0	18.0	93	16.6	0.55	0.05	0.18	0.23
LR_06, Wet Flat. Pine-Hardwood	21.5	1000	0	16.7	90	15.7	1.10	0.55	0.30	0.85
LR_07, Mesic Lower Slope	15.6	550	25	11.3	94	16.9	0.88	0.35	0.03	0.38
LR_08, Wet Flat. Pine-Hardwood	61.6	850	50	27.7	91	27.5	0.68	0.30	0.23	0.53
LR_09, Mesic Lower Slope	35.4	500	25	21.7	92	26.5	0.30	0.28	0.03	0.30
LR_10, Wet Flat. Pine Savanna	14.3	600	0	18.7	93	16.5	0.33	0.75	0.33	1.08
LR_11, Wet Pine Gallberry	30.2	625	100	22.7	93	22.3	0.35	0.28	0.28	0.55
LR_12, Mesic Lower Slope	19.7	275	0	18.7	97	26.6	0.08	0.08	0.08	0.15
LR_13B, Wet Flat. Pine Savanna	13.9	425	0	16.7	47	19.2	0.10	0.13	0.18	0.30
TC_01, Cypress Tupelo	70.1	700	50	32.0	98	32.3	0.25	0.00	0.05	0.05
TC_02, Baygall	17.2	625	50	11.8	85	16.7	0.18	0.23	0.23	0.45
TC_03, Floodplain Hardwood	15.7	650	0	14.7	92	16.7	1.53	0.45	0.20	0.65
TC_04, Floodplain Hardwood	47.1	700	0	30.1	95	23.8	0.38	0.00	0.00	0.00
TC_05, Floodplain Hardwood	40.2	400	0	28.3	96	27.6	1.23	0.10	0.05	0.15
TC_06, Mesic Lower Slope	21.9	475	0	26.0	95	20.6	0.10	0.18	0.05	0.23
TC_07, Wet Pine Gallberry	12.8	325	0	21.7	67	20.9	0.05	0.25	0.08	0.33
TC_08, Floodplain Hardwood	18.5	725	0	18.0	93	16.7	0.80	0.10	0.35	0.45
TC_09, Wet Pine Gallberry	39	875	25	27.0	91	21.2	0.55	1.90	0.00	1.90
TC_10, Mesic Lower Slope	23.1	675	25	19.5	94	19.0	0.30	0.53	0.10	0.63
TC_11, Wet Pine Gallberry	2.5	200	75	9.0	87	12.6	0.00	0.03	0.00	0.03
TC_12, Baygall	5.1	75	25	10.7	48	25.6	1.03	0.73	0.13	0.85
TC_13B, Dry Upland Pine	49.9	550	0	31.0	56	33.4	0.13	1.18	0.10	1.28
TC_14B, Wet Flat. Pine Savanna*	1.0	25	0	10.0	8	22.7	0.15	0.20	0.00	0.20