FLORISTICS OF DIFFICULT CREEK NATURAL AREA PRESERVE: A PIEDMONT MAFIC WOODLAND COMPLEX IN HALIFAX COUNTY, VIRGINIA, U.S.A.

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ABSTRACT

The 331-hectare (819-acre) Difficult Creek Natural Area Preserve (DCNAP) was established in Halifax County, Virginia to protect and manage habitat for rare vascular plant species and animals, and to restore plant communities. Mafic metavolcanic rocks of the Virgilina Formation and felsic metavolcanic and metasedimentary rocks of the Aaron Formation comprise the geologic units on the preserve. The Virgilina-derived soils have high shrink-swell potential, a dense hardpan layer, relatively high base status, and a significant gravelly or stony component; these soil conditions support the highest density of rare plant species known on the preserve. The first noteworthy vascular plant species were documented from the property in 1972 by botanist Alton Harvill of Longwood University, but detailed investigations of the flora did not begin until the site was revisited by the second author in 1993. Rare plant inventory has been the primary focus of botanists since that time. In 2001, the property was acquired by the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR) and dedicated as a state Natural Area Preserve, at which point active management for natural communities and associated rare species was initiated. Since the rare plants on site thrive in open woodland or savanna-like conditions, prescribed burns and timber harvests have been used by DCR stewards to restore habitat after decades of fire suppression and conversion of hardwood stands to loblolly pine plantations. In 2018, a thorough floristic study was initiated to highlight the significance of this flora beyond the documentation of rare plants. The two-year inventory documented 653 plant taxa, comprising 326 genera in 106 families. Fourteen of these species are of conservation concern at the global or state level; an additional 12 taxa are considered uncommon and of potential conservation concern (Townsend 2019). These rare or uncommon species are components of two globally rare plant communities. In addition, the globally rare lepidopteran, *Erynnis martialis* (Mottled Duskywing), occurs on the preserve, the only extant population known in Virginia. Due to agricultural impacts and widespread fire exclusion, few analogs to this flora exist within the southern Piedmont of Virginia.

RESUMEN

La "Difficult Creek Natural Area Preserve (DCNAP)" de 331 hectáreas (819 acres) se estableció en el condado de Halifax County, Virginia para proteger y gestionar el hábitat de especies de plantas vasculares raras y animales, y para restaurar comunidades vegetales. Las unidades geológicas de la reserva comprenden rocas metavolcánicas máficas de la Formación Virgilina y las metavolcánicas félsicas y metasedimentarias de la Formación Aaron. Los suelos derivados de la Virgilina tienen gran potencial de contracción-expansión, una capa caliza densa, son relativamente ricos en bases, y tienen un componente importante de gravas o piedras; estas condiciones del suelo soportan la alta densidad de especies vegetales raras que se conocen en la reserva. Las primeras especies de plantas vasculares importantes se documentaron de la propiedad en 1972 por el botánico Alton Harvill de la Universidad de Longwood, pero las investigaciones detalladas de la flora no empezaron hasta que el lugar fue revisitado por el segundo autor en 1993. El inventario de plantas raras ha sido el foco primario de los botánicos desde aquel tiempo. En 2001, la propiedad fue adquirida por el "Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR)" y dedicado a "Natural Area Preserve", en cuyo momento se inició la gestión activa de las comunidades naturales y especies asociadas raras. Como las plantas raras se desarrollan en condiciones de arbolado abierto o semejantes a sabana, los incendios prescritos y recogida de madera se han usado por los gestores del DCR para restaurar el hábitat después de décadas de supresión del fuego y conversión de arboledas de caducifolios en plantaciones de pinos (P. taeda). En 2018, se inició un estudio florístico riguroso para resaltar la importancia de esta flora más allá de la documentación de plantas raras. El inventario de dos años documentó 653 taxa de plantas, que comprenden 326 géneros de 106 familias. Catorce de estas especies tienen preocupación de conservación a nivel global o estatal; 12 taxa adicionales se consideran poco comunes y de potencial preocupación de conservación (Townsend 2019). Estas especies raras o poco comunes son componentes de dos comunidades vegetales globalmente raras. Además, la mariposa rara, *Erynnis martialis* (Mottled Duskywing), está en la reserva, la única población existente conocida de Virginia. Debido a impactos de la agricultura y exclusión del fuego generalizado, existen pocas analogías con esta flora en el Piamonte del sur de Virginia.

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INTRODUCTION

The earliest European explorers to visit the southern Piedmont of Virginia described the landscape as a mix of forests and open habitats, the latter of which they often ascribed to the industry of native peoples. Reflecting on these accounts, Hu Maxwell (1910), forester, author, and historian, remarked, "The opinion that Virginia at the time it first became known to white men was covered with vigorous and unbroken forest is erroneous. The proof of this is found in the writings of explorers and early histories."

Land clearing and maintenance of vegetation with fire by Native Americans in Virginia and neighboring states is well-documented (Fowler & Konopik 2007; Nowacki & Abrams 2008) and its use as a tool undoubtedly augmented the natural fire return interval, maintaining or expanding habitats that are now extremely rare in the region. The following excerpts from explorers' accounts focus exclusively on the open or savanna-like habitats they encountered in the southern Virginia Piedmont since these observations are germane to the discussion of plant communities and heliophytic rare species found at DCNAP. But these same accounts confirm that a wide range of habitats types—from well forested to "barren"—were observed.

Johann Lederer, a German physician and explorer employed by Governor William Berkeley, provided observations of the southern Piedmont in 1670. His account of a 50-mile trip to the village of "Akenatzy" (Occaneechi Islands near present-day Clarksville on the Staunton River) included observations near Difficult Creek (Cumming 1991). In one excerpt from this narrative, he noted "The Countrey here, though high, is level, and for the most part a rich soyl, as I judged by the growth of the Trees; yet where it is inhabited by Indians, it lies open in spacious Plains." Another observation in this area continues on the same theme: "The Country here, by the industry of these Indians, is very open, and clear of wood" (Cumming 1991).

Robert Beverly, brother in law of William Byrd II (see below), similarly declared of the Virginia Piedmont: "In some Places lie great Plats of low and very rich Ground, well Timber'd; in others, large Spots of Meadows and Savanna's, wherein are Hundreds of Acres without any Tree at all; but yield Reeds and Grass of incredible Height:" (Beverly 1705).

William Byrd II provided extensive observations in this region while conducting his survey of the boundary line between North Carolina and Virginia, including areas just south of DCNAP (Byrd & Ruffin 1841). In addition to his general mention of "forests," he also described extensive canebrakes, burned lands, thin woods, open ground, stony hills, "barren grounds, clothed with little timber" or "very thin of trees," areas with "hardly a tree of tolerable growth within view," and forested areas free of undergrowth. The effects of fire on this landscape were either strongly implied or specifically noted. Some entries refer specifically to the impacts of native peoples on the landscape as well as fluctuations in tribal societies: "… we were surprised with an opening of large extent, where the Sauro Indians once lived, who had been a considerable nation. But the frequent inroads of the Senecas annoyed them incessantly, and obliged them to remove from this fine situation about thirty years ago" (Byrd & Ruffin 1841).

Despite the open conditions and ease of travel Byrd sometimes described, he also encountered impenetrable thickets of shrubs, saplings, and vines, at least some of which were the result of abandonment of formerly cleared or cultivated grounds (Byrd & Ruffin 1841). Byrd described these transitional vegetation types as the bane of his survey effort.

Similar observations made by explorers in the Piedmont of the Carolinas have been adequately addressed in botanical studies elsewhere (e.g., Barden 1997; Davis et al. 2002). These botanical studies are very likely applicable to the study area's region as well but are not directly addressed in favor of highlighting the Virginia-specific observations included here.

Given the occurrence of lightning-caused fires, the long history of anthropogenic fire in the southeast, and millennia of shifting vegetation types due to climate (Aldrich et al. 2010; Kneller & Peteet 1993), the effects of natural phenomena such as lightning strikes and wind damage cannot be separated from human impacts when reading these explorers' accounts. Fowler and Konopik (2007) take a similar view over a much broader area: "In the South's fire-adapted ecosystems, their relationship [fire and people] is extremely intimate to the degree that they are inseparable." These forces have helped shape the flora of the southern Piedmont of Virginia and molded the landscape seen by the colonists.

Frost (1998) estimates a presettlement fire frequency of 4–12 years for this section of the southern Piedmont. The presence of large populations of highly conservative, light-demanding species such as *Cirsium carolinianum, Echinacea laevigata,* and *Eryngium yuccifolium* at DCNAP indicates better than any other measure that suitable habitat existed in the area long before the widespread landscape impacts associated with European settlement.

Early observers ascribed many open habitat types to the work of native peoples, but existing disturbance patterns would also have played a role in their formation, particularly in areas where soil characteristics cause drought-prone plants to be physiologically stressed. Prescribed burning and timber management are the principal management tools used at DCNAP to approximate these historic disturbance patterns and restore habitats that have largely vanished from the southern Piedmont of Virginia and the Carolinas.

Location, Topography, and Climate

Difficult Creek Natural Area Preserve (DCNAP) is centered at approximately N 36°45'18," W 78°43'50" and is located in the southern Piedmont County of Halifax, Virginia, approximately 12 miles east-northeast of the city of South Boston (Fig. 1). This 331-hectare (819-acre) property is bounded on the east by Difficult Creek, a tributary of the Staunton (Roanoke) River, on the west by Hall Branch of Buckhorn Creek, and on the south by VA Rt. 344 (MacDonald Road). It is bisected on a northeast-southwest axis by Allen's Mill Road (VA Rt. 719), a thoroughfare described as early as 1745 land patent documents as Coleman's Mill Road (Virginia Land Office 2019) and which follows the highest elevations on the property. A Dominion Energy transmission line crosses a large section of the preserve and a narrow distribution line passes through the preserve's extreme northern end. A natural gas pipeline operated by Transcontinental Gas Pipeline Corporation is located near the southwestern end of the property.

Topography is rolling with an elevation range of 100–176 m (330–530 ft) with slopes ranging from 0–10%. Several intermittent streams originate from the ridge forming the long axis of the preserve (roughly corresponding to Allens Mill Road). These small drainage features extend to the southeast and northwest of the road, providing minimal wetland habitat. Approximately 3 miles downstream from DCNAP, Difficult Creek drains into the Staunton (Roanoke) River, which soon becomes impounded by the John. H. Kerr Reservoir.

Halifax County experiences hot, humid summers and generally mild, cool winters, with rainfall peaking during the summer months and totaling 43 inches annually. Average high temperature is 86.6 Fahrenheit (30.3 C) in July and the average low is 26.6 Fahrenheit (-3.0 C) in January) (Southeast Regional Climate Center 2019).

Geology

The preserve is located within the Carolina Terrane, a geologic unit extending from Virginia to Georgia; it contains rocks of both volcanic and sedimentary origins. A northeast-southwest trending syncline that underlies the preserve includes geologic units mapped as the Virgilina and Aaron Formations, referred to in previous publications as "Virgilina Greenstone" and "Aaron Slate" (Bailey et al. 2016).

The Virgilina Formation is composed largely of greenish, schistose, mafic metavolcanic rocks as well as minor amounts of metavolcanic sandstone and schistose or phyllitic, felsic metavolcanic rocks. Rocks of this formation are generally more resistant to weathering than surrounding formations and are therefore associated with higher elevations on the preserve. Soils weathered from this parent material tend to be thin and clay-rich. Essential minerals isolated from this metavolcanic material include tremolite-actinolite, chlorite, and epidote, with accessory minerals of plagioclase, white mica, magnetite, ilmenite, talc, and quartz. Concentrations of calcium and magnesium in rocks of the Virgilina formation are often significantly higher than those of the adjoining Aaron Formation (Bailey et al. 2016; Kreisa 1980). The color and appearance of surface rocks hints at the heterogenous nature of this geologic unit. Blue-green, greenish, purplish, or grayish metavolcanic rocks are most often encountered (Figs. 2 & 3), but significant numbers of pale-colored metasedimentary rocks are also exposed as well as a significant amount of quartz. The darker rocks of this group have an obvious schistose quality.

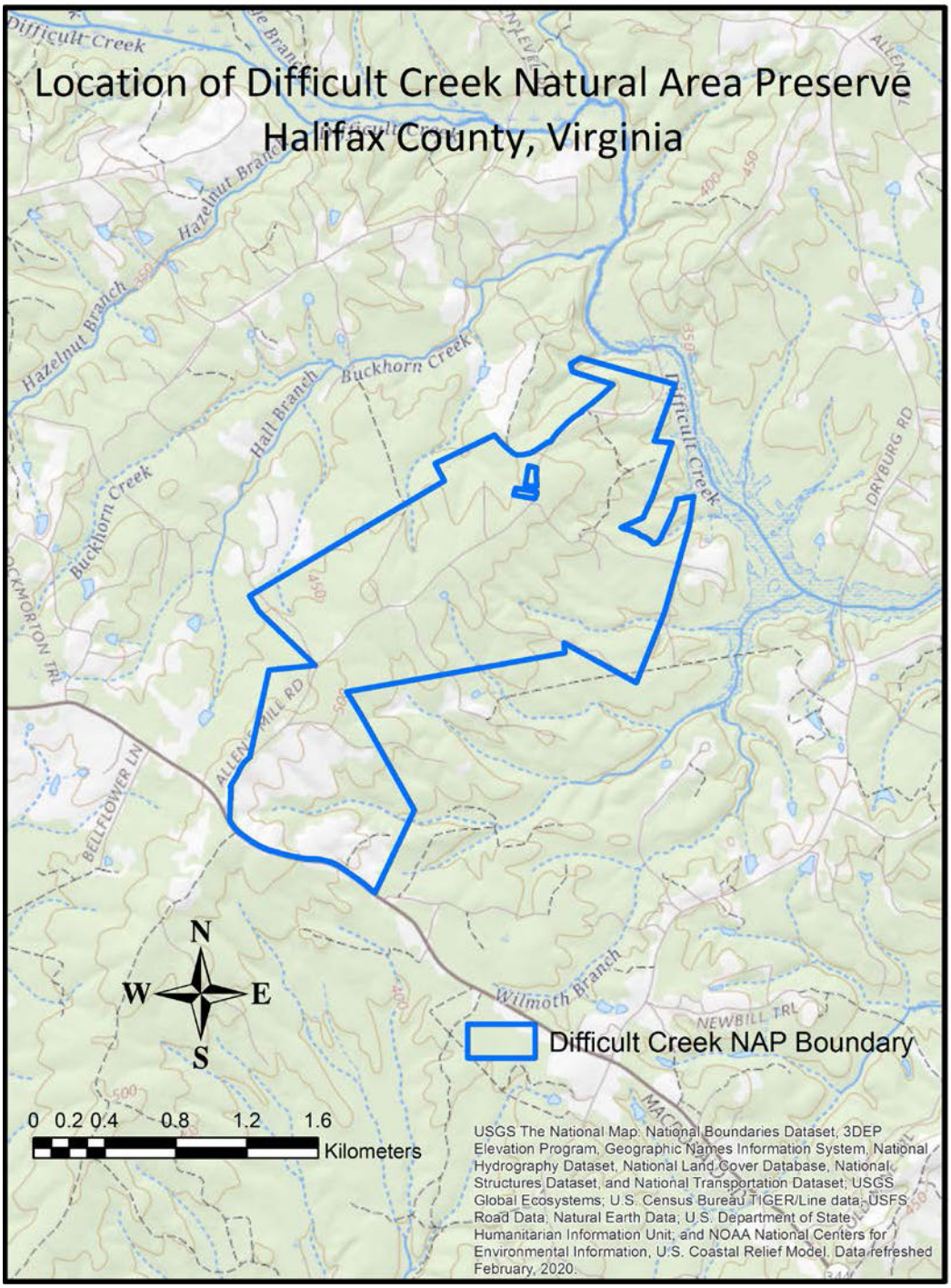

Fig. 1. Location of Difficult Creek Natural Area Preserve, Halifax County, Virginia

Fig. 2. Typical exposure of Virgilina Formation parent material. Photo by John Townsend (2019).

The Aaron Formation typically contains a sequence of metamorphosed clastic rocks that overlies the Hyco Formation and includes slate, phyllite, metasandstone, metaconglomerate, and shale with a lesser metavolcanic component. Most of these rocks display a slaty cleavage. Parts of this formation are rich in quartz, mica, and mudstone, as well as a gray to purple slate. This parent material is less resistant to weathering than that of the Virgilina Formation and occurs at lower elevations on the eastern side of the preserve property. Essential minerals isolated from the Aaron Formation include quartz, chlorite, white mica, and plagioclase, with accessory minerals of epidote, magnetite, hematite, chlorite, plagioclase, biotite, and ilmenite. Relatively low calcium and magnesium levels are characteristic of this formation (Kreisa 1980) but may approximate those of the Virgilina Formation in places due to its heterogenous nature. Rocks in this area are exposed mostly along eroding ephemeral streams and tend to be paler in color than the Virgilina group.

Soils

Correlating with the extent of the Virgilina Formation, Alfisols of the Virgilina Series (Virgilina gravelly silt loam and Virgilina-Poindexter Complex) are relatively clayey and weathered from mafic bedrock; they form the upper slopes of the preserve. These soils are moderately acidic and have higher base cation concentrations than Ultisols weathered from the Aaron Formation. They also support the overwhelming majority of rare plant populations on the preserve and a very high level of species diversity (Table 2). Eastham et al. (2009) describes a clayey greenstone gravel that characterizes the A and B horizons of these soil series, as well as a restrictive clay layer that limits rooting depth and produces a seasonally high (perched) water table. They also describe the high shrink-swell potential of these soils, which make them unsuitable for row crops and construction (Eastham et al. 2009).

Soils were investigated in the field as part of vegetation plot sampling protocol during this study, allowing for the characterization of soil profiles and nutrient levels (Table 1). Beyond the shallow clay loam of the A

Fig. 3. Fractured bedrock material showing schistose character. Photo by John Townsend (2019).

Table 1. Analysis of soil characteristics by plot at Difficult Creek Natural Area Preserve. Alphanumeric codes are in accordance with Virginia DNH Vegetation Plots Database naming conventions. Suffixes "A" and "B" indicate the paired samples taken per plot in 2019. Soil order is indicated for each sample, with Alfisols located on the Virgilina Formation and Ultisols on the Aaron Formation.

Plot	Cation Exchange Capacity (meq/100g)	pH	Calcium (ppm)	Magnesium (ppm)	Calcium-Magnesium Ratio	Manganese (ppm)	Base Saturation (%)
DCNAP1-1A (Alfisol)	5.81	5.7	917	132	6.95	290	100
DCNAP1-1B (Alfisol)	5.02	5.7	652	196	3.33	161	100
DCNAP3-1A (Alfisol)	1.72	4.9	258	40	6.45	58	100
DCNAP3-1B (Alfisol)	1.76	4.7	297	24	12.38	50	100
DCNAP6-1A (Alfisol)	6.25	4.7	451	112	4.03	54	53.7
DCNAP6-1B (Alfisol)	4.62	4.9	262	180	1.46	32	63.72
HALI002 (Alfisol)	14.48	4.8	357	130	2.75	330	21.13
DCNAP2-1A (Ultisol)	4.24	4.4	195	29	6.72	31	31.75
DCNAP2-1B (Ultisol)	6.09	4.4	37	56	0.66	6	12.48

horizon (ca. 10 cm), soil sampling confirmed a yellowish B horizon composed of dense gravel embedded in a friable clay matrix. This layer was exceptionally difficult to penetrate with a soil probe. At 40–45 cm, this gravelly clay gave way to a dense, yellowish clay hardpan layer that was all but impenetrable. Even though plant growth on Virgilina soils is somewhat inhibited by these physical characteristics, disturbances such as fire and tree removal are still needed to provide optimal rare plant habitat (pers. obs.). Similar observations have been made at another DCR preserve in the southern Piedmont (Grassy Hill Natural Area Preserve), where edaphic limitations alone are not sufficient to maintain the woodland openings inhabited by *Echinacea laevigata*, necessitating active vegetation management (Copenheaver et al. 2009).

The band of soils corresponding to the Aaron Formation flank the Virgilina soils series to the east and comprise Ultisols of the Montonia-Goldston, Tarrus-Badin, and Cid-Lignum soil series. These are generally silt loams, clay loams, and clays, with schistose bedrock. They are well drained to somewhat poorly drained and have low to moderate shrink-swell potential. These soils are usually more acidic and with lower base cation concentrations than the Virgilina series. Soil sampling confirmed an A horizon of yellowish silty loam and a B horizon containing red-orange saprolite, transitioning to a relatively dense orange-red clay with depth. No gravel deposits were found and no hardpan was detected. Species diversity on these Ultisols is often quite low, but since these floristically depauperate areas are also covered by dense, fire-suppressed forests, lack of management at least partly accounts for these vegetation differences. In fact, where managed with tools such as fire, mowing, and timber removal, species diversity is quite high and several rare plant populations do occur. A small, eroded area in the transmission right-of-way proved very instructive due to the exposure of an obvious Ultisol profile in an area with high floristic diversity and a population of the state-rare species *Eryngium yuccifolium*. The complex and varied parent material found on the Aaron Formation may also help explain some of the variation in vegetation types seen within its boundary. Variable floristic composition has been noted on the Aaron Formation outside of the preserve as well.

Two soil samples were collected from each of the five vegetation plots examined at DCNAP, four during this study and another from previous field work by DCR ecologists. These soils were analyzed by Brookside Laboratories, New Oxford Ohio. For the 2019 plots, samples from the A horizon (top 10 cm mineral soil), and B horizon (approximated at a depth below 10 cm at which the soil chroma and texture differed from the A horizon) were collected. Extractions were carried out using the Mehlich III method (Mehlich 1984).

For the measured soil parameters, samples taken from Alfisols of the Virgilina series were found to be consistent with soil survey data, exhibiting a very strongly acidic to moderately acidic reaction and a higher level of base cation concentrations than samples taken from Ultisols of the Aaron Formation, which were found to be extremely acidic and less fertile (Table 1). The pH values found in soils of the Virgilina series at DCNAP (mean pH 5.01, SD 0.46, n= 9), were quite similar to samples analyzed from vegetation plots on mafic

substrates elsewhere in the southern Piedmont of Virginia (mean pH= 4.94, SD = 0.56, n=39) (VA DCR-DNH 2019).

Land Use History of the Preserve

Colonial Land Office patents from the early to mid-1700s were consulted for the preserve and immediately adjacent tracts (Virginia Land Office 2019). These surveys include notes on boundary tree species and streams but no additional information. The use of such scant data to infer historical vegetation types is obviously problematic, but the surveys do provide the earliest mention of vegetation on the property. Based on translation of common names used at the time, *Quercus alba*, *Q. stellata*, *Q. velutina*, "Red Oak" (*Quercus falcata* or *Q. rubra*), and "Pine" (*Pinus* sp.) were specifically noted as boundary trees on uplands to the exclusion of all other taxa, with two-thirds of these noted as oak and the remainder pine. Mesic-site species such as *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Nyssa sylvatica*, "Maple" (*Acer floridanum* or *A. rubrum*), and *Fagus grandifolia* were only noted in lower landscape positions near streams. Given the fire adaptations of oak and pine species and the estimated fire return interval for the area, this pattern is not surprising. Although oaks were listed by species in the surveys, "Pine" was not. The only two species of pine known with certainty from uplands of the region in the Colonial era were Shortleaf Pine (*Pinus echinata*) and Virginia Pine (*Pinus virginiana*), the former most likely dominant on the property due to its adaptation to the fire-prone landscapes of the southern Piedmont and its dominance across the region (Burns & Honkala 1990a). No inferences can be drawn regarding tree density based on 18th century survey data.

Intensive agricultural impacts followed closely behind settlement in this area. Based on the generalized land use descriptions of Trimble (1974), the south-central part of Virginia was the first in the four-state southern Piedmont region to suffer from erosive agricultural practices, with negative impacts noted in present-day Halifax County prior to 1770. No specifics of land use at DCNAP are known for this early date, but it seems likely that at least portions of DCNAP were grazed or farmed during the period of intensive agricultural use that spanned the 18th and 19th centuries. The presence of small rock piles and a stock pond attest to at least some level of agricultural activity (C. Woodall, pers. comm , cited in Klopf et al. 2018). Since soils weathered from the Virgilina Formation are unsuited to row-crop agriculture due to severe physical limitations, grazing seems much more likely as an historic land use on this geologic unit. By contrast, soils weathered from the Aaron seem more conducive to growing crops and may have experienced more agricultural impacts. Halifax County agricultural census statistics for 1910 suggest a high likelihood of agricultural impacts as well, indicating that over 95% of county land area was in farms, with half of that acreage listed as improved (Department of Commerce, Bureau of the Census 1913). Another well-documented land use in this area was copper mining (Byrd & Ruffin 1841). Although 750,000 lbs of copper ore were removed from the Virgilina Formation prior to World War I, maps of prospect pits and mines indicate that the closest operations were located slightly south of DCNAP property (Laney 1917)

By the mid 20th Century, DCNAP was reforested in hardwoods, primarily oaks (*Quercus* spp.), as well as shortleaf pine (*Pinus echinata*) and perhaps Virginia pine (*Pinus virginiana*). Occurrence of this forest type is supported by historical aerial photographs (Klopf et al. 2018), the composition of remnant forests on site, and the observations of botanist Alton M. Harvill, who described the habitat variously as oak-hickory or oak-pine woods (Harvill 1973). This forest, like others in the region, was probably shaped by the selective harvesting of the highest-quality timber, leaving the area dominated by stands of culled hardwoods with gap-invading pines (Laney 1917).

In the early 1980s, most of the hardwood-pine uplands at DCNAP were clearcut and converted to a *Pinus taeda* plantation by the Hancock Timber Resource Group. Drum chopping, herbicide application, and (perhaps) site preparation burning facilitated tree planting and reduced hardwood competition. Hancock Timber later sold the property to the Devon Logging Company, who then sold the land to DCR in 2001. Devon Logging Company performed commercial thinning and clearcuts on portions of the site in 2000 and 2001 under guidance from DCR natural resource managers prior to acquisition (Klopf et al. 2018).

BOTANICAL INVESTIGATIONS AND FLORISTIC STUDY METHODS

In 1972, Alton M. Harvill and his wife Barbara J. Harvill visited the property adjacent to Allen's Mill Road and made several noteworthy botanical collections on the present-day DCNAP (Harvill 1973), including *Cirsium carolinianum* ("Extensive colonies in an oak-hickory woods"), *Gillenia stipulata* ("Borders of oak-hickory woods"), and plants he initially reported as *Marshallia obovata* ("Very localized colonies on border of an oak-hickory woods"). This *Marshallia* was later determined to be a new, geographically restricted species of mafic woodlands in the southern Piedmont of North Carolina and Virginia (Weakley and Poindexter 2012). Aside from general forest cover types, details such as tree density and floristic composition were not recorded by Harvill. Between these 1972 collections and initiation of the present study, roughly 80 species were vouchered on the property by several collectors, including DCR staff. Field work for the current project began in early April, 2018 and continued on a bi-weekly basis until mid-October, 2018, with lower-intensity collecting and vegetation plot sampling conducted during the growing season of 2019. A systematic survey of all management units was completed, assuring visits to all known habitats, geologic types, and management regimes. GPS tracks and ARC-GIS Collector software were used to ensure coverage of the property.

The vascular flora of DCNAP has been recognized as a diverse and distinctive floristic assemblage for many years, in large part due to the cumulative effects of habitat management. Despite this, no attempts to quantify this diversity had been made prior to 2019. In order to evaluate the level of species richness in areas underlain by the mafic Virgilina Formation, and to a lesser extent, the Aaron Formation, five plots were sampled (four during the 2019 growing season and one during a previous sampling effort by DCR ecologists). Since the intent was only to characterize levels of species richness and soil characteristics per plot, cover and abundance data were not determined. Plots were located using randomly generated GPS points within four management units, each of which featured a different level of forest density. The three plots on Alfisols included: 1) a periodically burned loblolly pine woodland of moderate stem density (Fig. 7), 2) a former pine plantation, logged to remove the loblolly pine and leaving a low density of remnant hardwoods, and 3) a transmission line right-of-way subjected to periodic mowing and prescribed burning (Fig. 8). The single plot on Ultisols was located within an acidic oak forest. Plots methods followed Peet et al. (1998), modified to include only 100 m^2 and 1 m^2 subplots. Presence/absence data was recorded for all vascular plants at both spatial scales and two soil samples per 100 m^2 plot were analyzed.

Several published floras of Piedmont hardpan habitats in the Carolinas (Reed 2018; Schmidt 2002; Stanley et al. 2019) were closely examined for parallels with the floristic composition of DCNAP. Additional Piedmont floras were reviewed more informally, but these departed too much from DCNAP habitats for useful comparison and were not used. The closest analog in terms of acreage, soil types, and habitat was found in Stanley et al.'s 2019 floristic study of Picture Creek Diabase Barrens (PCDB). This preserve is a useful unit for comparison with DCNAP since it is located only 75 km (45 m) to the south in Granville County, North Carolina and supports the only other extant population in the world (and type locality) of *Marshallia legrandii*. In the Picture Creek study, all taxa were assigned to soil series allowing a list of species occurring on mafic soil types to be compiled. When performing a similar analysis at DCNAP, it was found that the acreage of mafic soil types at the two preserves were more similar than other study areas, allowing for a more accurate comparison. Once a complete floristic list was compiled for DCNAP and compared with that of the entire PCDB property, an index of similarity (Sørensen 1948) was calculated as a measure of floristic similarity.

The primary taxonomic reference used was Weakley et. al. (2012) except in cases of previous misapplication of names, or due to the description of new species. Voucher specimens for each vascular plant species were collected in duplicate when possible during the 2018–2019 growing seasons. All taxa vouchered during this time period were deposited by the first author at the College of William and Mary herbarium (WILLI), and any duplicates deposited at Virginia Polytechnic Institute and State University (VPI). Specimens previously vouchered by other collectors were distributed more widely as noted in Appendix A. Plant community types were assigned by inspection to corresponding types in the U.S. National Vegetation Classification (USNVC 2019). Global and state rarity ranks are noted for all rare plants, animal, and plant communities.

RESULTS AND DISCUSSION

A total of 653 vascular plant taxa was documented (Appendix A) at DCNAP, 82 of which were new distributional records for Halifax County. Of this total, 86.5% are native, 12.2% are introduced, and 1.2% are either questionably native to Virginia or, if native elsewhere in the state, questionably native at DCNAP. Non-native taxa were found in greatest numbers near the county road and logging roads that cross the property as well as in a disturbed section of gas line right-of-way. Four of the eight management units were burned in the year prior to initiation of this study, eliciting a strong response from the herb layer and allowing for easier detection of heliophytic understory species.

Vegetation Description—General

Due to conversion from a hardwood-dominated forest to pine by previous owners, loblolly pine (*Pinus taeda*) still forms the canopy over much of the preserve although timber removal is steadily reducing its dominance. A prominent and diverse herbaceous flora is now characteristic of burn units on the property (Fig. 4) but when first purchased by DCR, such habitats were only well-developed in rights-of-way and along roadsides. The abundance and diversity of vascular plants has increased—sometimes spectacularly—within burn units after just one fire, but for some species these changes have been more incremental. The latter category includes some rare plants as well as warm-season (C_4) grasses like *Andropogon gerardii* and *Sorghastrum nutans*, all of which require high levels of illumination.

Remnant trees within the *Pinus taeda* matrix provide an indication of canopy composition on Virgilina soils before pine plantations were established. These species include a substantial oak component in upland landscape positions, including *Quercus alba, Q. marilandica*, *Q. phellos, Q. stellata,* and *Q. velutina*. Also widespread in this habitat are *Carya glabra*, *C. tomentosa*, *Pinus echinata*, and *Ulmus alata*. Oaks and shortleaf pines are expected to become increasingly dominant with repeated burning and removal of *Pinus taeda* canopy trees; species such as *Acer rubrum*, *Liquidambar styraciflua*, and *Nyssa sylvatica*, which are somewhat frequent on the preserve, are expected to decline due to their fire intolerance (Burns & Honkala 1990b). A similar pattern is suggested by 1700s survey data. Species composition on soils of the Aaron Formation overlaps with that of the Virgilina Formation in burned and thinned management units but is skewed toward species intolerant of fire in areas excluded from such management. Typical species of such fire-suppressed areas include *Acer rubrum* and *Liriodendron tulipifera*. These areas also exhibit increased tree density and leaf litter accumulation, a typical feature of present-day Piedmont forests due to a long period of widespread fire exclusion (Nowacki & Abrams 2008). Differences in soil chemistry, physical characteristics, and fire return interval also may encourage dominance by a different set of understory species than those seen on the Virgilina Formation.

Artificially open habitats have existed in the form of rights-of-way due to the installation of a power transmission line and distribution line, as well as a gas pipeline, since at least the 1960s (Klopf et al. 2018) (Fig. 5, 6, 8). Multiple rare plant populations occur in these rights-of-way and species diversity is very high on both the Aaron and Virgilina formations. A small section of distribution line right-of-way at the northern end of the preserve supports the only location on the preserve for the state-rare composite, *Marshallia obovata* var. *obovata* (Piedmont Barbara's-buttons). These open habitats have historically been maintained by Dominion Power through mowing and limited herbicide use but in recent years DCR has taken on more responsibility for management, which includes prescribed burning.

Plant Community Types

Since silvicultural operations removed most of the native forest canopy and replaced it with loblolly pine, the plant communities that once occurred on the property must be inferred from understory and midstory composition, soil type, landscape position, and small hardwood forest remnants nearby. These types are therefore approximations. Given the long history of interaction between humans and the land in the southern Piedmont, the concept of a "natural" community is a slippery one. See Table 3 for conservation status of plant communities. Fleming & Patterson's (2017) online resource provides a detailed discussion of each community type.

Fig. 4. Typical hardpan forest habitat at Difficult Creek Natural Area Preserve. These stands of *Pinus taeda* were planted after the removal of hardwoods by previous owners and are being managed with prescribed burning and canopy removal. Photo by John Townsend (2019).

Southern Piedmont Hardpan Forest (*Quercus stellata—Quercus alba—Carya glabra—Ulmus alata—Piptochaetium avenaceum—Scleria oligantha* **Forest—USNVC CEGL003714)**
This is the most widespread community type on soils of the Virgilina Series, covering most of the western two-thirds of the preserve. Aside from small areas with intact hardwood canopy found on the northern and southern ends of the preserve, the former hardpan forest canopy has been replaced by *Pinus taeda*, with the formerly dominant hardwoods existing at relatively low density and mostly in the understory. Even with an overstory dominated by planted loblolly pine, the herb layer is characteristic of the type, with the diagnostic graminoids *Piptochaetium avenaceum* and *Scleria oligantha* generally common and conspicuous.

Elsewhere in the southern Piedmont of Virginia, this community occurs most commonly on mafic igneous and metamorphic rocks, with several examples on the Virgilina Formation and other mafic geologic units. Potential or current canopy species occurring at DCNAP include oaks (*Quercus alba*, *Q. marilandica, Q. phellos,* and *Q. stellata*), hickories (*Carya glabra* and *C. tomentosa*), and pines (largely *Pinus echinata*). *Fraxinus americana* and *F. biltmoreana* were once common on the property but have been all but eliminated by the Emerald ash borer (*Agrilus planipennis*), causing scattered canopy openings where ash was formerly dominant. The state-rare *Carya carolinae-septentrionalis* seemed possible at this site since it is found not far to the south, also on the Virgilina Formation, but detailed inventory has only confirmed its more widespread congener, *Carya ovata*. Common midstory species include *Cercis canadensis*, *Diospyros virginiana*, *Chionanthus virginicus*, *Juniperus virginiana* var. *virginiana*, and *Ulmus alata*, also fitting the global concept for this community.

Over most of the area once occupied by this community type at DCNAP, restoration has been steadily reducing the loblolly pine overstory while using prescribed fire in the understory. The herb layer at DCNAP is now extremely diverse, increasing proportionately with fire frequency and degree of *Pinus taeda* removal. Since extant examples of Southern Piedmont Hardpan Forest are generally quite fire suppressed, the burned

Fig. 5. Transmission line right-of-way bisecting preserve. Photo by John Townsend (2019).

compartments at DCNAP may approximate a more open, woodland or savanna structure and composition that likely characterized the vegetation under pre-settlement disturbance regimes.

Little Bluestem—Indian-Grass Piedmont Prairie community type (*Schizachyrium scoparium—Sorghastrum nutans—Solidago juncea—Pycnanthemum tenuifolium* **Herbaceous Vegetation—USNVC CEGL006572)**
Vegetation of the site's transmission line and distribution line rights-of-way is similar to this type, which is based on frequently burned grasslands in several Southeastern military base training areas. Due to its constant maintenance by mowing and fire, this community has supported a diverse flora even during decades of fire suppression and canopy conversion. Robust populations of several rare herbaceous species occur in these rights-of-way as a result, along with impressive wildflower displays. The prolific flowering of such plants is consistently high due to high light levels from periodic mowing and/or burning. While this vegetation at DCNAP has developed under an artificial disturbance regime, it may well represent an analogue of the grassland component in a pre-settlement woodland/prairie mosaic.

As a result of timber cuts and burning, much of the NAP is tansitioning directly from loblolly pine forest to vegetation that is more open and savanna- or prairie-like than a typical Southern Piedmont Hardpan Forest. During this time, C_4 grasses typical of the Piedmont Prairie type have become more widespread in the thinned wooded communities. While heliophytic herbs have always thrived in the rights-of-way, their reproduction elsewhere on the preserve has also increased with the higher light levels resulting from prescribed burns and timber harvests.

Piedmont Acidic Oak-Hickory Forest (*Quercus alba—Quercus rubra—Carya tomentosa/Cornus florida/Vaccinium stamineum/Hylodesmum nudiflorum* **Forest, USNVC CEGL008475**)
On the eastern side of the property, a hardwood-dominated forest is found, intermixed with areas of *Pinus taeda* canopy. This community is dominant on a large area of the property east of the transmission line and

Fig. 6. Autumnal aspect of transmission line right-of-way, Difficult Creek Natural Area Preserve. Photo by John Townsend (2019).

Fig. 7. Plot DCNAP3-1, located in periodically burned loblolly pine woodland on Virgilina Formation. Photo by John Townsend (2019).

corresponds approximately to the area underlain by the Aaron Formation, although a small portion of this type occurs on the Virgilina Formation. It is difficult to predict what vegetation might dominate if this community were subjected to fire in the same manner as the rest of the preserve, but it seems certain that the understory would not be nearly as depauperate as it is currently, at least in areas with slightly higher base status. This community is dominated by oaks (*Quercus alba*, *Q. coccinea*, *Q. falcata*, *Q. montana*, *Q. ruba*, and *Q. velutina*) as well as the mesic-site hardwoods *Acer rubrum*, *Nyssa sylvatica*, *Liquidambar styraciflua,* and *Liriodendron tulipifera*. The understory is often very sparse and species diversity can be quite low in areas not receiving proper management; just 28 species, including only 3 herbaceous taxa, were present in a 100 m^2 vegetation plot sampled during this study. Dense shade and abundant leaf litter are likely far more responsible for this depauperate flora than underlying geology and soils. In fact, observations made on Aaron Formation soils in the transmission line confirm that floristic diversity could greatly increase with timber removal and prescribed burning, at least in areas with more favorable soil conditions. Observations of burned forests on an adajcent property also demonstrate that species diversity can be quite high on some soils derived from the Aaron Formation.

Ruderal Areas

The logging roads, fire lines, and disturbed sections of the gas and transmission line rights-of-way support the highest concentrations of ruderal species on the preserve, but also several rare native species. It is worth noting that the first major botanical discoveries at DCNAP were made along the edge of Allen's Mill Road due to the higher light levels and greater species diversity there, highlighting the importance of these narrow stretches of habitat. Particularly in the case of rare native species, this habitat is a precarious one due to the vagaries of vegetation management. Current mowing practices by VDOT have been effective at perpetuating this diverse flora but any changes in management (use of herbicide, for instance) could threaten its existence.

Fig. 8. Plot DCNAP1-1, located within transmission line right-of-way on Virgilina Formation. Chris Ludwig (left), and John Townsend (right) pictured. Photo by Karen Patterson (2019).

Noteworthy Phytogeographic and Habitat Affiliations of the Flora

As documented in other floristic studies of hardpan habitats (Schmidt 2002, Dayton 1966), some species characteristic of lowlands or boggy sites are widespread in the uplands of DCNAP, presumably due to the seasonally saturated soils. Examples of such species include *Acer floridanum*, *Coleataenia longifolia* ssp. *longifolia*, *Crataegus marshallii*, *Cyperus pseudovegetus*, *Dichanthelium microcarpon*, *D. yadkinense*, *Eleocharis engelmannii*, *E. tenuis*, *Fimbristylis annua*, *F. autumnalis*, *Gratiola neglecta*, *Helenium autumnale*, *H. flexuosum*, *Hypericum mutilum*, *Ilex decidua* var. *decidua*, several *Juncus* spp., *Lindernia dubia* var. *anagallidea*, *Mecardonia acuminata*, *Pluchea camphorata*, *Quercus phellos*, *Rhexia ventricosa*, several *Rhynchospora* spp., and *Sagittaria australis*.

Many plants at DCNAP are more characteristic of the Virginia Coastal Plain, including some that are nearly absent from the Piedmont. Some taxa that reach their westernmost extent in Halifax County include: *Acer floridanum*, *Arnica acaulis*, *Carex digitalis* var. *macropoda*, *Coleataenia longifolia* ssp. *longifolia*, *Crataegus marshallii*, *Dichanthelium aciculare*, *D. ravenellii*, *Galactia regularis*, *Gymnopogon brevifolius*, *Lechea minor*, *Phlox nivalis*, *Rhexia ventricosa*, *Rhynchospora corniculata*, *Sphenopholis filiformis*, *Vaccinium caesariense*, and *Vaccinium tenellum*. The grasses *Andropogon virginicus* var. *decipiens* and *Dichanthelium angustifolium* are otherwise restricted to the Coastal Plain with the exception of Augusta County, a Ridge and Valley locality well known for long-range Coastal Plain disjunctions. Several additional species reach their range limit in adjacent Pittsylvania County, including *Dichanthelium dichotomum* var. *nitidum*, *Ilex decidua* var. *decidua*, *Sabatia quadrangulata*, and *Trachelospermum difforme*. Some taxa do not conform so strictly to this edge-of-range pattern but, nevertheless have few occurrences west of Halifax County. Examples include *Lespedeza stuevei*, *Pluchea camphorata*, and *Rhynchosia tomentosa* (Virginia Botanical Associates 2019)

Species Richness and Floristic Comparisons

Vegetation plot data gathered at DCNAP in 2019 was compared with all vegetation plots in the DCR ecology plots database (VA DCR-DNH 2019) to assess species richness relative to that found in other Virginia vegetation types. Based on this analysis, the three plots sampled on Alfisols of the Virgilina Formation during this study (two in habitats actively managed with prescribed fire and thinning; the other in a transmission line right-of-way) were exceptionally diverse, both at the 1 m^2 and 100 m^2 spatial scales. These plots contained the three highest levels of species richness sampled in the state at both spatial scales. A comparison of these 2019 plots with plots of similarly high species diversity is included in Table 2. The plots that most closely approached this level of small-scale diversity were located in dry calcareous or mafic habitats in the Ridge and Valley, Blue Ridge, and Northern Piedmont physiographic provinces. None of these habitats were subjected to such intensive management, however, at least in the recent past, making for an imperfect comparison with plots at DCNAP.

This extraordinarily high level of species diversity at DCNAP may be reflective of: 1) canopy conditions, which range from densely wooded to treeless; the range of light conditions at DCNAP could allow for a mingling of open land and forest species: 2) the nearly two-decade-long, aggressive use of prescribed fire in a landscape known to have a naturally high fire return interval. Vascular plant diversity is promoted by such a disturbance regime, which increases illumination and removes litter that inhibits herbaceous establishment: 3) the presence of soils that are relatively high in base status, but also stressful and variable in moisture-holding ability due to high shrink-swell potential. This creates substrate variability in both space and time: 4) the geographic location of Halifax County, allowing the mingling of species at the western edge of their Coastal Plain distribution with widespread taxa of Piedmont and mountain forests.

The two additional plots sampled on the preserve—one during this study, the other during previous field work by DCR ecologists—prove instructive due to their lower levels of species richness and location on the landscape. Plot HALI002 was sampled prior to this study, in a small area that was not converted to pine during during the last major timber harvest; it features a relatively closed canopy dominated by hardwoods with the occasional shortleaf pine. This forest has not been burned or thinned since the establishement of the preserve, but sits on the same Alfisols as plots DCNAP1-1, 3-1, and 6-1, which were sampled in 2019 and which were located in intensively managed habitats. Only 46 species occurred in the more heavily forested HALI002 at the

Table 2. Highest levels of species richness at 1 m^2 and 100 m^2 scales in Virginia based on Virginia Natural Heritage plot data (n= 4,524). Plots from Difficult Creek Natural Area Preserve are in bold. Virginia plots with the next highest levels of species richness at both scales are provided for reference.

Plot	Species Richness (1 m^2)	Species Richness (100 m^2)	Physiographic Province	Geologic Map Unit	Community Type
DCNAP1-1	**–**	**108**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
DCNAP6-1	**–**	**97**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
DCNAP3-1	**–**	**93**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
AUGU001	–	88	Ridge & Valley	Elbrook formation (dolomite)	Central Appalachian Chinquapin Oak—Eastern Red Cedar Woodland
BUFF009P	–	86	Southern Blue Ridge	Ashe formation (amphibolite)	Southern Blue Ridge Mafic Woodland Seep
CLEV001P	–	78	Ridge & Valley	Nolichucky and Honaker formations	Appalachian Sugar Maple—Chinquapin Oak Dry Calcareous Forest
GWMP011	–	78	Northern Piedmont	Sykesville Formation Diamictite	Piedmont / Central Appalachian Sand Bar / River Shore (Tall Herbs Type)
MONT002	–	74	Ridge & Valley	Elbrook formation (dolomite and limestone)	Ridge and Valley Dolomite Woodland
MNBP038	–	70	Northern Piedmont	Shale and siltstone, interbedded	Piedmont / Central Appalachian Mafic / Calcareous Cliff
LOUD015	–	70	Northern Piedmont	Diabase	Central Appalachian Basic Ash—Hickory Woodland
DCNAP1-1	**41**	**–**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
DCNAP3-1	**29**	**–**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
DCNAP6-1	**26**	**–**	**Southern Piedmont**	**Virgilina formation**	**Southern Piedmont Hardpan Forest**
CLEV001P	18	–	Ridge & Valley	Nolichucky and Honaker formations	Appalachian Sugar Maple—Chinquapin Oak Dry Calcareous Forest
PWFP001P	18	–	Northern Piedmont	Alluvium	Coastal Plain / Piedmont Small-Stream Floodplain Forest
PINN006p	16	–	Ridge & Valley	Honaker formation (dolomite)	Appalachian Sugar Maple—Chinquapin Oak Dry Calcareous Forest
BUFF009P	13	–	Southern Blue Ridge	Ashe formation (amphibolite)	Southern Blue Ridge Mafic Woodland Seep
BUFF001P	13	–	Southern Blue Ridge	Ashe formation (amphibolite)	Inner Piedmont / Lower Blue Ridge Basic Oak—Hickory Forest
CEDA005p	13	–	Ridge & Valley	Hurricane Bridge limestone?	Southern Ridge and Valley Dry Calcareous Forest
BUFF005P	13	–	Southern Blue Ridge	Ashe formation (amphibolite)	Appalachian Rich Cove Forest (Tuliptree—Mixed Hardwoods Type)

100 m^2 scale, with over twice as many species occurring in plots on intensively managed areas with the same soil type and landscape position (Table 2). Even with this limited evidence, it seems likely that management differences are responsible for such a radical departure in species richness between HALI002 and the plots sampled in 2019. DCNAP2-1 was the only plot established on Ultisols of the Aaron Slate Formation, in a fire-suppressed hardwood forest type found across most of this geologic unit. Not surprisingly, the combination of extremely acidic soils, dense shading, and fire suppression have led to very low levels of species richness, in this case featuring just 28 species at the 100 m^2 scale. Over three times as many species occurred in plots sampled in the intensively managed sections of the preserve as in the plot on the Aaron Slate Formation.

Shifting focus to the landscape scale, species composition of the entire DCNAP flora was compared with that of Picture Creek Diabase Barrens (PCDB) (Stanley et al. 2019), the most analogous habitat in the region in terms of habitat and management types as well as acreage. The resulting percent similarity (based on Sørensen 1948) was only 64.9%. Although some habitats at these two preserves are quite similar, this relatively low floristic overlap (35.1%) is not surprising due to differences between the two areas, in particular the presence of a significant amount of wetland habitat at PCDB and its near absence at DCNAP. The presence of a significant amount of wetland habitat at PCDB and its absence at DCNAP, and a difference in overall acreage between the preserves (331 ha/819 ac at DCNAP, 165 ha/407 ac PCDB) are likely to be significant factors. Most surprisingly, once the species lists were refined to include only those taxa found on mafic soil types at both preserves, the index of similarity for the two properties was only 28.7%. One pitfall of focusing on these indices is the lack of species abundance and cover data, leaving unanswered the question of which species are dominant and characteristic at each site. Even though generalized abundance levels for all taxa were reported by Stanley (2019) and are reported here for DCNAP (Appendix A), a more thorough and quantitative vegetation sampling effort would be needed for an accurate comparison. But these low floristic similarity data do point out that mafic habitats in the southern Piedmont—even those with similar management interventions—can diverge quite widely in species composition. This in turn argues for the unique conservation value of each of these widely scattered and threatened habitats.

Rare and Restricted Plants

Fourteen plant species occurring on the study site are included in the DCR rare plant list (Townsend 2019, see Table 3 for conservation status ranks). Twelve less imperiled species occurring at DCNAP are included on the DCR watch list at the rank of S3 (Vulnerable). These species include: *Agrostis scabra*, *Andropogon virginicus* var. *decipiens*, *Carex meadii*, *Dichanthelium annulum*, *D. ravenellii*, *Gymnopogon brevifolius*, *Hexastylis lewisii*, *Hypericum drummondii*, *H. virgatum*, *Packera paupercula* var. *paupercula*, *Phlox nivalis*, and *Tragia urticifolia*.

The following discussions of rare species are grouped by patterns of rarity and geographic affinity. Information on the distribution of species in Virginia is based on the Digital Atlas of the Flora of Virginia (Virginia Botanical Associates 2019) and the description of national distribution patterns is based on the BONAP Taxonomic Data Center (Kartesz 2015). Most rare taxa on the preserve are restricted to the Virgilina Formation but some populations of *Eryngium yuccifolium* var. *yuccifolium* and *Gillenia stipulata* are also found on soils of the Aaron Formation as well.

Newly Described Species

Dichanthelium harvillii (Fig. 12) is known only from DCNAP, where it was first collected in 1995. Additional collections and taxonomic work in *Dichanthelium* sect. *Macrocarpa,* beginning in 2013, led to the description of this new taxon as well as a similar taxon from the Appalachians (see LeBlond et al., this issue). *Dichanthelium harvillii* grows as scattered clumps within burn units on the western half of the DCNAP property. Outside of the Virginia Piedmont, only limited searches of similar habitats in North Carolina have been made by the first author; much work remains to be done before the global conservation status of this species is known.

Globally Rare Species

The global conservation status ranks of these species range from G1 (Critically Imperiled) to G3 (Vulnerable)

Echinacea laevigata (Fig. 9) occurs at over 30 locations in the study area, with several hundred individuals

Table 3. Rare species and plant communities at Difficult Creek Natural Area Preserve as of 2019. Ranks follow Townsend (2019), Roble (2016), Fleming & Patterson (2017). At both the global and state level, lower numbers indicate a greater degree of imperilment. Taxa with global ranks of G1 to G3 are termed "globally rare"; those with state ranks of S1 and S2 are termed "state rare," regardless of global rank.

Taxonomic Group	Species (Scientific Name, Common Name)	Federal/State Legal Status	Global Rank/State Rank
Vascular Plant	*Anemone berlandieri* (Eastern Prairie Anemone)	–	G4?/S1
Vascular Plant	*Cirsium carolinianum* (Carolina thistle)	–	G5/S1
Vascular Plant	*Dichanthelium harvillii* (Harvill's Panic Grass)	–	GNR/S1
Vascular Plant	*Echinacea laevigata* (Smooth coneflower)	LE/LT	G2G3/S2/LE/LT
Vascular Plant	*Eryngium yuccifolium* var. *yuccifolium* (Northern Rattlesnake-master)	–	G5T5/S2
Vascular Plant	*Gillenia stipulata* (American Ipecac)	–	G5/S1
Vascular Plant	*Lythrum alatum* (Winged loosestrife)	–	G5/S2
Vascular Plant	*Marshallia legrandii* (Tall Barbara's-buttons)	–	G1/S1
Vascular Plant	*Marshallia obovata* var. *obovata* (Piedmont Barbara's-buttons)	–	G4G5T3T5/S1
Vascular Plant	*Matelea decipiens* (Old-field Milkvine)	–	G5/S1
Vascular Plant	*Pycnanthemum torreyi* (Torrey's Mountain Mint)	–	G2/S2
Vascular Plant	*Rynchospora harveyi* (Harvey's beaksedge)	–	G4/S1
Vascular Plant	*Sphenopholis filiformis* (Long-leaf Wedgegrass)	–	G4?/S1
Vascular Plant	*Sporobolus compositus* var. *compositus* (Tall Dropseed)	–	G5T5/S2
Animal	*Erynnis martialis* (Mottled Duskywing)	–	G3/S1S3
Natural community	Southern Piedmont Hardpan Forest		G2G3/S2
Natural community	Little Bluestem—Indian-Grass Piedmont Prairie		G3/SU

dispersed in woodland burn units and the transmission line right-of-way, making this one of the largest populations for this federally endangered species in Virginia. It is almost entirely restricted to mafic and calcareous substrates in the Piedmont and mountain physiographic regions of Virginia, the Carolinas, and Georgia.

Hexastylis lewisii is widespread enough in Virginia that it is not included on the DCR rare plant list (Townsend 2019), but is reported here due its rank of G3. Very few colonies were found at DCNAP, localized near a small stream headwater in an unburned, acidic hardwood forest. In Virginia, the species is heavily concentrated in the southern Piedmont; its global range is restricted to the Piedmont and Coastal Plain of Virginia and North Carolina, a pattern shared by only a handful of vascular plants, including the following species.

Marshallia legrandii (Fig. 10) is a southern Piedmont endemic currently known from two sites in the world, one at DCNAP, the other at Picture Creek Diabase Barrens in North Carolina (Weakley & Poindexter 2012; Stanley et al. 2019); a few additional populations have been documented historically by specimens, but are not known to be extant. The species was first reported from the site by Alton M. Harvill in 1972 (as *Marshallia obovata*). Based on herbarium labels, this discovery was likely made along a roadside, but the species has since appeared well away from roads and rights-of-way with continued prescribed burning and logging activity.

Pycnanthemum torreyi (Fig. 11) is known from the edge of a logging road between hardwood and pine-dominated forests. The species is often found in very low numbers, often—but not exclusively—in mafic and calcareous habitats of the Virginia mountains, Piedmont and (rarely) Coastal Plain. The global range consists of somewhat scattered occurrences, ranging from the east coast to the Mississippi River.

State Rare Species

These species fit within three broadly defined phytogeographic patterns

1) Taxa more widespread west of Virginia or with strong Midwestern affinities

Anemone berlandieri is restricted to a very small section of transmission line right-of-way. Up to 30 individuals have been seen, but vegetation management changes and the diminutive size of the plants have made the species a challenge to relocate in some years. It seems very likely that even the intensive botanical surveys

Fig. 9. *Echinacea laevigata*, a federally endangered species occurring in periodically burned woodlands and rights-of-way at Difficult Creek Natural Area Preserve. Photo by John Townsend (2019).

Fig. 10. ***Marshallia legrandii*****, a globally rare species occurring in periodically burned woodlands and road edges at Difficult Creek Natural Area Preserve. The only other extant population occurs at the type locality in adjacent Granville County, North Carolina. Photo by John Townsend (2019).**

conducted at DCNAP would be insufficient to detect additional populations, if they indeed exist. This is one of two populations in Virginia, located at the extreme northeastern tip of the species' south-central U.S. range.

Cirsium carolinianum is widespread and abundant in thin woodlands and open areas on the preserve. This biennial reacts vigorously to management interventions such as timber harvesting and prescribed fire. It occurs most abundantly west of the Appalachians, occurring as far west as eastern Texas and Oklahoma, but its pattern of occurrence east of the Appalachians is very sparse, including populations in the Piedmont of Virginia, the Carolinas, and Georgia.

Gillenia stipulata is widespread at DCNAP, where it is most often found in woodland habitats rather than treeless areas such as rights-of-way. Occurrences east of the Appalachians are isolated from a more central U.S. range that largely ends in Ohio, Kentucky, Tennessee, and Alabama. This species is probably the "Ipecac" described from areas of high and barren, stony ground in the general vicinity of DCNAP by William Byrd II during his 1728 border survey (Byrd & Ruffin 1841). Byrd's morphological description, common name usage, habitat notes, and location strongly suggest its identity as *G. stipulata*. The species is encountered rather frequently on DCNAP, whereas its more widespread congener *Gillenia trifoliata* was encountered only once, and in a different habitat than that described by Byrd.

Matelea decipiens is known from several small colonies at DCNAP, both in the transmission line right-of-way and interior burn units. A handful of other occurrences exist in the southern Virginia Piedmont, where they are also associated with mafic geology and woodland or open habitat conditions. The Piedmont occurrences in Virginia and the Carolinas are strikingly disjunct from the species' main range west of the Mississippi. Occurrences in the eastern U.S. are disjunct from the main range of this species and may not be conspecific with *M. decipiens*.

Fig. 11. *Pycnanthemum torreyi*, a globally rare species occurring along a woodland edge at Difficult Creek Natural Area Preserve. Photo by Gary Fleming (2014).

2) Taxa broadly distributed east of the Rockies

Eryngium yuccifolium var. *yuccifolium* has been documented in 19 Virginia counties but due to habitat loss, only three populations are extant, the one at DCNAP being by far the largest. This is one of several species providing strong evidence for historically open habitats at DCNAP due to its extreme shade intolerance and its documented affinity for prairies or open habitats elsewhere (Gould 1941). Reproduction by this species only occurs in open or selectively cleared habitats at DCNAP. Very few populations exist north of Virginia in the Atlantic coastal states.

Lythrum alatum was extirpated from the property when new pipeline construction eliminated its habitat, emphasizing the inherent vulnerability of rights-of-way and the value of aggressive management of adjacent, protected habitat to encourage population expansion. The species is otherwise known from small, widely scattered populations in wet habitats of the Virginia mountains and Piedmont, and a single site in the Coastal Plain. The Virginia occurrences are at the southeastern fringe of the species' range.

Sporobolus compositus var. compositus was recently discovered in the transmission line right-of-way. Its distribution in Virginia is strikingly diffuse, with the few occurrences scattered across every physiographic province; its global distribution is heavily concentrated in the central U.S., becoming very fragmented east of the Mississippi River.

3) Southeastern endemics

Marshallia obovata var. *obovata* is an endemic with strong Piedmont affinities throughout its range, extending only as far north as the southern Piedmont of Virginia. Nearly half of the Virginia occurrences have not been

observed in over four decades due to successional trends and habitat conversion. The genus *Marshallia* is well known for its association with glades, savannas, outcrops, thin woodlands, river scour zones, and other habitats with low or disrupted canopy cover. Occurrence of the recently named *Marshallia legrandii* on the property affords useful morphological and phenological comparisons, including the well-separated flowering times of the two species.

Rhynchospora harveyi is at the northernmost extent of its range in southern Virginia. The collections made in the burn units at DCNAP were the first since M.L. Fernald documented the species in the Virginia Coastal Plain (Fernald 1937). The outwardly similar *Rhynchospora globularis* var. *globularis* occurs in abundance on the property, complicating the search for additional *R. harveyi* populations.

Sphenopholis filiformis occurs at the northeastern end of its somewhat disrupted range. It has a history of discovery much like *Rhynchospora harveyi*, with the first collections made in the Virginia Coastal Plain by M.L. Fernald (Fernald 1941). *Sphenopholis filiformis* is an extremely delicate plant, easily obscured or suppressed by understory vegetation if not recently burned. Plants were first discovered along a woodland margin but have since been found in the adjacent burned woodland and in the transmission line right-of-way.

Rare Animals

Erynnis martialis (Mottled Duskywing) occurs on the preserve, the only extant population for this rare lepidopteran known in Virginia. This species has experienced steep declines across its range in recent years and was historically known from 22 counties in the state; the DCNAP population is the only one seen since 1990 (VA DCR-DGIF 2013).

Larvae of this species feed only on plants in the Rhamnaceae, the lone representative at DCNAP being *Ceanothus americanus* (New Jersey Tea). Habitat management with fire and mechanical means encourages both *Ceanothus* and habitat for the butterfly but burning too great an acreage at once may negatively impact the species, particularly since it pupates above ground. Current management guidelines are taking the needs of this species into account by using prescribed fire but ensuring that an adequate amount of habitat is left unburned in any given year (Klopf et al. 2018)

Occurrence of Similar Habitat Types in the Region

The flora of DCNAP is exceptional for the present-day southern Piedmont in terms of species diversity and rare plant density, but there is strong floristic evidence for similar habitats occurring across the region historically. Rare species associated with woodlands and open habitats currently exist at low densities throughout the southern Piedmont of Virginia, but were presumably more widespread based on estimated fire return intervals and historical documents. To place this flora in a regional context and provide evidence for such habitats across the region, an analysis of DCR element occurrences and habitat data was conducted. A total of 46 state- and globally-rare upland plants species with an affinity for open habitats were found to have populations in this area, at least historically. Woodlands, natural openings, and some rock outcrops currently support many of these rare plant populations, but 51% of all populations occur (or occurred) in artificially open habitats such as powerline rights-of-way and road edges. This indicates both the crucial role that these marginal habitats play in rare plant conservation within a highly altered landscape as well as the precarious nature of these populations' existence. The majority of these species are associated with mafic or calcareous geologic types regardless of habitat, but a significant number have less restrictive geologic affiliations. The presence of so many species as remnants in the drastically altered and degraded southern Piedmont landscape argues strongly for the historical occurrence of habitats similar to those being restored at DCNAP, and at a regional scale.

Notes on the Genus *Dichanthelium*

For its size, DCNAP contains an impressive amount of diversity in the genus *Dichanthelium*, with 25 taxa vouchered from the property. In North America, this level of diversity in the genus is comparable to published data for fire-maintained communities of the southeastern Coastal Plain, habitats known to contain the highest levels of small-scale vascular plant diversity in North America (Walker and Peet 1983) as well as the largest

number of *Dichanthelium* taxa found in any physiographic province (Weakley 2015). Two published floras from the Coastal Plain and Sandills ecoregions of North Carolina provide useful context for the *Dichanthelium* flora at DCNAP due to their similarly high levels of diversity in the genus and their much larger acreage. These include Shaken Creek Savannah in Pender and Onslow counties (26 *Dichanthelium* spp. over 2,448 ha/6,049 ac) and the Fort Bragg Military Reservation in Cumberland, Harnett, Hoke, and Moore counties (31 *Dichanthelium* spp. over 73,469 ha/181,546 ac) (Thornhill et al. 2014; Sorrie et al. 2006). The habitat types found at these sites diverge from those found at Difficult Creek due to geography, but the widespread use of prescribed fire (and, in the case of Fort Bragg, incendiary fire) is a common thread, as is lowered canopy density. No comparable levels of diversity in the genus *Dichanthelium* were noted in any published floras of the Piedmont of the Carolinas, regardless of acreage.

Voucher specimens of *Dichanthelium* were collected sporadically by the first and second authors beginning in the early 1990s incidental to general inventory work. The discovery of *Dichanthelium annulum* at DC in 2004 was important due to its presence on DCR's rare plant list at the time (Townsend 2004) and its occurrence in other mafic or calcareous community types with high species diversity and rare vascular plants. The Difficult Creek population consists of tens of thousands of plants spread across 75% of the preserve, a density found nowhere else in Virginia.

In 2013, two puzzling *Dichanthelium* specimens were discovered in Virginia, one in shale woodlands of the Ridge and Valley province (Bath County), and another in the mafic woodland burn units at DCNAP. Plants from both regions keyed poorly, always grouping closest to *Dichanthelium boscii*, *D. oligosanthes*, and *D. ravenellii* in regional keys but clearly not fitting them. After comparisons with other North American *Dichanthelium* taxa produced no clear results, the plants were suspected of either being hybrids or an undescribed taxon and sent to Richard J. LeBlond for examination. They have since proved to be morphologically distinct, not only from other *Dichanthelium* taxa, but from each other. The plants at DCNAP are newly described elsewhere in this issue as *Dichanthelium harvillii*, and are currently known only from the preserve (LeBlond et al. 2020). This taxon occurs sporadically across several burn units on the property, usually occurring as small, loosely associated colonies of 1–10 robust clumps. Very limited surveys of similar habitats in Virginia and adjacent North Carolina have been conducted by the first author without discovering additional populations; much more extensive field work will be needed to uncover new sites. Morphologically, *D. harvillii* possesses the large spikelets of taxa such as *Dichanthelium oligosanthes*, *D. boscii*, and *D. ravenellii*, has strongly bearded nodes, and has some leaf charactersitics of *Dichanthelium bicknellii* and *D. boreale*, both of which tend to have large "flag leaves" below the inflorescence and leaves of relatively uniform dimensions elsewhere along the culm (Fig. 12).

The high diversity of *Dichanthelium* at DCNAP is in keeping with the generally high level of species richness documented for the preserve (see discussion in Species Richness and Floristic Comparisons). At least some of this diversity is due to the presence of mafic geology, an aggressive fire and timber management program, and the geographic placement of the preserve. The co-occurrence of *Dichanthelium aciculare*, a species characteristic of sandy woodlands and clearings in the Coastal Plain, *Dichanthelium boscii*, a widespread taxon of various forested habitats, and *Dichanthelium annulum*, a specialist of dry mafic or calcareous woodlands in the mountains and Piedmont, encapsulates the range of microhabitats and phytogeographic affinities found in the *Dichanthelium* flora of DCNAP.

Habitat Management and Future of the Preserve

The flora of DCNAP would not exist in its present state without the aggressive management interventions conducted by DCR since 2001. Prescribed fires and timber harvests have been the primary tools used to restore and maintain habitat for rare species on the preserve, in keeping with inferred and documented land use history of the area. Seven timber harvests have taken place since DCR acquired the property in 2001, including thinning operations and nearly complete harvests in certain units. Over the same period, 24 prescribed burns were conducted, most frequently in spring. The largest number of burns have taken place in March (9), followed by April (4), and May (3), with 2 burns each in February and October. The increase in understory light levels due to fire and timber management has resulted in a dramatic increase in cover and

Fig. 12. *Dichanthelium harvillii*, a newly described species known only from Difficult Creek Natural Area Preserve, showing emerging secondary inflorescences and remnants of vernal panicle (at right). Photo by John Townsend (2018).

diversity of native forbs and grasses when compared with conditions in 2001 (Townsend, pers. obs; Table 2; Fig. 13).

As noted in the introduction, varying opinions exist regarding the exact composition, structure, and extent of plant communities in the southern Piedmont prior to European colonization, even with the benefit of early explorers' accounts. The stated, primary restoration goal at DCNAP is "to increase the size of populations of rare and declining plants within a fire maintained landscape containing a mosaic of open Piedmont prairie, savanna, and woodland. A secondary restoration goal is to achieve maximum richness and diversity of native heliophytic plants" (Klopf et al. 2018). Similar goals exist for many disturbance-dependent landscapes, including such disparate systems as the calcareous grasslands of Europe and the shrublands and grasslands of New England, where the focus is not necessarily on re-creating an exact, known vegetation type but on restoration of a unique and diverse assemblage of plants, many of them rare (Butaye et al. 2005; Foster & Motzkin 2003). Prescribed fire, timber harvesting, and targeted herbicide applications are the restoration tools being used at DCNAP to achieve these goals. The current dominance of *Pinus taeda* at DCNAP is the result of recent human intervention and its elimination is a key management objective due to its historical absence. As *P. taeda* is removed, canopy species composition is being shifted in favor of existing native species such as post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*),white oak (*Q. alba*), shortleaf pine (*Pinus echinata*), and hickories (*Carya glabra* and *C. tomentosa).* A total canopy cover of less than 60% is desired and tree density in some areas has already been reduced to a greater degree (Klopf et al. 2018). Hickories are currently frequent midstory species but may gradually become less common with continued burning due to lower fire tolerance (Tirmenstein 1991a; Tirmenstein 1991b; Coladonato 1992).

In woodland units managed through timber harvests and prescribed burning, species such as poverty oat-grass (*Danthonia spicata*), eastern needlegrass (*Piptochaetium avenaceum*), little-headed nutrush (*Scleria oligantha*), witch grasses (*Dichanthelium* spp.), bluestems (primarily *Schizachyrium scoparium*), and a matrix of diverse forbs now dominate the understory and should continue to increase in dominance with future burns and harvests. In areas managed for more sparsely forested or even treeless conditions, composition should be quite similar to woodland habitats but with increasing dominance by taller grasses such as little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), broomsedges (*Andropogon virginicus* var. *virginicus*, *A. virginicus* var. *decipiens*, and *A. gyrans*), Indian grass (*Sorghastrum nutans*), and big bluestem (*Andropogon gerardii*). These taxa are already widespread in the transmission and distribution line rights-of-way but repeated fires and harvests have caused them to reappear in forested units in increasing numbers as well. The only other location in the southern Piedmont of Virginia with analogous vegetation is the frequently burned training area of Fort Pickett in Dinwiddie and Nottoway counties, which features a mosaic of closed forest, open woodland, savanna, grassland, and coppice thicket vegetation that is quite spatially and temporally dynamic. Granitic substrates underlie nearly all of that installation but a small inclusion of mafic rocks occurs, producing a diverse and distinctive flora shaped by prescribed fire. This is the only other example of regularly burned vegetation on a basic substrate in the southern Piedmont of Virginia (Fleming & Van Alstine 1994). The Fort Pickett mafic unit is very strongly dominated by forbs, however, with almost none of the diverse grass cover found at DCNAP. The floristic divergence between these isolated sites in the southern Piedmont of Virginia provides a reminder: similarly aggressive management and mafic geology does not necessarily produce a similar flora or even similar vegetation structure.

The transmission line and distribution line rights-of-way at DCNAP have provided crucial open habitat for decades. Proper management of these artificial grasslands is therefore critical for rare species found on the preserve, a common trend seen in disturbance-dependent ecosystems throughout the Southeast. Dominion Energy has maintained the vegetation on these lines with periodic mowing, coupled in the last decade with targeted herbicide applications. Since 2008, DCR has coordinated closely with Dominion on management strategies, which now includes the use of prescribed fire. Even as adjacent woodlands are being managed and fire-suppressed species restored, the powerline rights-of-way continue to support some of the most diverse floral assemblages on the preserve.

Fig. 13. Difficult Creek Natural Area Preserve management unit 6 after removal of loblolly pine and prescribed burning. Photo by John Townsend (2018).

The success of habitat management efforts at DCNAP offers proof that the flora of the southern Piedmont is potentially far more diverse than generally perceived. This flora exists largely in a nascent state in the region due to contemporary logging practices, conversion of hardwoods to pine silvicultures, and fire exclusion but may be recovered with active management, particularly in areas with moderate to high soil fertility.

APPENDIX A

Annotated list of vascular plants. This list of 653 vouchered vascular plant taxa comprises 326 genera and 106 families. The taxa are organized in alphabetical order by family within four major groups: Lycophytes, Pteridophytes, Gymnosperms, and Angiosperms. Taxonomic treatment follows Weakley et al. (2012) with the exception of *Achillea borealis*, *Dichanthelium microcarpon*, and *Rubus pascuus*, which follow Weakley (2015). Herbarium acronyms follow Index Herbariorum (Thiers 2016) except the herbarium of the Virginia Natural Heritage Program (dnh). The majority of taxa was vouchered during the 2018–2019 growing seasons by the first author and noted as such (JFT). These specimens were deposited at the herbarium of the College of William and Mary (WILLI), with any duplicates deposited at the herbarium of Virginia Polytechnic Institute and State University (VPI). Nearly 80 additional taxa were collected during prior field work. These specimens were collected by: Allen Belden (AB), Gary P. Fleming (GPF), Alton M. Harvill (AMH), Michael J. Leahy (MJL), J. Christopher Ludwig (JCL), Milo Guthrie Pyne (MGP), Alan S. Weakley (ASW), and Thomas F. Wieboldt (TFW). These vouchers reside at several institutions: College of William and Mary (WILLI), Gary P. Fleming personal herbarium (gpf), George Mason University (GMUF), Longwood University (FARM), University of North Carolina, Chapel Hill (NCU), Virginia Division of Natural Heritage reference herbarium (dnh), and Virginia Polytechnic Institute and State University (VPI). Additional notes for each taxon include the following categories. **Native Status** (**N**=Native, **I**=Non-Native, **Q**=Nativity Uncertain); **Conservation Status** (**RL**=DCR Rare Plant List, **WL**=DCR Watchlist, **X**=Extirpated from preserve); **Distribution Notes** (**CR**=County Record); **Abundance on Property**: (**Ra**=Rare, **Un**=Uncommon, **Co**=Common)

LYCOPHYTES

Lycopodiaceae

Diphasiastrum digitatum (Dill. ex A. Braun) Holub; *JFT 6136* **N;Ra**

Selaginellaceae

Lycopodioides apodum Kuntze; *JFT 6510* **N;Ra**

PTERIDOPHYTES

Aspleniaceae

Asplenium platyneuron (L.) Britton, Sterns, & Poggenb.; *JFT 5957* **N;Un**

Blechnaceae

Woodwardia areolata (L.) T. Moore; *JFT 6786* **N;Un**

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore; *JFT 6134* **N;Ra**

Pteridium aquilinum (L.) Kuhn ssp. *pseudocaudatum* (Clute) Hulten; *JFT 6135* **N;Co**

Dryopteridaceae

Polystichum acrostichoides (Michx.) Schott; *JFT 5940* **N;Un**

Onocleaceae

Onoclea sensibilis L. var. *sensibilis*; *JFT 6051* **N;Un**

Ophioglossaceae

Botrypus virginianus (L.) Holub; *JFT 5934* **N;Un**

Sceptridium biternatum (Savigny) Lyon; *JFT 6109, 6455, 6473* **N;Un**

Osmundaceae

Osmundastrum cinnamomeum (L.) C. Presl; *JFT 6542* **N;Ra**

Osmunda spectabilis Willd.; *JFT 6544* **N;Ra**

Thelypteridaceae

Parathelypteris noveboracensis (L.) Ching; *JFT 6137* **N;Un**

Woodsiaceae

Athyrium asplenioides (Michx.) A.A. Eaton; *JFT 6509, 6749* **N;Un**

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L. var. *virginiana*; *JFT 6449* **N;Un**

Pinaceae

Pinus echinata Mill.; *JFT 6426, 6801* **N;Un**

Pinus taeda L.; *JFT 6504* **I;CR;Co** Planted across much of the property and also naturalized. Continued timber removal and prescribed fire will greatly reduce the dominance of this species. It is possible the species was native in this region but evidence for its occurrence as a native on the preserve is lacking.

Pinus virginiana Mill.; *JFT 6436, 6804* **N;Un**

ANGIOSPERMS

Acanthaceae

Ruellia caroliniensis (J.F Gmel.) Steud.; *JFT 3236, 6061* **N;Co**

Adoxaceae

Viburnum acerifolium L.; *JFT 6013* **N;Un**

Viburnum prunifolium L.; *JFT 5892* **N;Co**

Agavaceae

Yucca filamentosa L.; *JFT 6516* **Q;CR;Ra**
Likely naturalizing on preserve from past cultivation

Alismataceae

Sagittaria australis (J.G. Sm.) Small; *JFT 6372* **N;Ra**

Altingiaceae

Liquidambar styraciflua L.; *JFT 6229* **N;Co**

Amaryllidaceae

Allium cernuum Roth; *AMH 25908* (FARM) **N;Un**

Allium vineale L.; *JFT 6079* **I;Co**

Narcissus poeticus L.; *JFT 5858* **I;CR;Ra**

Anacardiaceae

Rhus copallinum L. var. *latifolia* Engl.; *JFT 6311* **N;Co**

Rhus glabra L.; *JFT 6189* **N;Co**

Toxicodendron pubescens Mill.; *JFT 5915* **N;Co**
Far more abundant on preserve than *T. radicans*

Toxicodendron radicans (L.) Kuntze var. *radicans*; *JFT 6327* **N;Co**

Apiaceae

Angelica venenosa (J. Greenway) Fernald; *JFT 6182, 6333* **N;Un**

Daucus carota L.; *JFT 6149* **I;Co**

Eryngium yuccifolium Michx.; *GPF 8600* (GMUF) **N;RL;Ra** Widely scattered in burned woodlands with very open canopy and in rights-of-way, predominantly on Alfisols but also in some Ultisol areas. Broadly distributed east of the Rockies.

Sanicula canadensis L.; *JFT 6141, 6527* **N;Co**

Thaspium barbinode (Michx.) Nutt.; *JFT 5841, 5893, 5939* **N;Un**

Thaspium trifoliatum (l.) A. Gray var. *trifoliatum*; *JFT 5893, 5939* **N;Un**

Zizia aurea (L.) W.D.J. Koch; *JFT 5798, 5906, 6756* **N;CR**

Apocynaceae

Apocynum cannabinum L.; *JFT 6082* **N;Co**

Asclepias amplexicaulis Sm.; *JFT 6742* **N;Ra**

Asclepias tuberosa L. ssp. *tuberosa*; *JFT 6075* **N;Un**

Asclepias variegata L.; *GPF 10452* (GMUF, WILLI); *JFT 6016, 6036* **N;Ra**

Asclepias verticillata L.; *JFT 6184* **N;CR;Un**

Asclepias viridiflora Raf.; *JFT 6073* **N;Un**

Matelea carolinensis (Jacq.) Woodson; *JFT 3452* **N;Ra**

Matelea decipiens (Alexander) Woodson; *JFT 4649* **N;RL;Ra** Occurrences in the eastern U.S. are disjunct from the main range of the species and may not be conspecific with *M. decipiens*. Only a few highly localized colonies exist on preserve, most in a transmission line right-of-way.

Trachelospermum difforme (Walter) A. Gray; *JFT 6138* **N;Un**

Aquifoliaceae

Ilex decidua Walter var. *decidua; JFT 5849, 5909* **N;Co**

Ilex opaca Aiton var. *opaca; JFT 5856* **N;Un**

Ilex verticillata (L.) A. Gray; *JFT 6511* **N;Ra**

Araliaceae

Aralia spinosa L.; *JFT 6771* **N;CR;Ra**

Aristolochiaceae

Endodeca serpentaria Raf.; *JFT 6015* **N;Un**

Hexastylis lewisii (Fernald) H.L. Blomq. & Oosting; *JFT 6776* **N;WL;Ra** Several small colonies in dry-mesic hardwood stand near creek headwater,

Hexastylis minor (Ashe) H.L. Blomq.; *GPF 10,459* (GMUF); *JFT 5839* **N;Ra**

Asteraceae

Achillea borealis Bong.; *JFT 6088* **N;Co**

Ageratina aromatica (L.) Spach; *GPF 8589* (GMUF); *TFW 9831* (VPI) **N;Co**

Ambrosia artemisiifolia L.; *JFT 6342* **N;Co**

Ambrosia bidentata Michx.; *JFT 6424* **Q;Un** This Midwestern species grows along road edges and in other areas with disturbed soils. Widely scattered populations occur in Virginia, most often found on mafic or calcareous substrates.

Antennaria plantaginifolia (L.) Hook.; *JFT 5805, 5819* **N;Co**

Antennaria parlinii Fernald ssp. *parlinii; JFT 5834* **N;CR;Un**

Arnica acaulis (Walter) Britton, Sterns, & Poggenb.; *JFT 5912* **N;Ra** At the western edge of its Virginia distribution.

Baccharis halimifolia L.; *JFT 5930, 5956* **N;CR;Ra**

Bidens aristosa (Michx.) Britton; *JFT 6374* **Q;Co**

Bidens bipinnata L.; *JFT 6520* **N;Co**

Brickellia eupatorioides (L.) Shinners var. *eupatorioides*; *GPF 8602* (GMUF); JFT *6522* **N;Co**

Centaurea stoebe L. ssp. *micranthos* (S.G. Gmel. ex Gugler) Hayek; *JFT 6150* **I;Un**

Chrysogonum virginianum L. var. *virginianum; JFT 5800, 6067* **N;Un**

Chrysopsis mariana Elliott; *JFT 6431* **N;Co**

Cichorium intybus L.; *JFT 6258* **I;Un**

Cirsium carolinianum (Walter) Fernald & B.G. Schub.; *AMH 25543* (FARM); *ASW 7258* (NCU); *GPF 10540* (GMUF, WILLI); *MJL, s.n.* (NCU) **N;RL;Un** This biennial species increases in abundance most noticeably following large-scale timber removal and fire. It occurs most commonly west of the Appalachians, the range becoming fragmented in the Piedmont of Virginia, the Carolinas, and Georgia.

Cirsium discolor Spreng.; *JFT 6351* **N;Un**

Cirsium pumilum Spreng.; *JFT 6175* **N;Un**

Cirsium vulgare (Savi) Ten.; *JFT 6319* **I;Un**

Conoclinium coelestinum DC; *JFT 6167, 6275* **N;Co**

Conyza canadensis (L.) Cronquist var. *canadensis; JFT 6306* **N;Co**

Coreopsis auriculata L.; *JFT 1434, 5868* **N;Un**

Coreopsis lanceolata L.; *JFT 5974, 6662* **Q;Ra** Presumably naturalized in gas pipeline easement from seed mix used to stabilize soil.

Coreopsis tinctoria Nutt.; *AMH 26315* (FARM) **I;Ra**

Coreopsis tripteris L.; *JFT 6336* **N;Un**

Coreopsis verticillata L.; *JFT 6062* **N;Co**

Doellingeria infirma (Michx.) Greene; *JFT 6539* **N;Co**

Echinacea laevigata (C.L. Boynton & Beadle) S.F. Blake; *JFT 6089* **N;RL;Ra** Colonies widely scattered across the western half of the preserve, in burned woodlands and rights–of-way on Alfisols. Restricted to mafic and calcareous substrates in the Piedmont and mountain physiographic regions of Virginia, the Carolinas, and Georgia.

Eclipta prostrata (L.) L.; *JFT 6517* **N;Ra**

Elephantopus carolinianus Raeusch.; *JFT 6350* **N;Co**

Elephantopus tomentosus L.; *JFT 6392* **N;Un**

Erechtites hieraciifolius (L.) Raf. ex DC.; *JFT 6358* **N;Co**

Erigeron annuus (L.) Pers.; *JFT 6661* **N;Un**

Erigeron strigosus Muhl. ex Willd. var. *strigosus*; *JFT 5916, 6052* **N;Co**

Eupatorium album L. var. *album*; *JFT 6202, 6304, 6305* **N;Co**

Eupatorium altissimum L.; *GPF* 8593 (GMUF, WILLI); JFT *8593* **N;Un**

Eupatorium capillifolium (Lam.) Small ex Porter & Britton; *JFT 6581* **N;Co**

Eupatorium godfreyanum Cronquist; *JFT 6210, 6313, 6321* **N;Co**

Eupatorium hyssopifolium L.; *JFT 6313, 6321* **N;Co**

Eupatorium perfoliatum L.; *JFT 6399* **N;Un**

Eupatorium pilosum Walter; *JFT 6284, 6483* **N CR;Co**

Eupatorium pubescens Muhl. ex Willd.; *JFT 6264, 6465* **N;Co**

Eupatorium rotundifolium L.; *JFT 6281* **N;Un**

Eupatorium saltuense Fernald; *GPF 8597* (WILLI); *JFT 6312, 6451, 6487* **N;Co**

Eupatorium serotinum Michx.; *JFT 6346* **N;Co**

Eupatorium sessilifolium L. var. *sessilifolium*; *JFT 6289, 6497* **N;Ra**

Eupatorium torreyanum Short & R. Peter; *JFT 6761, 6741, 6805* **N;CR;Un**

Eurybia compacta G.L. Nesom; *JFT 6322* **N;Un**

Euthamia caroliniana (L.) Greene ex Porter & Britton; *JFT 6795* **N;Ra**

Eutrochium fistulosum (Barratt) E.E. Lamont; *JFT 6396, 6328* **N;Ra**

Gamochaeta argyrinea G.L. Nesom; *JFT 3380, 5881, 5889* **N;Co**

Helenium amarum (Raf.) H. Rock var. *amarum*; *JFT 6530* **I;Un**

Helenium autumnale L.; *JFT 6370* **N;Ra**

Helenium flexuosum RafinesqueRaf.; *JFT 6215* **N;Un**

Helianthus atrorubens L.; *JFT 6279* **N;Co**

Helianthus divaricatus L.; *JFT 6162* **N;Co**

Helianthus giganteus L.; *JFT 6416, 6533* **N;Ra**

Hieracium gronovii L.; *JFT 6263* **N;Co**

Hieracium venosum L.; *JFT 5908* **N;Co**

Hypochaeris radicata L.; *JFT 6070* **I;CR;Un**

Ionactis linariifolia (L.) Greene; *JFT 6660* **N;Un**

Krigia dandelion (L.) Nutt.; *JFT 5829, 5859* **N;Un**

Krigia virginica (L.) Willd.; *JFT 5827* **N;Un**

Lactuca canadensis L.; *JFT 6187, 6348. 6748, 6772* **N;Co**

Leucanthemum vulgare Lam.; *JFT 5944* **I;Un**

Liatris pilosa Willd.; *JFT 6387, 6503* **N;Un**

Liatris spicata (L.) Willd. var. *resinosa* (Nutt.) Gaiser; *JFT 6236* **Q;CR;Ra** Collected from ecotone between burned pine woodland and gas pipeline easement. Possibly naturalized in right-of-way from seed mix used to stabilize soil.

Liatris squarrosa (L.) Michx. var. *squarrosa*; *JFT 6194* **N;Co**

Marshallia legrandii Weakley; *AMH 25539* (FARM, VPI); *ASW 7255* (NCU); *GPF 10448* (GMUF, VPI); *JFT 3233* **N;RL;Ra** Several widely scattered colonies occur in burned woodlands (or their edges) on Alfisols. Extant populations known only from DCNAP and Picture Creek Diabase Barrens, N.C.

Marshallia obovata (Walter) Beadle & F.E. Boynton var. *obovata*; *GPF 10458* (GMUF, WILLI); *JFT 3234, 4271* **N;RL;Ra** Only known from a narrow distribution line right-of-way at the northern end of the preserve, soil type uncertain. An endemic with strong Piedmont affinities throughout its range from Virginia to Alabama.

Mikania scandens (L.) Willd.; *JFT 6316* **N;Un**

Nabalus serpentarius (Pursh) Hook.; *GPF 8596* (GMUF) **N;Un**

Nabalus trifoliolatus Cass.; *JFT 6587* **N;Ra**

Packera anonyma (Wood) W.A. Weber & Á. Löve; *JFT 5914* **N;Co**

Packera paupercula (Michx.) Á. Löve & D. Löve var. *paupercula*; *JFT 5931, 5958, 5959, 5960, 5961* **N;WL;CR;Ra** These specimens should be investigated further due to taxonomic complexity of the *P. paupercula* complex.

Parthenium auriculatum Britton; *GPF 10455* (WILLI), *10544* (GMUF) **N;Co** Often co-mingling with *P. integrifolium* var. *integrifolium*, particularly in transmission line right-of-way.

Parthenium integrifolium L. var. *integrifolium*; *JFT 5905, 2096* **N;Co**

Pityopsis aspera (A. Gray) Small var. *adenolepis* (Fernald) Semple & F.D. Bowers; *JFT 6232* **N;Co**

Pluchea camphorata (L.) DC.; *JFT 6329* **N;Un**
Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt; *JFT 6307* **N;Co**
Pyrrhopappus carolinianus DC.; *JFT 6066* **N;Un**
Rudbeckia fulgida Aiton; *JFT 6362, 6747, 6799* **N;Un**
Rudbeckia hirta L.; *JFT 6129, 6183* **N;Co**
Rudbeckia laciniata L. var. *laciniata*; *JFT 6423* **N;Un**
Sericocarpus asteroides (L.) Britton, Sterns, & Poggenb.; *JFT 6334* **N;Un**
Sericocarpus linifolius Britton, Sterns, & Poggenb.; *GPF 10545* (WILLI) **N;Un**
Silphium asteriscus L.; *JFT 6166, 6337* **N;Co** Varietes not treated but alternate, opposite, and whorled-leaved plants occur on preserve, often closely intermixed. Culm vestiture variable but seemingly not correlating with any particular leaf arrangement.
Solidago altissima L.ssp. *altissima; JFT 6491, 6663* **N;Co**
Solidago bicolor L.; *JFT 6577* **N;Co**
Solidago erecta Pursh; *JFT 6528, 6582, 6650* **N;Un**
Solidago juncea Aiton; *JFT 6309* **N;Co**
Solidago nemoralis Aiton var. *nemoralis*; *JFT 6444* **N;Co**
Solidago pinetorum Small; *JFT 6203* **N;Co**
Solidago puberula Nutt.var. *puberula*; *GPF 14320* (gpf)*; JFT 6583, 6802* **N;Un**
Solidago rugosa Mill. var. *aspera* Fernald; *JFT 6347* **N;Co**
Solidago ulmifolia Muhl. ex Willd.; *JFT 6475* **N;CR;Ra**
Symphyotrichum concolor (L.) G.L. Nesom; *GPF 14321* (gpf)*; JFT 6656* **N;Co**
Symphyotrichum dumosum (L.) G.L. Nesom var. *dumosum*; *JFT 6411, 6651* **N;Co**
Symphyotrichum grandiflorum (L.) G.L. Nesom; *GPF 14322* (gpf)*; JFT 6506* **N;Un** Endemic to the Piedmont and Coastal Plain of Virginia and the Carolinas
Symphyotrichum laeve (L.) Á. Löve & D. Löve var. *concinnum* (Willd.) G.L. Nesom; *JFT 6590* **N;Ra**
Symphyotrichum lanceolatum (Willd.) G.L. Nesom var. *lanceolatum*; *JFT 6647* **N;Co**
Symphyotrichum patens (Aiton) G.L. Nesom var. *patens*; *JFT 6578* **N;Co**
Symphyotrichum pilosum (Willd.) G.L. Nesom var. *pilosum*; *JFT 6798* **N;Ra**
Symphyotrichum pilosum (Willd.) G.L. Nesom var. *pringlei* (A. Gray) G.L. Nesom; *JFT 6489* **N;Co**
Symphyotrichum undulatum (L.) G.L. Nesom; *JFT 6586, 6646* **N;Un**
Taraxacum officinale F.H. Wigg.; *JFT 5821* **I;Un**
Verbesina alternifolia (L.) Britton ex Kearney; *JFT 6378* **N;Co**
Verbesina occidentalis (L.) Walter; *JFT 6796* **N;Ra**
Vernonia glauca (L.) Willd.; *JFT 6177, 6262* **N;Co**
Vernonia noveboracensis (L.) Michx.; *JFT 6393* **N;Un**
Youngia japonica (L.) DC.; *JFT 5933* **I;CR;Ra**

Balsaminaceae
Impatiens capensis Meerb.; *JFT 6382* **N;Un**

Betulaceae
Alnus serrulata (Aiton) Willd.; *JFT 6404* **N;Un**
Carpinus caroliniana Walter; *JFT 6443* **N;Un**
Corylus americana Walter; *JFT 6010* **N;Ra**
Ostrya virginiana (Mill.) K. Koch; *JFT 6484* **N;Un**

Bignoniaceae
Bignonia capreolata L.; *JFT 6005* **N;Ra**
Campsis radicans (L.) Seem. ex Bureau; *JFT 6432* **N;Un**

Boraginaceae
Lithospermum canescens (Michx.) Lehm.; *JFT 5811* **N;Un**
Myosotis verna Nutt.; *JFT 3375, 5818* **N;Un**

Brassicaceae
Arabidopsis thaliana (L.) Heynh.; *JFT 5787* **I;Co**
Barbarea verna (Mill.) Asch.; *JFT 5789* **I;Un**
Cardamine hirsuta L.; *JFT 5791* **I;Co**
Cardamine parviflora L. var. *arenicola* (Britton) O.E. Schulz; *JFT 5793, 5814, 5835, 5848* **N CR;Un**
Lepidium campestre (L.) W.T. Aiton; *JFT 6043* **I;Un**
Lepidium densiflorum Schrad.; *JFT 5872* **I;CR;Un**
Rorippa palustris (L.) Besser ssp. *palustris*; *JFT 6130* **I;Ra**

Cabombaceae
Brasenia schreberi J.F. Gmel.; *JFT 6268* **N;CR;Un** Locally abundant in artificial pond

Campanulaceae
Lobelia inflata L.; *JFT 6390* **N;Un**
Lobelia puberula Michx.; *JFT 6324* **N;Co**
Lobelia spicata Lam. var. *spicata*; *JFT 5973, 6478* **N;CR;Co**
Triodanis perfoliata (L.) Nieuwl.; *JFT 6007* **N;Co**

Cannabaceae
Celtis occidentalis L.; *JFT 6380, 6430* **N;Un** Sterile specimens, perhaps fitting the concept of *Celtis smallii* Beadle

Caprifoliaceae
Lonicera japonica Thunb.; *JFT 6012* **I;Co**
Lonicera sempervirens L.; *JFT 5896* **N;Un**
Symphoricarpos orbiculatus Moench; *JFT 6310* **Q;Co** Often treated as native in parts of the east but this shrub is now so ubiquitous and weedy across Virginia in a range of habitats that its original extent and status cannot be determined. It has invaded mafic habitats in Virginia where unknown until recent decades, but no similar observations are available for mafic woodland habitats at DCNAP.
Valerianella umbilicata (Sull.) Alph. Wood; *JFT 5866, 5945, 6077* **N;Un**

Caryophyllaceae
Cerastium brachypetalum Pers.; *JFT 5817a* **I;CR;Ra**
Cerastium glomeratum Thuill.; *JFT 5817b* **I;Un**
Dianthus armeria L. ssp. *armeria; JFT 6044* **I;Ra**

Celastraceae
Euonymus americanus L.; *JFT 6117* **N;Un**

Ceratophyllaceae
Ceratophyllum echinatum A. Gray; *JFT 6417* **N CR;Ra** In small, apparently permanent pool of headwater stream

Cistaceae
Lechea minor L.; *JFT 6181* **N;CR;Ra** At the western edge of its Virginia distribution.
Lechea racemulosa Michx.; *JFT 3230, 6331* **N;Un**
Lechea tenuifolia Michx.; *JFT 6158, 6388* **N;Un**

Colchicaceae
Uvularia perfoliata L.; *JCL 42618-01* **N;Ra**
Uvularia sessilifolia L.; *JFT 6471* **N;Ra**

Convolvulaceae

Cuscuta pentagona Engelm.; *JFT 6413* **N;Ra**

Ipomoea lacunosa L. **N;Ra**

Photo record (JCL)**.** Plants could not be relocated for specimen collection

Ipomoea pandurata (L.) G. Mey.; *JFT 6106* **N;Un**

Cornaceae

Cornus amomum Mill.; *JFT 5847, 6766* **N;Un**

Cornus florida L.; *JFT 5809* **N;Un**

Cyperaceae

Carex albicans Willd. ex Spreng.; *JFT 3383* **N;Un**

Carex caroliniana Schwein.; *JFT 6037, 6777* **N;Ra**

Carex complanata Torr. & Hook.; *JFT 5985* **N;CR;Ra**

Carex crebriflora Wiegand; *JFT 6004* **N;Un**

Carex crinita Lam. var. *crinita*; *JFT 6285* **N;Un**

Carex debilis Michx.; *JFT 5986a, 6046* **N;CR;Un**

Carex digitalis Willd. var. *digitalis*; *JFT 6014* **N;CR;Ra**

Carex digitalis Willd. var. *macropoda* Fernald; *JFT 6011, 6039, 6086* **N;Co** At the western edge of its Virginia distribution.

Carex glaucodea Tuck. ex Olney; *JFT 5999, 3235, 3450, 5922, 6022, 6038, 6111, 6783* **N;Co**

Carex gravida L.H. Bailey; *JFT 6221* **Q;Ra**

Carex hirsutella Mack.; *JFT 5923* **N;Co**

Carex intumescens Rudge var. *intumescens*; *JFT 6468* **N;Ra**

Carex laxiflora Lam.; *JFT 6031* **N;CR;Ra**

Carex longii Mack.; *JFT 6154* **N;CR;Un**

Carex lurida Wahlenb.; *JFT 5987a, 6185* **N;Un**

Carex meadii Dewey; *JFT 5855* **N;WL;CR;Un** Almost exclusively in transmission line right-of-way, where locally common on Alfisols.

Carex muehlenbergii Schkuhr ex Willd. var. *muehlenbergii*; *JFT 5996, 6124* **N;CR;Ra**

Carex nigromarginata Schwein.; *JFT 3382* **N;Un**

Carex normalis Mack.; *JFT 6113, 6775* **N;Ra**

Carex reznicekii Werier; *JFT 5815, 5998* **N;Un**

Carex squarrosa L.; *JFT 6080* **N;Ra**

Carex striatula Michx.; *JFT 5948* **N;Ra**

Carex styloflexa Buckley; *JFT 5990* **N;CR;Ra**

Carex vulpinoidea Michx.; *JFT 6126* **N;Un**

Carex willdenowii Schkuhr ex Willd.; *JFT 5935* **N;Co**

Cyperus echinatus (L.) Wood; *JFT 6195* **N;Un**

Cyperus iria L.; *JFT 6339* **I;Un**

Cyperus polystachyos Rottb.; *JFT 6301* **N;CR;Un**

Cyperus pseudovegetus Steud.; *JFT 6206, 6330* **N;Ra**

Cyperus strigosus L.; *JFT 6415* **N;Co**

Eleocharis engelmannii Steud.; *JFT 6190, 6774* **N;CR;Un**

Eleocharis verrucosa (Svenson) L.J. Harms; *JFT 6152* **N;Un** Additional specimens **(***JFT 3379* - VPI, WILLI) are immature; they are likely *E. verrucosa* but could be another taxon in the *E. tenuis* complex

Fimbristylis annua (All.) Roem. & Schult.; *JFT 6278, 6368* **Q;CR;Un**

Fimbristylis autumnalis (L.) Roem. & Schult.; *JFT 6367* **N;Un**

Rhynchospora corniculata (Lam.) A. Gray; *JFT 6186* **N;Un** At the western edge of its Virginia distribution.

Rhynchospora globularis (Chapm.) Small; *JFT 3238, 4272, 4276, 4277* **N;CR;Co**

Rhynchospora glomerata (L.) Vahl var. *glomerata*; *GPF 8604* (WILLI); *JFT 8604* **N;Co**

Rhynchospora harveyi W. Boott; *JFT 4065, 4739, 6760* **N;RL;Ra** Probably widely dispersed in burned woodlands, where usually mixed with *Rhynchospora globularis* and *R. recognita*. DCNAP marks the northernmost extent of the species' range

Rhynchospora inexpansa (Michx.) Vahl; *JFT 6233* **N;Ra**

Rhynchospora recognita (Gale) Kral; *JFT 3237, 4738* **N;Co**

Scirpus cyperinus (L.) Kunth; *JFT 6228* **N;Un**

Scirpus georgianus R.M. Harper; *JFT 6200* **N;Un**

Scleria elliottii Chapm.; *JFT 6739, 6750* **N;CR;Ra**

Scleria oligantha Michx.; *JFT 5992, 6085, 6097, 6743* **N;Co** On of the most widespread and abundant understory species on Alfisols, along with *Piptochaetium avencaeum*.

Scleria pauciflora Muhl. ex Willd. var. *pauciflora*; *JFT 6227, 6345* **N;Ra**

Dioscoreaceae

Dioscorea villosa L.; *JFT 6463* **N;Un**

Ebenaceae

Diospyros virginiana L.; *JFT 6427* **N;Un**

Ericaceae

Chimaphila maculata (L.) Pursh; *JFT 5995* **N;Un**

Gaylussacia baccata (Wangenh.) K. Koch; *JFT 5891, 5983* **N;Un**

Gaylussacia dumosa (Andrews) Torr. & A. Gray; *JFT 5976* **N;Ra**

Kalmia latifolia L.; *JFT 6482* **N;Ra**

Lyonia ligustrina (L.) DC. var. *ligustrina*; *JFT 5897, 6318* **N;Co**

Oxydendrum arboreum (L.) DC.; *JFT 6442* **N;Un**

Rhododendron periclymenoides (Michx.) Shinners; *JFT 5838* **N;Ra**

Vaccinium caesariense Mack.; *JFT 5857* **N;CR;Ra** At the western edge of its Virginia distribution.

Vaccinium formosum Andrews; *JFT 6267* **N;CR;Un**

Vaccinium fuscatum Aiton; *JFT 6543, 6778* **N;Un**

Vaccinium pallidum Aiton; *JFT 5852, 5984* **N;Co**

Vaccinium tenellum Aiton; *JFT 6260; JCL 42618-02* **N;CR;Ra** At the western edge of its Virginia distribution.

Vacciunium stamineum L.; *JFT 5851* **N;Co**

Euphorbiaceae

Acalypha gracilens A. Gray; *JFT 6272, 6355, 6408* **N;Co**

Acalypha rhomboidea Raf.; *JFT 6391, 6519* **N;Co**

Croton glandulosus L. var. *septentrionalis* Müll. Arg.; *JFT 6588* **Q;Un**

Euphorbia maculata L.; *JFT 6406, 6490* **N;Un**

Euphorbia nutans Lag.; *JFT 6434* **N;Un**

Euphorbia pubentissima Michx.; *JFT 5949, 5952, 6002, 6020* **N;Co**

Tragia urticifolia Michx.; *JFT 6063* **N;WL;Un**

Fabaceae

Albizia julibrissin Durazz.; *JFT 6521* **I;Ra**

Amphicarpaea bracteata (L.) Fernald; *JFT 6422* **N;Co**

Baptisia tinctoria (L.) Vent.; *JFT 6282* **N;Un**

Centrosema virginianum (L.) Benth.; *JFT 6286* **N;Ra**

Cercis canadensis L. var. *canadensis*; *JFT 5806* **N;Co**

Chamaecrista fasciculata (Michx.) Greene var. *fasciculata*; *JFT 6237* **N;Un**

Chamaecrista nictitans (L.) Moench var. *nictitans*; *JFT 6323* **N;Un**

Clitoria mariana L. var. *mariana*; *JFT 6104* **N;Co**

Desmodium ciliare (Muhl. ex Willd.) DC.; *JFT 6457, 6486* **N;Un**

Desmodium laevigatum (Nutt.) DC.; *JFT 6315* **N;Co**

Desmodium marilandicum (L.) DC.; *JFT 6320, 6403a, 6403b, 6456, 6523* **N;Co**

Desmodium nuttallii (Schindl.) B.G. Schub.; *JFT 6385, 6458, 6459, 6494, 6538, 6655* **N;CR;Un**
Desmodium obtusum (Muhl. ex Willd.) DC.; *JFT 6524* **N;Un**
Desmodium paniculatum (L.) DC. var. *paniculatum*; *JFT 6271, 6308* **N;Co**
Desmodium perplexum Schub.; *JFT 6465, 6546* **N;CR;Un**
Desmodium rotundifolium DC.; *JFT 6540* **N;Un**
Galactia regularis (L.) Britton, Sterns, & Poggenb.; *JFT 6188* **N;CR;Co** At the western edge of its Virginia distribution.
Gleditsia triacanthos L.; *JFT 6042* **Q;Ra**
Hylodesmum nudiflorum (L.) H. Ohashi & R.R. Mill; *JFT 6356, 6782* **N;Un**
Kummerowia striata (Thunb.) Schindl.; *JFT 6340* **I;Un**
Lespedeza bicolor Turcz.; *JFT 6414* **I;Ra**
Lespedeza cuneata (Dum. Cours.) G. Don; *JFT 6298* **I;Co**
Lespedeza frutescens (L.) Elliott; *JFT 6402* **N CR;Co**
Lespedeza hirta (L.) Hornem. var. *hirta*; *JFT 6400* **N;Co**
Lespedeza procumbens Michx.; *JFT 6349* **N;Co**
Lespedeza repens (L.) W.P.C. Barton; *JFT 6122* **N;Co**
Lespedeza stuevei Nutt.; *JFT 6361, 6381, 6527, s.n.* (dnh) **N;Un**
Lespedeza violacea (L.) Pers.; *JFT 6357, 6499, 6537* **N;Un**
Lespedeza virginica (L.) Britton; *JFT 6344, 6369, 6493* **N;Co**
Medicago lupulina L.; *JFT 5901* **N;Un**
Melilotus albus Medik.; *JFT 6074* **I;Un**
Orbexilum pedunculatum (Mill.) Rydb. var. *psoralioides* (Walter) Isely; *ASW 7260* (NCU); GPF *10542* (WILLI); *JCL 42703-01* (NCU) **N;Un**
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S.M. Almeida ex Sanjappa & Predeep; *JFT 6421* **I;Un**
Rhynchosia tomentosa (L.) Hook. & Arn.; *JFT 6161* **N;Co**
Senna hebecarpa (Fernald) H.S. Irwin & Barneby; *JFT 6270, 6534* **N;Un**
Strophostyles umbellata (Muhl. ex Willd.) Britton; *JFT 6168* **N;Co**
Stylosanthes biflora (L.) Britton, Sterns, & Poggenb.; *JFT 6425* **N;Co**
Tephrosia virginiana (L.) Pers.; *JFT 5969* **N;Co**
Trifolium arvense L.; *JFT 6128* I;**Un**
Trifolium dubium Sibth.; *JFT 6091* **I;CR;Un**
Trifolium pratense L.; *JFT 5941* **I;Ra**
Vicia caroliniana Walter; *JFT 5795* **N;Co**
Vicia sativa L. ssp. *nigra* (L.) Ehrh.; *JFT 5918* **I;Co**
Vicia villosa Roth ssp. *varia* (Host) Corb.; *JFT 5975* **I;Ra**
Wisteria sinensis (Sims) DC; *JFT 6512* **I;Ra**

Fagaceae
Castanea pumila (L.) Mill.; *JFT 6335* **N;Ra**
Fagus grandifolia Ehrh.; *JFT 6476* **N;Un**
Quercus alba L.; *JFT 6222* **N;Co**
Quercus coccinea Münchh.; *JFT 6235* **N;Ra**
Quercus falcata Michx.; *JFT 6226* **N;Un**
Quercus marilandica Münchh. var. *marilandica*; *JFT 5879* **N;Co**
Quercus montana Willd.; *JFT 6437* **N;Un**
Quercus phellos L.; *JFT 5880* **N;Un**
Quercus rubra L.; *JFT 6225* **N;Un**
Quercus stellata Wangenh.; *JFT 6214* **N;Co**
Quercus velutina Lam.; *JFT 6447* **N;Un**

Gentianaceae
Gentiana villosa L.; *GPF* 8605 (GMUF); *JFT 6652* **N;Un**
Sabatia angularis (L.) Pursh; *JFT 6198* **N;Un**
Sabatia quadrangula Wilbur; *JFT 6231* **N;Un**

Geraniaceae
Geranium carolinianum L.; *JFT 5861* **N;Un**
Geranium maculatum L.; *JFT 6785* **N;Ra**

Hamameliadaceae
Hamamelis virginiana L. var. *virginiana*; *JFT 6480* **N;Un**

Hypericaceae
Hypericum crux-andreae (L.) Crantz; *JFT 6481, 6767* **N;Ra**
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray; *GPF 8598* (GMUF) **N;WL;Un**
Hypericum gentianoides (L.) Britton, Sterns, & Poggenb.; *JFT 6155* **N;Co**
Hypericum hypericoides (L.) Crantz; *JFT 6273, 6317* **N;Co**
Hypericum mutilum L. var. *mutilum*; *JFT 6352* **N;Co**
Hypericum prolificum L.; *JFT 6212* **N;Co**
Hypericum punctatum Lam.; *JFT 6159* **N;Co**
Hypericum stragulum W.P. Adams & N. Robson; *JFT 6266* **N;Co**
Hypericum virgatum Lam.; *JFT 2780* **N;WL;Un**

Hypoxidaceae
Hypoxis hirsuta (L.) Coville; *JFT 5833* **N;Co**

Iridaceae
Iris verna L. var. *smalliana* Fernald ex M.E. Edwards; *JFT 5796, 5822* **N;CR;Un**
Sisyrinchium angustifolium Mill.; *JFT 6047* **N;Un**
Sisyrinchium mucronatum Michx.; *JFT 5831, 5884* **N;Co**

Juglandaceae
Carya cordiformis (Wangenh.) K. Koch; *JFT 6485* **N;Ra**
Carya glabra (Mill.) Sweet; *JFT 2779, 5929* **N;Co** *JFT 2779* Fits concept of var. *hirsuta* (Ashe) Ashe and distributed as such; *JFT 5929* fits concept of var. *glabra*
Carya ovata (Mill.) K. Koch; *JFT 6469, 6470* **N;Un**
Carya tomentosa (Lam. ex Poir.) Nutt.; *JFT 6216* **N;Co**
Juglans nigra L.; *JFT 6514* **N;Ra**

Juncaceae
Juncus acuminatus Michx.; *JFT 6098, 6143, 6529, 6759, 6768* **N;Un**
Juncus anthelatus (Wiegand) R.E. Brooks; *JFT 6199, 6280* **N;CR;Un**
Juncus biflorus Elliott; *JFT 6078, 6139* **N;Co**
Juncus brachycarpus Engelm.; *GPF 10457* (WILLI); *JFT 3449, 4274, 6178* **N;Un**
Juncus bufonius L.; *JFT 6125* **N;Un**
Juncus coriaceus Mack.; *JFT 6084* **N;Un**
Juncus dichotomus Elliott; *JFT 6087* **N;Un**
Juncus effusus L.; *JFT 6069* **N;Un**
Juncus marginatus Rostk.; *JFT 6142* **N;Un**
Juncus secundus P. Beauv. ex Poir.; *JFT 6704* **N;Ra**
Juncus tenuis Willd.; *JFT 6123, 6132* **N;Co**
Luzula bulbosa (Alph. Wood) Smyth & L.C.R. Smyth; *JFT 5832, 5887* **N;Un**
Luzula multiflora (Ehrh.) Lej. var. *multiflora*; *JFT 5813* **N;Un**

Lamiaceae
Clinopodium vulgare L.; *JFT 6163* **N;Un**
Cunila origanoides (L.) Britton; *JFT 6140* **N;Co**
Lycopus americanus Muhl. ex W.P.C. Barton; *JFT 6287, 6818* **N;Un**
Lycopus virginicus L.; *JFT 6439, 6654* **N;Un**
Monarda fistulosa L. var. *fistulosa*; *GPF 10541* (GMUF); *JFT 6160, 6745* **N;Un**

Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim.; *JFT 6496* **I;CR;Ra** A relatively recent and fast-spreading introduction, largely known from the Coastal Plain and Piedmont

Physostegia virginiana (L.) Benth. ssp. *praemorsa* (Shinners) P.D. Cantino; *GPF 8603* (GMUF)*; JFT 6460; TFW 8775* (VPI) **N;Un**

Prunella vulgaris L. var. *lanceolata* (W.P.C. Barton) Fernald; *JFT 6008* **N;Co**

Pycnanthemum pycnanthemoides (Leavenw.) Fernald var. *pycnanthemoides*; *JFT 6196* **N;CR;Un**

Pycnanthemum tenuifolium Schrad.; *JFT 6102* **N;Co**

Pycnanthemum torreyi Benth.; *JCL 41014-01* (VPI) **N;RL;Ra** A very small colony occurs along a woods road**.** Populations in Virginia are never large, usually occurring in mafic and calcareous habitats of the Virginia mountains, Piedmont and (rarely) Coastal Plain. It has a highly disrupted range, almost entirely east of the Mississippi River.

Salvia lyrata L.; *JFT 5869* **N;Co**

Salvia urticifolia L.; *GPF 10454* (GMUF, WILLI)*; JFT 5863* **N;Un**

Scutellaria elliptica Muhl. var. *hirsuta* (Short & R. Peter) Fernald; *JFT 6093* **N;CR;Co**

Scutellaria integrifolia L.; *JFT 6076, 6461* **N;Co**

Scutellaria leonardii Epling; *GPF 10456* (GMUF, WILLI) **N;Un**

Trichostema dichotomum L.; *JFT 6418* **N;Un**

Lauraceae

Sassafras albidum (Nutt.) Nees; *JFT 6433* **N;Co**

Liliaceae

Erythronium umbilicatum C.R. Parks & Hardin ssp. *umbilicatum*; *JFT 5842* **N;Un**

Lilium superbum L.; *JFT 6781* **N;Ra** sterile specimen; other *Lilium* highly improbable due to phytogeography and habitat

Linaceae

Linum intercursum E.P. Bicknell; *GPF 10546* (GMUF)*; JFT 2777* **N;Un**

Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald; *JFT 6740* **N;Un**

Linum striatum Walter; *JFT 6419, 6746* **N;Un**

Linderniaceae

Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperr.; *JFT 6375* **N;Un**

Lythraceae

Lythrum alatum Pursh; *JFT 5106* **N;RL;X;Ra** Extirpated from the property when new pipeline construction eliminated its habitat. Otherwise known from small, widely scattered populations in wet habitats of the Virginia mountains and Piedmont, and a single site in the Coastal Plain. The Virginia occurrences are at the southeastern fringe of the species' range.

Rotala ramosior (L.) Koehne; *JFT 6300* **N;Ra**

Magnoliaceae

Liriodendron tulipifera L.; *JFT 6450* **N;Un**

Melastomataceae

Rhexia mariana L. var. *mariana*; *JFT 6207* **N;Co**

Rhexia ventricosa Fernald & Griscom; *JFT 4721* **N;CR;Ra** At the western edge of its Virginia distribution.

Rhexia virginica L.; *JFT 6277* **N;Un**

Moraceae

Morus rubra L.; *JFT 6120* **N;Ra**

Nartheciaceae

Aletris farinosa L.; *GPF 10,548* (GMUF); *JFT 5981* **N;Co**

Nyssaceae

Nyssa sylvatica Marshall; *JFT 6230* **N;Co**

Oleaceae

Chionanthus virginicus L.; *JFT 5854, 5894* **N;Un**

Fraxinus americana L.; *JFT 6213* **N;Un**

All *Fraxinus* species are either dead or in severe decline with the exception of saplings and seedlings

Fraxinus biltmoreana Beadle; *JFT 6118* **N;Un**

Fraxinus pennsylvanica Marshall; *JFT 6269* **N;Ra**

Ligustrum sinense Lour.; *JFT 6006* **I;Un**

Onagraceae

Ludwigia alternifolia L.; *JFT 6211* **N;Un**

Ludwigia palustris (L.) Elliott; *JFT 6764* **N;Un**

Oenothera biennis L.; *JFT 6383* **N;Un**

Oenothera fruticosa L.; *JFT 5971* **N;CR;Co**

Oenothera laciniata Hill; *JFT 5899* **N;Un**

Orchidaceae

Cypripedium acaule Aiton; *JFT 6435* **N;Ra**

Goodyera pubescens (Willd.) R. Br.; *JFT 6474* **N;Un**

Liparis liliifolia (L.) Rich. ex Lindl.; *JFT 6033* **N;Ra**

Platanthera ciliaris (L.) Lindl.; *JFT 6332* **N;CR;Ra**

Spiranthes cernua (L.) Rich.; *JFT 6659* **N;Ra**

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer; *JFT 6363* **N;Ra**

Spiranthes ovalis Lindl. var. *erostellata* Catling; *JFT 6591* **N;CR;Ra**

Tipularia discolor (Pursh) Nutt.; *JFT 6259* **N;Un**

Orobanchaceae

Agalinis decemloba (Greene) Pennell; *GPF 15920* (VPI) **N;Un** Restricted or nearly restricted to transmission line right-of-way

Agalinis purpurea (L.) Pennell; *MGP 2013-10* (NCU) **N;Un**

Agalinis setacea (J.F. Gmel.) Raf.; *GPF 15921* (GMUF, VPI)*; JFT 6803; MGP 2013-005, 2013-006, 2013-007, 2013-008* (NCU) **N;Un**

Agalinis tenuifolia (Vahl) Raf.; *GPF 8591* (GMUF); *JFT 6800; MGP 2013-009* (NCU)*; TFW 8755* (VPI) **N;Co**

Aureolaria pedicularia (L.) Raf. ex Pennell; *JFT 6401* **N;Ra**

Aureolaria virginica (L.) Pennell; *JFT 6179* **N;Un**

Orobanche uniflora L.; *JFT 5865* **N;Ra**

Pedicularis canadensis L.; *JFT 5801* **N;Ra**

Oxalidaceae

Oxalis dillenii Jacq.; *JFT 5895* **N;Co**

Oxalis colorea (Small) Fedde; *JCL 42618-03; JFT 5845, 5860* **N;Co** These plants with large, red-lined flowers were identified using Nesom (2014)

Oxalis violacea L.; *JFT 5883* **N;Un**

Passifloraceae

Passiflora incarnata L.; *JFT 6384* **N;Ra**

Passiflora lutea L.; *JFT 6477* **N;Ra**

Paulowniaceae

Paulownia tomentosa (Thunb.) Steud.; *JFT 5950* **I;Ra**

Phrymaceae

Mimulus ringens L. var. *ringens*; *JFT 6397* **N;Un**

Phyllanthaceae

Phyllanthus caroliniensis Walter ssp. *caroliniensis*; *JFT 6501* **Q;Un**

Phytolaccaceae

Phytolacca americana L. var. *americana*; *JFT 6096* **N;Co**

Plantaginaceae

Gratiola neglecta Torr.; *JFT 6153* **N;Un**

Mecardonia acuminata (Walter) Small var. *acuminata*; *JFT 6217* **N;Co**

Nuttallanthus canadensis (L.) D.A. Sutton; *JCL 42711-01* (VPI); *JFT 5862* **N;Co**

Penstemon canescens (Britton) Britton; *JFT 5910* **N;CR;Un**

Penstemon digitalis Nutt. ex Sims; *JFT 6003, 6035* **N;CR;Un**

Plantago aristata Michx.; *JFT 6127* **I;Co**

Plantago lanceolata L.; *JFT 6009* **I;Co**

Plantago rugelii Decne.; *JFT 6589* **N;Co**

Plantago virginica L.; *JFT 5790* **N;Co**

Plantago wrightiana Decne.; *JFT 6029* **I;CR;Un**

Veronica arvensis L.; *JFT 5792, 5844* **I;Co**

Veronicastrum virginicum (L.) Farw.; *JCL 2018-01* **N;Ra**

Platanaceae

Platanus occidentalis L.; *JFT 6209* **N;Un**

Poaceae

Agrostis hyemalis (Walter) Britton, Sterns, & Poggenb.; *JFT 5911, 6025* **N;Co**

Agrostis perennans (Walter) Tuck.; *JFT 6343, 6462, 6525* **N;Co**

Agrostis scabra Willd.; *JFT 6090* **N;WL;CR;Un**

Aira elegans Willd. ex Roem. & Schult.; *JFT 5873, 5962* **I;Co**

Andropogon gerardii Vitman; *GPF 8594* (GMUF, WILLI); *JFT 8594* **N;Un**

Andropogon gyrans Ashe; *JFT 6576* **N;Co**

Andropogon ternarius Michx. var. *ternarius*; *JFT 6580, 6649* **N;Un**

Andropogon virginicus L. var. *decipiens* C.S. Campb.; *JFT 6657* **N;WL;CR;Ra** Well disjunct from the rest of its Coastal Plain distribution. It occurs even more remarkably in Augusta County, a Ridge and ValleyAugusta County.

Andropogon virginicus L. var. *virginicus*; *JFT 6446, 6575* **N;Co**

Anthoxanthum odoratum L.; *JFT 5807, 5876* **N;Co**

Aristida longespica Poir. var. *longespica*; *GPF 8592* (WILLI); *JFT 6441, 6531; TFW 8754* (WILLI) **N;Co**

Aristida oligantha Michx.; *JFT 6341* **N;Un**

Aristida purpurascens Poir.; *JFT 6407, 6454, 6536* **N;Co**

Arthraxon hispidus (Thunb.) Makino var. *hispidus*; *JFT 6495* **I;Un**

Bromus commutatus Schrad.; *JFT 5993, 6017* **I;Un**

JFT 6017 appears transitional to *B. racemosus*; the two taxa are very difficult to separate

Bromus hordeaceus L. ssp. *hordeaceus*; *JFT 5900, 5920* **N;CR;Un**

Bromus pubescens Muhl. ex Willd.; *JFT 6172* **N;Un**

Chasmanthium latifolium (Michx.) H.O. Yates; *JFT 6174* **N;Un**

Chloris virgata Sw.; *JFT 6242* **I;CR;Ra** Presumably naturalized in gas pipeline easement from seed mix used to stabilize soil.

Cinna arundinacea L.; *JFT 6394* **N;Ra**

Coleataenia anceps (Michx.) Soreng ssp. *anceps*; *JFT 6197* **N;Un**

Coleataenia longifolia (Torr.) Soreng ssp. *longifolia*; *JFT 6371* **N;CR** At the western edge of its Virginia distribution.

Cynodon dactylon (L.) Pers. var. dactylon; *JFT 6299* **I;Ra**

Dactylis glomerata L.; *JFT 5917* **I;Un**

Danthonia sericea Nutt.; *JFT 5903, 5982, 6099* **N;Co**

Danthonia spicata (L.) P. Beauv. ex Roem. & Schult.; *JFT 5878, 5913* **N;Co**

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark; *JFT 4645, 4722* **N;Un** At the western edge of its Virginia distribution.

Dichanthelium acuminatum (S.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann; *JFT 4063, 5991, 6023, 6026* **N;Co**

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark; *JFT 3453, 4275, 6030, 6708* **N;Un**

Dichanthelium angustifolium (Elliott) Gould; *JFT 4067, 4638, 6526, 6744, 6757* **N;Un**

Dichanthelium annulum (Ashe) LeBlond; *JFT 3232, 3451, 5954* **N;WL;Co** The largest population known in Viginia

Dichanthelium bicknellii (Nash) LeBlond; *JFT 4639, 4641, 4642, 4644, 4646, 4648, 6054* **N;Un** This species is widely scattered in Virginia, and at low densities where found. The DCNAP population is one of the largest known in Virginia.

Dichanthelium boscii (Poir.) Gould & C.A. Clark; *JFT 5925, 5997* **N;Co**

JFT 5925 fits the concept of var. *molle* (Vasey) A.S. Hitchcock & Chase; this morphotype is very distinctive and far more common on the preserve than plants conforming to the concept of var. *boscii*

Dichanthelium clandestinum (L.) Gould; *JFT 5989, 6048* **N;Co**

Dichanthelium columbianum (Scribn.) Freckmann; *JFT 5977* **N;Ra**

Dichanthelium commutatum (Schult.) Gould var. *ashei* (T.G. Pearson ex Ashe) Mohlenbr.; *JFT 5942, 6092* **N;CR;Co** Far more abundant than var. *commutatum* on preserve

Dichanthelium commutatum (Schult.) Gould var. *commutatum*; *JFT 5924, 6479* **N;Co**

Dichanthelium depauperatum (Muhl.) Gould; *JFT 5874, 5902* **N;Co**

Dichanthelium dichotomum (L.) Gould var. *dichotomum*; *JFT 4640, 5926, 5986b, 6027, 6040, 6072* **N;CR;Co** *JFT 6040, 6072* are closest to concept of var. *barbulatum* (Michx.) Mohlenbr.

Dichanthelium dichotomum (L.) Gould var. *nitidum* (Lam.) LeBlond; *JFT 4741, 4742, 4743, 5955* **N;Un**

Dichanthelium harvillii Ludwig & LeBlond; *JCL 2431 A (VPI),2431B (WILLI), 2431C (GMUF); JCL, s.n. (BRIT, DUKE, NCSC, NCU); JFT 4723 (VPI), 4744 (VPI), 6053 (US, NY, MO, PH), 6754 (dnh)* **N;RL;Ra** New species published concurrently with this paper, thus far known only from burned woodlands at DCNAP, where it occurs in small colonies of loosely associated plants.

Dichanthelium laxiflorum (Lam.) Gould; *JFT 2778, 6024c* **N;Co**

Dichanthelium meridionale (Ashe) Freckmann; *JFT 4643, 5978, 6071, 6024b* **N;Un**

Dichanthelium microcarpon (Muhl. ex Elliott) Mohlenbr.; *JFT 6001* **N;Co**

Dichanthelium ovale (Elliott) Gould & C.A. Clark var. *addisonii* (Nash) Gould & C.A. Clark; *JFT 6180, 6738* **N;CR;Un**

Dichanthelium polyanthes (Schult.) Mohlenbr.; *JFT 6064* **N;Co**

Dichanthelium ravenelii (Scribn. & Merr.) Gould; *GPF 10549* (GMUF); *JFT 4062, 6032* **N;WL;Un** At the western edge of its Virginia distribution.

Dichanthelium scoparium (Lam.) Gould; *JFT 6171* **N;Co**

Dichanthelium sphaerocarpon (Elliott) Gould var. *sphaerocarpon*; *JFT 3231* **N;Co**

Dichanthelium villosissimum (Nash) Freckmann var. *villosissimum*; *JFT 5953, 6021, 6024a, 6028* **N;CR;Un**

Dichanthelium yadkinense (Ashe) Mohlenbr.; *JFT 6000* **N;Ra**

Digitaria ciliaris (Retz.) Koeler; *JFT 6364* **I;Un**

Digitaria ischaemum (Schreb.) Muhl.; *JFT 6365* **I;Un**

Echinochloa crusgalli (L.) P. Beauv. var. *crusgalli*; *JFT 6205* **I;Un**

Eleusine indica (L.) Gaertn.; *JFT 6377* **I;Un**

Elymus glabriflorus (Vasey) Scribner & C.R. Ball; *JFT 3448, 6165, 6256, 6703* **N;Co**

Elymus riparius Wiegand; *JFT 4064* **N;Un**
Elymus virginicus L.; *JFT 4273, 6238* **N;Un**
Eragrostis capillaris (L.) Nees; *JFT 6488, 6797* **N;CR;Un**
Eragrostis pilosa (L.) P. Beauv. var. *pilosa*; *JFT 6302* **I;Un**
Eragrostis refracta (Muhl.) Scribn.; *JFT 6410* **N;Co**
Eragrostis spectabilis (Pursh) Steud.; *JFT 6303, 6412, 6579* **N;Co**
Festuca paradoxa Desv.; *JFT 2776, 6705* **N;Un**
Festuca subverticillata (Pers.) E.B. Alexeev; *JFT 6083* **N;Un**
Glyceria striata (Lam.) Hitchc. var. *striata*; *JFT 5988* **N;Un**
Gymnopogon ambiguus (Michx.) Britton, Sterns, & Poggenb.; *GPF 8595* (WILLI) **N;Un**
Gymnopogon brevifolius Trin.; *JFT 6373; TFW 8769* **N;WL;Ra** At the western edge of its Virginia distribution.
Holcus lanatus L.; *JFT 6081* **I;Un**
Leersia virginica Willd.; *JFT 6354* **N;Co**
Lolium perenne L. var. *aristatum* Willd.; *JFT 5919* **I;CR;Un**
Melica mutica Walter; *JFT 5830* **N;Co**
Microstegium vimineum (Trin.) A. Camus; *JFT 6584* **I;Un**
Miscanthus sinensis Andersson; *JFT 6751* **I;Un**
Muhlenbergia capillaris (Lam.) Trin.; *GPF 8599* (WILLI); *JFT 6507, 8599* **N;Un**
Muhlenbergia sylvatica (Torr.) Torr. ex A. Gray; *GPF 14319* (VPI); *JFT 4066, 6353, 6498, 6500* **N;Co**
Panicum dichotomiflorum Michx. var. *dichotomiflorum*; *JFT 6376* **N;Un**
Panicum verrucosum Muhl.; *JFT 6438* **N;CR;Un**
Panicum virgatum L. var. *virgatum*; *JFT 6240* **N;CR;Ra** Perhaps naturalized in gas pipeline easement from seed mix used to stabilize soil.
Paspalum dilatatum Poir.; *JFT 4740, 6204, 6770* **I;Un**
Paspalum floridanum Michx.; *JFT 6297, 6648* **N;Un**
Paspalum laeve Michx.; *JFT 6283, 6445, 6758, 6762* **N;Un**
Paspalum setaceum Michx.; *JFT 6409, 6502* **N;Co**
Piptochaetium avenaceum (L.) Parodi; *JFT 5877* **N;Co** One of the most widespread and abundant understory species on Alfisols, along with *Scleria oligantha*.
Poa annua L.; *JFT 5826* **I;Co**
Poa autumnalis Muhl. ex Elliott; *JFT 5932* **N;Ra**
Poa bulbosa L. var. *vivipara* Koeler; *JFT 5825* **I;CR;Ra**
Poa compressa L.; *JFT 6107, 6707* **I;Un**
Poa pratensis L. ssp. *pratensis*; *JFT 5870, 5947* **I;Un**
Saccharum alopecuroides (L.) Nutt.; *JFT 6448* **N;Un**
Schedonorus arundinaceus (Schreb.) Dumort.; *JFT 5871* **I;Un**
Schizachyrium scoparium (Michx.) Nash var. *scoparium*; *JFT 6386* **N;Co**
Setaria faberi R.A.W. Herrm.; *JFT 6276, 6773* **I;Co**
Setaria pumila (Poir.) Roem. & Schult. ssp. *pumila*; *JFT 6239, 6325, 6326* **I;Co**
Sorghastrum nutans (L.) Nash; *JFT 6360* **N;Un**
Sphenopholis filiformis (Chapm.) Scribn.; *JCL 51914-01* (VPI); *JFT 4647, 5888, 5890* **N;RL;Ra** Populations at DCNAP are very few and of limited size, along edges of burned woodlands or in the transmission line right-of-way. DCNAP is at the western edge of its Virginia distribution and the northeastern end of its somewhat disrupted global range.
Sphenopholis nitida (Biehler) Scribn.; *JFT 5882* **N;Co**
Sphenopholis obtusata (Michx) Scribn.; *JFT 5980* **N;Un**
Sporobolus clandestinus (Biehler) Hitchc.; *JFT 6453* **N;Co**
Sporobolus compositus (Poir.) Merr. var. *compositus*; *JFT 6535, 6585, 6658* **N;RL;CR;Ra** One small colony in transmission line right-of-way. The species' distribution in Virginia is strikingly diffuse, occurring rarely in every physiographic province. Its largely central U.S. range becomes very fragmented east of the Mississippi River.
Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood; *JFT 6366* **N;Un**
Tridens flavus (L.) Hitchc.; *JFT 4068, 6261* **N;Co**
Tripsacum dactyloides (L.) L. var. *dactyloides*; *JFT 6173* **Q;Un**
Vulpia octoflora (Walter) Rydb.; *JFT 5943, 5994, 6049, 6050* **N;Co**

Polemoniaceae
Phlox nivalis G. Lodd. ex Sweet; *JFT 5797* **N;WL;Un** At the western edge of its Virginia distribution.
Phlox ovata L.; *AB 1428* (GMUF); *GPF 10451* (GMUF, WILLI); *JFT 6018* **N;Un**

Polygalaceae
Polygala incarnata L.; *ASW 7261* (NCU) **N;Un**
Polygala nuttallii Torr. & A. Gray; *JFT 6208* **N;Co**
Polygala senega L.; *AB 1430* (GMUF) **N;Co**
Polygala verticillata L.; *JFT 6121, 6156* **N;Co**

Polygonaceae
Persicaria longiseta (Bruijn) Kitag.; *JFT 6274* **I;Co**
Persicaria maculosa Gray; *JFT 6492* **I;Un**
Persicaria sagittata (L.) H. Gross; *JFT 6532* **N;Ra**
Rumex crispus L. ssp. *crispus; JFT 6131* **I;Co**

Primulaceae
Lysimachia lanceolata Walter; *GPF 10547* (GMUF, WILLI); *JFT 6068* **N;Un**
Lysimachia quadrifolia L.; *JFT 5979* **N;Un**

Ranunculaceae
Anemone americana (DC.) H. Hara; *JFT 5840* **N;Ra**
Anemone berlandieri Pritz.; *JFT 5864* **N;RL;Ra** One colony in transmission line right-of-way. The DCNAP population is one of only two known in Virginia; they are located at the extreme northeastern tip of the species' south-central U.S. range.
Anemone virginiana L. var. *virginiana*; *JFT 6176* **N;Un**
Clematis ochroleuca Aiton; *GPF 10,540* (GMUF); *JFT 5850* **N;Un**
Clematis virginiana L.; *JFT 6765* **N;Ra**
Ranunculua hispidus Michx.; *JFT 5812* **N;Un**
Ranunculus recurvatus Poir. var. *recurvatus*; *JFT 6779* **N;Un**
Ranunculus sardous Crantz; *JFT 6133* **I;Ra**
Thalictrum pubescens Pursh; *JFT 6220* **N;CR;Ra**
Thalictrum thalictroides (L.) A.J. Eames & B. Boivin; *JFT 5799* **N;Co**

Rhamnaceae
Ceanothus americanus L.; *GPF 10453* (GMUF) **N;Co** Sole larval food plant of the Mottled Duskywing (*Erynnis martialis*)

Rosaceae
Agrimonia microcarpa Wallr.; *JFT 6755b* **N;CR;Un**
Agrimonia parviflora Aiton; *JFT 6379* **N;Co**
Agrimonia rostellata Wallr.; *JFT 6405* **N;Un**
Amelanchier arborea (F. Michx.) Fernald; *JFT 5808* **N;Un**
Amelanchier spicata (Lam.) K. Koch; *JFT 6428* **N;CR;Ra**
Aronia arbutifolia (L.) Pers.; *JFT 6545* **N;Un**
Crataegus crus-galli L. var. *crus-galli*; *JFT 6108* **N;CR;Ra**

Crataegus intricata Lange var. *rubella* (Beadle) Kruschke; *JFT 4069, 6095, 6505* **N;Un**
Crataegus marshallii Eggl.; *JFT 5898, 6116* **N;Un** This species of bottomlands can be found on some of the highest elevations on the preserve, presumably due to a seasonally high water table. DCNAP is at the western edge of its Virginia distribution.
Crataegus pruinosa (H.L. Wendl.) K. Koch; *JFT 6115* **N;CR;Un**
Crataegus uniflora Münchh. var. *uniflora*; *JFT 5853, 5921* **N;Co**
Fragaria virginiana Mill.; *JFT 5867* **N;Co**
Geum virginianum L.; *JFT 6164* **N;Co**
Gillenia stipulata (Muhl. ex Willd.) Nutt.; *AMH 25873* (FARM); *GPF 8590, 10,449* (GMUF) **N;RL;Un** This species' main range is west of Virginia, with a disjunct cluster of occurrences in the Piedmont of Virginia and North Carolina. It occurs across most of DCNAP, but usually not in large colonies. It often occupies more shaded habitats on the preserve and does not respond as strongly to prescribed fire as other rarities.
Gillenia trifoliata (L.) Moench; *JFT 6019* **N;Ra**
Potentilla canadensis L. var. *canadensis*; *JFT 5804, 5828* **N;Co**
Potentilla simplex Michx.; *JFT 5904* **N;Un**
Prunus americana Marshall; *JFT 5820* **N;Ra**
Prunus mahaleb L.; *JFT 5970* **I;CR;Ra**
Prunus serotina Ehrh. var. *serotina*; *JFT 6429* **N;Co**
Prunus subhirtella Miq.; *JFT 5886, 5928* **I;CR;Ra**
Pyrus calleryana Decne.; *JFT 6769* **I;Ra** Single small individual in ditch; likely eradicated by collection
Rosa carolina L. ssp. *carolina*; *JFT 5968* **N;Co**
Rosa multiflora Thunb. ex Murray; *JFT 6398* **I;Un**
Rosa palustris Marshall; *JFT 6420* **N;Un**
Rubus cuneifolius Pursh; *JFT 6169* **N;Un**
Rubus flagellaris Willd.; *JFT 5875, 6103* **N;Co**
Rubus pascuus L.H. Bailey; *JFT 6041* **I;CR;Ra** (= *Rubus discolor*, misapplied)
Rubus pensilvanicus Poir.; *JFT 5837* **N;Co**

Rubiaceae
Diodia teres Walter; *JFT 6157* **N;Co**
Diodia virginiana L.; *JFT 6151* **N;Co**
Galium circaezans Michx.; *JFT 6110, 6466* **N;Un**
Galium obtusum Bigelow; *JFT 6045* **N;Un**
Galium pilosum Aiton; *JFT 6094, 6100* **N;Co** Some specimens glabrate, approaching the vestiture of *G. orizabense* Hemsley ssp. *laevicaule* (Weatherby & Blake) Dempster
Galium triflorum Michx.; *JFT 6464, 6467* **N;Un**
Houstonia caerulea L.; *JFT 5788* **N;Co**
Houstonia longifolia Gaertn.; *JFT 6706* **N;Un**
Houstonia purpurea L. var. *purpurea*; *JFT 5936, 6780* **N;Un**
Houstonia pusilla Schöpf; *JFT 5803* **N;Un**
Houstonia tenuifolia Nutt. *GPF* (WILLI); *JFT 5972, 8601, 8766* **N;Co**
Mitchella repens L.; *JFT 6784* **N;Un**

Ruscaceae
Maianthemum racemosum (L.) Link ssp. *racemosum*; *JFT 6101* **N;Un**
Polygonatum biflorum (Walter) Elliott var. *biflorum*; *JFT 5938* **N;Co**

Salicaceae
Populus grandidentata Michx.; *JFT 6508* **N;CR;Ra**
Salix humilis Marshall; *JFT 6541* **N;Un**
Salix nigra Marshall; *JFT 6359* **N;Un**

Santalaceae
Comandra umbellata (L.) Nuttall var. *umbellata*; *JFT 5907* **N;Co**

Sapindaceae
Acer floridanum (Chapm.) Pax; *JFT 3381, 5846, 5946* **N;Un** At the western edge of its Virginia distribution.
Acer negundo L. var. *negundo*; *JFT 6515* **N;Un**
Acer rubrum L.; *JFT 5810* **N;Co**

Saxifragaceae
Heuchera americana L.; *JFT 5927* **N;Ra**
Tiarella cordifolia L.; *JFT 5843* **N;Ra**

Scrophulariaceae
Verbascum thapsus L.; *JFT 6170* **I;Un**

Simaroubaceae
Ailanthus altissima (Mill.) Swingle; *JFT 6119* **I;Un**

Smilacaceae
Smilax bona-nox L.; *JFT 5937* **N;Co**
Smilax glauca Walter; *JFT 6105* **N;Co**
Smilax hispida Raf.; *JFT 6513* **N;Co**
Smilax pulverulenta Michx.; *JFT 6472.* **N;Un**
Smilax rotundifolia L.; *JFT 6219* **N;Co**

Solanaceae
Physalis heterophylla Nees; *GPF 10543* (GMUF); *JFT 6755a* **N;Co**
Physalis virginiana Mill. var. *virginiana*; *JFT 5951, 6034* **N;CR;Co**
Solanum carolinense L. var. *carolinense*; *JFT 6065* **N;Co**

Tetrachondraceae
Polypremum procumbens L.; *JFT 6218* **N;Un**

Typhaceae
Typha latifolia L.; *JFT 6653* **N;Ra**

Ulmaceae
Ulmus alata Michx.; *JFT 6223* **N;Co**
Ulmus americana L.; *JFT 6112, 6224* **N;Un**

Urticaceae
Boehmeria cylindrica (L.) Sw.; *JFT 6288* **N;Un**

Verbenaceae
Verbena brasiliensis Vell.; *JFT 6763* **I;Ra**
Verbena urticifolia L.; *JFT 6389* **N;Un**

Violaceae
Viola bicolor Pursh; *JFT 5802* **N;Un**
Viola palmata L.; *JFT 5885* **N;CR;Un**
Viola primulifolia L.; *JFT 5987b, 6440* **N;Un**
Viola sagittata Aiton var. *ovata* (Nutt.) Torr. & A. Gray; *JFT 5823* **N;CR;Un**
Viola sagittata Aiton var. *sagittata*; *JFT 5816* **N;Un**
Viola sororia Willd.; *JFT 5836* **N;Co**

Vitaceae
Parthenocissus quinquefolia (L.) Planch.; *JFT 6234* **N;Co**
Vitis cinerea (Engelm. in A. Gray) Engelm. ex Millardet var. *floridana* Munson; *JFT 6314* **N;CR;Un**
Vitis rotundifolia Michx. var. *rotundifolia*; *JFT 6114* **N;Un**
Vitis vulpina L.; *JFT 6518* **N;Un**

Xanthorrhoeaceae
Hemerocallis fulva (L.) L.; *JFT 6241* **I;Ra**

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