

UVA DECARBONIZATION ACADEMY

FINAL REPORT, August 2025

PROJECT TOPIC: UVA Forest Patches

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MENTOR: Dr. Tim Beatley

I. Goals

- i. Increase biodiversity and carbon sequestration capacity of 6 planted patches on grounds through infill recommendations and planting.
- ii. Do broad biodiversity assessment to explore current species at forest patches compared with control site
- iii. Assess invasives in planted and established patches on grounds to develop a comprehensive maintenance protocol
- iv. Discover the unique character of each patch and its living inhabitants, and explore experimental engagement initiatives, generating nature-based awe

II. Introduction and Motivation

“This is land knowledge, which doesn’t mean we know something about the land, rather it means we are learning to live in the ways the land lives.” - Natalie Diaz, “Fusings” (Adeyemo et al., 2023).

In 2025, we were given a tree education. The Forest Patches team has colloquially dubbed itself, “Tree School.” Each of us entered Tree School with deep interest in ecology and general impressions of what we might want to do. What linger are the fieldtrips we took with the Decarbonization Cohort and with Dr. Beatley every week, learning from the land itself.

We met in the shade of the Earlysville Oak, the second largest white oak in Virginia. We wove through James Madison Montpelier Forest, learning how to read a forest—that young trees can wait decades in shade before they are released into sunlight by falling trees. We listened to the Murray family at Panorama Farms discuss the land relationships they cultivated as children, how, “everywhere we look we see stories.” It is through close attention to the land that we learn how the land wants to be—in many cases, the answers are multiple. Panorama has land devoted to compost, grasslands restoration, green burial, and forestry. At Morven, a food garden accompanies plans for timber production, regenerative cattle grazing, and grasslands restoration. Cultivating diversity, of land use and the inhabitants of the living land, seems the best hope we have to “live in ways the land lives.” A major task of our summer then, was to support ecological diversity in everything we endeavored to do.

Densification and Diversification

This summer, we sought to do a broad assessment of the 6 established patches: Monroe, Hancock, Hereford, Meadow Creek, Carr’s Hill, and 4th side. Since 2023, UVA Forest Patches has established 6 new forest patches, building on a network of existing forested areas around Grounds. These patches were

planted with available resources guided in part by the Akira Miyawaki method of dense planting and rapid-replacement.

This year, we were advised by facilities to shift our attention to the maintenance and development of these established patches, with the goal of getting them to be more self-sustaining and creating a maintenance protocol that brings in other stakeholders on grounds. In service of these goals, we would like to densify and diversify the patches by planting more trees, shrubs, and groundcover, increasing the carbon sequestration capacity and biodiversity of the established patches, and lowering the watering burden on facilities.

Meadow Patches

Hoping to diversify UVA's floristics, we sought to establish meadow patches around grounds. Temperate grasslands are the most threatened biome globally. Despite their endemic species richness and previous widespread distribution, southeastern grasslands, including those of Virginia's Piedmont, have lost an estimated 90% of their former range. Those that remain face continued habitat loss and fragmentation, the disruption of natural disturbance regimes, invasive species pressure, and changes in temperature and precipitation due to climate change (Coscia et al., 2024). Discussions with prairie restoration stakeholders around the community suggest that at one point, our region was comprised of 50% grasslands. One way we endeavored to diversify UVA's native ecosystems was to recapture monoculture lawn around grounds and begin restoring grasslands. We've been told that facilities is looking to increase low-maintenance landscaping sites around grounds. And thus, we sought to find steep-slope, difficult-to-mow areas of campus that could be converted to support pollinators.

Biodiversity Assessment

Under the guidance of Dr. Timothy Beatley, we were encouraged to conduct a broad biodiversity assessment of the current patches to establish what species (primarily visible fauna) are present in the patches. With this information, we can situate the patches in a broader network of species movement and essential habitat in our region, Charlottesville and Albemarle. We expanded the camera trap monitoring of previous years' projects and began monitoring birds using the Merlin app.

Invasive/Weed Control

Developing a maintenance protocol for UVA's wild places inevitably raises the question of invasives plant species. Even when trees survive, lianas, including native vines such as grape, may reduce carbon sequestration by some trees over time (Peters et al., 2023; for the effect on tree growth see Ladwig & Meiners, 2009; for effects of vine control in tropical forests see Finlayson et al., 2022 and correction) in both temperate and tropical ecosystems. Additionally, invasive species can have adverse impacts on the ability of the forest to regenerate into the future, as we learned from Robert Myers on our trip to Montpelier Landmark Forest, and they may also exhibit allelopathic behavior which may hinder the growth of native plants (Cipollini & Bohrer, 2016). As such, it is important to understand what invasive species are found at UVA, particularly near the forest patches and consider methods for and benefits or downsides of their removal or control.

Our group eventually learned from Richard Hopkins that Facilities Management is already planning and/or undertaking a survey of Grounds which may include much of this data once the project was

underway. This suggested that a comprehensive map may not be as necessary, but our data may still be useful for imminent removal projects.

Challenges were also posed to the Monroe Edible Patch as it was being encroached on by grass earlier in the summer, something that came up during our first meeting with Facilities Management.

Community Engagement and Placemaking

One of Dr. Beatley's main interests is the concept of "regenerative awe", which offers a host of benefits of human health and wellness. One need not travel far to experience the benefits of regenerative awe. Our hope is to cultivate our UVA Forest Patches as destinations where community members can experience the benefits of building a relationship with the land. Exploring engagement measures, such as art installations, is another theme of our work this summer.

Biomass Calculation

Forest patches' carbon sequestration rapidly increases over the first five years (Roy et al., 2025). It is worthwhile to attempt to quantify the carbon sequestration and storage of our newly planted forest patches, in line with the efforts of previous years' Forest Patches teams. This will create high quality data that can be used for comparison by future teams, as well as allow us to estimate the growth of our patches over the last year.

III. Methodology

Updated Forest Patch Boundaries

Existing boundaries for the older forest patches were retained, and the old proposed forest patches were renamed "potential forest patches". The new forest patches were mapped using ArcGIS Field Maps (a tool which was initially suggested for a different purpose by Chris Gist of the UVA Scholar's Lab). However, due to limitations in the location accuracy of a mobile phone, the boundaries were estimated by visually approximating the position of the different points by comparing surroundings with the *World Imagery* basemap (n.d.). However, obvious landmarks were sometimes lacking in at least one dimension, and the accuracy may be limited in favor of ease of mapping.

Biomass Calculation

For our biomass survey, we recorded the height, species, and DBH of every tree which reached approximately breast height in each patch (sometimes D30 or DFork were collected instead, particularly when DBH was not an option for some shorter trees or shrubs which were also measured), with the exception of the Monroe Edible Patch (Magarik et al., 2020). Our methods were as follows: each team member was given a different measurement to take (species, DBH, etc.). We then used flagging tape to mark each tree with a unique ID number. This allowed us to each take measurements asynchronously and still track our measurements to the same tree. For DBH, we used mostly digital calipers for trees

under 9cm in diameter and a tape measure for larger trees, calculating DBH from measured circumference. For height, we used the Arboreal Tree app to estimate height due to time considerations (this was the fastest method that we found).

As a general rule, for trees or shrubs below DBH (1.37m), we took one of two measurements: D30, diameter at 30 cm or DFork, the diameter below DBH where a tree/shrub split into multiple significant stems. On some occasions, multiple stems may need to be measured on shrubs, in which case, the standard practice is to measure up to 6 stems then do a quadratic sum of the diameters. A variety of metrics is necessary for measuring small urban trees, but as it stands, we cannot factor trees below DBH into carbon or biomass calculations. This is a developing area of urban forestry. Future teams may prioritize DBH and height measurements on standard morphological specimens to create more reproducible data year/year.

The cutoff for what short trees or shrubs were considered was inconsistent. Future groups would do well to standardize the methodology for what should be measured and how it should be measured, should they seek to continue the biomass survey.

Species were identified using a combination of Seek by iNaturalist, Virginia Department of Conservation and Resources' plant lists, and other identification sources (see More_Plant_Sources in the Google Drive). In some cases, such as that of the planted chokeberries, identifications were cross-referenced with past planting lists, but this was not necessarily done across the board. For the reference of future forest patches teams, the Virginia Department of Forestry's *Common Native Trees of Virginia*, which previous years had provided in the shared Box folders, and *Common Native Shrubs and Woody Vines of Virginia* contain identification keys for common plants and may help to simplify the process.

Our data analysis was done in Rstudio. With help from Elizabeth Doty, we developed a program to estimate the biomass each tree using allometric equations based on DBH and species. For Hancock, we used D30 instead of DBH for plants below 1.7m, due to the lack of tall trees. There is, notably, some margin of error to our calculations, as there are no allometric equations available for young trees, and thus the ones used were meant for larger trees, leading to an underestimate (with the exception of the Hereford Patch, which includes adult trees). We did, however, still use our estimates to calculate % growth from last year in the 4th Side and Carr's Hill patches.

It should be noted that for this assessment and the biodiversity assessments, our analysis of Hereford primarily focused on the more mature patch with large trees, rather than the relatively new planting, much of which was shorter than breast height and so was not necessarily measured. However, we notably did not consider several large shrubs and several trees which appeared slightly discontinuous with the larger forest patch in our assessment of Hereford patch.

Biodiversity Assessment

Camera Traps

Five camera traps were established, one each in Hereford, Carr's Hill, Meadow Creek, Hancock and 4th side patches, prioritizing arboreal density in the sightline of each camera. A camera trap was not established at Monroe due to the high volume of pedestrian traffic.

Data collection began on July 14th and concluded on August 4th. In all, approximately 2-3 weeks of recording data were collected from each patch, barring technical interruptions due to the need for

battery and SD card changes. Results from the camera traps were manually inspected for wildlife by watching hours of playback footage.

Cameras were set to “low sensitivity,” recording 24 hours a day, and were set to take a 10-20 second video of detected movement. They were also set to produce a combined image and video capture of each detection. Cameras were adjusted to low sensitivity after a preliminary review of data collection indicated that high sensitivity detection resulted in excessive captures.

Merlin/Bird Monitoring

Two observations each were conducted on seven locations (the six planted forest patches and one control site near the small lawn area between New Cabell Hall and Nau Hall) for a total of fourteen observation periods. The plan was to begin approximately 5-10 minutes before sunrise.

We used the Merlin app by Cornell Ornithology Lab to identify bird song. Godinez & Antonio (2024) found that the app did produce a number of both false negatives and false positives relative to a trained human ear. However, given time constraints and lack of expertise in identifying birdsong by ear, the app was a suitable tool for an avian biodiversity assessment.

The visual observations appeared to be of limited utility given the untrained eye of the observer and obstruction by objects such as trees. As such, the visual observation was abandoned after three observations, but some of the animals observed have still been noted.

Variation in start times and sunrise times have been noted in Table 2 and may be taken into account with the survey’s results. Additionally, observation periods varied somewhat, noted in the same table. Notably, the longest observation period (Meadow Creek on July 29) was extended due to a train passing by during the observation period.

Infill and Patch Expansion Planning

Miyawaki-style forest patches call for, among other things, the planting of forest patches at a density of approximately 3 plants/m² (Lewis, 2022). Visiting the patches, it was clear to our group that to obtain more of the benefits of Miyawaki-style forest patches, the density of our forest patches needed to be increased. Under current Landscape and Amenities standards, it is not realistic to raise patches to Miyawaki standards from current plant density in one year. For example, that would constitute a 26X increase in plantings in 4th Side patch alone. As such, our broad goals were to increase plant density by a factor of 1.5-2 depending on patch conditions.

In service of our goals to raise the biodiversity of established patches on grounds, we examined the following site conditions: moisture, aspect, shade/sun exposure, and present species condition.

Attempting to fill in planting gaps using the 80-10-10 rule (70-80% trees, 10-20% shrubs, and 10% leafy plants) we chose plants which best represented late succession hardwood forests based on site condition (Lewis, 2022). Key resources in determining suitable plants were the USDA Plants Database, Plant NOVA Natives, Virginia Department of Forestry’s “Common Native Trees of Virginia” plant ID guide

(Powell, 2022b), Prairie Moon Nursery, and the VDCR Native Plant Finder, as well as anecdotal advice from local foresters like Robert Myers and discussions with Rich Hopkins and Helen Wilson.

Meadow Patches Planting

We were in conversation with a variety of grasslands ecologists and landscape designers in the community. Jill Trischman-Marks gave us initial recommendations during our visit at the Botanical Garden of the Piedmont. Visiting the grassland burial site at Panorama Farms also gave us some useful suggestions, like using local cultivars from Little Blue Stem or the Piedmont Discovery Center. Discussions with Dr. Manuel Lerdaу at Morven’s grasslands restoration project suggested the benefits of prioritizing robust southerly phenotypes. Research into native indicator species involved reading literature on ruderal and remnant grasslands in the piedmont from Coscia et al. (2024), Plant NOVA Natives, Piedmont Master Gardeners, and visiting remnant or restored grasslands, among others, suggested priority species for planting recommendations.

Invasive/Weed Control

Invasive Species Mapping and Monitoring

Initially, invasive species were mapped using a Garmin GSMap 78S. Approximate polygons of invaded areas were determined by mapping points along the apparent boundaries while attempting to keep track of the species of the points and when old polygons end and new ones begin. At times, some points felt substantially out of line with the rest of the polygon or too sparse to justify mapping in a polygon, but it seemed worthwhile to note their presence, so the points were mapped as individual points. These points were then imported into Garmin BaseCamp and from there into ArcGIS Pro, where they were either assigned a polygon identity based on notes taken while points were being collected, or they were left null. Some guidance as to GPS usage and transferring data via BaseCamp was provided by Professor John Porter, who also lent Professor Raymond Dueser’s GPS. Points were also assigned species in a similar manner. Polygons are intended to guide broad understanding of invasive presence. As such, edges may be smoothed in places and some error may be present not only in the location reading of the GPS but also in the point of initial collection.

In some cases, the edge of a polygon was delineated in part by a boundary which it seemed impractical or unnecessary to physically map. These polygons were manually adjusted in ArcGIS Pro using an imagery basemap (*World Imagery*, n.d.) to guide the adjustments.

Mapping focused on Porcelain-berry (*Ampelopsis brevipedunculata*), Asiatic Bittersweet (*Celastrus orbiculatus*) and English Ivy (*Hedera helix*). Kudzu (*Pueraria montana* var. *lobata*) was also sometimes noted when present. All of these plants are listed with an invasiveness of “high” by the Virginia Invasive Plant Species list for October 2024 (Heffernan et al., 2024), which was used to guide our understanding of what plants were invasive. Seek by iNaturalist was used at times to either identify or support the identification of the invasive species included, but plants were also sometimes identified based on human observation alone. Porcelain-berry was generally distinguished from other similar-looking species using its hairiness level, and its upward-facing berries (see the Porcelain-berry section in Invasive Species References and Info in the Google Drive, but especially Sanderson, 2020), though for practical reasons not every point mapped was checked to fully distinguish between grape and porcelain-berry. As such, some points listed in the map may not truly be porcelain-berry. That said, Peters et al. (2023) points out that native grape can also have a negative impact on carbon sequestration and storage and

even suggests strategically controlling the grape populations (albeit carefully and somewhat selectively so). Additionally, further examination of the vine can be taken before its removal.

Some polygons were edited manually roughly in line with the imagery basemap (*World Imagery*, n.d.)

After it became clear during our conversation with Richard Hopkins that much of this data could be redundant with data collection already planned by Facilities Management, GPS data point collection wound down and emphasis was instead placed on gaining a broader sense of what invasive species were present near the patches and how we might think about removal or control.

Grass Removal at the Monroe Edible Patch

We met with Facilities Management for 4 mornings in mid-July to lay clear tarp on the lawn grass that had encroached in the Monroe patch. We cut the tarp into strips, cutting holes for the plants to fit through, and secured the tarp to the ground. This process is known as solarization, which produces a greenhouse effect, hopefully heating and sterilizing the soil. In hot summer months, it can successfully kill plants in 2-3 weeks (Hoidal, 2021).

Meadow Patches

Proposed meadow patch locations were selected based on the following criteria: low foot traffic, emphasis towards steeper slopes, afternoon sun exposure, and existing lawn/turf grass. Pictures were taken of 12 possible sites. We met with Helen Wilson and Rich Hopkins and, with their input, selected the 6 proposed sites.

IV. Results, Discussion, and Future Recommendations

Figure 1 shows the location of the current forest patches. Although the planted area was sometimes constrained by other concerns such as utilities, it suggests the possibility of expanding the existing patches.

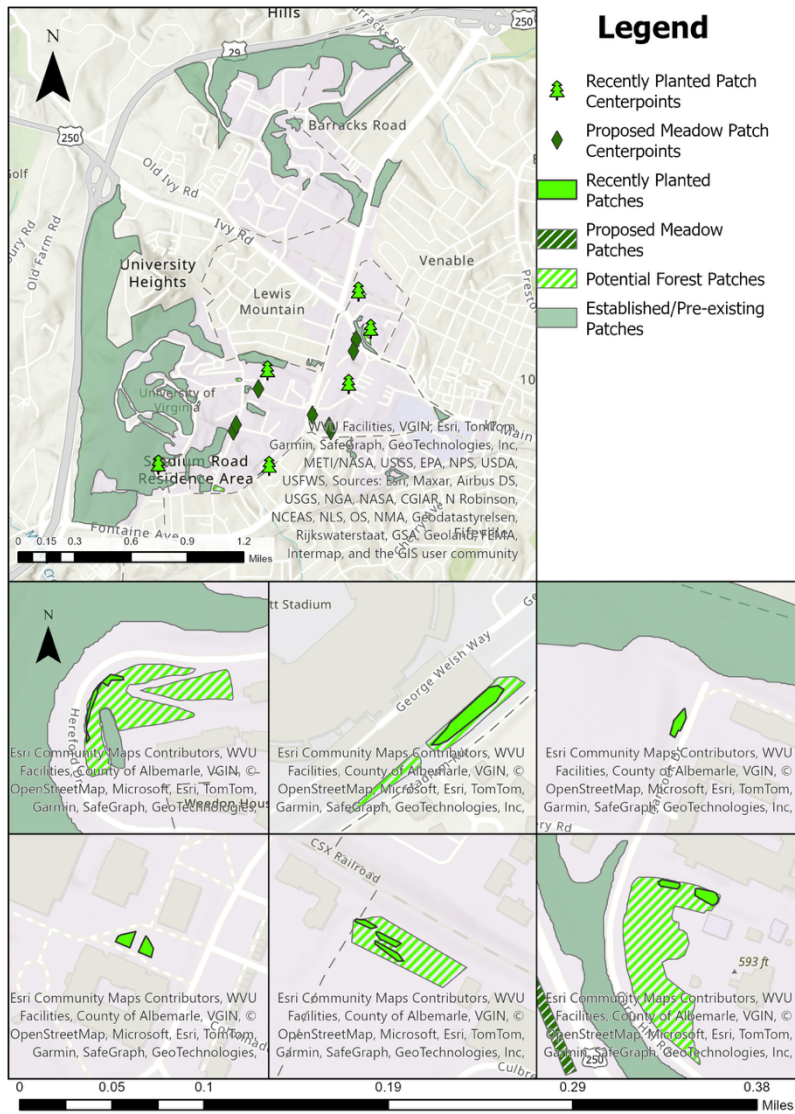


Fig. 1. Approximate locations of established, potential, and planted forest patches on UVA grounds as well as the locations of proposed meadow patches (where applicable). For more detail on meadow patch locations, see Figure 8. The “Established/Pre-existing Patches” layer and the “Potential Forest Patches” layer have been taken from Germain (2023), though with some renaming.

Biomass Calculation

With the exception of the Hereford Patch, our biomass calculations are likely drastic underestimates. This comes from the difficulty of estimating the mass of young trees, as all models we found were meant for more mature forests. This excepts the Hereford patch however, because this year we chose to measure the larger trees that predate 2023’s planting. Still, we believe that % growth is a useful metric to calculate from these. With that, the estimated biomass for each patch (including last year’s calculations and overall % growth) is listed below (Table 1). Notably, percent growth metrics were only

relevant to 4th Side and Carr's Hill, where there were standing biomass measurements that correlated with the data from the previous year.

	Biomass 2024 (kg)	Biomass 2025 (kg)	% Growth
4th Side	23.17561	27.5094	18.69978827
Hereford	5.461067	42218.74	
Monroe	N/A	N/A	
Carr's Hill	11.63824	16.34949	40.4807716
Meadow Creek	N/A	52.0851	
Hancock	N/A	12.51235	

Table 1: Biomass Calculations for Summer '24 and '25

Invasive Species Monitoring and Control

Mapping and Identification

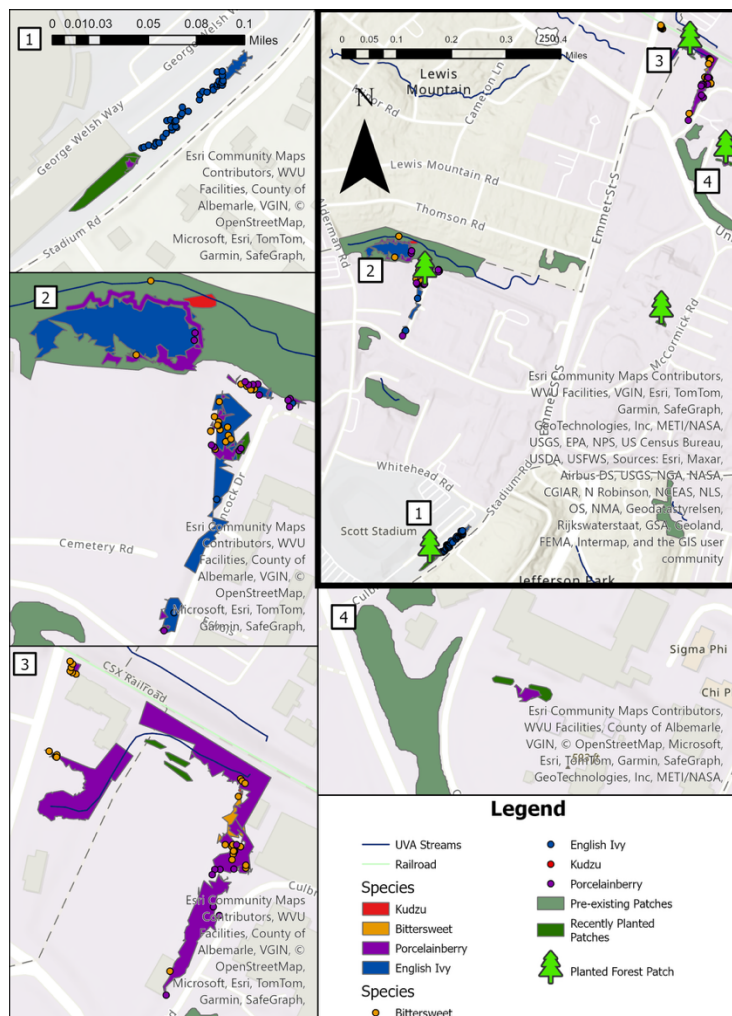


Fig. 2. The presence of invasive species as identified by the Virginia Invasive Plant Species list for October 2024 (Heffernan et al., 2024) at several locations throughout UVA Grounds as of summer 2025, with their broader locations on the university's grounds shown in the upper right. The presence of a railroad and streams are also noted, with that data provided courtesy of University of Virginia Energy & Utilities GIS Office. The porcelain-berry in the southeast portion of 3 is sparsely present in a meadow patch but was mapped on a broad scale for convenience and to minimize further disturbance. The two large porcelain-berry polygons in the roughly north-central portion of 3 should be connected behind the stream. The "Pre-existing Patches" layer is taken from Germain (2023).

A number of invasive species were found in or near the patches. Porcelain-berry was present in or very close to all of the planted patches except Monroe. Asiatic bittersweet was also repeatedly spotted, but often small enough that it could feasibly be removed by hand.

In some cases, notable populations of invasive species were found in areas where long-term control may be extremely difficult due to either existing infrastructure or geography, such as train tracks or a creek, or due to what seemed to be a high probability of secondary invasion should the primary invader be removed. Jill Trischman-Marks of the Botanical Garden of the Piedmont may be a valuable person for groups interested in managing these populations to talk with, given the relative success she described for us in fending off invasion along railroad tracks. The subject was also raised during our visit to

Montpelier, but they did not appear to have an easy solution. For helpful discussion of secondary invasion, see Pearson et al. (2016) and Hess et al. (2019).

Although *Sericea lespedeza* was not mapped, it was noted among other places in the passive rewilding site on Carr's Hill (for more information/sources, see Invasive Species References & Info in the Google Drive). Porcelain-berry was sparsely present in the meadow patch along Carr's Hill shown in Figure 2. Porcelain-berry was also present on the stairs descending from Carr's Hill Field from Arts Grounds. Worsening invasion should be noted and dealt with if necessary.

The area near Hancock patch is particularly interesting for its abundance of English Ivy. Although it is not the only patch with a substantial *H. helix* population nearby, the scale and thoroughness (as can be seen in Figure 3 below) of the invasion here are noteworthy.



Fig. 3. English Ivy in the woods between Alderman Road and Old Dorms

More detailed descriptions of invasive species locations and recommendations for future action can be found in Appendix A.

Grass Removal at the Monroe Edible Patch

The application of clear plastic to the Monroe Edible Patch appears to have been partially successful, as is visible in Figure 4. Dead grass is visible and the area between the plants is largely cleared. Grass appeared to be visibly dying underneath the plastic to the best of our recollection within days. Sometime after the removal of the plastic, patches of grass are once again visible in the patch near the edges. This technique has potential for future application, as it successfully reduced the density of unwanted lawn grass during peak growing season in the center of the patch with minimal impact to desired plants. In the future, facilities may consider ways to conserve the plastic used for solarization by labeling the specific place where each tarp sheet was laid for future use.



Figure 4. Grass within the Monroe Edible Patch does in some places despite covering the patch with a clear plastic covering for several weeks. Dead grass is also visible.

Biodiversity

Merlin/Bird Monitoring

A total of 43 bird species were identified by the Merlin app over the course of our observations (see Table 2 in Appendix D). Of these, the northern cardinal and house finch were the only two which were at some point identified in all 7 of the patches. The median identified species was recorded in two patches, and the average number of patches in which any given identified species was recorded in was approximately 2.63. The greatest number of bird species during a given observation was identified at Hereford on July 7 (20 separate bird species) and the least number (5 species each) was found in the Monroe Edible Patch on August 4 and Meadow Creek on July 29.

As can be seen in Figure 5, the most bird species were identified in Hereford (23 total), and the fewest were identified in Meadow Creek (8 total). The number of bird species present in Hereford is perhaps unsurprising given the amount of forested area nearby. The relatively low number of species in Meadow Creek might be attributable to the presence of the nearby railroad, Emmet Street, or Carr's Hill Field.

Interestingly, only two of the six forest patch locations had more bird species than the "control" New Cabell Hall/Nau Hall location, and one had an equal number. A longer or more uniform study might produce different or more significant results. It is also possible that while the current, immature state of many of the forest patches has thus far not been a significant boon to bird species richness, larger and more established forest patches might have a positive effect, as is suggested by the Hereford and Carr's Hill results.

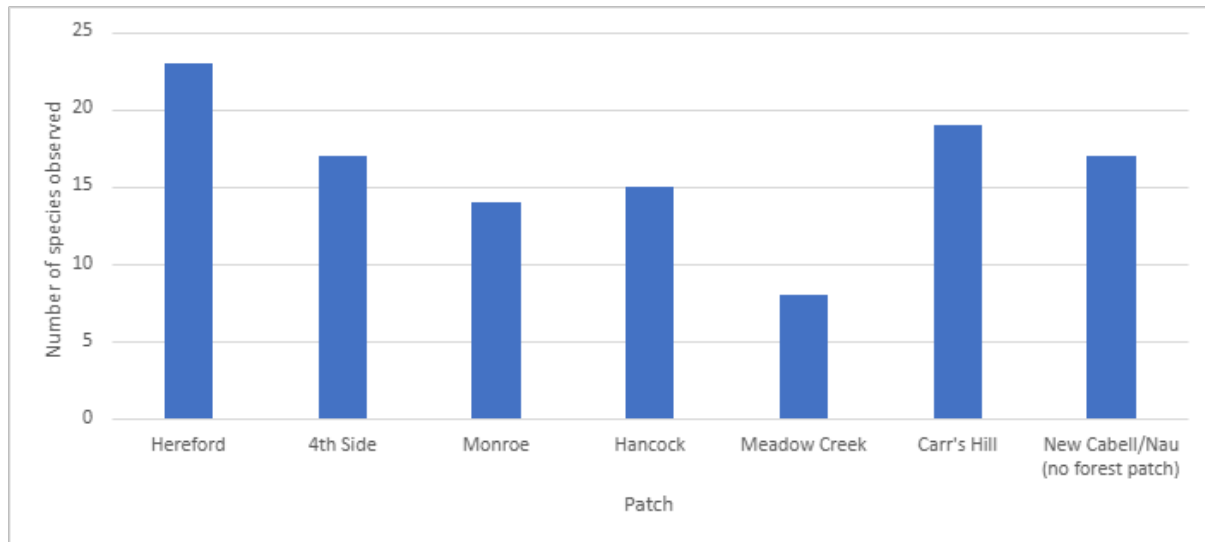


Figure 5. Number of bird species identified by the Merlin app in or near each of six forest patches and one control site (the field between New Cabell Hall and Nau Hall). Note that observations for the Hereford patch were made on the east side of the more established mature patch, rather than amid the newly planted patch.

Figure 6 shows the proportion of the 15 “unique” species identified at each patch. Each site except Meadow Creek, which had zero, had at least two. Some of this variation may be due to variation within the part of the summer when recordings were collected. Future projects could compare the compositional diversity of flora against the diversity of birds recorded at each site to determine whether there is a substantial correlation.

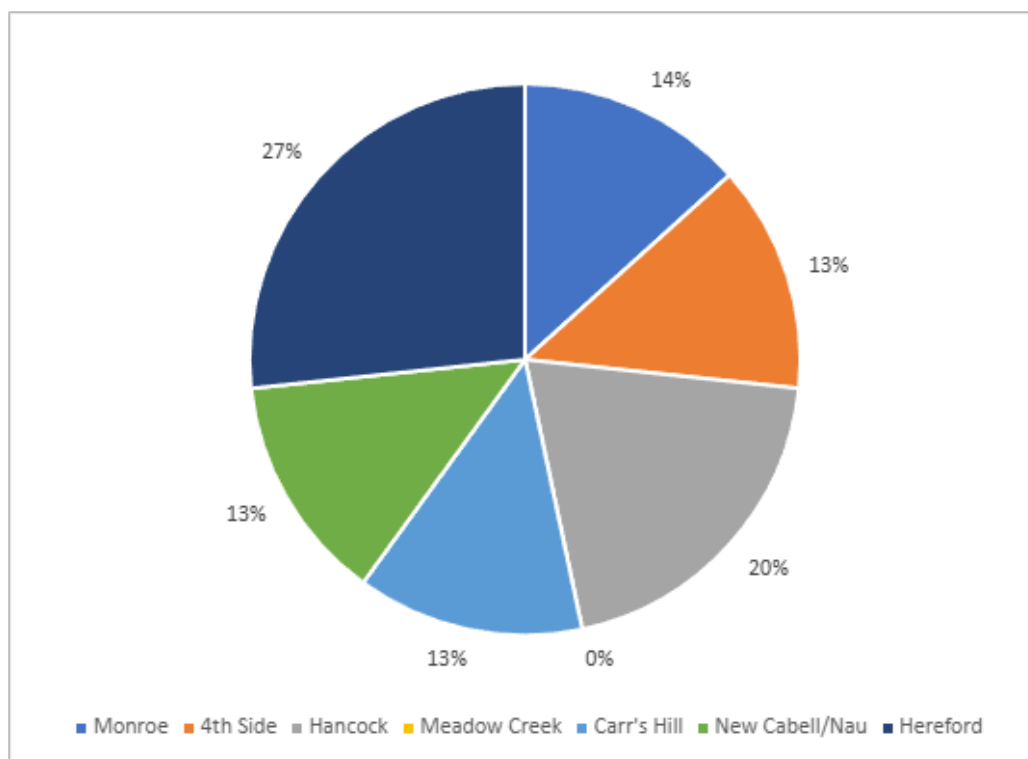


Figure 6. Proportion of the 15 unique bird species (i.e. species identified only in one patch) identified by the Merlin app by location. Each of these locations corresponds to a planted forest patch except for New Cabell/Nau which was measured near the field between New Cabell Hall and Nau Hall, but recordings for Hereford were taken along the side of the more mature forest patch opposite the relatively newly planted forest patch, not within or alongside the newer patch.

Camera Traps

Hereford Patch showed the most promise in recording using established technology. Higher canopy on the older patch allowed for less visual disturbance of leaves, making the camera itself more precise in its capture of significant movement. 4th Side and Hancock patches were especially sensitive to the movement of leaves and traffic, respectively. As such, it was laborious to comb through hundreds of captures which were either cars or wind. Future teams may consider setting different sensitivities to capture based on location of each camera and/or placing camera traps lower to the ground where there is a high volume of visual disturbance at the sightline.

Observations:

Hereford: Deer were recorded on 4 separate occasions, with a doe and fawn visible in one capture. It is possible that this is a resident deer population that travels from nearby O-Hill forest. Fox recorded once at 2:26am.

4th Side: No significant species observed, but occasional bird flutter is visible.

Hancock: No significant species observed.

Carr's Hill: Skunk and Rabbit each observed on separate occasions.

Meadow Creek: No significant non-avian species observations, but a catbird is captured.

See Table 3 in Appendix C for full data on each notable capture. Most active times were in the 2am hour, right before dawn and in the 10 pm hour.

Special thanks to volunteer Nathan Frank who helped establish and monitor the camera traps throughout the season.

Screenshots of significant captures in Hereford, 4th Side, Meadow Creek, and Carr's Hill Patches can be found in Appendix C

Engagement

We are in the process of developing Poet-Tree boxes, which we plan to inaugurate at the forthcoming in-fill fall plantings. These boxes will display collected poems which can reverberate with the experience of being with the forest. We plan to incorporate student poetry in the Poet-Tree boxes, creating an upload channel accessible on-site. Planned candidates for the Poet-Tree boxes are Hereford, Meadow Creek, and 4th Side patches.

Infill and Patch Expansion Recommendations

4th Side

The 4th side patch is located along Stadium road on the southeast side of the Scott Stadium parking garage. It is adjacent to a high foot traffic sidewalk and bus stop. The patch is currently dominated by young eastern redbud and black tupelo trees, with some mature redbuds located on the edges. The patch has very low species richness, with just 4 species present: the two previously mentioned, buckeye, and dwarf rhododendron. redbuds and black tupelos are growing richly in this patch and have high leaf density. Current planting is somewhat dense near the center but lacks a real understory. There are also a few gaps in planting and room for significant expansion of the understory under the mature redbuds.

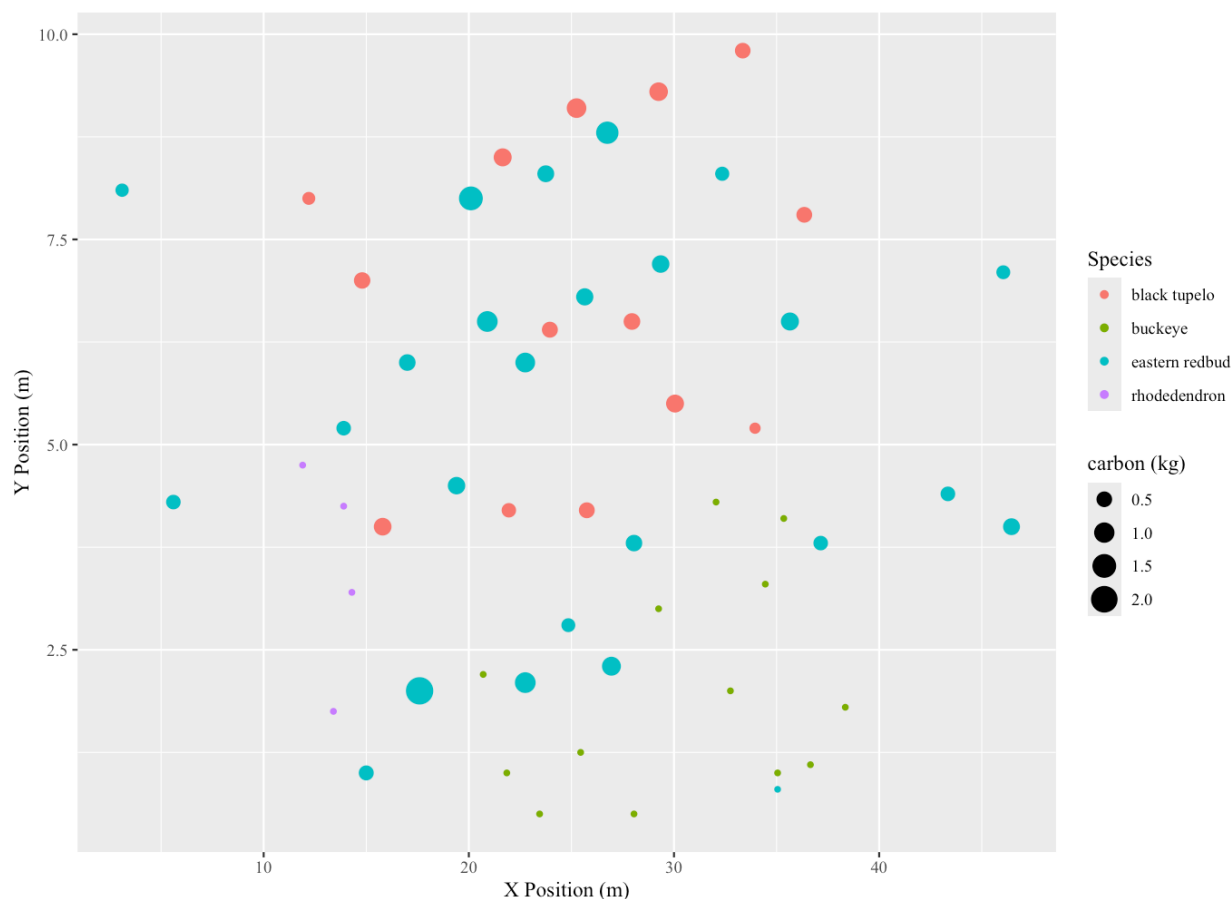


Figure 7. Map of trees by carbon (kg) at the 4th side Forest Patch

We propose that the patch be split up into three areas: the westmost section (to the left of the garage entrance), the eastmost section by the drainage grate, and then the most densely planted section in the middle.

West Section:

This area has a developed canopy from mature redbuds but lacks understory vegetation. We suggest that native rhododendron (*Rhododendron maximum* and *catawbiense*) be planted in the shade under the existing trees, near to the parking garage and with several feet of clearance from the sidewalk to the west. We also suggest planting a pawpaw cluster under the redbud canopy nearest to the westmost sidewalk, which will preserve a pedestrian sightline.

Middle Section:

This is the most densely planted section of the patch. The eastern redbuds and black tupelo trees will form a thick canopy once grown, and to prepare for the shade and revealed space, we suggest that the stand be planted with understory shrubs and ferns to mimic a mature Appalachian forest. Some of our suggested plants include elderberry, Christmas fern, hay scented Fern, and viburnum.

East Section:

This section is planted less densely than the middle section and has a slope meant to lead water to a drainage ditch. We envision planting some woody trees as well as herbaceous growth. Flowering dogwood tolerates partial shade when young, so this is an ideal candidate for densifying. In addition,

there are already other flowering dogwoods along stadium road. In the back, by the parking garage, more rhododendrons will be planted, which will provide beautiful flowers in the summer months.

Hancock

Hancock is an East facing patch, established in 2024. It is characterized by a mixture of short to medium height trees along with some Christmas ferns. Sweetbay magnolia, eastern redbud, red maple, red oak, and black tupelo are all present. The patch condition on the northernmost edge is superior to the patch condition behind the brick utility implement on the southern edge. We recommend staggering the current site with shrubs, with special attention to the shadier southern edge. We recommend planting short shrubs and sedges to act as a midstory to shade leafy plants.

Southern Section:

We recommend planting pawpaw (*Asimina Triloba*) a native broadleaf fruiting understory tree, which fares well in shady conditions and is especially likely to grow in groups. We believe these to be ideally suited for the shady area behind the utility implement.

Northern Section:

American persimmon; *Diospyros virginiana*, native understory fruiting understory tree, which according to the USDA, has “adaptability to a wide range of soils and climates, and immunity from disease and insects. Moist, well-drained soils provide best conditions but the plant will tolerate hot, dry, poor soils, including various city conditions” (*Plant Guide "Common Persimmon"*, n.d.). Furthermore, Virginia is on northern edge of this plant’s region, suggesting that it is likely to fare better in warming conditions. We also suggest planting smooth witheredod, *Viburnum nudum*, a native deciduous shrub growing in savannas, low, and wet woods. It has shown success as a showy shrub in the Darden Botanical garden. It would be ideal as an intermediate species to shade established ferns.

Monroe

Few planting recommendations are needed, but some site improvement recommendations could be effective. Species in Monroe Patch include prickly pear, Golden currant, New Jersey tea, Bee balm, Fragrant sumac, Black chokeberry, Allegheny blackberry, Black Raspberry, Early lowbush blueberry, Rugosa rose, American black elderberry, garden strawberry. Consider placing a bench next to the adjoining swamp white oak tree, mirroring benches closest to Shannon library. Monroe, which has potential to be enjoyed by the public, does not have any supporting infrastructure.

Planting should prioritize non-invasive groundcover which can deter the presence of unwanted grass and lower the overall maintenance burden. To replace encroaching lawn, we recommend blue violet. *Viola sorroria* is a perennial native flower sometimes used as groundcover which self-seeds and has both edible flowers and leaves.

Carr’s Hill

Carr’s Hill is a successful two-lobe patch facing the Northwest, established in 2023, with the westernmost lobe gaining more afternoon sun exposure. Present species include eastern redbuds, Carolina sweetshrub, American persimmon, black cherry, black tupelo, dogwood, American beech, downy skullcap and pine. Trees on the eastern edge of the patch have shown more canopy growth and are closer to the adjoining forest. We can surmise that partial shading of this half of the patch from the

afternoon sun has successfully acted as a late-successional canopy, mimicking the conditions of a native forest; whereas, the western lobe, which is less densely planted, has not yet established a sufficient canopy to self-shade.

Western section

Limited changes are needed, but to strengthen the late succession hardwoods of the western lobe of the patch we recommend planting tulip poplar, *Liriodendron tulipifera*, a fast-growing, dense canopy hardwood, which is showing good resilience in climate affected conditions. We believe that it will be ideally suited to shade the persimmons, dogwoods, and beeches that prevail on the western lobe. Tulip poplars are dense and tall on the eastern lobe and provide ample shade for the middlestory below. Pignut hickory, *Carya galbra*, according to Robert Myers at the demonstration Montpelier forest, are a fast-growing landmark species of late-succession eastern forests and are likely to show greater climate resilience than other species.

Meadow Creek

Meadow Creek or Carr's Hill field can be understood as a riparian boundary forest. As such, choosing species that are late successional and also occur most abundantly near watersheds should be priority. Overall, the patch appears to be healthy and is densely planted. Some consideration should be given to the encroachment of invasive grass into the patch. Some of the lower shrubs seem to be having difficulty emerging from the dense underbrush. We propose expanding Meadow Creek east towards the mature trees and/or towards the creek. We could envision a transitional landscape that moves from dense forest to a more Savannah-like ecosystem, gaining partial shade from mature trees while prioritizing native grasses. Rich Hopkins also recommended planting native grasses and wildflowers in between the lobes of the patch.

Southern Lobe:

We recommend planting more black tupelo, *Nyssa sylvatica*, which has shown success at other drainage sites, like 4th Side patch. It also has good sun tolerance. It would be ideally suited for the riparian boundary. We also recommend willow oak, *Quercus phellos*, which is commonly found along waterways; current plantings at Meadow Creek are showing success.

Eastward expansion:

Post oak, *Quercus stellata*, common in grassland savannah and highly drought tolerant, in the white oak family. Would be best suited for creating a partial savannah in expanding the patch to the East.

Northern expansion:

We recommend mixing cool season cover crop grasses, like Virginia Rye, with landmark species of the Piedmont meadow, such as milkweeds, goldenrods, and bluestems. A more detailed explanation of our meadow planting recommendations can be found under "Meadow Patches."

Hereford

Based on Piedmont succession patterns in NC and Virginia (Forest Succession, n.d.), we can assume that Hereford is in a 30-70 year successional transition from mature pine to hardwood. Our overall recommendation for this patch is to allow natural succession to progress. New plantings on the western lobe of the patch seem to be benefitting minimally from the partial shading of the adjoining mature

forest. Some more sun-tolerant species could be planted to densify this area. Based on conversations with Robert Myers, some chosen release of volunteer seedlings, where mature pines are excessively shading them, could speed up the succession of the forest to mature hardwood; however, this would reduce carbon storage benefits of the mature forest in the short-term. Emphasis should be placed on protecting volunteer hardwood species on the forest floor. Leafy-plants, like ferns, which enjoy moist conditions and shade could be planted to increase native vegetation to support resident wildlife under the canopy.

We propose planting the shaded forest with ferns, as it is lacking any substantial underbrush at the moment. This will help mimic a later successional forest and create habitat for birds and small mammals.

Meadow Patches

We've identified 6 potential meadow patch sites and will be seeking planting approval for them later this fall with the UVA Landscape and Arboretum Committee.

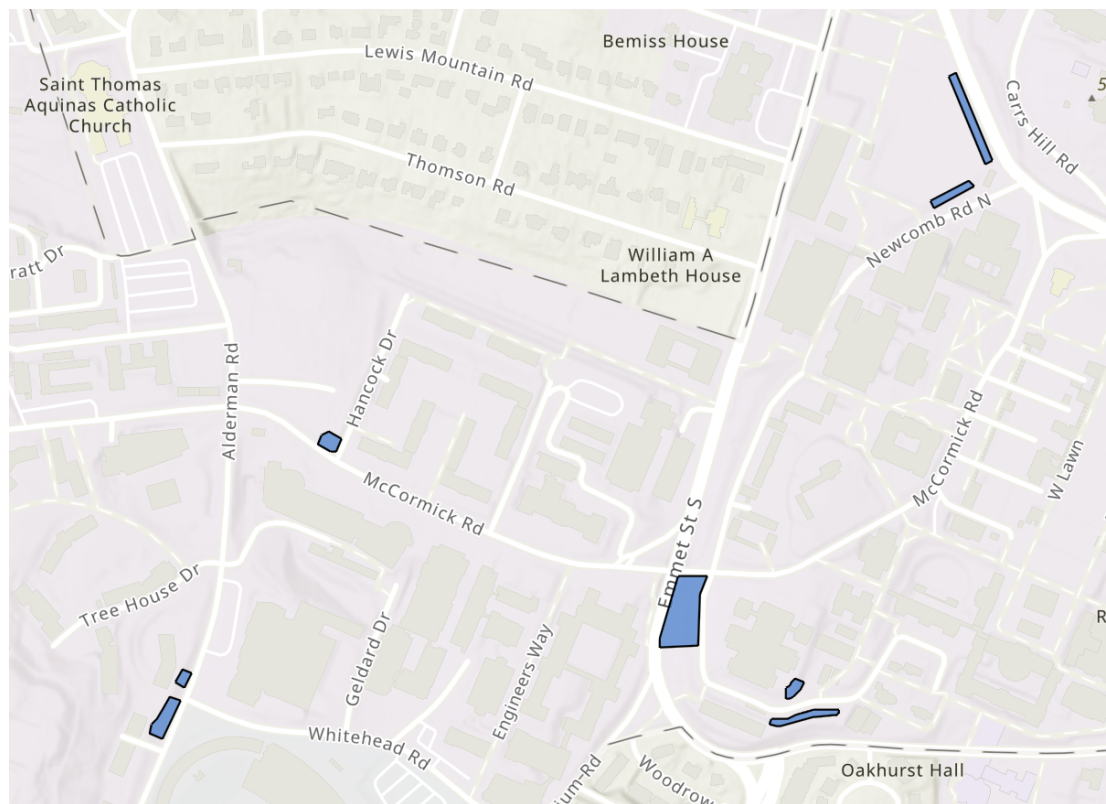


Figure 8. Proposed Meadow Patch Locations. The basemaps are UVA Topographic (2025) layered over World Hillshade (2025).

We recommend mixing regional seed mixes with hyper local cultivars to the Central Virginia region. Little Blue Stem Plant Nursery and Piedmont Discovery Center will be useful for finding indicator species that reflect healthy native grass restorations. Co-seeding a cover crop (cool season grasses) will also be necessary to outpace fescue and will keep the patches looking vibrant for longer while warm season forbs take hold. The Quarry Gardens at Schuyler may be used as a model for the kind of native grassland

restoration that would most benefit the ecology of our region. JW Townsend is working on a meadow restoration near Carr's Hill Field. They could also serve in an advisory and maintenance capacity. After a final mow in late fall, a first seeding can occur with cool season grasses. In late winter or early spring right after the final frost, warm season grasses and forbs should be laid. (*Native Warm Season Grass (NWSG)*, 2020).

Cool season:

We recommend planting Virginia Wild Rye, *Elymus virginicus*, a short grass with much taller seed heads which look like wheat. It self seeds and grows easily and can outcompete out Japanese Stilt-grass. (*Grasses / Plant NOVA Natives / Virginia*, n.d.).

Warm season:

We recommend planting a small amount of purple love grass, *Eragrostis spectabilis*, which works as a good groundcover. In late summer, it has attractive purple grass flowers. It is planted densely near Garrett Hall. Purpletop, *Tridens flavus*, also produces seed heads on top of low clumps which show well in large quantities.

We also recommend these indicator species be planted in the warm season:

- Blue sedge; *Carex glaucoidea*
- Elliott's bluestem; *Andropogon gyrans*
- Splitbeard bluestem ; *Andropogon ternarius*
- Small's goldenrod ; *Solidago pinetorum*
- Churchmouse threeawn ; *Aristida dichotoma*
- Butterfly pea ; *Clitoria mariana*
- Butterfly milkweed ; *Asclepias tuberosa*
- Swamp milkweed; *Asclepias incarnata*
- Purple Milkweed ; *Asclepias purpurescens*
- Blue Wood or Heart-leaved Aster ; *Symphyotrichum cordifolium*
- Black-eyed susan ; *Rudbeckia hirta*
- Joe Pye Weed; *Eutrochium purpureum*
- Bee Balm; *Monarda Didyma*

The VA Northern Piedmont Seed Mix UPL available at Ernst is an ideal starting mix for the restoration. Cost is \$51.19/lb. Site specific planting recommendations are also found at Ernst Seed. Full planting list and plant providers can be found in Appendix D.

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Appendix

Appendix A:

{In the interest of fairness to my group members, I'm going to complete this part and send it to you separately so that the rest of this can get approved. - Jenny}

Appendix B:

Table 2: Bird Observations Using Merlin App

Patch	Hereford		4th side		Monroe		NCH/Nau		Meadow Creek		Carr's Hill		Hancock	
Observation Information														
Date	7/7	8/1	7/8	7/30	7/9	8/4	7/24	8/2	7/28	7/29	7/30	7/31	8/1	8/3
Sunrise time ^{1,2}	5:56:57	6:15:56	5:57:34	6:14:14	5:58:11	6:18:31	6:09:14	6:16:48	6:12:33	6:13:23	6:14:14	6:15:05	6:15:56	6:17:40
Observation began	5:51	5:45	5:50	6:01	5:57	6:00	6:05	5:41	6:09	6:10	6:09	6:14	6:14	6:16
Minutes before sunrise ³	6	31	8	13	1	19	4	36	5	3	5	1	2	2
Observation Period (min)	24:59		24:59		27:34		25:00		25:02	32:41	25:50	26:39	25:55	26:01
Species ⁴														
American Crow			1	1			1	1						1
American Goldfinch	1	1	1				1		1		1	1	1	1
American Robin	1	1	1	1	1	1		1			1	1	1	1
Baltimore Oriole					1	1					1	1		
Blue Grosbeak														1
Blue Jay	1	1	1				1		1	1	1	1	1	1
Brown Thrasher	1										1			

¹"Sunrise and Sunset Times"

² "July 2025"

³ Values have been rounded up to the nearest minute. Note that because observation beginnings were taken only to the minute but sunrise times include seconds, this is generally an overestimate.

⁴ Observations highlighted in red were indicated with the red circle by Merlin, and observations highlighted in yellow were indicated with the yellow symbol. This indicates some uncertainty (increasing certainty, respectively, compared to one another) as to what is being identified. However, because these symbols were not necessarily consistently noted and the uncertainty indicators were not retained with the data, there may be some species about which the app was uncertain which are not indicated here.

Brown-headed Cowbird	1											1		
Carolina Chickadee	1							1						1
Carolina Wren	1	1	1	1	1	1	1	1	1	1	1	1		
Cedar Waxwing														1
Chimney Swift			1		1									
Chipping Sparrow	1						1							
Common Grackle					1									
Downy Woodpecker	1											1		
Eastern Bluebird		1							1					
Eastern Towhee	1			1										
Eastern Wood-pewee	1	1												
Fish Crow			1											
Gray Catbird			1	1	1			1			1	1	1	1
Great Blue Heron	1													
Great Crested Flycatcher	1				1									
Great Egret		1												
House Finch	1		1	1	1	1	1		1		1	1	1	1
House Sparrow				1							1			
Mourning Dove											1		1	1
Northern Cardinal	1	1	1		1		1	1	1	1	1	1		1
Northern Flicker												1		
Northern House Wren								1						

Appendix C: Camera Trap Image Highlights and Data

Table 3: Significant Camera Trap Sightings

Patch	Hereford				Carr's Hill	
Sighting	1 deer	1 deer	2 deer	Fox	Rabbit	Skunk
Date	7/18	7/20	7/20	8/3	7/24	7/28
Time	22:34	6:00	21:31	2:26	2:49	2:57

Camera Trap Image Highlights



Catbird in flight at Meadow Creek



White tailed doe grazing at Hereford Patch



Doe grazing in daylight at Hereford Patch



Skunk sighting at Carr's Hill Patch



Unidentified bird at 4th Side Patch



Gray fox at twilight in Hereford Patch

Appendix D: Planting Recommendations

Table 4: Planting Requests

Common Name	Scientific Name	Carr's Hill	Meadow Creek	4th Side	Hereford	Hancock	Meadow Patches	Total
Paw Paw	<i>Asimina Triloba</i>			10		10		20
American Beech	<i>Fagus grandifolia</i>	5	5	5				15
Tulip Poplar	<i>Liriodendron tulipifera</i>	5		5				10
Pignut Hickory	<i>Carya glabra</i>	5				5		10
Post oak	<i>Quercus stellata</i>		5					5
American Persimmon	<i>Diospyros virginiana</i>					5		5
Basswood	<i>Tilia americana</i>			5				5
Black gum	<i>Nyssa sylvatica</i>		10					10
Flowering dogwood	<i>Cornus florida</i>			5				5
Willow Oak	<i>Quercus phellos</i>		10					10
White oak	<i>Quercus alba</i>		3			3		
Total Trees		15	33	30	0	20	0	98

Great Rhododendron	<i>Rhododendron maximum</i>			10				10
Purple Rhododendron	<i>Rhododendron Catawbiense</i>			10				10
Smooth Witherod	<i>Viburnum nudum</i>	5		10		5		20
American Elderberry	<i>Sambucus canadensis</i>	5		10		5		20
Northern Spicebush	<i>Lindera benzoin</i>		5					5
Total Shrubs		10	5	40	0	10	0	65
Virginia Wild Rye	<i>Elymus virginicus</i>		2lb				20 lb	22 lb
Purple Love Grass	<i>Eragrostis spectabilis</i>		1 oz				1 oz	2 oz
Purpletop	<i>Tridens flavus</i>		2lb				4 lb	6 lb
Total Grasses			4 lb 1 oz				24 lb 1 oz	28 lb 1 oz
Hay Scented Fern	<i>Dennstaedtia punctilobula</i>	5		5	15			25
Christmas Fern	<i>Polystichum acrostichoides</i>	5		5	15			25
New York Fern	<i>Thelypteris noveboracensis</i>	5			15			20
Total Ferns		15		10	45			70
Blue Violet	<i>Viola sororia</i>	MONROE PATCH – 1 oz for Cover Crop						1oz
Rattlesnake Plantain	<i>Goodyera Ooblongiflora</i>				10			
Butterfly milkweed	<i>Asclepias tuberosa</i>		1 seed packet				2 seed packets	3 seed packets
Black-eyed susan	<i>Rudbeckia hirta</i>		1 seed packet				2 seed packets	3 seed packets
Elliott's bluestem	<i>Andropogon gyrans</i>		1 seed packet				2 seed packets	3 seed packets
Small's goldenrod	<i>Solidago pinetorum</i>		1 seed packet				2 seed packets	3 seed packets

Swamp milkweed	<i>Asclepias incarnata</i>		1 seed packet				2 seed packets	3 seed packets
Butterfly pea	<i>Clitoria mariana</i>		1 seed packet				2 seed packets	3 seed packets
Blue Wood or Heart-leaved Aster	<i>Symphyotrichum cordifolium</i>		1 seed packet				2 seed packets	3 seed packets
Joe Pye Weed	<i>Eutrochium purpureum</i>		1 seed packet				2 seed packets	3 seed packets
Bee Balm	<i>Monarda Didyma</i>		1 seed packet				2 seed packets	3 seed packets
Total Flowers								
Ernst Seed Mix	VA Northern Piedmont						29 lb	29 lb

Plant Providers

Colesville in Richmond

Little Blue Stem in Charlottesville

Hummingbird in Charlottesville

Ernst in PA

Native Plant Consortium affiliated with Piedmont Discovery Center

Twinleaf Native Nursery

Missouri Nursery

Prairie Moon

Appendix E: Proposed Meadow Patch Sites





