

Tree diversity survey of Whites Woods Nature Center, Indiana County, PA

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Overview

This report has been prepared in response to a commission by the Friends of White's Woods (FWW).

Goals:

- 1) To develop a complete list of tree species present at White's Woods Nature Center and describe community composition
- 2) To develop lists of species and describe composition for each previously existing management unit of the property
- 3) To recommend management for protection of tree diversity

Site description and sampling methods

Whites Woods Nature center encompasses a 250 acre parcel of mostly-forested land in White Township, Indiana County, PA. The park owned and managed by White Township, and was acquired in 1968. White's Woods is bordered by residential development, a road, and Indiana University property. Topography is variable, with relatively flat uplands dissected by stream valleys and long, moderately-steep slopes. Multiple slope aspects are present in the park. The forest is fragmented by gas wells and roads that open the canopy in places, as well as a utility right-of-way that cuts a corridor through the park.

Natural vegetation at White's Woods is deciduous forest typical of the Unglaciated Allegheny Plateau. The diversity of topography contributes to plant diversity, with different communities present in valleys, ridgetops, and slopes. Communities differ with slope position and aspect, and resemble the Tuliptree-Beech-Maple, Red oak-Mixed hardwood, and Dry oak-Heath communities defined by Fike (1999). Oaks are most common in upland areas, with beech and maple characterizing valleys and north-facing slopes. Tulip poplar is abundant throughout.

Most of White's Woods is regrowth forest that was present before 1938 (Figure 1). A section of the ridgetop and south-facing slope in the Northern and Western section of the park (a) is some of the youngest forest in the site; it appeared to be old field vegetation that grew following recent abandonment from agriculture, most likely pasturing. A few trees with spreading, open-grown branching typical of open habitats persist within the modern forest, and are visible in the 1938 aerial photo (b). It is possible that other parts of White's Woods were used for agriculture in the past, but would have been abandoned no later than the early 1900s. Of the forest present in 1938, forest in the central upland area was comparatively young (c) and likely dates to the early 1900s. The Eastern slope (d) appears to have been fairly open, with individual trees visible. The northeastern corner (e) appears to have been a shrubland or very young forest recruiting on previously cleared land. The only old forest in 1939 was the North-facing slope (f). We can conclude, based on canopy texture, that, other than this section of old forest, all forest stands in White's Woods have been cleared, at least partially, in the previous 150 years. Most forest present in 1938 had regrown after clearing.



Figure 1: Aerial photo of White's Woods Nature Center from 1938 showing forest and openland.

Survey methods

Tree diversity was assessed in October 2022 using both meander surveys and quantitative plot-based sampling. During a previous survey, Millstone Land Management divided White's Woods into seven management tracts ranging in size from 10 to 15 acres (Figure 2, Table 1). These management units formed the basis of the diversity survey. Within each unit, sampling plot locations were non-randomly selected to capture the diversity of slope aspects and landscape positions. At each plot location, a 12x12 meter square was measured with a compass and transect tapes; every tree within was measured for diameter at breast height (DBH) and identified. A total of 25 plots were sampled across units 1, 2, 3, 4, 6, and 7. Unit 5 was not sampled. Any tree species present in a unit but not a plot were added to the overall species list for that unit. The unit-level species lists and all plot data were combined to develop overall data for the park.

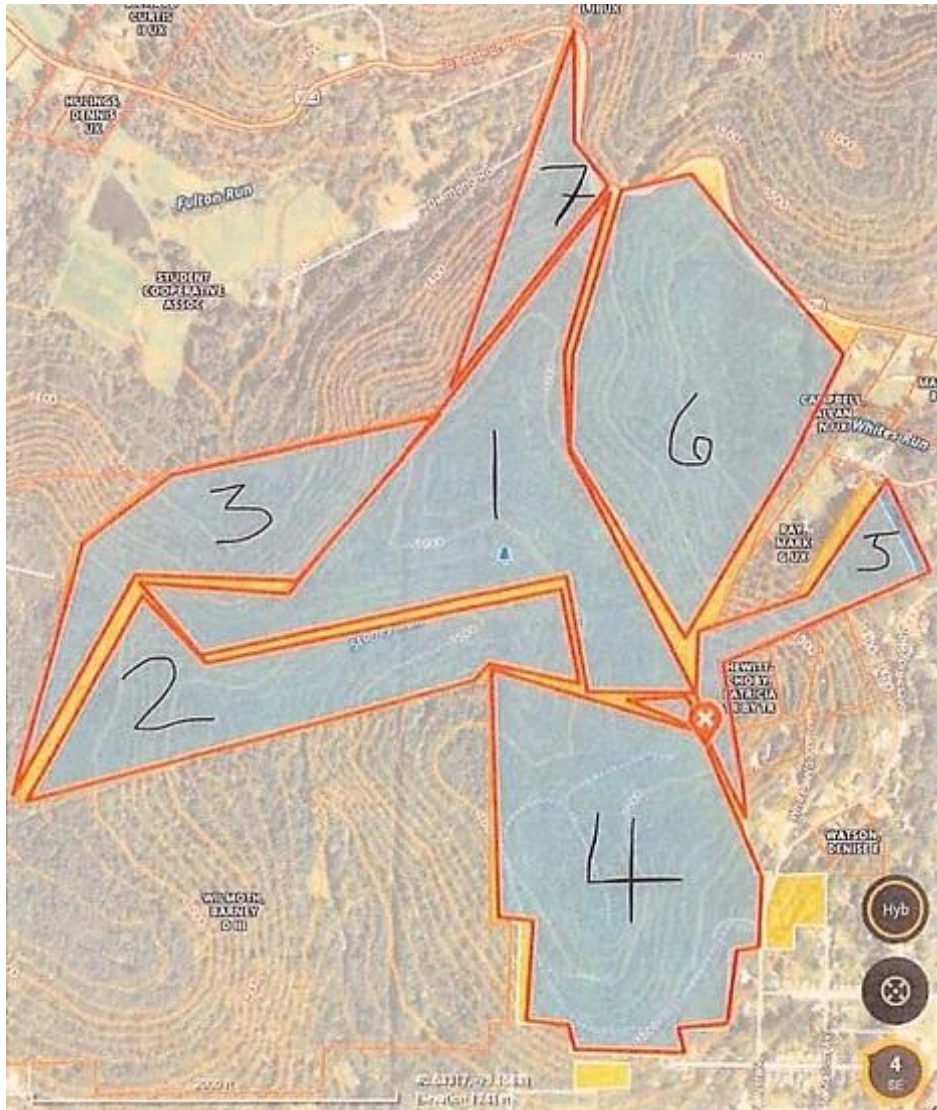


Figure 2: Management units of Whites Woods from the Millstone Land Management plan. Map by Michael Lawer, 3/11/2020 (obtained from FWW website, Summer 2022).

Table 1: Sizes of management units of White’s Woods from the Millstone Land Management plan (obtained from FWW website, Summer 2022).

Management unit	Size (acres)
1	50
2	30
3	25
4	50
5	15
6	50
7	10

Results

Overall tree diversity

A total of 28 tree species were identified at White's Woods Nature Center (Table 2). Most are locally common and typical of forests in western Pennsylvania (Fike 1999). Composition was characterized by a diverse assemblage of oaks, hickories, and maples. Black cherry, sweet birch, tulip poplar and American beech were widespread. Less common species include silver maple, which was restricted to lowland areas in the Northeastern-most corner of White's Woods, bitternut hickory, found on one East-facing slope, and scarlet oak, which was present on uplands in the southern section of the park. American chestnut, though rare, is also noteworthy. Multiple individuals were present in dry ridgetop areas. Although chestnut resprouts are not uncommon in the region, at least one individual has reached an unusually large size (>15cm DBH). No evidence of fruiting was observed, but future monitoring of the larger individuals may be useful.

Table 2: Tree species observed at White's Woods in Fall 2022

Species	Common name	Units observed
<i>Acer rubrum</i>	Red maple	1,2,3,4,6,7
<i>Acer saccharinum</i>	Silver maple	6
<i>Acer saccharum</i>	Sugar maple	4
<i>Betula lenta</i>	Sweet birch	1,2,3,4,6,7
<i>Carpinus caroliniana</i>	Ironwood	Observed 2021, no location info
<i>Carya cordiformis</i>	Bitternut hickory	6
<i>Carya glabra</i>	Pignut hickory	4
<i>Carya ovata</i>	Shagbark hickory	4,7
<i>Carya</i> spp.	Hickory spp.	1,2,3,4,6
<i>Castanea dentata</i>	American chestnut	1, 6
<i>Cornus florida</i>	Flowering dogwood	Observed 2021, no location info
<i>Fagus grandifolia</i>	American beech	1,2,3,4,6,7
<i>Fraxinus americana</i>	White ash	4,6,7
<i>Fraxinus pennsylvanica</i>	Green ash	2, 4
<i>Ilex opaca</i>	American holly	Not native, no location info
<i>Liriodendron tulipifera</i>	Tulip poplar	1,2,3,4,6,7
<i>Magnolia accuminata</i>	Cucumber magnolia	1,4,6
<i>Nyssa sylvatica</i>	Black gum	1,4,6,7
<i>Ostrya virginiana</i>	Hophornbeam	1,3,4,6,7
<i>Populus deltoides</i>	Eastern cottonwood	Observed 2021, no location info
<i>Populus grandidentata</i>	Bigtooth aspen	2,4,6
<i>Prunus serotina</i>	Black cherry	1,2,3,4,6,7
<i>Quercus alba</i>	White oak	1,4
<i>Quercus coccinea</i>	Scarlet oak	4
<i>Quercus montana</i>	Chestnut oak	1,3,4
<i>Quercus rubra</i>	Northern red oak	1,2,3,4,6,7
<i>Quercus velutina</i>	Black oak	1,4,6,7
<i>Sassafras albidum</i>	Sassafras	1,4,6

Overall composition

Proportions of each tree species in the community differed between canopy and sapling layers. Tulip poplar was the most abundant species in the canopy layer, with northern red oak and red maple nearly codominant (Figure 2a). Sugar maple, black cherry, and other oaks were also widespread. Within the canopy layer, oaks tended to dominate at larger size classes despite being less common overall. Canopy composition is consistent with second-growth forests in the Allegheny Plateau (Fike 1999). The dominance of tulip poplar reflects site history: as an early successional species, it colonizes logged areas and abandoned farmland and forms second-growth stands dominated by single tulip poplar cohorts (Lafon 2004). With time, this dominance is reduced as shade-tolerant trees establish within the stand, individual tulip poplars die off, canopy gaps form, and other species establish in gaps. There is evidence of gap formation occurring in White's Woods currently, although the forests will likely carry legacies of their logging and establishment history for many decades if not longer.

The sapling layer was visibly dominated by red maple, with sweet birch and black cherry subordinate (Figure 2b). Other species were present but less common. Oaks and tulip poplar, some of the dominant species in the canopy layer, were rare or absent. This pattern reflects multiple ecological processes at play. Both red maple and sweet birch are shade-tolerant and can establish under closed canopies. Tulip poplar is shade-intolerant and does not typically recruit under closed canopies, and instead relies on canopy gaps or wind disturbances like tornado blowdowns to regenerate. Oak regeneration can be limited by deep shade as well, but heavy herbivory by white-tailed deer is likely a key factor in the absence of oak saplings (Petersson et al. 2019). The dominance of less-palatable species like red maple and sweet birch further support the impacts of herbivory in shaping forest composition at White's Woods. As the canopy layer ages and develops more gaps, it could be expected that shade-intolerant species would be able to colonize gaps and contribute to stand diversity in the future (Oliver and Larson 1996); however, high levels of herbivory are likely to prevent regeneration of palatable species even as canopy heterogeneity increases.

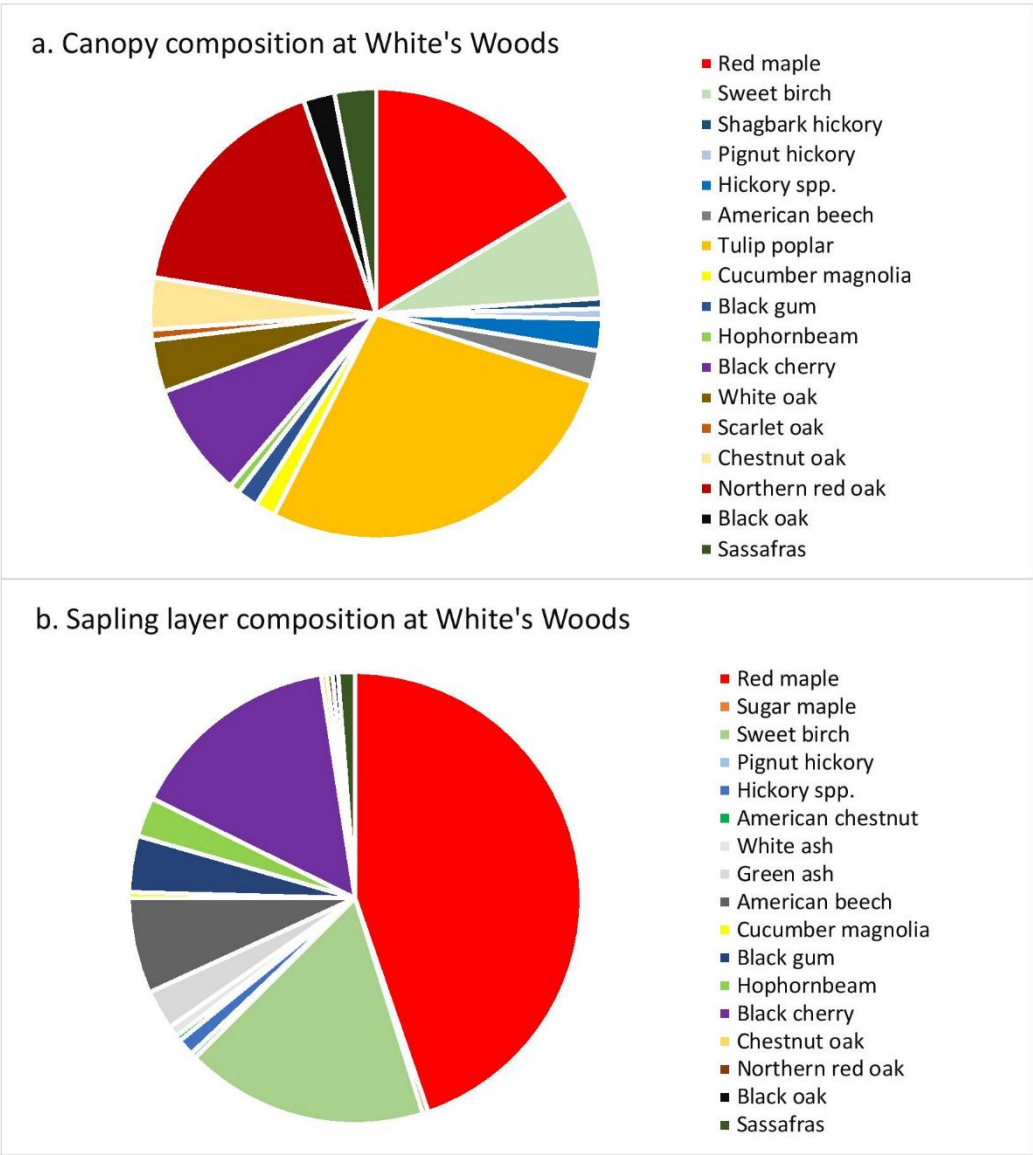


Figure 2: Composition of the canopy and sapling layers of White’s Woods.

Comparison of management units

Species richness differed between management units (Figure 3). The number of species corresponded to size and environmental diversity. Large units generally had more species than small units; the effect of size interacted with landscape diversity in that units with multiple landscape positions, such as unit 1, 4, and 6, had more species than others more homogeneous in slope position and aspect such as Unit 2.

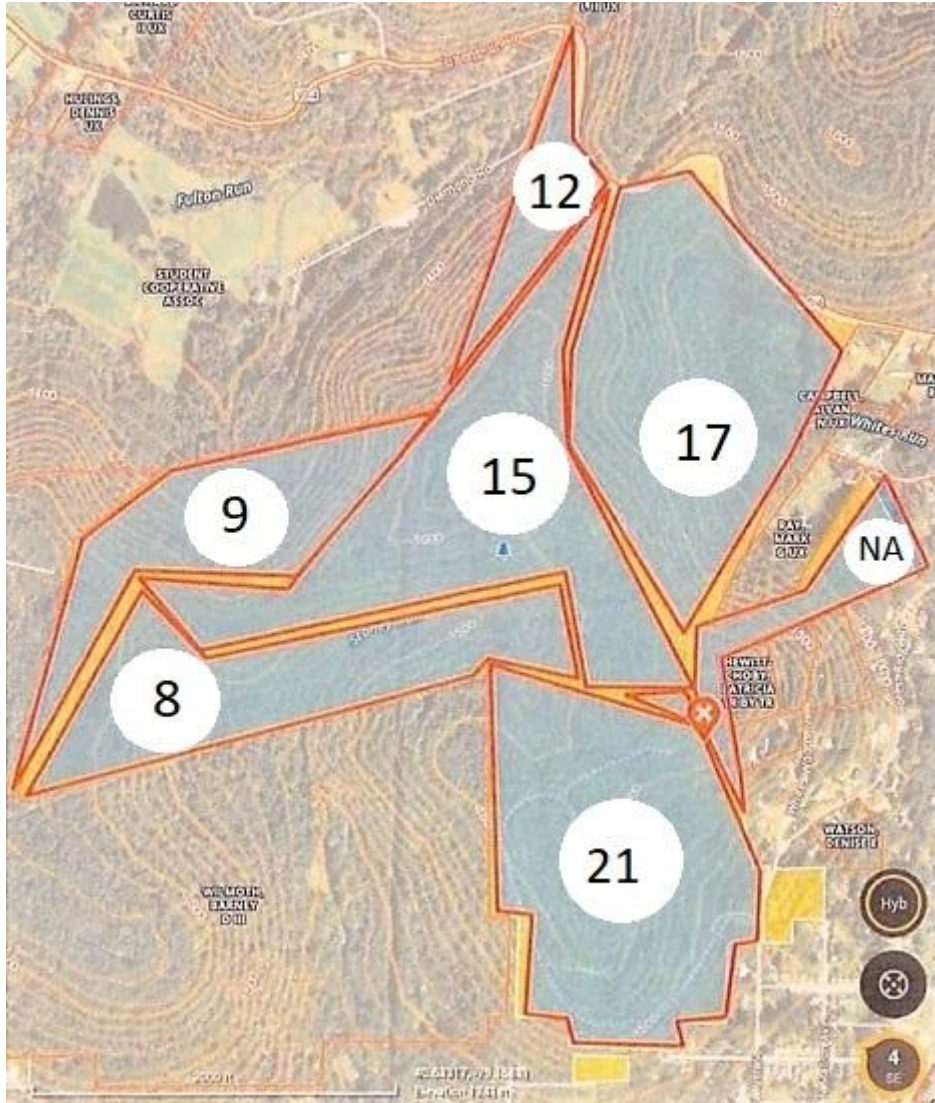


Figure 3: Tree species richness of management units at White's Woods.

Canopy composition also differed between management units and reflected both their size and environmental heterogeneity (Figure 4). Oaks and hickories were more abundant in units with upland habitats, while beech and maple occupied a higher proportion of the canopy on lower slopes. Tulip poplar was common in all units and typically composed about 20-30% of the canopy, but its degree of dominance varied. Its frequency across the landscape in all sites reflects historical land abandonment patterns. Red maple and northern red oak also composed significant portions of the canopy in most units. Black cherry was especially frequent in Units 2 and 7. Black, white, and chestnut oaks were present but rarely dominant and most abundant in Units 1, 4, and 7. Differences between units appear to be driven by species with strong habitat preferences: while generalists such as red maple are widespread across units, distributions of species with distinct habitat preferences like black oak and American beech create variation between units.

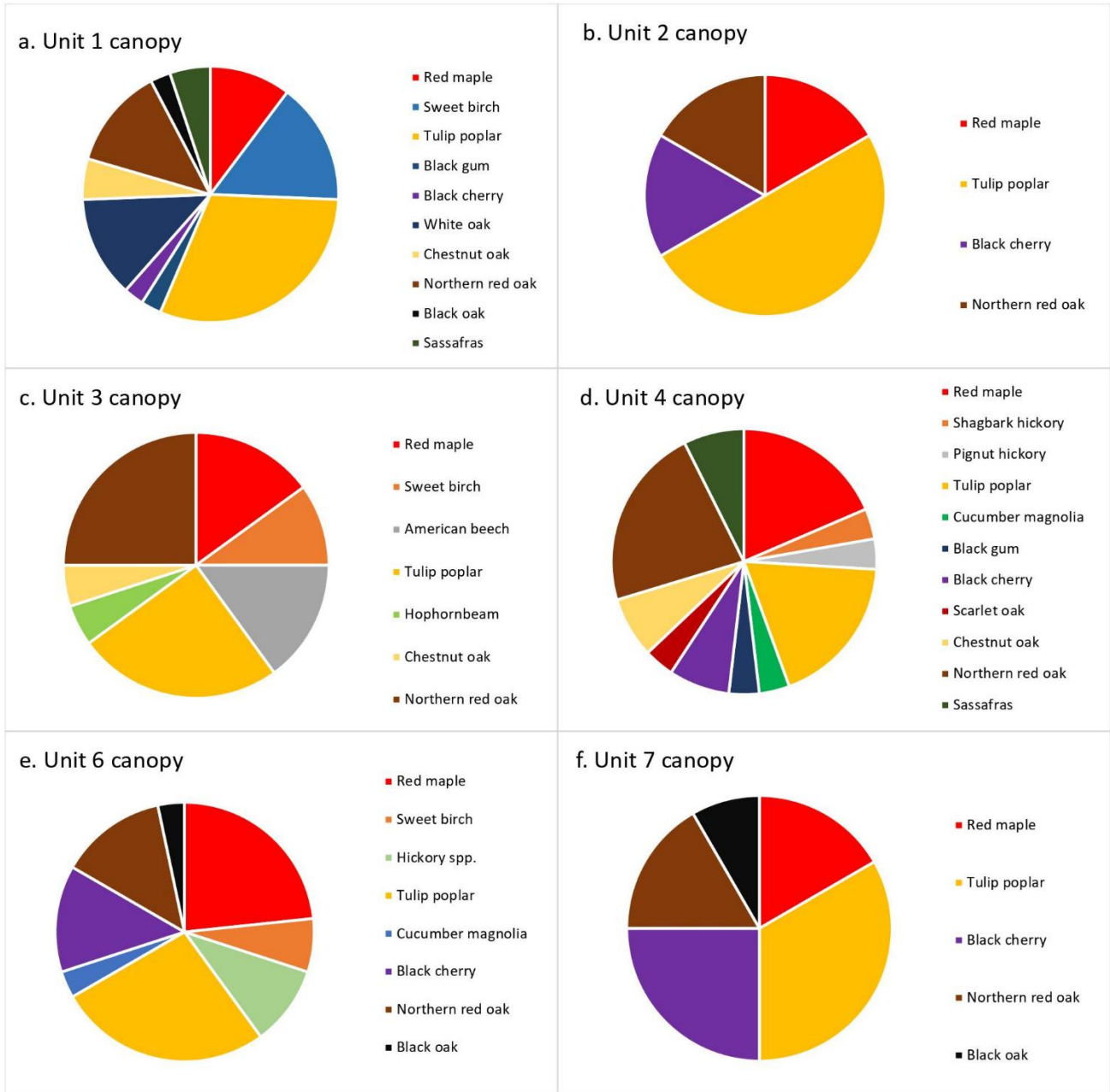


Figure 4: Canopy composition for management units at White's Woods

Sapling (trees <10 cm DBH) composition differed across units, but mostly as a result of less-abundant species. Red maple was strongly dominant throughout, consistent with widely observed trends toward increasing red maple abundance in eastern forests (Abrams 1998). Sweet birch and black cherry were common in some units, but not present in all (Figure 5). Sapling layers were typically less diverse than the canopy and more likely to be dominated by a single species that made up 40-60% of stems counted. Shade-tolerant and later-successional species

like American beech were also more common in the sapling layer than the canopy, which reflects typical patterns of stand development in which shade-tolerant species establish under the early-established canopy trees (Poulson and Platt 1996).

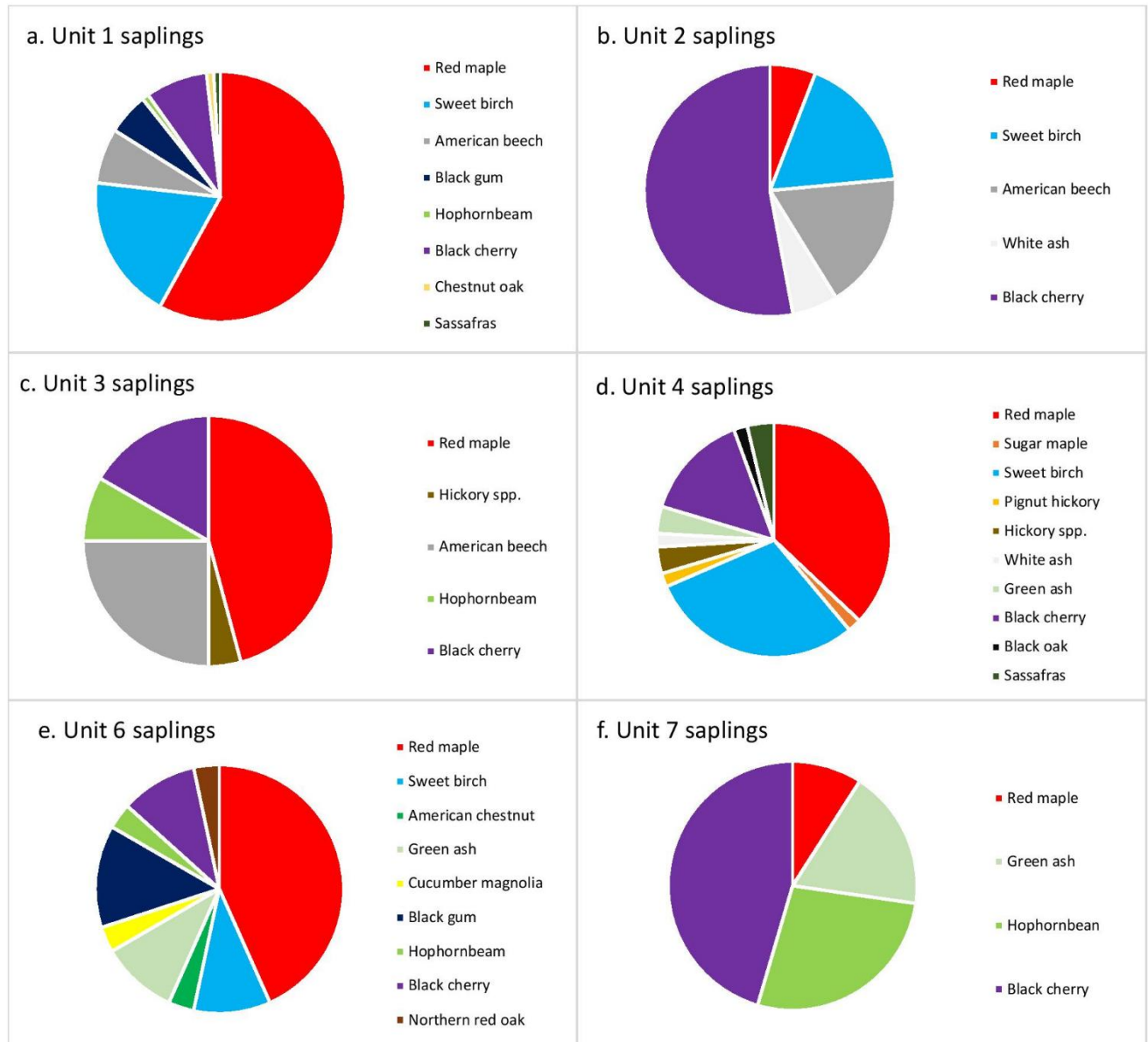


Figure 5: Sapling layer composition for management units at White's Woods.

Management recommendations for protection of tree diversity

Deer management

White's Woods Nature Center is subject to heavy deer browse, that has already impacted the tree community. The canopy layer developed at lower deer densities and includes many palatable tree species, but the sapling layer shows evidence of regeneration failure for palatable species such as oaks and a shift toward browse-resistant species (Tilghman 1989, Kain et al. 2011). Although many oaks are present on site and seed production or dispersal does not appear to be an obstacle, oak seedlings (which were observed on multiple site visits) are browsed before transitioning to the sapling stage. It is also worth noting that some previously-recorded highly-palatable herbaceous species, like pink lady's slipper and trillium, have been significantly suppressed in areas of the park (FWW personal communication, 2021). Significant control of deer-browse should be the top priority for protection of tree diversity in White's Woods. Because of the location of the preserve in a densely populated area and heavy recreational use, deer population management presents multiple challenges. Consultation with municipalities and organizations that have reduced deer populations in similar settings would be invaluable for developing an actionable plan. If no satisfactory management can be undertaken, there will likely ultimately be continued serious long-term impacts on the botanical diversity of the site.

Shade and canopy heterogeneity

The tree community at White's Woods is shifting toward more shade-tolerant species, as can be expected in closed-canopy forest at this successional stage (Oliver and Larson 1996). Many areas of White's Woods are dominated by tulip poplar cohorts that likely originate at the time the land was last logged or abandoned from agriculture (Lafon 2004). These stands are starting to develop more structural diversity as individual tulip poplars die and canopy gaps develop. Because species like oaks require light to recruit as saplings (Cho and Boerner 1991), it can be expected that development of canopy gaps and more variable light environments on the forest floor would have a positive impact on future stand diversity.

If the deer population is effectively suppressed, forest succession will likely allow regeneration of a diverse canopy. Canopy gaps are starting to form that will provide light for regeneration of shade-intolerant species. While creation of artificial canopy gaps by single-tree or small-group harvests has the potential to increase stand heterogeneity at a faster rate than natural forest succession by releasing saplings or initiating new cohorts, the potential drawbacks of harvest in White's Woods likely outweigh the ecological benefits of tree removal at this stage. The likely success of diversity-oriented forest management is also strongly limited by browse pressure (Nuttle et al. 2013). Recruitment of new trees in any natural or human-created gaps would be filtered by the effects of heavy deer herbivory and may backfire by causing further dominance of non-palatable species (Kain et al. 2011). Openings from tornado blowdowns in comparable communities have not increased canopy diversity, but instead led to near monocultures of sweet birch and tulip poplar except where deer are excluded (MA Holmes and CF Olmsted pers. obs. 2021). To the extent that regeneration of oaks is a desirable goal, success will be prevented by the high deer population unless deer-browse is effectively suppressed.

Tree size and structural heterogeneity

The diversity of tree sizes at Whites Woods is also worth retaining for biodiversity. Tree size diversity is a hallmark of older and long-established forests (Oliver and Larson 1996), and large trees fill distinct ecological roles in forests that cannot be approximated by smaller individuals (Lindenmeyer et al. 2012). Large trees are especially ecologically valuable as wildlife habitat (DeGraaf 1985) and as seed producers, as size influences the number of fruit or seeds produced (Bogdziewicz et al. 2020). For these reasons, the decline of large old trees has negative consequences for ecosystem integrity and should be avoided (Lindenmeyer et al. 2012). Large trees are also especially valuable for carbon sequestration due to their growth rates (Stephenson et al. 2014). To encourage diversity of canopy structure as well as species composition, large trees should be retained throughout the property.

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