Ohlsson, R., M.H. MacRoberts, B.R. MacRoberts, and J.M. Kelley. 2024. Floristics and forest structure of a pine-hardwood slope forest at Eddie D. Jones Park, Caddo Parish, northwestern Louisiana. Phytoneuron 2024-77: 1–18. Published 11 November 2024. ISSN 2153 733X

FLORISTICS AND FOREST STRUCTURE OF A PINE-HARDWOOD SLOPE FOREST AT EDDIE D. JONES PARK, CADDO PARISH, NORTHWESTERN LOUISIANA

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ABSTRACT

We studied the vascular flora and forest structure of a 3.0 ha pine-hardwood slope forest at Eddie D. Jones Park, Caddo Parish, Louisiana. We identified 181 species, 129 genera, and 72 families. Ten (5.5%) of these species are considered non-native. The native mean-coefficient-of-conservatism is 4.7 and the floristic quality index is 61. The vegetation overall is intermediate in composition to hardwood slope and shortleaf pine/oak-hickory communities, with more mesophytic elements occurring in the lower third of the slope. The overstory is dominated by *Pinus echinata*, *Quercus falcata*, *Liquidambar styraciflua*, *P. taeda*, and *Quercus alba* and the midstory is dominated by *Acer floridanum* and *Ostrya virginiana*. Few quality remnants of this forest type remain in the region, and although this site is in a relatively mature and natural state, historical records suggest that the current structure of the forest differs from the "average acre" as described in the 1800s.

A striking thing about the pine-hardwood forests west of the Mississippi River in the Upper West Gulf Coastal Plain (south Arkansas, north Louisiana, northeast Texas, and southeast Oklahoma (hereafter UWGCP), is that few, if any, natural remnants remain (Bragg 2008; MacRoberts & MacRoberts 2008b, 2009). Virtually all pine was cut by the early 20th century (Bragg 2008; Carr 2000), and historical information can be the best source of what presettlement forests were like. Most historical information is fragmentary and localized (Bragg 2008; Carr 2000; MacRoberts & MacRoberts 2008a, 2008b, 2009; MacRoberts et al. 1997 and references). For example, Custis and Freeman in 1806 described the upland forest as being "…cloathed with White and Black Oak, Hickory, and Pine, without much undergrowth" (Flores 1984: 177). In 1876, Lockett (1876, p. 46 and 59) wrote that of the uplands of northwest Louisiana "The prevailing forest … is a very good one of mixed timber. Oaks of various kinds are principally the red, white, black, and post oak varieties, the dogwood, beech, sassafras, hickory, black gum, sweet gum, ash, maple, and shortleaf pine constitute the larger growth. There is generally a thick undergrowth of bushes such as hackberry, chinquapin, elder, sour-wood, prickly ash, et cetera, with many fox grape and muscadine vines." Writing about southwest Caddo Parish, where our study area is located, he continued that "All the country drained by these bayous is a rolling … country with a strong oak growth prevailing. In the western part of the parish and near Spring Ridge the shortleaf pine is found to some extent, and, in fact, occasional pine trees may be seen almost anywhere in the section of Caddo we are now noticing, but they do not form a characteristic feature." Lockett did not distinguish between loblolly pine (*Pinus taeda*) and shortleaf pine (*Pinus echinata*) but called both shortleaf as distinct from longleaf pine (*Pinus palustris*) farther south. From Lockett's description, it would appear that pines were not the dominant species, but rather oaks prevailed in the region. As Bragg (2008, p. 49) has said, "dramatic shifts in stand structure, tree density, overstory and ground cover pattern generated by centuries of commercial exploitation, settlement, and alteration to historical disturbance regimes have undoubtedly produced a substantially different vegetation environment in the UWGCP." There is also bias in discussion of these stands, namely that stands dominated by hardwoods are often referred to as pine-hardwood rather than hardwood-pine (pers. obs.). We will nonetheless use the term pine-hardwood, both to support continuity of our work with previous descriptions and to acknowledge the large, old cohort of shortleaf pine on our site.

In short, the dynamics of pine-hardwood forests are poorly understood, even the extent to which they originally occurred on the landscape (Lester et al. 2005), and the best that can be done is to study remnants in areas that, according to historical records, were pine-hardwood forest at the time of settlement and are currently in good condition (Carr 2000). Unlike many plant communities in the UWGCP such as prairies and xeric sandylands, there are few "typical" stands upon which to base a presettlement description of pine-hardwood forest. Additionally, aside from general lists of "typical" species, we have few complete or near complete lists for specific pine-hardwood sites. The best examples (e.g., TNC's Lennox Woods, the privately owned Urania Set-Aside tract, Arkansas' Lost 40, Castor Creek Scenic Area on the Kisatchie NF) do not yet have published checklists.

Robert Kral, working in northern Louisiana in the late 1950s and early 1960s, was impressed with the flora of the forests he observed. In these he found many localized northern species such as *Podophyllum peltatum*, *Polygonatum biflorum*, and *Viola pubescens* (Kral 1966; see also Van Kley 2006). And Kral (1966, p. 398) warned that "...one of the most critical areas of descriptive or floristic ecology remains literally untouched in northern Louisiana and eastern Texas. Many extensive stands of hardwood forest still remain relatively undisturbed as the region is still not very heavily populated. However, such studies must be done soon. Industry in the form of hardwood pulp, veneer, and furniture mills is rapidly moving into the region; in many other parts of these areas hardwoods are being cleared out to make room for pine."

Since most descriptions of UWGCP pine-hardwood forest are based on canopy species and do not consider ground cover vegetation (Carr 2000; McLaughlin 2007), the main purpose of this study is to describe the total flora and silvic structure of one pine-hardwood slope forest.

STUDY SITE

Our study site is located within the 387-ha Eddie D. Jones Park, owned by Caddo Parish and administered by the Caddo Parish Parks and Recreation Department. This site was selected for the study because of its accessibility and because it is considered to be one of the best pine-hardwood forest remnants in the UWGCP (Lester et al. 2005). The sloping area we studied, effectively a macroplot, measures about 340 m by 88 m (3.0 ha.) (Figs. 1 and 2). The center of the plot is 32º15'48.7" N and 93º56'32.6"W and its boundaries avoid areas of recent anthropogenic disturbance, the alluvial plain below, and the roadside ecotone as differentiated ca. 2011. The slope faces north to northwest. Elevation is about 91 m at the top and 72 m at the bottom. The overall slope is about 15º but it ranges from nearly flat to steep ravines with 80º walls. The site parallels the floodplain of Cypress Bayou, which ultimately flows into Wallace Lake, which in turn flows into the Red River. The plot canopy is continuous where undamaged and leaf-off aerials show a ratio of 30 percent pines to 70 percent hardwoods, the former dominating the ridges and the latter dominating the ravines. Ground vegetation is generally sparse with much leaf litter (Fig. 3). The 1980 soil survey of Caddo Parish described the soils as "Woodtell fine sandy loam, 8 to 20 percent slope" ("fine, montmorillonitic, thermic Vertic Hapludalfs") of Tertiary age (Edwards et al. 1980). Detailed weather data can be found for the Shreveport Regional Airport (https://www.weather.gov/) 24 km northeast of the study site. Annual rainfall for the area is between 127 and 152 cm but in 2010 and 2011 this fell to 76 and 80 cm per annum, which was considered severe drought. A severe drought was also experienced in 2023.

The history of the plot is not entirely clear. Native Americans occupied the area and modified the vegetation but in what ways is little understood. After the Civil War, the site was owned by the Maiden family, freed slaves who were deeded several thousand acres. They farmed the uplands in cotton, raised cattle and hogs, hunted the slopes and bottomlands, and utilized the timber (Larry Maiden, pers. comm.). Caddo Correctional Institute (now Forcht Wade Correctional Center) obtained the land in 1971, and timber was thinned across much of the property in 1991 (Anonymous 1997, timber management plan). The site is presently owned by Caddo Parish and was opened as a park in 2003. Its miles of trails are popular with mountain bikers and equestrians. Most of the park was included in the Louisiana Natural Areas Registry in 2007. The site has not burned in recent memory (Larry Raymond pers. comm.). We found no fire scars on the trees. The drought of 2010-2011 killed many pines, and at least twelve were killed by the 2023 drought. A storm in the summer of 2023 toppled trees on the slope and adjacent floodplain with straight-line winds out of the northwest. Aerial imagery and field visits indicate that 15% of the overstory was windthrown, and as much as 40% lost tree tops and large branches, mostly on the lower slope and along the ravines.

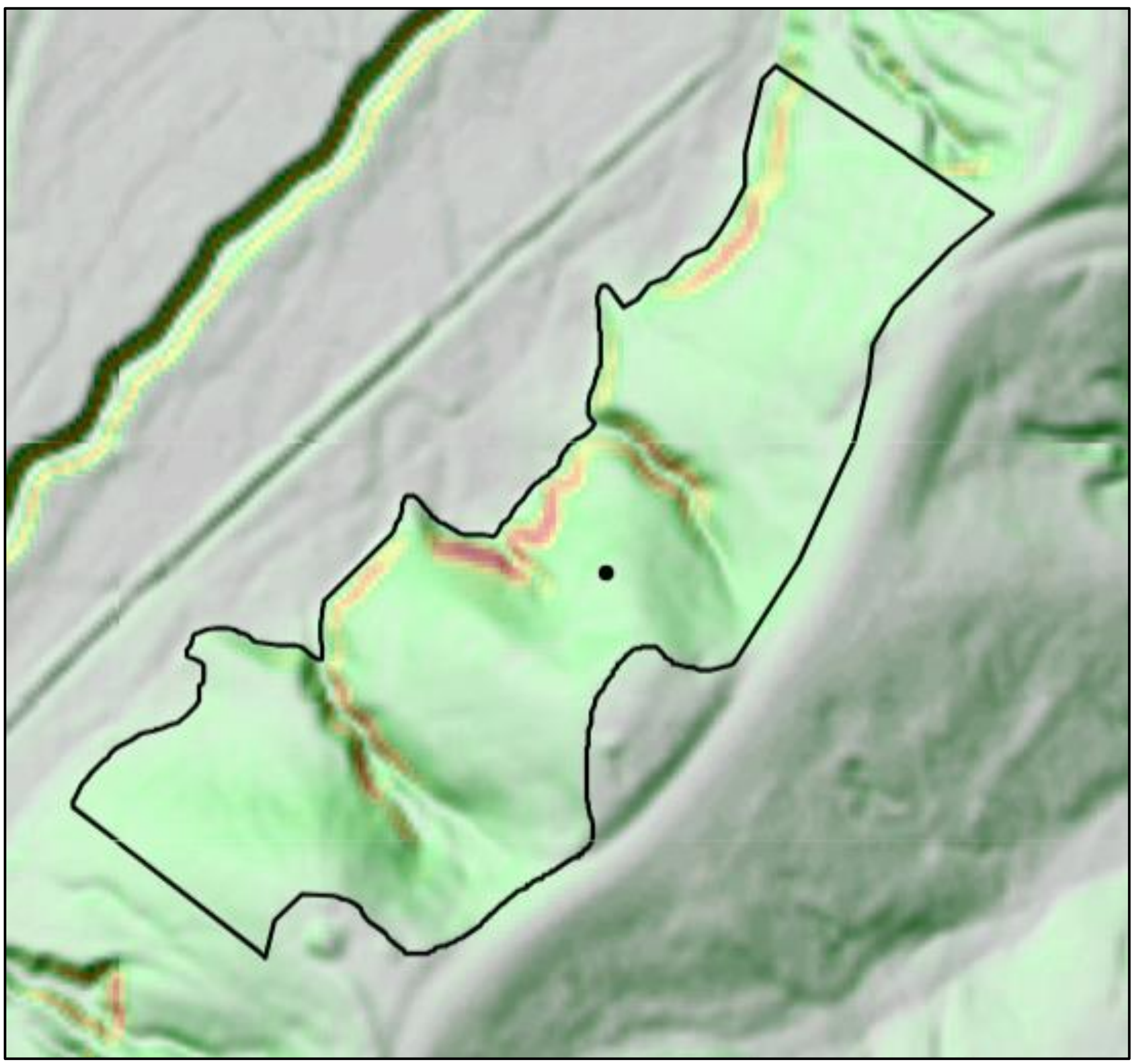

Figure 1. Map of study site with slope-angle shading and plot boundaries overlaid.

METHODS

From 2009 to 2012 we collected the vascular flora in all seasons except winter, and a few additional trips were made in 2023 and 2024. Coefficients of conservatism were also analyzed using a recent Arkansas checklist and the methods therein (Witsell et al. 2024). Some species were not collected either because they were toxic, abundant in herbaria and unmistakable, or because they had already been collected nearby within the park, and in these cases we often provide an iNaturalist (https://www.inaturalist.org/) observation instead. Plant specimens are deposited in LSUS, LSU, and KBL. Nomenclature and identification primarily follow Diggs et al. (1999; 2006) and Smith (1994).

We used the witness trees from the 1831 land survey of the area to determine whether or not tree proportions have changed in the ensuing 180 years (OSL, https://wwwslodms.doa.la.gov/). We listed all trees in the four townships surrounding our study site (which was essentially in the center). The townships were T15NR15W, T15NR16W, T14NR15W, and T14NR16W. The problems of using land survey data have been amply discussed elsewhere (Whitney & DeCant 2001), but an earlier study of Caddo Parish based on land survey information found no particular biases (MacRoberts & MacRoberts 2005).

In 2023, we cruised 10 points spaced along a meandering transect that traversed the areas least affected by the windthrow. At each point we used an angle-gauge (BAF 10) to sample trees in the midstory and overstory (≥10 cm DBH), and recorded species, diameter, and height when possible. For all "borderline" trees, or those windthrown or broken in 2023, we checked their diameters against the limiting distance for the angle-gauge and measured from the center of their root ball or trunk to the sampling point to judge inclusion. These distances and the tree heights were measured with a Nikon Forestry Pro 2 laser device, and diameters were measured with a centimeter-graduated diameter tape (to the nearest cm). We accounted for slope by holding the prism perpendicular to slope as described in Mitchell, Hughes, and Marcy (1995). Our sample includes trees lost in 2023 among the standing composition, thereby normalizing our snag (≥10 cm and ≥2 m tall) density, which was sampled along with the live trees. These data thus constitute a snapshot from immediately before the storm. We took core samples as low as possible from dominant and codominant pines and ring-porous hardwoods at various elevations; we also counted rings from trees cut to clear bike trails after the 2023 windthrow. Core samples were taken with a 50 cm increment borer and shaved in the field with a scalpel, the rings counted, and then the cores discarded. We also cored several pines in 2011. All ages using these various methods are simple ring counts and therefore represent minimum estimates of tree age, which we also express as dates of recruitment. We analyzed the results of our cruise in the manner described by Mitchell, Hughes, and Marcy (1995). We extracted diameter distribution from their method of calculating densities by size class and calculated frequency as the percentage of sampling points at which a species was among the "in" trees.

We also sampled regeneration of overstory and midstory trees (≤1.5 cm DBH) within thirteen plots of radius 2.71 m (23.06 m^2), ten of which were centered at the angle-gauge sampling points and three of which were offset by six paces along the same contour line. From this roughly 1% sample of regeneration, we hoped to predict future trends in overstory composition. We settled on this strange design after our initial plan to cruise thirteen points failed; three points were rejected because they fell on uncorrectably steep slopes or unsafe areas of windthrow.

We collected soil samples from the upper 20 cm near the top, middle, and bottom of the slope. These were analyzed for pH, various elements, and soil texture at Louisiana State University Soil Testing and Plant Analysis Laboratory.

RESULTS

Table 1 gives the species found at the site. There were 181 species, 129 genera, and 72 families present. Ten species were non-native. The Asteraceae, Poaceae, and Cyperaceae were the most species rich families. The site is dominated by native species and very few exotics were encountered. Edge-of-range rarities at the Eddie Jones slope included *Forestiera ligustrina*, *Quercus muehlenbergii*, *Solidago auriculata*, *Ribes curvatum*, and *Viola pubescens*. Kelley (2022) reported *Rudbeckia triloba* and *Astragalus canadensis* from the floodplain below the slope, but neither was found within the study area. The mean coefficient of conservatism for native species was 4.7 and the native floristic quality index was 61; these indicate that the site is of appreciable remnant quality and that the flora has not been significantly altered by anthropogenic disturbance.

In the 1831 land survey, there were 826 witness trees in the four townships surrounding the study site. Of these 559 (68%) were oaks ("Red Oak" dominated, followed by "White Oak" followed by "Black-Jack"), 115 (14%) were pine (species not distinguished), 92 (11%) were hickory, and 60 (7%) were other species. These results indicate that the main tree species in 1831 are still among the main species today. At our study site, the proportion of each is markedly different than the general cover of this area in 1831. Chart 1 illustrates this point.

Our cruise of the overstory and midstory (≥10 cm DBH) captured ten snags and 126 live stems of eighteen different species (Table 2). The plots, as portrayed by three factor importance values and tempered by field observations, revealed an overstory dominated by *Pinus echinata*, *Quercus falcata*, *Liquidambar styraciflua*, *P. taeda*, and *Quercus alba* and a midstory dominated by *Acer floridanum* and *Ostrya virginiana*. Basal area is currently dominated in descending order by *Pinus echinata*, *P. taeda*, *Quercus falcata*, *Liquidambar styraciflua*, *Acer floridanum*, and *Q. alba*. These six comprise 21.1 m^2/ha. (73%) of the 28.9 m^2/ha. total basal area. Density tells a different story: *Acer floridanum*, *Ostrya virginiana*, *Liquidambar styraciflua*, *Quercus falcata*, *Q. alba*, *Pinus echinata*, and *Carya tomentosa* dominated; they accounted for 343 (87%) of the 393 stems/ha.. There were 31 snags/ha. (2.29 m^2/ha. basal area) in various stages of decay. The mean DBH for all species was 30.6 cm: for *Pinus* spp. 49.4 cm, for *Quercus* spp. 36.1 cm, for *Acer floridanum* 20.0 cm, and for all other species 23.7 cm. Heights for sample trees ranged from 7.6 to 38.8 m, and when plotted on a graph in ascending order the resulting line depicted a continuous vertical distribution of heights (i.e., all heights were represented, rather than being conspicuously stratified). While the range of heights is representative, we are unaware of any method to calculate a height distribution without artifacts of selection by angle gauge; the height and diameter are strongly correlated (pers. obs. JMK). The largest diameter tree in the study area, a statistical outlier, was a 107 cm *Quercus pagoda*.

Chart 2 gives the diameter distribution; it is shifting into a typical uneven-aged structure overall, but the dominant overstory species are mostly even-aged. The larger trees compare favorably in size to the large trees measured in a relatively undisturbed beech-hardwood forest in east Texas (MacRoberts & MacRoberts 1997) but are smaller than trees measured by Bragg (2004) in a pine-hardwood remnant in southern Arkansas. Nonetheless, these measures indicate that the study site is probably approaching maturity. This was confirmed by our establishment dates from 21 trees (Chart 3). The current overstory dominants are mostly 75-95 years old (recruited 1928-1948), but our limited sample suggests several pulses of recruitment occurred in the early twentieth century. The oldest pine in our sample, a statistical outlier, dated back to the 1880s; if included in our sample, the recruitment dates would span seven decades (Chart 3 illustrates this).

Regeneration plots captured 229 stems (≤1.5 cm DBH) of 22 tree species, suggesting that there are 7,633 such stems per hectare. This density is roughly 15% lower than reports from similarly composed forests in old growth and mature conditions from the region (Allen 1994; Bragg 2004; Glitzenstein et al. 1986). The composition of the regeneration is disparate to the midstory and overstory sample — only ten (33%) of the 30 species found between the two plot types was present in both. The stem counts were dominated by *Acer floridanum*, *Quercus nigra*, and *Carya cordiformis*, which accounted for 63% of the stems sampled (Table 3). Non-target plant species were listed in our notes for the regeneration plots to give a qualitative sense of the understory flora: *Callicarpa americana*, *Vitis* spp., *Carex* spp., *Scleria* sp., *Smilax* spp., *Arundinaria gigantea*, *Polystichum acrostichoide*s, *Toxicodendron radicans*, and *Vaccinium arboreum* were noted from at least a third of the plots.

Table 4 gives the soil data. Fairly high levels of calcium exist in the mid to lower parts of the slope where erosion probably exposed a deeper layer. This appears to affect the flora, lending calciphiles such as *Solidago auriculata*. The site is loosely divisible into a lower and upper slope community, perhaps on account of this feature. There is also a noticeable layer of impervious clay in some areas, as well as a number of iron-stone boulders which jut 20-80 cm out of the ravines and trails.

DISCUSSION

During this study we were interested in locating "northern" and "vernal" species of the type that Kral (1966) described. While he was looking at a slightly different plant community than we were (hardwood dominated deep ravines and narrow alluvial plains as opposed to slopes) we did locate a few of the species he mentioned, notably *Botrychium virginianum*, *Lindera benzoin*, *Packera obovata*, *Phlox divaricata*, *Podophyllum peltatum*, *Polygonatum biflorum*, and *Viola pubescens*. While we did not specifically survey for fungi, interesting species found included a morel (*Morchella* cf. *esculenta*), old man of the woods (*Strobilomyces sp.)*, and a cup fungus (*Urnula craterium*). Many species of songbirds were encountered and many are known to occur in the park from sight records on eBird (https://ebird.org/); Chuck-Will's-Widows (*Antrostomus carolinensis*), Eastern Whip-Poor-Wills (*Antrostomus vociferus*), Pileated Woodpeckers (*Dryocopus pileatus*), and Pine Warblers (*Setophaga pinus*) being among the more interesting. Eastern gray squirrels and white-tailed deer were common, the latter having browsed the understory and ground flora very heavily. Butterflies too were well represented (Jeff Trahan†, http://www.jtrahan.com/butterflies); rarities such as Henry's elfin (*Callophrys henrici*) and lace-winged roadside skippers (*Amblyscirtes aesculapius*) call the slopes home.

While something is known about nineteenth century trees through travelers' accounts and land surveys, virtually nothing is known about the herbaceous layer or general biota of these forests. Whether what we found in this study is typical of presettlement slope forests remains unknown as there are no early descriptions for comparison. However, since we found only ten (5.5%) exotics, of which only *Lonicera japonica* was abundant, the site can be viewed as relatively undisturbed (MacRoberts et al. 2008).

The current tree structure of the Eddie Jones Slope forest is apparently different from the "average acre" in 1831 or 1876, but our study has not sought to determine the reason for the difference. While it is clearly a pine-hardwood forest, it is not identical to descriptions by the early settlers and travelers in the UWGCP (Bragg 2008). The largest trees were much larger then, and pine was probably much less important than now. Nonetheless, the dominant pine at the site is *Pinus echinata* and probably was in 1831. Presettlement distribution and stand structure of this species in the UWGCP are still uncertain. There are suggestions that shortleaf pine may have been a dominant species on sandy ridgetops but was rarely, if ever, the only tree species present. It certainly is not today (Bragg 2004, 2008; Carr 2000; MacRoberts & MacRoberts 2009 and references).

We did not find a directly applicable association for the Eddie Jones slope community in any of the regional or national vegetation classification schemes; it seems to grade into multiple associations within these treatments. In the Louisiana framework of natural communities, it is probably best considered a Shortleaf Pine/Oak-Hickory Forest, but it shares traits with Calcareous Forests and Hardwood Slope Forests (Lester et al. 2005). The site shares the most listed indicator species with the Southern Mesophytic Forest community, but this community features many Appalachian species and is only known from the Florida parishes (those east of the Mississippi River (Lester et al. 2005). Van Kley and Turner (2009) used the National Ecological System hierarchical framework to characterize the National Forests and adjacent areas of the West Gulf Coastal Plain. Our slope forest best fits their

231Ea. 9.3.10 "White Oak-American Beech-Loblolly Pine/*Chasmanthium*, Loamy Mesic Lower Slopes land-type," even when taking into account that our site lacks *Fagus* and that *Pinus taeda* is less common than *P. echinata*. Our slope forest also has similarities to their 231 Ea. 9.1.30 and their 231 Ea.9.2.10 which are each dominated by *Pinus echinata* and *Chasmanthium* grasses but on differing soils. NatureServe (https://explorer.natureserve. org/) lists types (e.g. CES 203.476, CEGL008585, CEGL008575, CEGL007207) across the Southeast that correlate favorably on aspects of soil, topography, overstory composition, and ground flora, but none in combination match our site. Perhaps none of this apparent ambiguity is surprising considering that forested slopes are not uniform throughout and that these sites are narrowly sandwiched between uplands and moist bottomlands.

Carr (2000) studied pine-hardwood forests in Bossier Parish and found species composition and richness differed significantly between slope and ridgetop. Ridgetops had twice the richness as slopes. Slopes had a much sparser distribution of plants and had larger open areas of leaf litter. Further, the species were largely different. Carr (2000) concluded that the two should be considered different communities. Ridgetops resemble savannas (see MacRoberts & MacRoberts 2009) while slopes have a continuous canopy. Ridgetops have continuous ground cover while slopes have many openings devoid of herbaceous plants. Using Sorensen's Index of Similarity, we compared the Eddie Jones site to a pine-hardwood ridgetop in Bossier Parish (MacRoberts & MacRoberts 2009) 60 km to the northeast. The result is 26, confirming what Carr (2000) found; slope and ridge are different communities. A comparison of the site to a beech-hardwood ravine 90 km south (MacRoberts & MacRoberts 1997) gave an index of similarity of 44, indicating that they are similar but not precisely the same community.

The Eddie Jones forest differs from most others in the surrounding townships in the steepness of the slopes, which likely protected it from fire and may have predisposed it to a closed canopy structure and more mesophytic composition. That said, abundant pine regeneration was observed along the roadside adjacent the southeast boundary of our plot, along with heliophytes such as *Aristida purpurascens*, *Dichanthelium angustifolium*, *Panicum verrucosum*, *Schizachyrium scoparium*, *Bradburia pilosa*, *Boltonia diffusa*, *Croton michauxii*, *C. lindheimeri*, *Desmodium ciliare*, *Helianthus hirsutus*, *Symphyotrichum dumosum*, and *S. patens*, which are absent from our checklist of the interior slope forest.

A disparate composition of the regeneration to the midstory and overstory suggests that a forest is undergoing succession toward a more shade-tolerant composition (Bragg 2004; Glitzenstein et al. 1986). The two are fairly balanced (as measured by a two-factor importance value of relative frequency and relative density) in the Eddie Jones Slope Forest, but *Acer floridanum* was much more important in the regeneration plots (Chart 4). This balance suggests to us that the forest is at a mid-successional state of composition despite its youthful structure. In response to storm damage like that suffered in 2023, species like *Acer floridanum*, *Ulmus alata*, *Ulmus rubra*, *Celtis laevigata*, *Quercus muehlenbergii*, *Q. nigra*, *Cercis canadensis*, and *Asimina triloba* are likely to increase in importance across the site. As they near the end of their typical lifespan, *Pinus echinata* and *P. taeda* may significantly decrease in importance within the next 50-100 years, unless a stand-level disturbance (e.g., windthrow, fire, cutting) offers abundant recruitment space and loosens the grip of the shade tolerant seedlings below. The majority of the species present are well adapted to the site and will probably persist for a long time.

The presence of pine regeneration and heliophytes suggests that the upper slope might support an open, pine-dominated structure with a rich grassland ground flora if frequent fires were instituted. While we can say with confidence that the lower slope has been mesic for many decades or centuries, and while a strong pattern is also evident in the vegetation along the roadside, we cannot draw a clear border between the mesic lower slope and a theoretical, pine-studded grassland above. The Eddie Jones forest represents a case in point to the site-level nuance of a region's historical cover as defined by

GLO witness trees; open shortleaf pine/oak-hickory woodlands may have prevailed in the region, especially on moderate slopes and ridgetops, but such structure might not offer the best characterization of individual sites historically, presently, or potentially.

ACKNOWLEDGEMENTS

Larry Raymond, Former Director of Caddo Parks and Recreation, supported and reviewed this study. Christopher Reid (LSU School of Renewable Natural Resources) helpfully provided a review. Craig Rudolph (USDA Forest Service, Southern Research Station) kindly collected the core samples in 2011. We appreciate confirmation of validity for our tree analyses given by Dr. Quang Cao (LSU School of Renewable Natural Resources).

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Table 1. Species occurring in the study area. JMK= John Michael Kelley. MM = MacRoberts & MacRoberts collection. Number only refers to Ohlsson-Salmon collections. iNat# = Observation accessible online (https://www.inaturalist.org/observations/) by placing the number only at the end of the given URL. An asterisk (*) indicates a non-native.

Aspleniaceae
Asplenium platyneuron (L.) B.S.P., 278

Dryopteridaceae
Onoclea sensibilis L., 336
Polystichum acrostichoides (Michx.) Schott, 295

Ophioglossaceae
Botrychium biternatum (Savigny) Underw., 314
Botrychium virginianum (L.) Sw., 268

Polypodiaceae
Pleopeltis polypodioides (L.) E.B. Andrews & Windham, 391
**Thelypteris torresiana* (Gaud.) Alston, JMK EDJ1

Schizaeaceae
**Lygodium japonicum* (Thunb.) Sw., JMK EDJ2

Cupressaceae
Juniperus virginiana L., 329

Pinaceae
Pinus echinata Mill., 330
Pinus taeda L., iNat188370299

Araceae
Arisaema dracontium (L.) Schott, 346

Arecaceae
Sabal minor (Jacq.) Pers., 285

Cyperaceae
Carex cherokeensis Schwein., 374
Carex festucacea Schkuhr ex Willd., 373
Carex frankii Kunth, 337
Carex joorii L.H. Bailey, 377
Carex leavenworthii Dewey, 359
Carex planispicata Naczi, 378
Carex retroflexa Muhl. ex Willd., 376
Scleria oligantha Michx., MM 8949

Dioscoreaceae
Dioscorea villosa L., 392

Juncaceae
Juncus tenuis Willd., 332
Luzula echinata (Small) F.J. Herm., 341

Liliaceae
Allium canadense L., MM 8951
Polygonatum biflorum (Walter) Elliott, 358

Orchidaceae
Listera australis Lindel., 352
Tipularia discolor (Pursh) Nutt., 321

Poaceae
Agrostis perennans (Walter) Tuck, iNat188318359
Andropogon virginicus L., JMK EDJ3
Arundinaria gigantea (Walter) Muhl., 368
Chasmanthium latifolium (Michx.) Yates, 214
Chasmanthium sessiliflorum (Poir.) Yates, 265
Danthonia spicata (L.) Beauv. ex Roem. & Schult., iNat188370547
Dichanthelium boscii (Poir.) Gould & C.A. Clark, 360, MM 8943
Dichanthelium commutatum (Schult.) Gould, JMK EDJ4
Dichanthelium laxiflorum (Lam.) Gould, MM 8950
Elymus virginicus L., MM 8941
Leersia virginica Willd., JMK EDJ5
Melica mutica Walter, 345
Oplismenus hirtellus (L.) P. Beauv., 213
Panicum anceps Michx., 343

Smilacaceae
Smilax bona-nox L., 371
Smilax glauca Walt., iNat188305107
Smilax hispida Raf., JMK EDJ6
Smilax smallii Morong, 279

Aceraceae
Acer negundo L., (no specimen collected)
Acer rubrum L., 274
Acer floridanum (Chapm.) Pax, 281

Anacardiaceae
Toxicodendron radicans (L.) Kuntze, (no specimen collected)

Annonaceae
Asimina triloba (L.) Dunal, 304

Apiaceae
Chaerophyllum tainturieri Hook., MM 8944
Sanicula canadensis L., MM 8948
Sanicula odorata (Raf.) Phillippe, (no specimen collected)
Cryptotaenia canadensis (L.) DC. iNat208798761

Aquifoliaceae
Ilex decidua Walter, 322
Ilex vomitoria Aiton, 296

Araliaceae
Aralia spinosa L., 267

Aristolochiaceae
Aristolochia serpentaria L., MM 8945

Asclepiadaceae
Asclepias variegata L., 335

Asteraceae
Ambrosia artemisiifolia L., 381
Conoclinium coelestinum (L.) DC., 309
Elephantopus carolinianus Raeusch., 284
Elephantopus tomentosus L., iNat189103517
Erechtites hieracifolia (L.) Raf. ex DC., (no specimen collected)
Erigeron philadelphicus L., 385
Eupatorium capillifolium (Lam.) Small, (no specimen collected)
Eupatorium perfoliatum L., 302
Eupatorium serotinum Michx., 306
**Facelis retusa* (Lam.) Sch. Bip., 395
Gamochaeta pensylvanica (Willd.) Cabrera, 384
Helianthus strumosus L., MM 8946
Lactuca floridana (L.) Gaertn., 394
Mikania cordifolia (L.) Willd., 271, JMK 1120
Packera glabella (Poir.) C. Jeffrey, 382
Packera obovata (Muhl. ex Willd.) W.A.Weber & A.Love, 369
Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt, 323
Solidago auriculata Shuttlw. ex S.F. Blake, 272
Solidago caesia L., 311
Solidago rugosa Mill., 372
Symphyotrichum drummondii (Lindl.) G.L. Nesom, 308
Symphyotrichum lateriflorum (L.) A. & D. Love, MM 8947
Verbesina helianthoides Michx., MM 8945
Verbesina virginica L., 300

Berberidaceae
Podophyllum peltatum L., 342

Betulaceae
Carpinus caroliniana Walter, 283
Ostrya virginiana (Mill.) K. Koch, 362

Bignoniaceae
Bignonia capreolata L., 294
Campsis radicans (L.) Seem., JMK EDJ8

Boraginaceae
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Lobelia cardinalis L., 310
Lobelia puberula Michx., 313
Triodanis perfoliata (L.) Nieuwl., 383, MM 8942

Caprifoliaceae
**Lonicera japonica* Thunb., 298
Sambucus canadensis L., JMK EDJ9
Viburnum dentatum L., MM 8948
Viburnum rufidulum Raf., 228

Caryophyllaceae
Cerastium glomeratum Thuill. (no specimen collected)
**Stellaria media* (L.) Vill., 372

Clusiaceae
Hypericum hypericoides (L.) Crantz, MM 8940
Hypericum apocynifolium Small, JMK EDJ10

Cornaceae
Cornus florida L., 273

Cucurbitaceae
Melothria pendula L., JMK EDJ11

Elaeagnaceae
**Elaeagnus pungens* Thunb., iNat

Ericaceae
Vaccinium arboreum Marsh., 365
Vaccinium stamineum L., iNat208380382

Euphorbiaceae
Acalypha gracilens A. Gray, 312
Euphorbia corollata L., 379

Fabaceae
Cercis canadensis L., 297
Clitoria mariana L., 288
Desmodium glabellum Michx., iNat188317194
Desmodium nudiflorum (L.) DC., 201, 289
Gleditsia triacanthos L., iNat188666879
Lathyrus venosus Muhl. ex Willd. (no specimen collected)
Vicia minutiflora F.G. Deitrich (no specimen collected)

Fagaceae
Quercus alba L., 286
Quercus falcata Michx., 318, 366
Quercus michauxii Nutt., 270
Quercus muhlenbergii Engelm., 316
Quercus nigra L. (no specimen collected)
Quercus shumardii Buckley, 317
Quercus stellata Wangenh., 320
Quercus velutina Lam., iNat188318560

Grossulariaceae
Ribes curvatum Small, 266

Hamamelidaceae
Liquidambar styraciflua L., 276

Hippocastanaceae
Aesculus pavia L., 351

Juglandaceae
Carya cordiformis (Wangenh.) K. Koch, 315
Carya texana Buckl., iNat189816656
Carya alba (L.) Nutt. ex Elliott, iNat188318436
Juglans nigra L., 319

Lamiaceae
Salvia lyrata L., 347

Lauraceae
Lindera benzoin L., JMK EDJ22
Sassafras albidum (Nutt.) Nees, 367

Meliaceae
**Melia azedarach* L., 275

Molluginaceae
**Mollugo verticillata* L., JMK EDJ14

Moraceae
Morus rubra L., 387

Nyssaceae
Nyssa sylvatica Marsh., 282

Oleaceae
Forestiera ligustrina (Michx.) Poir., JMK EDJ15
Fraxinus americana L., MM 8947
**Ligustrum sinense* Lour., 303

Oxalidaceae
Oxalis dillenii Jacq., 361

Passifloraceae
Passiflora incarnata L., JMK EDJ16
Passiflora lutea L., 328

Phrymaceae
Phryma leptostachya L., 215

Phytolaccaceae
Phytolacca americana L., JMK EDJ17

Polemoniaceae
Phlox divaricata L., 352
Phlox pilosa L. (no specimen collected)

Polygonaceae
Polygonum virginianum L., JMK EDJ18

Ranunculaceae
Ranunculus abortivus L. iNat202281597
Ranunculus recurvatus Poir., iNat 208384310

Rhamnaceae
Berchemia scandens (Hill) K. Koch, 277

Rosaceae
Agrimonia rostellata Wallr., 291
Crataegus berberifolia Torr. & Gray, iNat188898282
Crataegus marshallii Eggl., 334
Crataegus spathulata Michx., 333
Geum canadense Jacq., 235
Prunus mexicana S.Watson, (no specimen collected)
Prunus serotina Ehrh., 280
Rubus trivialis Michx., 390

Rubiaceae
Galium aparine L., MM 8950
Galium pilosum Aiton, MM 8941

Rutaceae
Zanthoxylum clava-herculis L., iNat189103237

Sapotaceae
Sideroxylon lanuginosum Michx., 301

Scrophulariaceae
Mimulus alatus Aiton, 287

Solanaceae
Physalis pubescens L., 393
Solanum carolinense L., iNat188336728
Solanum ptycanthum Dunal, JMK EDJ20

Tiliaceae
Tilia americana L., 363

Ulmaceae
Celtis laevigata Willd., 364
Ulmus alata Michx., JMK EDJ21
Ulmus rubra Muhl., 290

Urticaceae
Boehmeria cylindrica (L.) Sw., 307
Urtica chamaeodryoides Pursh (no specimen collected)

Valerianaceae
Valerianella radiata (L.) Dufr., 375

Verbenaceae
Callicarpa americana L., 293

Violaceae
Viola palmata L., 348, iNat202281480
Viola pubescens Aiton, 380
Viola missouriensis Greene, iNat202281420.

Vitaceae
Parthenocissus quinquefolia (L.) Planch., 388
Vitis aestivalis Michx., 331
Vitis rotundifolia Michx., 269

Table 2. Midstory and overstory (≥10 cm DBH) metrics.

Species	Density/ha.	Relative Density	Relative Freq.	Relative BA	IV
Acer floridanum	87.6	22.3	11.76	9.52	**44**
Pinus echinata	23.03	5.86	13.23	17.46	**37**
Quercus falcata	44.3	11.28	10.29	13.49	**35**
Liquidambar styraciflua	48.8	12.42	7.35	10.31	**30**
Ostrya virginiana	68	17.31	7.35	3.17	**28**
Pinus taeda	23.8	6.06	7.35	13.49	**27**
Quercus alba	28.7	7.3	7.35	8.73	**23**
Fraxinus americana	7.1	1.8	7.35	3.96	**13**
Quercus stellata	11	2.8	2.94	4.76	**11**
Carya alba	19.6	4.99	2.94	1.58	**10**
Quercus nigra	6.5	1.65	4.41	3.17	**9**
Ulmus alata	4.8	1.22	4.41	1.58	**7**
Quercus shumardii	2.2	0.56	2.94	2.38	**6**
Tilia americana	7.7	1.96	2.94	1.58	**6**
Juglans nigra	1.8	0.45	2.94	1.58	**5**
Quercus velutina	4.6	1.17	1.47	1.58	**4**
Ulmus rubra	2.7	0.68	1.47	0.79	**3**
Quercus michauxii	0.5	0.12	1.47	0.79	**2**

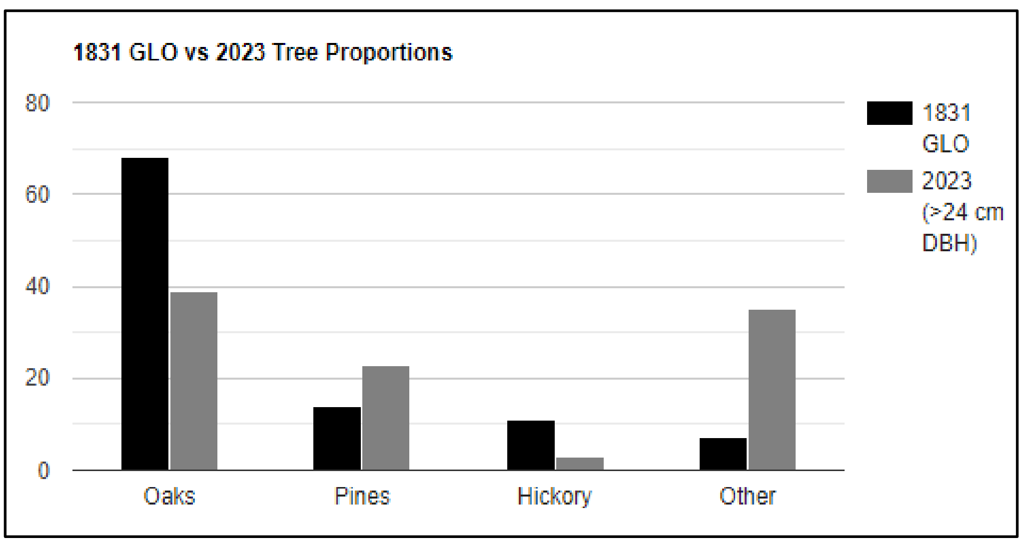

Chart 1. Proportion by stem density of tree categories in the 1831 GLO survey witness trees and 2023 cruise (>25 cm).

Table 3. Regeneration (≤1.5 cm DBH) metrics.

Species	Relative density	Relative frequency	IV
Acer floridanum	40.17	13.43	**53.6**
Quercus nigra	13.97	11.94	**25.9**
Carya cordiformis	9.17	13.43	**22.6**
Quercus falcata	6.11	5.97	**12**
Asimina triloba	7.42	4.47	**11.9**
Ulmus rubra	4.36	7.46	**11.8**
Quercus alba	3.93	5.97	**9.9**
Celtis laevigata	3.49	4.47	**7.9**
Prunus serotina	1.31	4.47	**5.7**
Fraxinus americana	0.87	4.47	**5.3**
Acer negundo	1.74	2.98	**4.7**
Sassafras albidum	1.31	2.98	**4.2**
Morus rubra	0.87	2.98	**3.8**
Ulmus alata	0.87	2.98	**3.8**
Cercis canadensis	0.87	1.49	**2.3**
Aesculus pavia	0.87	1.49	**2.3**
Quercus velutina	0.43	1.49	**1.9**
Carya texana	0.43	1.49	**1.9**
Sideroxylon lanuginosum	0.43	1.49	**1.9**
Q. muehlenbergii	0.43	1.49	**1.9**
Quercus shumardii	0.43	1.49	**1.9**
Ostrya virginiana	0.43	1.49	**1.9**

Table 4. Soil sample results: numeric results other than pH are in ppm.

	pH	Ca	Cu	Mn	P	K	Na	S	Zn	Texture
Upper Slope	5	660	0.48	355	2.5	76	15	11	9	fine sandy loam
Middle Slope	6	1845	0.68	556	23.1	209	18	14	4	fine sandy loam
Lower Slope	6.4	2301	1.22	547	8.3	173	16	9	4	fine sandy loam

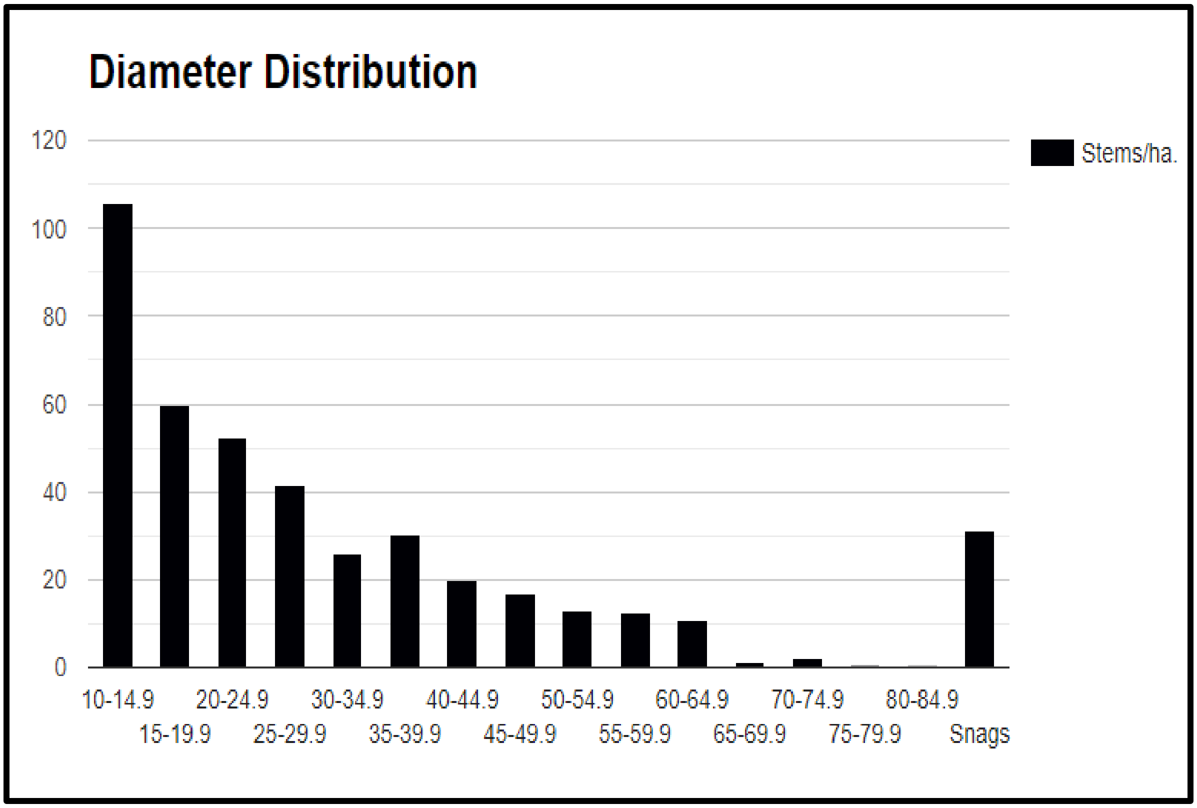

Chart 2. Diameter distribution for live stems of all species (≥10 cm DBH) and snags (≥10 cm DBH and ≥2 m tall).

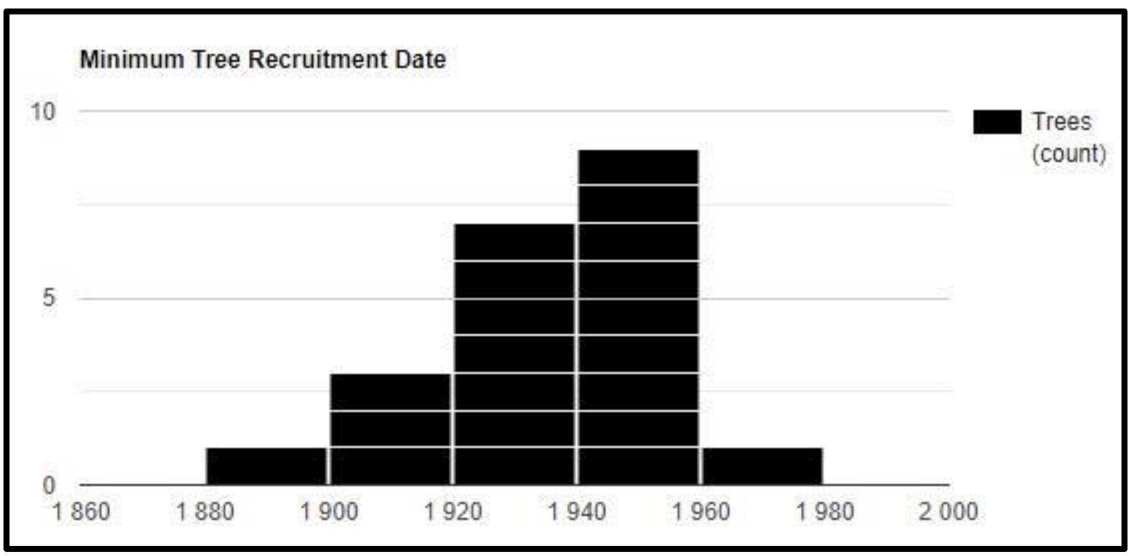

Chart 3. Establishment date distribution for 21 cut and cored trees.

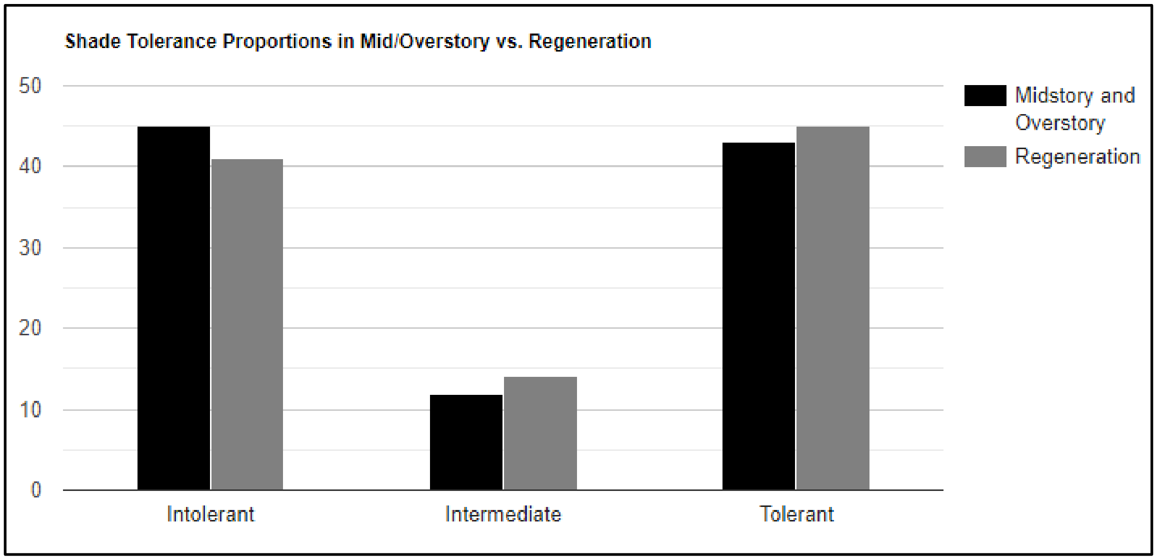

Chart 4. Proportion of shade tolerance classes in the midstory and overstory stratum versus the regeneration. Values are two-factor importance values (relative density plus relative frequency).

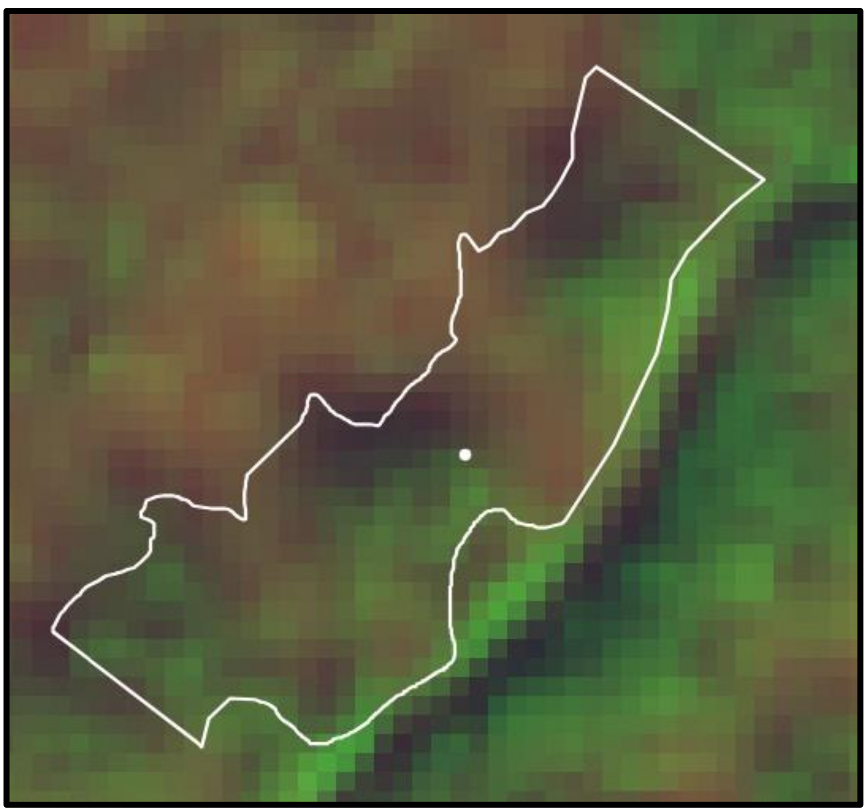

Figure 2. Leaf off aerial showing pines on the ridges and hardwoods along the lower slopes and steep drainages.

Figure 3. Forest physiognomy.