An analysis of successional status of three forest communities in North Carolina

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Abstract

Vegetation analyses of the woody plants in three different forest communities across North Carolina (Raven Rock State Park, Julian Price Memorial Park, and Weymouth Woods-Sandhills Nature Preserve) revealed varying degrees of forest succession around the state. Eight to ten plots were utilized in each community to sample the canopy, subcanopy, transgressive, and seedling strata. The data collected were used to produce importance values for the species in the forests. The strata within each forest were compared with a community similarity test to aid in determining the levels of succession. The study showed that all three communities are somewhat mature hardwood forests, with dominant species still shifting.

Introduction

There is little virgin forest left in North Carolina; forests have been cut, grazed, and cleared for agriculture. In spite of this, new forests are growing to replace the old ones on a large scale. At sixty percent, North Carolina has the tenth highest percentage of forest cover in the United States (The Federal Reserve Bank of Minneapolis, 2002). In other words, the forests of North Carolina form a great patchwork of young, old, and intermediate ages. These successional differences add more variability to a state which naturally has a wide range of plant life, from the mountains to the coastal plain. Possessing knowledge of what changes are occurring in this array of forest types is useful when deciding what management methods to employ for future preservation.

This study analyzed the successional status of three unique forests by determining the importance of various species within each system and tracing the relationships between strata. For example, consider a forest which has a canopy stratum dominated by hardwood trees and a subcanopy stratum comprised of several species of understory trees. The transgressive and seedling strata contain young members of the dominant species in the upper strata, and replace the older members when they die. By studying the relationships among the species, it can be seen that this example forest is a mature hardwood forest. The

aim of this study was to produce similar conclusions about each of the three forests sampled.

Material and Methods

The study was conducted in three locations in North Carolina: Raven Rock State Park in Harnett County, Weymouth Woods-Sandhills Nature Preserve in Moore County, and Julian Price Memorial Park in Watauga County. The Julian Price and Weymouth Woods data were collected by the Summer Ventures at UNC-Charlotte Field Biology and Ecology classes of 2003 and 2009, respectively, and the Raven Rock data were collected by the class of 2010. Eight to ten square quadrats were established in each forest community. The center points were randomly set by tossing a weighted ball into the vegetation. From each point, a 100 m^2 quadrat was measured and marked with flags. A 25 m^2 plot and a 1 m^2 plot were marked within the 100 m^2 quadrat.

The woody plants in each quadrat were identified (scientific names in Tables 1-3 were found in Wernert, 2007) and measured for dbh (diameter at breast height). The measurements were taken with a DBH tape that gives a diameter measurement based upon the circumference of the tree. Trees with a diameter of 10 cm or more were classified as part of the canopy stratum and those with a diameter of 2.5 to 10 cm were classified as part of the subcanopy stratum. A tree taller than the knee with a diameter of less than 2.5 cm was classified as a transgressive, and any tree species shorter than the knee was classified as a seedling.

Data were collected for canopy trees in the 100 m^2 quadrat, for the subcanopy and transgressive strata in the 25 m^2 quadrat, and for seedlings in the 1 m^2 quadrat (see Fig. 1). Diameters were recorded for canopy and subcanopy plants only. Count data were collected for transgressives and seedlings. If a plant was located on the boundary of a quadrat, but most of it was inside, it was counted and recorded; if a plant was on a boundary but was mostly outside, it was disregarded.

After the data were collected in the field, the density, frequency, and basal area were calculated for each species, whenever possible. The relative values were then calculated for each of the three attributes. For

canopy and subcanopy plants, the relative density, frequency, and basal area were added to create an importance value (IV=300). For transgressives and seedlings, the relative density and frequency were added (IV=200). The data for Weymouth Woods lacked dbh values for subcanopy plants; therefore, the importance values for the subcanopy stratum in Weymouth Woods are also based solely on relative density and frequency (IV=200).

To further understand the successional status of each forest, community similarity tests were utilized to compare different strata. The canopy was compared to the subcanopy and the transgressive stratum was compared to the seedling stratum.

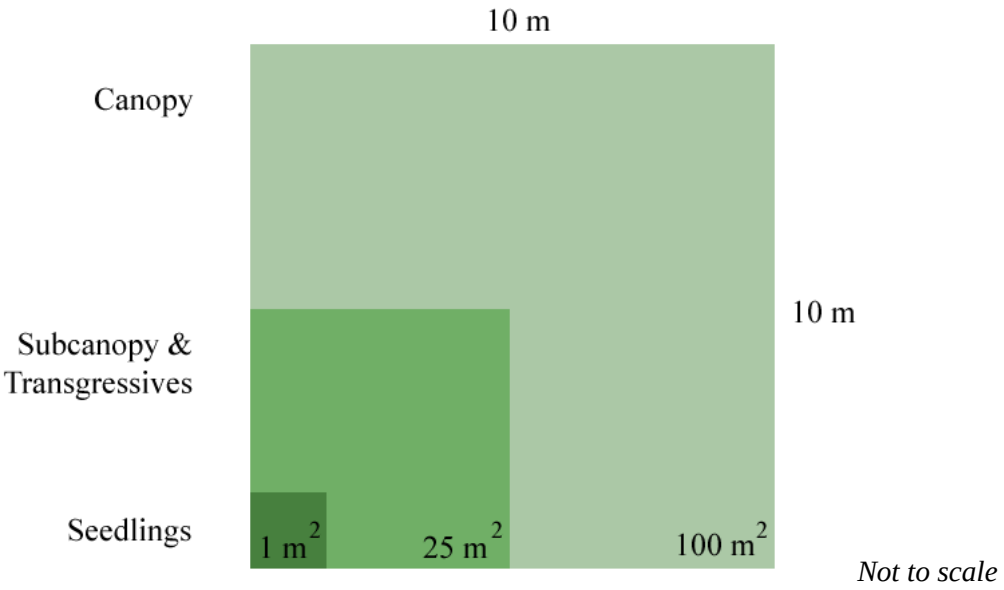

Figure 1. Quadrat layout.

Results

The importance value data for the species in each forest are separated by strata and are listed in Tables 1-3. The larger a species' IV, the more important its role was in the stratum. The results of the community similarity tests between strata are listed in Table 4, in terms of the Bray-Curtis index.

Table 1. Raven Rock State Park, 2010.

Species	Canopy IV=300	Subcanopy IV=300	Transgressive IV=200	Seedling IV=200
Red Maple - *Acer rubrum*	28	58	13	22
Mockernut Hickory - *Carya tomentosa*	14	---	---	---
Flowering Dogwood - *Cornus florida*	6	33	17	---
American Beech - *Fagus grandifolia*	17	24	---	12
American Holly - *Ilex opaca*	7	---	---	13
Sweetgum - *Liquidambar styraciflua*	53	15	---	7
Black Tupelo - *Nyssa sylvatica*	---	42	---	---
Sourwood - *Oxydendrum arboreum*	38	101	20	---
Shortleaf Pine - *Pinus echinata*	37	---	14	8
Loblolly Pine - *Pinus taeda*	---	14	88	---
Black Cherry - *Prunus serotina*	---	---	---	8
White Oak - *Quercus alba*	19	---	---	61
Scarlet Oak - *Quercus coccinea*	11	---	---	18
Blackjack Oak - *Quercus marilandica*	---	14	---	---
Chestnut Oak - *Quercus prinus*	48	---	23	21
Black Oak - *Quercus velutina*	22	---	25	30

Table 2. Julian Price Memorial Park, 2003.

Species	Canopy IV=300	Subcanopy IV=300	Transgressive IV=200	Seedling IV=200
Red Maple - *Acer rubrum*	11	39	51	100
Striped Maple - *Acer pensylvanicum*	7	31	29	---
Downy Serviceberry - *Amelanchier arborea*	---	---	11	30
American Chestnut - *Castanea dentata*	---	24	7	---
American Beech - *Fagus grandifolia*	---	---	11	---
Witch-hazel - *Hamamelis virginiana*	---	136	19	---
Mountain Holly - *Ilex montana*	---	70	10	---
Tulip Poplar - *Liriodendron tulipifera*	42	---	---	---
Cucumber Magnolia - *Magnolia acuminata*	11	---	3	---
Fraser Magnolia - *Magnolia fraseri*	51	---	---	---
Black Tupelo - *Nyssa sylvatica*	7	---	---	---
Sourwood - *Oxydendrum arboreum*	7	---	---	---
Wild Black Cherry - *Prunus serotina*	---	---	4	---
Chestnut Oak - *Quercus prinus*	86	---	19	---
Northern Red Oak - *Quercus rubra*	79	---	34	70

Table 3. Weymouth Woods-Sandhills Nature Preserve, 2009.

Species	Canopy IV=300	Subcanopy IV=200	Transgressive IV=200	Seedling IV=200
Mockernut Hickory - *Carya tomentosa*	6	23	44	---
Flowering Dogwood - *Cornus florida*	19	35	12	---
Common Persimmon - *Diospyros virginiana*	14	26	19	---
American Holly - *Ilex opaca*	---	36	20	---
Sweetgum - *Liquidambar styraciflua*	10	9	---	---
Black Tupelo - *Nyssa sylvatica*	5	31	13	---
Sourwood - *Oxydendrum arboreum*	58	18	10	---
Longleaf Pine - *Pinus palustris*	25	---	---	---
Loblolly Pine - *Pinus taeda*	31	13	10	---
White Oak - *Quercus alba*	7	---	18	---
Scarlet Oak - *Quercus coccinea*	---	---	4	---
Southern Red Oak - *Quercus falcata*	7	---	---	---
Blackjack Oak - *Quercus marilandica*	17	9	5	---
Northern Red Oak - *Quercus rubra*	8	---	---	---
Post Oak - *Quercus stellata*	26	---	---	---
Black Oak - *Quercus velutina*	67	---	24	---
Sweetleaf - *Symplocos tinctoria*	---	---	20	---

Table 4. Strata Similarity, expressed in terms of the Bray-Curtis index.

Location	Canopy vs. Subcanopy	Transgressive vs. Seedling
Raven Rock	0.346	0
Julian Price	0.335	0.482
Weymouth Woods	0.385*	0

*The subcanopy data from Weymouth Woods lacked dbh values; the figure here is based upon relative density instead of importance value.

Discussion

The canopy in the forest sampled at Raven Rock State Park was dominated jointly by sweetgum, chestnut oak, sourwood, and shortleaf pine. However, sourwood in the subcanopy holds a more important position, with an IV of 101 (see Table 1). This, along with the fact that the canopy and subcanopy have a similarity

value of only 0.346 (Table 4), suggests that the canopy is changing and sourwood will hold a more prominent role in the future. Loblolly pine was the most prevalent species in the transgressive stratum (IV of 88), but it will eventually no longer be tolerant of the shade of the hardwoods and will decline. The white oak, with an IV of 61 in the seedling stratum, can be expected to progress through the strata and become a more important species in the higher strata.

At Julian Price Park, chestnut oak and Northern red oak held the most important positions in the canopy stratum. Fraser magnolia and tulip poplar were also important, albeit to a lesser degree. The subcanopy, however, was constituted largely of witch-hazel, and only four other species were observed in the stratum. As a shrubby plant, it will continue to dominate the subcanopy and will most likely not become a canopy tree. In the transgressive and seedling strata, red maple had a significant presence, suggesting that it will become a more important species in the higher strata of the forest. Northern red oak, one of the principal species in the canopy, also had a strong presence in both the transgressive and seedling strata, indicating that young Northern red oaks may be growing to replace the older trees in the canopy. In spite of this, the 0.335 similarity value between the canopy and subcanopy and the 0.482 similarity between the transgressive and seedling strata (see Table 4) suggest that the forest is still undergoing succession, species are still shifting, and it has not yet reached full maturity.

The area studied in Weymouth Woods had a forest canopy comprised primarily of black oak and sourwood. Species with high importance values but less prevalence than black oak and sourwood were post oak and two pine species, loblolly pine and longleaf pine. These pine tree species are more representative of the vegetation of the Weymouth Woods area, but the lack of prescribed fire in the general vicinity of the bog near the study site has allowed a second-growth hardwood forest to occur. The pine species in the canopy will probably decline but persist as incidentals. The subcanopy stratum seemed to be shared among several species, including American holly, flowering dogwood, common persimmon, and mockernut hickory. The similarity value between the canopy and subcanopy, at 0.385, supports the notion that succession is still occurring at a fairly high level. Based upon the IV values in Table 3,

mockernut hickory will assume a more important role as the transgressives progress to the higher strata, as will white oak, to a lesser degree; sourwood, however, will begin to decline and lose its place of prominence. No seedling data were collected in Weymouth Woods; it is possible that the data do not sufficiently represent the seedling stratum and the sample size should have been larger.

Conclusion

The vegetative richness of North Carolina is evident in any region of the state, and each forest has its own unique story to tell. Each of the three forests analyzed in this study are undergoing continual change, and this study revealed some of the information about the transformations taking place. The shift of dominance among plant species in a forest is a key issue in learning to preserve and manage our natural resources. While this study did reveal some important clues, a more complete study with more quadrats in each area would be beneficial.

Literature Cited

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Data Referenced

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