COMMUNITY COMPOSITION IN CANOPY GAPS AS INFLUENCED BY PRESENCE OR ABSENCE OF RHODODENDRON MAXIMUM

Christopher T. Rivers, David H. Van Lear, Barton D. Clinton, and Thomas A. Waldrop

Abstract-The process of gap formation and recolonization plays an important role in the structure and composition in southern Appalachian forests. The understory composition existing before a disturbance will shape successional patterns of the future stand. Rhododendron maximum is native to the southern Appalachians and exists as a major understory component in cove forests. Its frequency of occurrence has been increasing over the past century due to the demise of the American Chestnut, heavy logging at the turn of the century, and suppression of fire. Increasing densities of R. maximum reduced species richness and coverage in the regeneration layer and reduced recruitment into understory and strata. Woody and herbaceous species regenerated poorly, if at all, under R. maximum's dense canopy. Only shade-tolerant woody species like Tsuga canadensis, and Acer rubrum regenerate in R. maximum thickets, and their densities are markedly decreased.

INTRODUCTION

In the southern Appalachians forest canopy disturbance occurs frequently (Runkle 1982). Magnitude of disturbance varies greatly from hurricanes removing complete stands to a single limb dying. Removal of part of the canopy layer creates a void in the integrity of the canopy, which Barden (1989) defines as a canopy gap. The process of canopy gap formation and recolonization plays a substantial role in determining structure and composition of southern Appalachian forests. Understory composition existing before the disturbance will shape successional patterns of the future stand (Clebsch and Busing 1989).

R. maximum is native to the southern Appalachians (Bowers 1960) and exists as a major understory component. Its frequency of occurrence has been increasing over the past century due to changes in natural and anthropogenic disturbance factors (McGinty 1972; Phillips and Murdy 1985). Its increase in abundance and range is reducing species richness and altering patterns of succession (Baker and Van Lear In Press).

Effects of various sized forest gaps on understory vegetation have been studied extensively (Runkle 1982, Canham 1989, Clebsch and Busing 1989, Poulson and others 1989, Phillips and Shure 1990, Runkle and others 1992). However, little is known regarding the effects of R. maximum on gap succession in the southern Appalachians (Hedman and Van Lear 1994).

The most comprehensive and detailed investigations of R. maximum have occurred at the Coweeta Hydrologic Laboratory near Franklin North Carolina (McGinty 1972; Monk and others 1985; Phillips and Murdy 1985). McGinty (1972) suggests R. maximum did not occur as frequently in the early 1900's as it does now. Native Americans initially used fire as a management tool (Cronon 1983), which may have controlled the occurrence of R. maximum. European settlers continued this practice for clearing land and driving game. Exclusion of fire in this century is considered a disturbance and a change in historical management, since fire was historically present throughout the landscape (Monk and others 1985, Phillips and Murdy 1985, MacCleery 1992, Baker and Van Lear In Press) and may have contributed to the up slope migration of R. maximum.

Historically, R. maximum occurred primarily in riparian zones out of competitive necessity, but fire suppression and other factors allowed it to spread up slope, often to ridge tops. Fire probably top killed R. maximum and allowed other species a chance to grow ahead of its resprouting. Frequent fire, especially in the growing season, could have completely killed individual stems (Baker and Van Lear 1998).

As a result of the increasing abundance of R. maximum, southern Appalachian cove forests will probably experience a significant structural and compositional change over the next century (Hedman and Van Lear 1994, Clinton 1995, Baker and Van Lear In Press). R. maximum often has by far the highest importance value of all understory species in the southern Appalachians (Hedman and Van Lear 1994, Baker and Van Lear In Press). Although scattered overstory and midstory trees are found in the regeneration layer under R. maximum canopies. Vigorous thickets of R. maximum are capable of suppressing this regeneration. However, Acer rubrum and Tsuga canadensis are sometimes capable of establishing and competing under a R. maximum canopy (Clinton and others 1994).

The objective of this study was to determine effects of R. maximum on community composition and species richness in various-sized canopy gaps in cove forests of the southern Appalachians.

METHODS

Study Site Locations

This study was conducted in the Blue Ridge Mountain Physiographic province of the southern Appalachian Mountains. Sites were located in Andrew Pickens Ranger District of Sumter National Forest in Oconee County, South Carolina along Slatten Branch in the Ellicott Rock Wilderness Area: Tallulah Ranger District of the

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2 Graduate Student and Professor, Clemson University, Department of Forest Resources, Clemson, SC 29634-1003; Research Ecologist, USDA Forest Service Southern Research Station, Coweeta Hydrologic Lab. 3160 Coweeta Lab Road, Otto, NC 28763; and Research Forester, USDA Forest Service: Southern Research Station: Clemson, SC 29634, respectively.
In this study no gaps were sampled with a "High" importance value. In gaps containing a midstory dominated by *R. maximum*, species richness averaged 16.7 species in gaps with *R. maximum* present and 7.9 species without (fig. 1). White ash averaged 9.1 individuals/m² (fig. 1), while maple averaged 9.0 individuals/m² (fig. 1). Individuals of *R. maximum* were significantly lower than 50.9 individuals/m² in gaps without (fig. 2). Average midstory density was significantly lower than 1.0 and 0.1 for gaps without and with *R. maximum* respectively (fig. 2). Shade-intolerant midstory species were almost completely eliminated and shade-tolerant species increased at levels where light to recruitment into the overstory could occur. Total tree regeneration was higher in gaps containing little to no *R. maximum* than in gaps containing *R. maximum*. This agrees with the findings of Phillips and Murdy (1985) and Clinton and others (1994).

**RESULTS AND DISCUSSION**

**Gap Vegetation**

In the Southern Appalachian Mountains, *R. maximum* is the dominant subcanopy species, occupying approximately 30 million ha with densities of 32,000 individuals/ha. Expansion of this species is a concern for ecologist and hardwood forest managers because recruitment of canopy tree seedlings is inhibited under heavy overstory density. Potential causes include reduced seed rain by *R. maximum* foliage. Nilsen and others (1996) found that species presence and fitness were affected by low light, indirect effects of inhibited

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**Table 1** Density and basal area of *R. maximum* by thicket density category (Baker and Van Lear in press)

<table>
<thead>
<tr>
<th>Thicket Density</th>
<th>Basal Area (m²)</th>
<th>Number of Stems/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>11-22</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>5-11</td>
<td>17</td>
</tr>
<tr>
<td>Low</td>
<td>2-5</td>
<td>36</td>
</tr>
<tr>
<td>Scarse</td>
<td>0-2</td>
<td>13</td>
</tr>
</tbody>
</table>

In this study no gaps were sampled with a "High" density rating. Gaps met the following criteria: 1) gap-making tree(s) must have been upper canopy trees at the time of gap formation, 2) gaps must be naturally occurring, 3) gaps must be less than 5 years old, and 4) gaps must occur on only one site type, i.e., mesic. In some gaps was restricted to a linear zone narrower than 35 m from a stream. Gap age was estimated by examining the immodal growth of previously suppressed growth-determinant individuals within the gap.

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**Figure 1** Relation between species richness and vegetation stratum with *R. maximum* present and absent in southern Appalachian cove forest gaps. Each stem with the same letter and subclass were not significantly different at 0.05 level.

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**Figure 2** Relation between species density and vegetation stratum with *R. maximum* present and absent in southern Appalachian cove forest gaps. (Means with the same letter and subclass were not significantly different at 0.05 level.)

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**Understory Vegetation**

Woody species—*Acer rubrum, Lindendoron tulipifera, Betula lenta, and Tsuga canadensis were the most important woody species in gap containing *R. maximum*. *Acer rubrum*, *Betula lenta, Lindendoron tulipifera, and Quercus rubra in gaps without *R. maximum* were the most important. Brooks (1985) found that shade tolerant species were dense in all gap sizes, which agrees with our findings.

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**Herbaceous Species**—Most important herbaceous species in gaps containing *R. maximum* were *Tiarada cordifolia, Smilax rotundifolia, Polystachyum acracrodites, Michelia peregrina, and Viola lutea. Gap size was positively correlated with *Tiarada cordifolia, Thelepyrs novaeboracensis, Polystachyum acracrodites, Thallicum clyudum, and Solidago curta*, increasing order of importance. All these species are typical mesic constituents. and are moderately shade tolerant. *Heracleum species* were most adversely affected by increases in *R. maximum* density, with average richness decreasing significantly from 36.5 to 11.5 species as *R. maximum*.
maximum density increased (fig. 1). Average species density decreased from 47.0 to 6.7 individuals/m² (fig. 2).

Vegetational Relationships
As *R. maximum* density increased the number of potential overstory species decreased. Similarly, richness and density of potential midstory and understory species decreased. Herbaceous species experienced the most dramatic decrease (fig. 1 and 2). These findings indicate that future diversity of Appalachian cove forests will be reduced as *R. maximum* coverage increases. The high density of herbaceous species in the lower density thickets diminishes the relative importance of midstory and overstory species. Herbaceous vegetation may also be a detriment to regenerating overstory species.

CONCLUSIONS
In gaps where *R. maximum* dominated the shrub layer, mid/understory development and diversity were restricted. Species richness and density were significantly lower in gaps containing *R. maximum* and richness and density of the herbaceous layer was also dramatically reduced. *Tsuga canadensis* and *Acer rubrum* were the most dominant species inventoried in gaps with *R. maximum*.

Species of varying degrees of tolerance to understory conditions are capable of establishment in small to medium size canopy openings in the absence of an evergreen understory. Continued and increasing presence of *R. maximum* in the mid-story will eventually contribute to the decrease of species richness in the overstory and alter forest structure and composition.

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REFERENCES

Baker, T.T.; Van Lear, D.H. [In press]. Relations between density of rhododendron thickets and diversity of riparian forests.


