Lessons Learned in 84-Year-Old Plots at Looking-Glass Rock, North Carolina

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Abstract— *Looking Glass Rock is a large, exposed granite pluton that is a special place for recreation and wildlife in the Pisgah National Forest. Even-aged timber stands surrounding the base of the rock originated in 1916 from clearcutting of the original mixed-species virgin stands. Two species now account for 86 percent of the 211 ft^2 of stand basal area per acre: overstory yellow-poplar (81 percent) and mid-story silverbell (5 percent). Timber management is not a current option in this area. If options change, however, research results suggest several techniques for managing and regenerating this and other stands on productive sites.*

Introduction

Looking Glass Rock (LGR) is a large, exposed granitic pluton that is widely recognized as a special place in the Pisgah National Forest of western North Carolina (figure 1). Rising nearly 1000 feet above the surrounding landscape, LGR is readily visible from many locations, particularly the nearby Blue Ridge Parkway, and is proposed for the National Registry of Natural Landmarks. LGR is managed as a special interest area by the Pisgah District to provide nesting and foraging habitat for the threatened peregrine falcon, to preserve the unique botanical features characteristic of the xeric habitats associated with thin soils on the top of the pluton, and to maintain the scenic attributes desirable for recreational uses, such as hiking and rock climbing. The 1600-acre LGR area also is exceptional because it contains the oldest hardwood silvicultural research plots in the southern Appalachians.

Figure 1—The Looking-Glass Rock special interest area in the Pisgah National Forest, as viewed from the Blue Ridge Parkway. Photo by Bill Lea, www.billlea.com.

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The plots were installed in the fall of 1923 to evaluate growth and mortality of natural regeneration after clearcutting.

The typical recreation user probably does not know that timber stands surrounding LGR are relatively young and largely even-aged. The stands originated after a wildfire in logging debris from cutting in 1913 of the last virgin stand on George Vanderbilt's Pisgah Forest, which later became the nucleus of the Pisgah National Forest. Of particular interest to silviculturists, however, is the mesophytic stand that developed naturally on the east-facing, high-quality site at the base of LGR. Development of this stand has been reported at ages 18 years (Abell 1935), 42 years (Wahlenberg 1950), 51 years (Della-Bianca 1971), and 60 years Della-Bianca (1983). In the 1983 report, Della-Bianca suggested that one of the pioneer species, yellow-poplar (*Liriodendron tulipifera*), would not relinquish domination of the stand in the near future. Few examples are available of long-term changes in species composition after clearcutting of stands on high-quality sites in the southern Appalachians. One purpose of our paper is to update stand development at LGR, which was last reported 20 years ago. Another purpose is to explore management options that could be applied to similar stands. Although this and other stands around LGR will not be managed for timber production, research findings from nearby Bent Creek Experimental Forest provide methods that can be used to manage stands on similar sites.

Methods

Study Area

LGR is about 30 miles south of Asheville, NC, and 5 miles northwest of Brevard. Elevation is about 3100 feet at the base of the rock and 4000 feet at the top. Climate in this area is temperate, with short, cool winters and long, warm summers. Precipitation is plentiful and evenly distributed, with over 65 inches annually. Bedrock geology is mainly gneisses and schists. The intrusive LGR pluton, however, consists of resistant Whiteside granite, which has been exposed through weathering and erosion of the softer surrounding rocks. Canopy vegetation at this intermediate elevation consists of several species of oaks (*Quercus* spp.) and pines (*Pinus* spp.) on the xeric to subxeric ridges and slopes, and yellow-poplar, sweet birch (*Betula lenta*), northern red oak (*Q. rubra*), and a number of other species on submesic and mesic lower slopes and coves. Midstory vegetation consists of sourwood (*Oxydendrun arboretum*), dogwood (*Cornus florida*), red maple (*Acer rubrum*), and silverbell (*Halesia carolina*). An evergreen shrub layer of mountain laurel (*Kalmia latifolia*) may be present on xeric and subxeric sites, and rhododendron (*Rhododendron maximum*) is common on some mesic to subhydric sites. Common forms of natural disturbance include crown and stem breakage and uprooting from extensive ice storms and small patches of windthrow from localized, intensive microbursts associated with thunderstorms.

Timber Stand Studied

The original LGR stand consisted of mixed species, mainly American chestnut (*Castanea dentata*), yellow-poplar, and some cucumbertree (*Magnolia acuminata*). Volumes averaged about 40 thousand board-feet per acre. The stand of about 120 trees per acre was cut in 1913 using a diameter limit of 14 inches DBH for chestnut and chestnut oak (*Q. prinus*), and 16 inches for yellow-poplar and other species. Surveying the stand after logging and seeing only snags and culls, Frothingham[3] said, "Lumbermen would call the area clear cut." Wildfire burned through the logging slash on May 11, 1916. By 1919, abundant seedlings of yellow-poplar had become established, as often occurred following severe fires on moist sites in the Southern Appalachians (Frothingham 1931, p. 41). However, the yellow-poplar seedlings and sprouts of other desirable species were mostly shaded by a dense stand of undesirable staghorn sumac (*Rhus typhina*) and silverbell. Silviculturists of the day were concerned that the stand of desirable species might not emerge.

Four sample plots were established in fall 1923 near the base of the northeastern side of LGR to evaluate the feasibility of releasing desirable regeneration from the competition of undesirable species. The treatment, termed "cleaning," removed sprouts of chestnut, sumac, and silverbell from two of the plots. Della-Bianca (1983), however, found little practical difference between treatments in this case study at age 60. In October 1999, after 84 years of growth, we inventoried all arborescent vegetation ≥0.6 inches DBH on each of the four 0.5-acre permanent plots. Because 1923 treatment effects were no longer evident, we pooled data from the cleaned and uncleaned plots. Site index averages 110 feet for yellow-poplar at 50 years (Della-Bianca 1971).

Results

Fifteen species are now present on the plots (table 1). In terms of stem numbers, the present LGR stand is dominated by two understory and one

Table 1—Numbers of trees ≥0.6 inches DBH by species, at seven stand ages on permanent plots at Looking-Glass Rock, Pisgah National Forest, NC.

	Stand age (years						
Arborescent species[a]	**8**	**13**	**18**	**34**	**51**	**60**	**84**
American chestnut	324	97	108	0	0	0	0
Black locust	222	368	71	61	23	17	5
Carolina silverbell	205	227	298	171	107	235	359
Chestnut oak	21	28	29	9	2	2	2
Cucumbertree	9	18	10	8	7	8	3
Fraser magnolia	[b]	[b]	[b]	[b]	[b]	[b]	8
Northern red oak	30	41	46	23	10	8	4
Staghorn sumac	828	751	628	0	0	0	0
Striped maple	[b]	[b]	[b]	[b]	[b]	[b]	94
White ash	2	5	3	6	5	5	2
White basswood	18	32	23	10	6	6	3
Yellow-poplar	182	890	422	402	188	139	96
Other[c]	78	92	108	61	25	69	15
All live	1919	2549	1746	751	373	489	591
All standing dead	[d]	[d]	[d]	[d]	[d]	[d]	47

[a] Common and scientific names: American chestnut, *Castanea dentata*; black locust, *Robinia pseudoacacia*; Carolina silverbell, *Halesia carolina*; Chestnut oak, *Quercus prinus*; cucumbertree, *Magnolia acuminata*; Fraser magnolia, *Magnolia fraseri*; northern red oak, *Q. rubra*; staghorn sumac, *Rhus typhina*; striped maple, *Acer pensylvanicum*; white ash, *Fraxinus americana*; white basswood, *Tilia heterophylla*; yellow-poplar, *Liriodendron tulipifera*; flowering dogwood, *Cornus florida*; hickory spp. *Carya spp.*; red maple, *Acer rubrum*; sourwood, *Oxydendrun arboretum*; sweet birch, *Betula lenta*.
[b] Included with "Other" category in previous reports (Della-Bianca 1983).
[c] Includes: Flowering dogwood, hickory spp., red maple, sourwood, and sweet birch.
[d] Not measured in previous inventories.

[3] Frothingham, E.H. 1917. Report on study of cutover areas in the southern Appalachians. Unpublished report on file at Bent Creek Experimental Forest, USDA Forest Service, Southern Research Station, Bent Creek Experimental Forest, Asheville, NC.

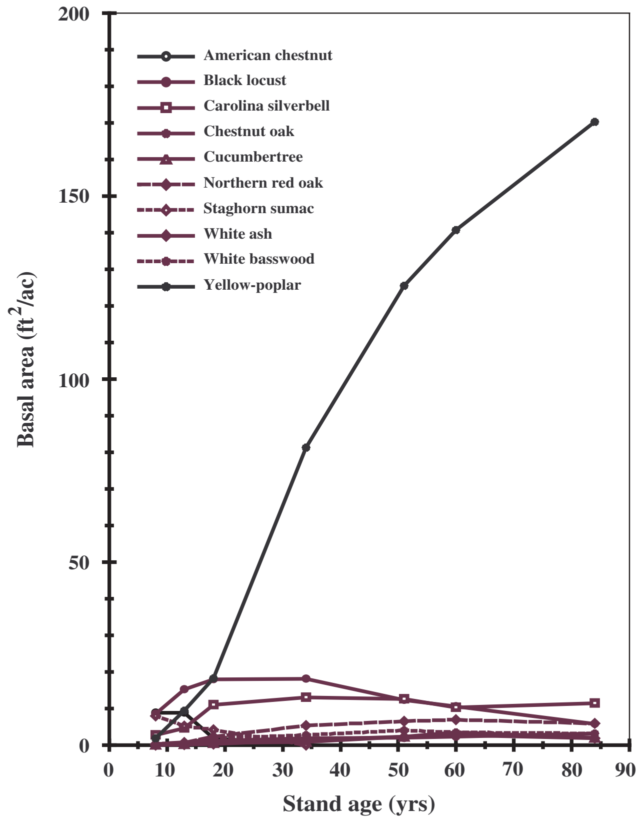

Figure 2—Basal area by tree species at seven stand ages on research plots at Looking-Glass Rock. Not shown are basal areas of *Fraser magnolia* (striped maple) and five other minor species (listed in table 1), which totaled 7.36 ft^2/ac at age 84.

overstory species. About 77 percent of the stems are silverbell and striped maple (*Acer pensylvanicum*) in the understory. Yellow-poplar is the dominant canopy species but accounts for only 16 percent of stem numbers. Silverbell and yellow-poplar have always been a major component of the stand, but staghorn sumac, American chestnut, and black locust (*Robinia pseudoacacia*) were more important in the early history of the stand. Total stem density declined until age 51, then increased as shade tolerant species grew large enough (≥0.6 inches DBH) to be tallied.

Yellow-poplar accounts for 81 percent of the total stand basal area of 211 ft^2 per acre (figure 2, table 2). Three other species, Carolina silverbell, black locust, and northern red oak make up 11 percent of basal area. For most species, basal area has decreased over time, particularly between ages 60 and 84, when considerable mortality occurred. Basal area of yellow-poplar, however, has increased consistently. The mean annual basal area increment for the stand was 2.51 ft^2 per acre. Since age 60, annual increment has averaged 1.21 ft^2 per acre.

Discussion

Long-term observations of stand development at LGR and elsewhere suggest that low- to moderate-elevation, high-quality sites in the southern Appalachians will regenerate quickly after clearcutting and will usually be dominated by a single desirable species: yellow-poplar. Data from the LGR plots demonstrates the consequences of clearcutting on good sites in the southern Appalachians where yellow-poplar reproduction consists of sprouts from cut stumps and seedlings from buried seeds. The fire after the harvest at LGR likely helped rather than hindered yellow-poplar establishment by

Table 2—Plotting points for figure 2 by species: basal area in ft^2/acre at seven stand ages.

	Stand age (years)						
Arborescent species	**8**	**13**	**18**	**34**	**51**	**60**	**84**
American chestnut	8.84	8.88	1.83	0	0	0	0
Black locust	8.62	15.24	18.03	18.12	12.28	10.63	5.84
Carolina silverbell	2.70	4.62	11.02	13.11	12.63	10.24	11.41
Chestnut oak	0.17	0.44	1.22	1.83	2.05	2.26	3.18
Cucumbertree	0.09	0.35	0.61	0.87	2.31	3.48	1.96
Fraser magnolia	[a]	[a]	[a]	[a]	[a]	[a]	3.31
Northern red oak	0.26	0.78	2.35	5.40	6.53	6.97	5.88
Staghorn sumac	7.93	5.23	4.22	0	0	0	0
Striped maple	[a]	[a]	[a]	[a]	[a]	[a]	2.22
White ash	<0.05	0.09	0.22	1.39	2.35	2.70	1.92
White basswood	0.26	0.65	1.92	2.70	4.09	3.44	3.22
Yellow-poplar	1.83	9.49	18.29	81.27	125.44	140.77	170.30
Other [b]	0.96	1.74	3.57	5.44	1.70	2.09	1.83
All live	31.70	47.51	65.07	130.10	169.43	182.49	211.06
All standing dead	[c]	[c]	[c]	[c]	[c]	[c]	16.42

[a] Included with "Other" category in previous reports (Della-Bianca 1983).
[b] Includes: Flowering dogwood, hickory spp., red maple, sourwood, and sweet birch.
[c] Not measured in previous inventories.

top-killing competition and exposing mineral soil, which aided germination of both stored and new seeds from a few surviving seed trees. Yellow-poplar can capture the canopy of high-quality sites from a cohort of mixed species soon after harvest and hold it for many, many years. Dominance will likely be maintained until the occurrence of some significant overstory disturbance, such as crown breakage from an ice storm, which allows additional light on the forest floor to stimulate development of advance regeneration of species with intermediate shade tolerance, such as some oaks. At LGR, however, development of intermediate species on the forest floor resulting from crown disturbance is unlikely because the dense midstory of the shade-tolerant silverbell and striped maple will intercept much of the additional light.

The findings about regeneration and stand dynamics at LGR should be applicable on other high-quality sites in the southern Appalachians. Such sites, which cover moist slopes and coves, include about a third of the landscape (Frothingham 1931). On a high-quality site in the nearby Bent Creek Experimental Forest, Beck and Hooper (1986) also found that yellow-poplar dominated 20 years after the original stand of mixed species was clearcut. One interesting difference between these two stands is composition of the midstory. Silverbell does not occur naturally at Bent Creek and significant amounts of dogwood and red maple are lacking at LGR. Loftis (1989) likewise found that yellow-poplar was a major component of stands regenerating high-quality sites after clearcutting, but the proportions were more variable than those at LGR and Bent Creek clearcuts. When yellow-poplar is present in a stand at crown closure, it is likely to maintain or gain canopy space because of its rapid growth and longevity, unless natural disturbances or silvicultural treatments occur.

Although the LGR stand will not be managed for timber production, we can speculate on outcomes of hypothetical management scenarios based on results of research at Bent Creek. Even though the LGR stand is almost 90 years old, approaching a time when we might consider regeneration, continued management of the present thrifty and likely long-lived yellow-poplar stand also could be attractive. One or more intermediate cuttings could be prescribed to salvage mortality and concentrate growth on the best trees. Low thinning, for example, would increase the average diameter of the residual stand and increase radial growth for several years. Larger trees would be produced more quickly than without silvicultural activity (Beck and Della-Bianca 1981).

Due to high stand volumes and the longevity of yellow-poplar, a number of regeneration options are available. Single-tree selection has not been successful in yellow-poplar stands (Della-Bianca and Beck 1985), but group selection is feasible with group openings as small as one-quarter acre (Beck 1988). Treatment of midstory competition in the openings would encourage yellow-poplar regeneration from seed and sprouts. Representation of other species would depend on the presence of large advance reproduction at the time of cutting and stump sprouts created by cutting (Loftis 1985).

The longevity of yellow-poplar provides great flexibility in converting even-aged stands to uneven-aged stands. Two-aged stand management will work (Beck 1987). The low residual basal areas required for the creation of two-aged stands is reached with a single cut or with two cuts. The regeneration will be dominated by seedlings and sprouts of yellow-poplar as long as midstory competition is controlled. Again, the longevity of the residual yellow-poplar will provide several options as the new age class develops. At mid-rotation, one could remove the older age class in a selection thinning, leaving an even-aged stand. Alternatively one could leave the two-aged stand in place until the end of the rotation. Another option would be to begin the regeneration process again, leaving residual trees of both existing age classes to create an irregular structure with multiple age-classes.

Research has also shown that conventional shelterwood systems can regenerate these stands (Loftis 1983). Over a broad range of residual basal areas, species composition of regeneration has been roughly the same as would have been expected after application of the clearcutting method, as long as the overwood is removed in a timely manner. Yellow-poplar has typically dominated the species composition of new stands. Other species have been present when they occurred as advance reproduction in the previous stand or regenerated from stump sprouts.

Research at Bent Creek suggests that it is possible to change the species composition in stands dominated by yellow-poplar, increasing the amounts of other species such as northern red oak or white ash (*Fraxinus americana*). Loftis (1990) used herbicide treatments to reduce shading from tolerant midstory species, such as silverbell and dogwood, to allow development of desirable species with intermediate shade tolerance. This treatment can be applied in a uniform fashion across an entire stand or in a group or patchwise fashion. After large advance reproduction of these species has developed, usually in about 10 years, the overstory can be removed in any number of ways to provide timely release of the advance reproduction and representation of these species in the new stand.

In summary, LGR provides today important botanical, wildlife, and recreation resources on the Pisgah Ranger District. Equally important to silviculturists, but not so obvious, are the long-term lessons available from observations of stand development on the oldest regeneration research plots in the southern Appalachians. There and elsewhere on good-quality sites in the southern Appalachians, one desirable species, yellow-poplar, has been a significant component of stands regenerated by clearcutting. Yellow-poplar tends to dominate those stands for many years unless a natural disturbance occurs or a silvicultural treatment is imposed to achieve other management objectives.

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