USING GROUP SELECTION TO REGENERATE OAKS IN NORTHERN ARKANSAS

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Abstract—We examined the regeneration dynamics within group selection openings in 12 mature oak-hickory forests in the Ozark Mountains of northern Arkansas. Plots were established in openings harvested in 1991, 1994, 1995, and 1998. Seventy seven percent of the openings were < 0.4 acre, which is the frequently reported minimum opening size for successfully regenerating oaks. Openings were dominated by black cherry (*Prunus serotina* Ehrh.), blackgum (*Nyssa sylvatica* Marsh.), red maple (*Acer rubrum* L.), and flowering dogwood (*Cornus florida* L.). White oak (*Quercus alba* L.) and red oak (*Q. rubra* L. and *Q. velutina* Lam.) density varied widely among study sites but averaged 9 percent. Most oaks were in a free-to-grow position. No oaks were recorded in about one-third of the openings. The future species composition of the openings will probably be more diverse than that of the unharvested portions of the forests studied.

INTRODUCTION

Successfully regenerating oak species in upland hardwood forests of the Southern and Eastern United States has been a vexing problem for generations of foresters. On many sites, mature oak forests have been replaced by shade tolerant and fire sensitive non-oak species (Abrams 1998, Lorimer 1993). Where adequate oak regeneration has been obtained, cutting methods generally create environmental conditions favorable for shade intolerant and intermediate species. These methods include clearcutting (Sander and Graney 1993), shelterwood (Brose and others 1999, Loftis 1990), and group selection (Murphy and others 1993).

Group selection is a regeneration harvest combined with improvement cutting throughout the stand that promotes an uneven-aged structure (Minckler 1986). Compared to clearcutting and shelterwood, group selection has been less frequently applied to hardwood forests in general and oak forests in particular. One reason for its limited adoption by forest managers may be an uncertainty of how to regulate the harvest and the residual stand structure. Roach (1974) and Nyland (2002) suggest that group selection after the third or fourth harvest becomes difficult to apply because of the increasing number of groups. Miller and others (1995) and Smith (1980) distinguish between group selection, which is regulated by volume and basal area, and patch cutting, for which area control is used.

Despite the limited number of group selection studies established in oak forests, two recommendations have been consistently reported. First, the average diameter of openings should be at least one to two times the height of the surrounding overstory trees (Clark and Watt 1971, Fischer 1981, Law and Lorimer 1989, Miller and others 1995, Minckler 1989, Minckler and Woerheide 1965, Trimble 1973). At least twice the tree height is favored by most authorities. Thus, a circular opening placed among 75-foot-tall trees should be at least 150 feet in diameter and 0.4 acre in size. However, these values would vary by slope and aspect (Fischer 1981, Law and Lorimer 1989). Second, an abundance of well-developed and vigorous oak advance regeneration and/or small stems with sprouting potential are required prior to harvest (Hill and Dickmann 1988, Johnson and others 2002, McQuilkin 1975, Murphy and others 1993, Weigel and Parker 1995).

In the Ozark Mountains of northern Arkansas, group selection has been practiced, albeit infrequently, by the U.S. Forest Service over the past 15 years. For example, in the Sylamore Ranger District of the Ozark National Forest, 89 oak stands totaling about 3,600 acres are being managed using group selection (Personal communication. Bob Rhodey, Ozark National Forest, Mountain View, AR). However, the structure and species composition of regenerated openings are unknown. Thus, we selected 12 group selection stands on the Sylamore Ranger District for study. The objectives were: (1) to evaluate the level of success in regenerating oaks, and (2) to examine if the density of oak regeneration was influenced by opening size, opening age, and site.

METHODS

Study Areas

The 12 study sites are mature white oak (*Quercus alba* L.)-red oak-hickory (*Carya* spp.) forests located in Stone and Baxter Counties in north-central Arkansas. Red oaks include northern red oak (*Q. rubra* L.) and black oak (*Q. velutina* Lam.). Site index is 60 to 70 feet at age 50. Elevations range from 760 to 1,210 feet. Most soils are Noark, Clarksville, and Nixa very cherty silt loams on side slopes and ridgetops (Ward 1983, Ward and McCright 1983).

The study sites were selected from a USDA Forest Service database and shared the following characteristics: oak-hickory forests that had naturally regenerating group selection openings; 20 to 100 acres in size located on the southern part of the Sylamore Ranger District; and site preparation followed harvest by 1 year or less and consisted of: (1) felling unmerchantable oaks to encourage sprouting and (2) hand tool and chemical control of unmerchantable non-oaks. To describe the regeneration dynamics over time, we selected three sites that were harvested in each of the following years: 1991, 1994, 1995, and 1998. No one directly or indirectly involved with this study was present during site preparation

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or harvesting. Also, there is no record of the amount of oak advance regeneration in the openings prior to or after the harvests.

Data Collection and Analysis

In August and December, 2004, and January, 2005, 5 group openings at 11 sites and 4 group openings at 1 site were selected for measurement. All openings were located along or near a main skid trail. A transect was established along the long axis of each opening from one side of the opening to the other. Transects were oriented in a variety of bearings. Three 0.01 acre plots were installed on each transect so that plots fell at 25 percent, 50 percent, and 75 percent of the transect length. In each plot, living trees > 1.0 inch d.b.h. were tallied by species and d.b.h. Oaks were also classified as either free-to-grow or suppressed. The perimeter of every opening was mapped with a global positioning system (GPS) receiver.

Acreage was calculated for every opening from the GPS data. Opening locations were overlaid on digital topographic maps so that the landscape position and aspect of every opening could be examined. Based on this visual examination, openings were classified as either xeric or mesic. Xeric openings were on ridgetops, south-facing slopes, and other dry sites, while mesic openings were in hollows and on north- and east-facing slopes.

Plot data were summarized to describe species composition and stand structure. Simple linear regression was used to explore the relationship between oak density and opening size. Analysis of variance was used to test for differences in oak density by age of the openings. A t-test was used to compare the mean oak density on xeric and mesic sites (SAS Institute 1993). Significance for all analyses was accepted at $P \leq 0.05$.

RESULTS AND DISCUSSION

Seventy seven percent of the group openings were 0.4 acre or less in size. Twenty percent of the openings were 0.4 to 0.6 acre and 3 percent were larger than 0.6 acre. The smallest opening was 0.09 acre and the largest was 0.94 acre.

All 12 study sites had abundant stems per acre (table 1). Tree density ranged from 1,133 to 2,080 stems per acre and averaged 1,461 stems per acre (s=297). Twenty nine tree species were recorded. Of these, black cherry (*Prunus serotina* Ehrh.), blackgum (*Nyssa sylvatica* Marsh.), red maple (*Acer rubrum* L.), and flowering dogwood (*Cornus florida* L.) were dominant. At each site, one of these taxa was the most abundant or second-most abundant species. Combined, their densities ranged from 200 to 986 stems per acre with a mean of 672 stems per acre (s=264). In contrast, density of white oak and red oak ranged from 0 to 207 stems per acre and 0 to 133 stems per acre, respectively. Mean white oak density was 83 stems per acre (s=70), and red oak was 56 stems per acre (s=49). Across all sites, 9 percent (s=6) of the trees were oaks. Other important species in some stands included sassafras [*Sassafras albidum* (Nutt.] Nees) and hickory.

Most regeneration was 1 or 2 inches d.b.h. (fig. 1). Not surprisingly, stems 3 to 6 inches d.b.h. were more abundant in the older harvests. Most large trees were black cherry, blackgum, and red maple. Few oaks were larger than 3 inches d.b.h. In spite of this, most oaks were not suppressed. In fact, 71 percent of red oak and 67 percent of white oak were free-to- grow. There was no significant difference (P=0.11) in the mean number of oaks among sites cut in 1991 (121 stems per acre), 1994 (133 stems per acre), 1995 (213 stems per acre), and 1998 (76 stems per acre). The low number of trees in the 1998 harvests (fig. 1) probably indicates that not enough time has elapsed for many trees to grow into the 1 inch d.b.h. size class.

There was not a significant linear relationship ($P=0.52$, $r^2=0.01$) between the mean number of oaks in a group opening and the size of the opening. Large openings did not have more oaks than small openings. Nineteen of the 59 total openings, or about one third, had no oaks at all. Similarly, there was no significant difference (P=0.33) in the mean number of oaks in openings on xeric (164 stems per acre) and mesic (120 stems per acre) sites.

Our results indicated that group selection openings were dominated by non-oak species 6 to 13 years after harvest. Perhaps the relatively low number of oaks was due to the small opening size, lack of oak advance regeneration, and/or inadequate site preparation after harvesting. For example, over three-fourths of the openings were less than the 0.4 acre

Table 1—Stems per acre greater than 1 inch d.b.h. in group openings at the 12 study sites located in mature oak-hickory stands in northern Arkansas

	Sites[a]												
Species	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Red oak	7	7	100	133	40	7	120	53	40	0	113	47	56
White oak	60	27	200	87	120	13	140	207	80	47	0	20	83
Blackgum	87	213	292	193	60	247	493	380	53	107	120	33	190
Black cherry	247	220	50	320	147	233	67	47	407	287	153	93	189
Dogwood	147	380	233	33	40	13	207	67	40	160	7	7	111
Red maple	53	67	200	440	100	33	113	333	413	280	87	67	182
Sassafras	80	73	33	80	53	187	13	33	73	80	0	533	103
Hickory	47	20	117	413	87	33	73	20	53	0	193	53	92
Others	553	413	233	233	533	600	327	940	480	240	620	280	454
Total	1,280	1,420	1,458	1,933	1,180	1,367	1,553	2,080	1,640	1,200	1,293	1,133	1,461

[a] Sites 1-3 harvested in 1991; sites 4-6 harvested in 1994; sites 7-9 harvested in 1995; and sites 10-12 harvested in 1998.

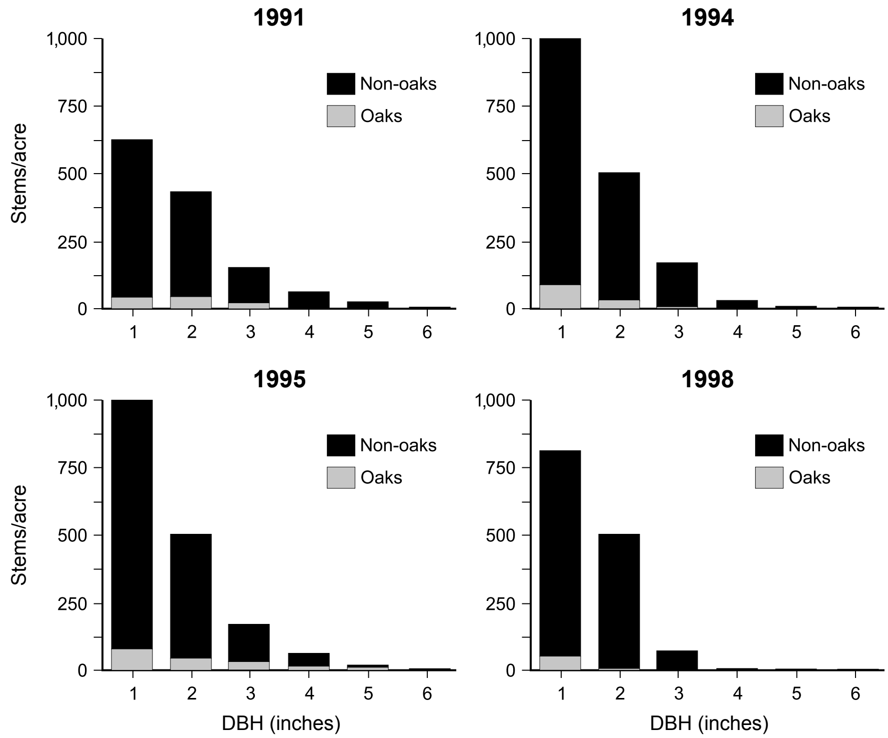

Figure 1—Diameter distribution of trees in group openings harvested in 1991, 1994, 1995, and 1998 in mature oak-hickory stands in northern Arkansas.

minimum recommended for regenerating oaks (Clark and Watt 1971, Fischer 1981, Law and Lorimer 1989, Miller and others 1995, Minckler 1989, Minckler and Woerheide 1965, Trimble 1973). Any or all of these factors could have influenced oak survival and development and confounded the relationships between oak regeneration, opening age, and site (mesic or xeric). Weigel and Parker (1995) noted that some group selection studies, ours included, are limited because they are not established prior to harvesting. This does not permit controlling opening size, and it provides an incomplete picture of regeneration dynamics and the factors influencing regeneration.

Despite the high density of non-oak species, oaks were measured at all sites. In fact, 9 of the 12 sites had at least 67 oaks per acre, 7 sites had over 100 oaks per acre, and 4 sites contained at least 220 oaks per acre. Most of these trees were in a free-to-grow position. It is unclear how these oaks will fare in the future. One possibility is that the combination of small opening size and competition from faster-growing species will eventually limit the ability of oaks to attain upper canopy positions. On the other hand, a number of studies indicate that oaks may not be the predominant species early in stand development but over time can increase in importance relative to competing species (Clatterbuck and Hodges 1988, Johnson and Krinard 1988, Oliver and Larson 1996).

Mature forests in the vicinity of the study sites are dominated by oak and hickory, with other overstory species generally making up < 10 percent of total density and < 5 percent of total basal area (Soucy and others 2004). It seems likely that some oak will survive and perhaps thrive in most of the openings for an extended period. However, given that one-third of the openings we sampled had no oaks, we speculate that the long-term species composition within the openings will be more diverse in general than that of the surrounding, older forests.

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