EFFECTS OF TWO PRESCRIBED FIRES ON RED MAPLE REGENERATION ACROSS FOUR LEVELS OF CANOPY COVER

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INTRODUCTION

Oak species have maintained an important role in eastern U.S. forests for the last 8,000 years (Foster and others 2002). Intense changes in land use and disturbance regimes brought on by European settlement helped oak persist and expand its range through the 1800s. Mixed-oak forests persist as the predominant forest type in present-day eastern forests, but very little oak recruitment into the overstory has occurred since the implementation of fire suppression in the early 1900s (Abrams 1992). Advanced oak regeneration on high-quality and some intermediate-quality sites is being replaced in the midstory by more mesic, shade-tolerant species (Abrams and Nowacki 1992). Red maple (*Acer rubrum*) is often the most frequently occurring competitor on upland oak sites in much of the eastern United States (Abrams 1998, 2005). Current thinking is that reintroduction of representative fire regimes into eastern oak systems may help promote oak recruitment and impede the development of red maple competition.

Brose and Van Lear (1998) found that red maple was controlled most effectively with spring and summer burns, when carbohydrate reserves in the rootstocks are low and fire intensities tend to be higher. Burns of lower intensity present less potential hazard, but several low-intensity burns may be necessary to achieve the same results as a single, high-intensity burn (Loftis 1990, Brose and Van Lear 1998).

OBJECTIVE

The objective of this study was to determine the additive effects of two low-intensity prescribed fires on red maple regeneration across four levels of canopy cover by testing the hypothesis that red maple densities in medium and large size classes (25 cm tall – 2.54 cm diameter at breast height [d.b.h] and > 2.54 cm d.b.h., respectively) will be reduced to a greater degree following the second burn than following the first.

METHODS

SITE DESCRIPTION

Second-growth natural oak stands on state forest land were selected as study sites in Michigan: southern Crawford County (84°45’W, 44°31’ N, elevation 400 m) and southern Roscommon County (84°41’ W, 44°14’ N, elevation 300 m). Both counties are within the Grayling Outwash Plain of the Highplains District of the northern Lower Peninsula (Albert 1995). All stands occurred on sandy, mixed, frigid, Alfic Haplorthods developed in pitted outwash, and soil physical and chemical properties among stands were comparable (Kim and others 1996). All sites were designated as moderately productive. Slopes were ≤ 5 percent. Site index for

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northern red oak in the Lakes States region was 17-18 m at 50 years (Carmean and others 1989, Kim and others 1996). Tree ring counts on stumps, following canopy treatment in 1991, indicated the oak stands were 88-100 years old.

EXPERIMENTAL DESIGN

Natural oak stands were divided into three replicate blocks measuring 1.74 ha. Each of the three blocks was subdivided into four plots measuring 66 m x 66 m (0.44 ha). Each plot randomly received one of four canopy cover treatments: clearcut, 25-percent residual canopy, 7-percent residual canopy, or uncut control. All stands were cut between fall 1990 and early spring 1991. Four understory treatment subplots measuring 15 m x 15 m (0.02 ha each) were arranged in a square at the center of each canopy treatment plot in 1991, and maintained intermittently through 1996.

MEASUREMENTS

Natural regeneration was measured in 2001, 2003, 2006, and 2009 at four sampling plots within each understory subplot at the end of the growing season in late July/early August. Genets of woody stems were tallied by species into three size classes: (small) stems < 25 cm height, (medium) stems 25 cm height – 2.54 cm diameter, and (large) 2.54 cm diameter – 10 cm diameter. Small size-class stems were measured within square meter quadrats. Medium size-class stems were measured within 2-m diameter circular plots. Large size-class stems were measured within 4-m diameter circular plots. Smaller sampling plots were nested within larger plots.

STATISTICAL ANALYSIS

Red maple densities were averaged across understory plots to achieve canopy cover treatment means for each oak block. Treatment means and standard errors were calculated using SAS 9.2 (SAS Institute, Cary, NC). Paired t-tests were used to evaluate differences between pre- and post-burn seedling densities associated with each fire using SAS 9.2. P-values were reported at a significance level of alpha = .05 for two-tailed t-tests.

RESULTS

MEDIUM SIZE CLASS

In clearcut treatments, red maple densities were reduced by 54.4 percent following fire 1 and by 40.3 percent following fire 2. In 25-percent canopy cover, densities were reduced by 43.5 percent following fire 1 and by 26.77 percent following fire 2. In 75-percent canopy cover, densities were reduced by 44.0 percent following fire 1 and by 31.7 percent following fire 2. In uncut control treatments, densities were reduced by 60.1 percent following fire 1 and by 43.2 percent following fire 2.

LARGE SIZE CLASS

In clearcut treatments, red maple densities were reduced by 48.6 percent following fire 1 and by 3.0 percent following fire 2. In 25-percent canopy cover, densities were reduced by 65.5 percent following fire 1 and by 24.3 percent following fire 2. In 75-percent canopy cover, densities were reduced by 79.5 percent following fire 1 and by 58.3 percent following fire 2. In uncut control treatments, densities were reduced by 85.7 percent following fire 1 and by 75.0 percent following fire 2.

DISCUSSION

The hypothesis that red maple stems in the two larger size classes would be reduced more by the second fire than by the first was not supported. Each fire reduced red maple densities across all canopy treatments, but densities were reduced to a greater degree following the first fire. Many of the larger surviving stems were stump sprouts, which emerged from thinned midstory saplings following canopy treatments in 1991. These stems had 10 years to develop between initial thinning treatments and the first prescribed fire. Densities may have been reduced more following the first fire because of high mortality among stressed, ill-formed, or diseased stems, leaving only the most robust, well established stems, which then had six growing seasons to recover before the second fire. Reducing these robust stems may require continued repeated burning.

CONCLUSION

Low-intensity prescribed burns implemented more frequently than in this study may help to reduce large red maple regeneration that can survive and recover between longer periods. More frequent burns, however, may also have an adverse effect on oak regeneration. Overall, the two prescribed fires had a cumulative effect, reducing red maple densities by 46-74 percent in the medium size class and by 53-87 percent in the large size class, which may increase the competitive ability of desired oak regeneration.

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