EFFECTIVENESS OF HERBICIDE AND FIRE TO FAVOR OAK REGENERATION IN OHIO SHELTERWOOD STANDS

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Extended abstract—Poor oak regeneration is a major problem throughout much of the Central Hardwoods region, as shade-tolerant species have become abundant in the midstory and understory of mature oak stands. Low light levels reduce the survival of oak seedlings and prevent the accumulation of larger oak advance reproduction. To address this issue, we initiated a study in southern Ohio to document the response of oak and other tree regeneration to shelterwood harvest, herbicide, and prescribed fire.

Four study sites were established in 2005, each with four 20-acre treatment units. Among sites, tree basal area averaged 96–126 square feet per acre, of which 74–85 percent was oak-hickory. The entire area of each site received a commercial shelterwood cut (50 percent BA reduction) in 2005 or 2006. The treatments were 1) Control (C), 2) Herbicide (H), 3) Burn (B) and 4) Herbicide + Burn (HB). The H treatment was an autumn stem-injection of all non-oak-hickory trees >2 inches DBH with glyphosate (54 percent active ingredient), prior to the shelterwood harvest (SWH). Burns were conducted in early April in 2012 or 2013, 5 to 7 years after SWH; flame lengths were mostly 1–3 feet in length.

Twelve plots (25.4 feet radius) were established per treatment unit to sample vegetation. Pretreatment tree regeneration (large seedlings 1 to 4.4 feet tall and saplings 4.5 feet tall to 3.9-inches DBH) was sampled in 2005 (year 0). Regeneration (saplings only) was recorded again in 2010 (year 5), 4 or 5 years after the SWH. Finally, saplings were sampled in 2015 (year 10), 9 or 10 years after the SWH and 3 or 4 years after the burns. Species were classified into five groups that made up >97 percent of stems: 1) oak-hickory, 2) sassafras, 3) red maple, 4) other-tolerant (all other shade-tolerant species, of which blackgum and sourwood were most abundant), and 5) poplar-aspen-cherry (yellow-poplar, bigtooth aspen, black cherry, shade-intolerant species that established from seed after SWH).

In year 0 (pre-treatment), red maple and other-tolerants made up 88 percent of the 630 saplings per acre. Among large seedlings, the most abundant species/group was sassafras (31 percent of stems), followed by oak-hickory (23 percent), other-tolerants (22 percent), and red maple (21 percent).

After the SWH, sprouts from stumps >3 inches basal diameter of non-oak-hickory trees were abundant in units not treated with herbicide; red maple occurred at the greatest densities, followed by blackgum and sourwood. The herbicide greatly reduced the density of stump sprouts of the treated species, with the exception of red maple. Stump sprouts of treated species other than red maple were 83 percent less abundant in treated units, while red maple density was only 38 percent lower on herbicide-treated units.

By year 5, a dense sapling layer, averaging 2811 stems per acre, had developed. Across treatments, the most abundant group was poplar-aspen-cherry (26 percent of saplings), followed by other-tolerant (23 percent), red maple (22 percent), oak-hickory (19 percent), and sassafras (9 percent) (fig. 1). Analyses showed no significant herbicide effect on the relative abundance of regeneration for any group (Hutchinson and others 2016). The relative abundance of oak-hickory, red maple, and other-tolerants did not change significantly from year 0 to year 5; i.e., there was also no “harvest” effect on relative abundance. There was, however, a significant increase of poplar-aspen-cherry and a significant decrease in sassafras.

One year prior to the prescribed fires, a subset of saplings (oak-hickory, red maple, blackgum, yellow-poplar, sassafras) were tagged in order to quantify rates of mortality after fire. Nearly all stems were topkilled, but all species had very low mortality rates (<10 percent) after fire with the exception of yellow-poplar, for which 53 percent of topkilled saplings failed to resprout.

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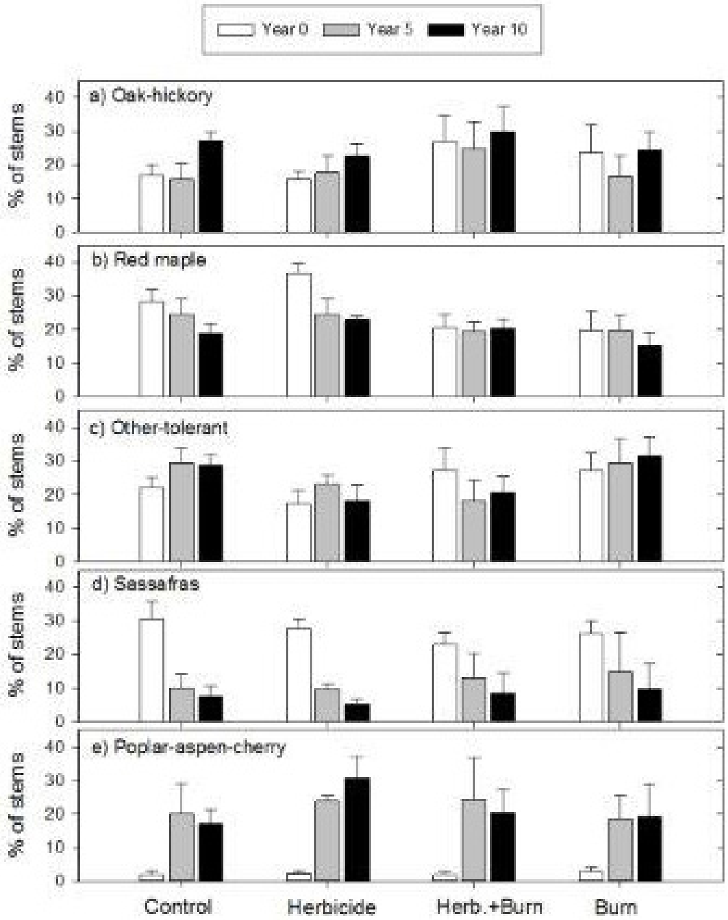

Figure 1—Mean (± 1 standard error) relative abundance of tree regeneration for species/groups in years 1, 5, and 10, among four treatments in Ohio shelterwood stands. Note: the Control treatment was a shelterwood harvest with no additional treatment.

By year 10, 3 or 4 years after the burns, mean sapling density across treatments had increased to 4288 stems per acre. On the B and HB treatments, the relative abundance of species/groups showed very minor changes after fire (fig. 1). Surprisingly, this was true even for the poplar-aspen-cherry group, in which we documented greater rates of post-burn mortality for yellow-poplar. The average relative abundance of oak-hickory in the sapling layer in year 10 was quite similar among treatments, ranging from 23 percent on H to 30 percent on HB; oak-hickory exhibited modest increases in relative abundance on all treatments from year 5 to year 10.

Our results indicate that the relative abundance of oak-hickory regeneration changed very little from year 0 to year 10, across all treatments (fig. 1). This was also the case for red maple and the other-tolerant group. By contrast, there was a large increase, across all treatments, in the relative abundance of poplar-aspen-cherry, as these species established from seed and grew rapidly after the SWH. There was a concomitant decrease in sassafras in all treatments after the SWH.

Why were the impacts of the herbicide and prescribed fire treatments, which were designed to favor oak-hickory regeneration, so limited in this study? Two factors limited the effects of herbicide. First, prior to treatment, all stands had high densities of shade-tolerant saplings that were below the 2.5 inches DBH threshold for herbicide treatment. These cut or damaged untreated saplings sprouted prolifically after the SWH. Second, glyphosate was not very effective on red maple, which was the most abundant species in the midstory. With regard to fire, it appeared that two factors limited its effectiveness to favor oak-hickory. First, the study plan proposed to conduct spring growing-season burns, which have been shown to greatly favor oaks over competitors that leaf out earlier. However, we were unable to conduct growing season burns because of Ohio regulations related to state-endangered animal species. Second, the prescribed fires were likely conducted too long (5–7 years) after the SWH. By that time, the non-oak saplings were large and resprouted vigorously, as did the oak-hickory saplings, after being topkilled in the dormant-season burns.

These preliminary results suggest that oak-hickory will remain a significant component of these stands, but with much reduced dominance in the future. In hindsight, a more gradual approach of reducing stand density to develop competitive oak regeneration, via a non-commercial preparatory cut or prescribed fire, prior to the heavy SWH, would be more likely to increase the competitive position of oak-hickory regeneration after the SHW.

LITERATURE CITED

Hutchinson, T.F.; Rebbeck, J.; Stout, S. 2016. The devil is in the small dense saplings: A midstory herbicide treatment has limited effects on short-term regeneration outcomes in oak shelterwood stands. Forest Ecology and Management. 372: 189-198.