# Sprout-Origin Hardwood Reproduction Dominates After Multiple Prescribed Fires on the William B. Bankhead National Forest, Alabama

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**Overview:**

- Upland mixed pine-hardwood forests on the William B. Bankhead National Forest (BNF) in the southern US are being managed to move them towards more hardwood dominance using thinning and prescribed fire.
- Cultivating the reproduction cohort so that desired species such as oaks are favored over less-desirable species such as red maple is challenging for these contemporary stands, which have not been disturbed for many years. This lack of disturbance has resulted in a failure of small oak seedlings to recruit into more competitive positions for eventual release into a new overstory canopy while red maple densities and larger sized seedlings have increased.
- Both thinning and multiple prescribed fires are needed to stimulate reproduction growth and recruitment; oak and red maple reproduction densities are highest under the most disturbance, one thin to a residual 50 basal area and five fires.
- Large (4.5 ft tall up to 1.5 inches dbh) red maple seedling sprouts are dominating the reproduction cohort.
- Five prescribed fires have not eliminated the red maple in favor of oak reproduction.

**Summary:**

Management problem: Widespread failure of oak regeneration and subsequent loss of the oak component has been reported across Eurasia and the Americas. The oak regeneration issue has been linked to changing disturbance regimes, including the lack of fire. Burning used in combination with stand thinning creates conditions that should be conducive to oak regeneration establishment and recruitment, including increased understory light and decreased woody plant competition.

Management need: Managers are using thinning and prescribed fire prescriptions aimed at restoring hardwood dominance in upland pine-hardwood mixed-woods. While prescribed fire has been purported to sustain the dominance of oaks, contemporary forests have altered species composition and structure and responses to these current disturbances are unknown.

Research purpose: We examined the sprouting dynamics of the reproduction cohort in response to one thinning and multiple prescribed fire treatments. While sprouting by both oak and red maple after being top-killed by fire is expected, the competitive dynamics of the sprouting response is unknown. We examined the origin (natural reproduction seedling or sprout), densities and size classes of oaks and red maple in response to a combination of thinning and burning.

**Silvicultural Concepts:**

- Treatments: We used the BNF's Forest Health and Restoration Project's parameters of thinning (with a residual basal area ranging from 75 to 50 square feet per acre, BA) and prescribed fire (with a return interval ranging from 3 to 9 years) to plan and implement a study with a randomized complete block design with a 3- by 3 factorial treatment arrangement and four replications of each treatment (see Schweitzer and others (2016) for study details).
- Fire treatments: All fires are dormant season fires. While management and research are done at the stand level, prescribed fire is done at the landscape scale, and burn sizes ranged from 150 to 3,000 acres (60−1,200 ha). The "research burns" were embedded within a larger burn plan on the BNF. Fire behavior was variable across stands and years. Thermocouples measured fire temperatures and showed a range of average maximum temperatures from 207 ºF to 486 ºF (table 1).
- Treatments covered in this review include:
    - Stands thinned once to a residual basal area of 50 BA
    - Within 13 years, thinned stands received no fire, 2 fires (infrequent fire, with a return interval of 9 years) or 5 fires (frequent fire, with a return interval of 3 years)
    - Control stands were neither thinned nor burned
- Using permanent sample plots, we assessed the reproduction cohort by species, size class and origin (sprout or seedling) after 13 years.
    - Oaks (*Quercus alba, Q. coccinea, Q. prinus, Q. rubra, Q. stellata, Q. velutina*) are desired production and red maple (*Acer rubrum*) is a primary woody competitor.
    - Across all treatments total reproduction was 35% red maple and 18% oaks.
    - In thinned stands with no fire red maple and oak were 49% and 11% of total reproduction, respectively; for thinned stands with frequent fire, 47% and 36%, respectively.
    - Sprout origin stems dominated the burns stands, with greater than 80% of red maple and oak reproduction sprouts (figs. 1 and 2).

- For the frequent fire stands, reproduction in the largest size class, 4.5 ft tall up to 1.5 in DBH, were red maple sprouts 26% (1105 SPA) compared to only 3% oaks (90 SPA). (figs. 1 and 2).

**Management Applications:**

- Many managers in the Southeast use prescribed fire in either pine or hardwood systems as a part of integrated management plans.
- We are using thinning and burning tools to move pine-hardwood mixed-woods towards forests that are more hardwood dominated.
- Our study on the BNF is a true Forest Service partnership between the National Forest System and Research and Development.
- Managing hardwood systems is nothing like managing southern pines.
- Restoring the historic disturbance regime, which included fire, is paramount to successful restoration of healthy and resilient hardwood forests.
- As we continue to burn these stands, we are observing that red maple seedling sprouts are dominating the regeneration cohort.
- A management consideration would be to consider other tools to control the red maple, such as herbicide treatment, coupled with thinning and fire.
- Understanding the feedback system of fire, whereby vegetation influences flammability and fire effects and fire effects influence future vegetation, is paramount in using fire in a restoration capacity.
- Fire does have a role to play in the restoration and sustainability of southeastern oak forests.
- Along the way, we demonstrated that coproducing science isn't really that daunting. The partnership of research and management is foundational to identifying research problems in forestry and to developing practical science-based solutions to problems of high priority to forest managers.

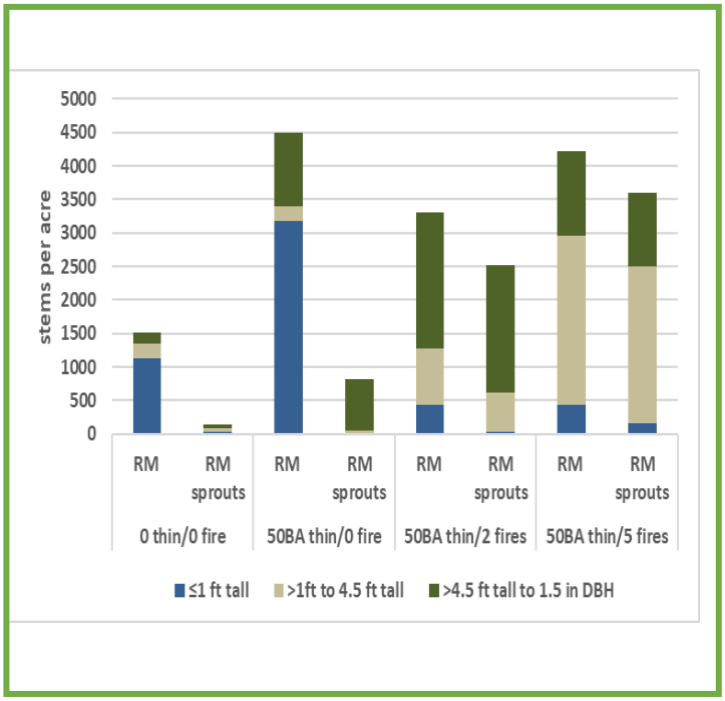


**Figure 1**—From four treatments on the Bankhead National Forest, Alabama, red maple reproduction by all tallies and tallies that are sprouts.

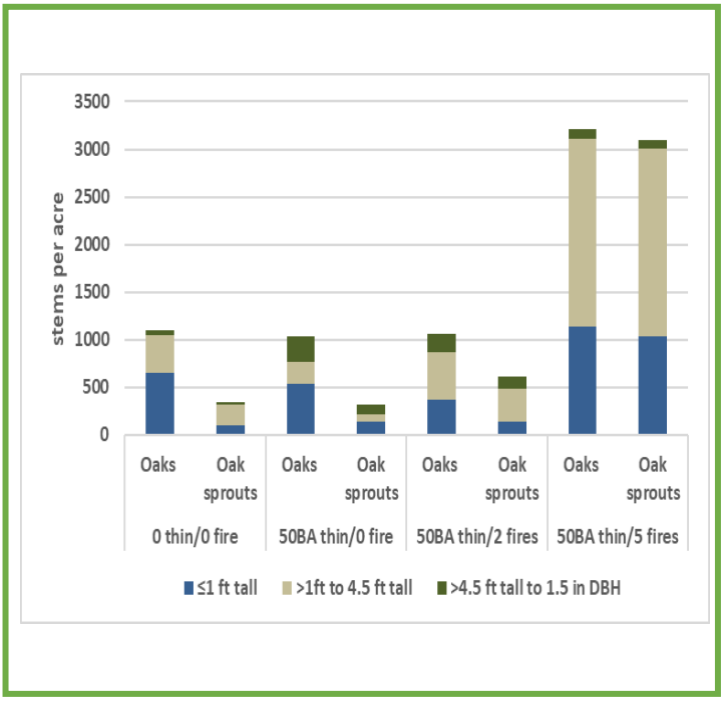


**Figure 2**—From four treatments on the Bankhead National Forest, Alabama, oak reproduction by all tallies and tallies that are sprouts. Note y-axis differs from figure 1.

**Table 1**—Fire temperature data (average maximum and standard deviation) collected from thermocouples systematically placed in prescribed fire stands on the William B. Bankhead National Forest, Alabama.

| Year | Fire (Rx) | Average | StdDev | Average by Rx | StdDev by Rx |
|---|---|---|---|---|---|
| | | Max temp (°F) | Max temp (°F) | Max temp(°F) | Max temp(°F) |
| 2007 | Rx1 | 216.2 | 176.1 | 211.7 | 136.7 |
| 2008 | | 207.3 | 97.4 | | |
| 2009 | Rx2 | 211.4 | 91.2 | 267.9 | 95.2 |
| 2010 | | 195.8 | 81.1 | | |
| 2011 | | 396.7 | 113.4 | | |
| 2012 | Rx3 | 353.8 | 123.0 | 412.7 | 147.4 |
| 2013 | | 397.4 | 177.9 | | |
| 2014 | | 486.9 | 141.3 | | |
| 2015 | Rx4 | 291.3 | 106.4 | 374.7 | 153.6 |
| 2016 | | 355.0 | 168.3 | | |
| 2017 | | 477.9 | 186.0 | | |
| 2018 | Rx5 | 367.6 | 121.3 | 332.8 | 125.6 |
| 2019 | | 331.3 | 126.7 | | |
| 2020 | | 299.5 | 128.6 | | |

**References**

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