# LANDSCAPE-SCALE FIRE RESTORATION ON THE BIG PINEY RANGER DISTRICT IN THE OZARK HIGHLANDS OF ARKANSAS

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**Abstract.—**The Ozark-St. Francis National Forest, The Nature Conservancy (TNC), the Arkansas Natural Heritage Commission, Arkansas Forestry Commission, private landowners, and others are currently engaged in a collaborative project to restore the oak-hickory and pine-oak ecosystems of the Ozark Highlands on 60,000 acres of the Big Piney Ranger District. Frequent historical fires and native grazers (e.g., elk and bison) maintained an open canopy of woodlands and savannas, where oaks, hickories, and shortleaf pine dominated. Today, these former woodlands now contain "forest-like" closed canopies (dominated by oak-hickory, oak-shortleaf pine, and shortleaf pine) caused by changes in land-use practices, including fire suppression, domestic livestock grazing, and silviculture. Historic records indicate that pre-European settlement Ozark woodlands averaged 38-76 trees per acre. Current densities average 300-1,000 stems per acre. Oak decline and the red oak borer have affected at least 300,000 acres of the Ozark National Forest and about 1.5 million acres of the Ozark Highlands. The Big Piney Ranger District is implementing a long-term, landscape-scale ecosystem restoration project in a TNC conservation priority area. Specific project activities include the application of periodic prescribed fire and thinning by commercial and noncommercial methods. The goals of these activities are to improve forest health, restore fire-dependent woodland ecosystems, and provide for safety by reducing hazardous fuels in the wildland/urban interface. A comprehensive monitoring program documenting ecosystem responses to prescribed fire and woodland thinning treatments is currently being implemented. The monitoring program includes tracking changes in overstory, understory, and herbaceous plant species, the structure of plant communities, fuel loads, nonnative invasive species, and breeding and wintering bird communities.

## INTRODUCTION

Fire has been a dominant force in establishing and maintaining woodland ecosystems throughout North America (Pyne 1982). Forest health issues in the Ozark Mountains of Arkansas mirror changes occurring in other forest ecosystems throughout the country. Altered fire regimes and past land management activities have led to a significant increase in fuel loads and tree densities, a shift in species composition, and a decline in forest health. Currently, there are substantially more degraded woodlands with closed canopies (oak-hickory, oak-pine, and shortleaf pine [*Pinus echinata* Mill.]), and less woodlands (oak-pine woodland, oak-hickory woodland, and shortleaf pine woodland) than occurred historically under a more frequent fire regime (Foti 2004). The frequent, low-intensity fire regime under which these ecosystems evolved has been disrupted (Guyette and Spetich 2003). The woodlands of the Ozark and Ouachita Mountains were heavily logged 80-100 years ago. By the 1920s and 1930s systematic fire protection had been established on National Forest and private lands, and the fire frequency was drastically reduced (McGuire 1941, Bass 1981, Strausberg and Hough 1997, Soucy et al. 2005). Historic records indicate that presettlement tree density in the Ozark Highlands (Bailey 1998) ranged from 38-76 trees per acre (Foti 2004). Current densities in much of the region range from 300-1,000 stems per acre. Increased stand density leads to increased competition for available nutrients, sunlight, and moisture. Fralish (2004) states that in addition to densification, woodland communities are shifting from a fire-adapted oak-pine dominated community to a more fire-intolerant community of red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.), and American

beech (*Fagus grandifolia* Ehrh.). During periods of drought, trees already stressed by resource competition become more vulnerable to disease and insect attack, such as the red oak borer. Fire suppression has greatly reduced the once-common oak and pine woodlands on National Forest lands; their integrity is at risk.

Dendrochronologists and other researchers have investigated the fire history of the Ozark Highland over the last 30 years. At three sites on the Big Piney Ranger District, Guyette and Spetich (2003) reported mean fire return intervals of 5-16 years from 1680-1820, 2-3 years from 1821-1880, 2-5 years from 1881-1920, and >62 years (one study site) to 80 years (two study sites) from 1921-2000. Recent work from three additional sites on the Big Piney Ranger District revealed mean fire return intervals of 1.4-5.4 years from 1810-1920 (Guyette et al. 2006). Engbring et al. (2008) reported mean fire return intervals for a site in north-central Arkansas of 1.9 years from 1820-1900, 2.1 years from 1901-1930, and 2.6 years from 1931-2003. Reduced fire frequency beginning in the 1920s reflects the implementation of effective fire suppression and prevention programs in Arkansas (Bass 1981).

The Ozark Highlands are biologically important due to the diversity provided by a system of fire-adapted, wooded, and partially wooded herbaceous plant communities. More than 150 species of animals and plants are endemic to the Ozark Highlands. Most of these species rely in some way upon healthy oak and pine ecosystems. Many socially, economically, and ecologically important species inhabit these ecosystems, such as neotropical migratory birds, white-tailed deer, black bear, turkey, and quail.

In 2001 the U.S. Forest Service (USFS) and multiple partner groups initiated the largest ecosystem restoration project in the USFS Southern Region. The project encompasses 60,000 acres of the Big Piney Ranger District, Ozark-St. Francis National Forest, in Arkansas. The goal of the project is to restore structure, function, and ecological processes that will develop and sustain oak and pine woodland ecosystems. This paper describes project planning, including modeling and quantifying desired conditions, and implementation. The use and effectiveness of collaborative partnerships at multiple levels are also described.

## RESTORATION SITE LOCATIONS

Six restoration areas, ranging from 6,000 acres to 12,500 acres, were established on the Big Piney Ranger District. At the time of establishment, the areas were in the General Forest Management Area of the 1986 Ozark-St. Francis Land and Resource Management Plan. Under the Revised Land and Resource Management Plan (USDA FS 2005), the areas are in the oak woodland and pine woodland management areas. The six sites are primarily in the Lower Boston Mountains Subsection. The location of each restoration area within this subsection represents one or more of the land type associations (LTAs) (USDA FS 1997) that occur on the District.

## PROJECT DEVELOPMENT

### Collaborative Partnerships

Collaborative partnerships at multiple levels have formed to address the current state of declining forest health throughout the Ozark Highlands. The ecosystem restoration project described here is supported by the Oak Ecosystem Restoration Team, which includes representatives from the Arkansas Wildlife Federation, Arkansas Game and Fish Commission, Arkansas Forestry Commission, Arkansas Natural Heritage Commission, U.S. Fish and Wildlife Service, University of Arkansas Cooperative Extension Service, The Nature Conservancy (TNC), USFS, and USFS - Southern Research Station. The Oak Ecosystem Team has selected the Big Piney Ranger District's Ecosystem Restoration Project as a demonstration site for the restoration of fire-adapted woodland ecosystems in the Ozark Highlands. The partnership uses this demonstration site to host public, private, and legislative tours and to provide information on current and desired ecological conditions and strategies for achieving ecosystem restoration objectives.

The ecosystem restoration project is also part of the Fire Learning Network (FLN), a collaborative project between the USFS, Department of the Interior, and TNC. The FLN promotes the development and testing of creative,

Figure 1.—Current condition of a degraded oak-hickory woodland.

adaptive, multi-ownership fire management strategies that are compatible with the National Fire Plan goals and TNC's conservation goals. The network strives to achieve tangible results at landscape and ecoregional scales. Projects within the network have completed ecological models, developed spatially explicit maps of current and desired future conditions, developed alternative management scenarios for ecological restoration, and developed broad-based monitoring programs to track progress toward achieving desired future conditions.

## Landscape Assessment

Based on an analysis of the Government Land Office (GLO) records, Foti (2004) concluded that 67 percent of the Ozark Highlands presettlement landscape was composed of open woodlands, savanna, and prairie. On the Big Piney, open woodlands occurred most frequently on ridge tops, flats, and south-facing slopes and less frequently on upper north-facing slopes, toe slopes, and bottoms. Mid and lower north-facing slopes were more densely forested. Oak, oak-pine, and pine woodlands occurred on about 80 percent of the land area of the district during presettlement times.

In 2002 oak and pine woodlands covered less than 6 percent of the land area. The Big Piney Ranger District and its partners identified 60,000 acres in six areas (Middlefork-12,200 acres, Rotary Ann-12,500 acres, Piney-12,200 acres, Oak Mt.- 6,000 acres, Eastside-11,300 acres, Southfork- 6,000 acres) for a long-term ecosystem restoration project. Project area boundaries adjoin about 14,000 acres of private property; almost 1,100 acres of private property are inside the designated restoration areas, providing opportunities for public-private partnerships.

## Ecological Models

To develop an understanding of how the ecosystems within the project area function, the project team and partners collaboratively developed and quantified conceptual ecological models using the Vegetation Dynamics Development Tool (Beukema et al. 2003). This process expanded the partners' ecological understanding and aligned alternative treatment options with the desired condition (plant community structure and species composition) envisioned for the landscape.

**Quantifying and Mapping the Current Condition**

We used the NatureServe (www.natureserve.org) classification system to identify seven cover types: *Oak-Hickory Closed Canopy, Oak-Hickory Woodland, Oak-Pine Closed Canopy Forest, Oak-Pine Woodland/Savanna, Shortleaf Pine Closed Canopy Forest, Shortleaf Pine Woodland/Savanna,* and *Sandstone Glade.* We used these cover types and three data sets (land type-associations, land types, and USFS Natural Resource Information

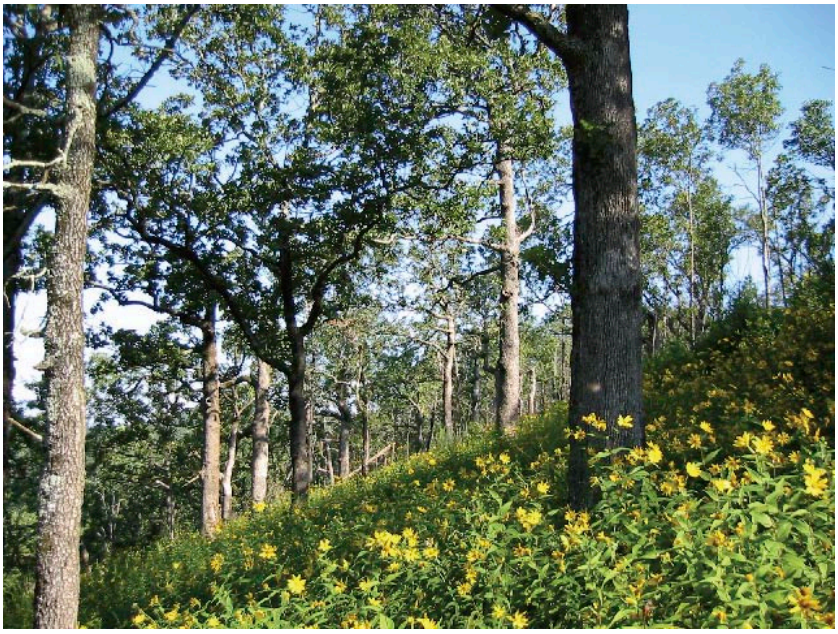

Figure 2.—Desired condition of a restored oak-hickory woodland.

System FSVeg cover types) to define and map current ecological conditions. LTAs (USDA FS 1997) were used to qualitatively map the plant communities that occur within the project area: the Mesic Morrow Mountain Uplands, Bloyd Mountain Valleys, Lower Atoka Hills and Mountains, and the Arkansas Valley Hills. Each LTA was mapped and overlaid with the current cover types derived from ground-truthed orthophoto quads and FSVeg data. A land type (subdivision of LTA) combines a suite of ecological characteristics (soil type, aspect, slope, and climate conditions) that distinguish it from other land types. We classified land types as riparian, toe slope, south slope (lower, middle, and upper), ridge top, and north slope (lower, middle, and upper). This information was projected across the project area. Current cover types were quantified for the project areas (Table 1).

### Desired Conditions

Information used to develop the scientific justification for the desired condition included historical accounts, dendrochronological studies, GLO records, scientific literature, and the information inherent to the Ecological Classification System. The desired condition of each cover type was quantified, described, and delineated across the project area using geographic information systems. Cover types were mapped to depict their locations under the historical fire regime. Once this process was completed, the desired conditions were presented to the project partners in a collaborative, peer-reviewed process (FLN 2002b) to refine the product (Table 1).

## PROJECT IMPLEMENTATION

We developed a 10-year implementation plan that strategically identifies five key areas crucial to the project's success: (1) prescribed fire; (2) public outreach; (3) noncommercial mechanical treatments; (4) commercial timber sales; and (5) monitoring. The purpose of the 10-year work plan was to set annual implementation targets

**Table 1.—Quantification of current and desired conditions**

| Cover Type | Current Condition (%) | Desired Condition (%) |
|---|---|---|
| Oak-Hickory Closed Canopy Forest[a] | 75 | 16 |
| Oak-Hickory Woodland | 1 | 35 |
| Oak-Pine Closed Canopy Forest | 8 | 0 |
| Oak-Pine Woodland/ Savanna | 4 | 38 |
| Shortleaf Pine Closed Canopy Forest | 10 | 0 |
| Shortleaf Pine Woodland/Savanna | 1 | 10 |
| Glade/Prairie | 1 | 1 |

[a]Includes degraded Oak-Hickory Woodland currently classified as Forest.

**Table 2.—Restoration Treatments for 2004-2014**

| Project Area | Prescribed Fire | Thinning |
|---|---|---|
| Middle Fork | 12,200 acres | 4,300 acres |
| Piney | 12,000 acres | 6,705 acres |
| Rotary Ann | 12,500 acres | 4,478 acres |
| South Fork | 6,000 acres | 2,830 acres |
| Oak Mountain | 6,000 acres | 4,122 acres |
| East Side | 11,300 acres | 5,816 acres |

for all staff (U.S. Forest Service and partners) working on the project and to track progress toward achieving the desired condition. Management actions with National Environmental Policy Act (NEPA) requirements were approved for the Middle Fork area in 2002. By 2004, all management action planning and NEPA requirements were completed for the remaining five restoration areas. Table 2 outlines the management actions planned for each restoration area. These actions will significantly move the ecosystems toward the desired overstory structural condition within 10 years.

## Public Relations and Educational Strategies

The team developed public relations education strategies through the planning process (FLN 2002a). Defining these strategies broadens the thinking behind restoration implementation by identifying possible barriers and by exploring a variety of issues that are generally not captured with traditional planning efforts. The FLN team identified the need to develop public support for the use of prescribed fire and mechanical thinning for this ecosystem restoration project and specifically the need to deal with the public's concerns about smoke pollution. Furthermore, the team recommended addressing credibility issues with the public, enhancing collaborative relationships with partners, and developing an outreach process to include new partners.

## Prescribed Burning

Prescribed fire is crucial in meeting desired ecological conditions. The desired fire regime includes a fire return interval that ranges from 2 to 5 years with the entire area being burned 2 to 4 times during the duration of the project (10 years). Both the seasonality and severity of fire are adjusted to achieve the desired ecological condition. Dormant-season fires are used in parts of the project area to reduce fuel loads. A combination of dormant- and growing-season fire is used to achieve the desired fire effects on plant community structure and composition.

Since the inception of the restoration project in 2002 through mid-2008, 100,000 acres have been burned (some units burned multiple times). Most of these large-scale burns have taken place in the dormant or early growing season (January-April). The average size of a single-day burn is about 2,000 acres. Multiple-day burn units are up to 5,500 acres. Less than 5 percent of the acreage has been burned in the summer. The largest growing-season burn spanned 10 days (June 24- July 4, 2006), due to the limited availability of a helicopter for aerial ignition. The historic fire regime is being restored on public and private lands.

## Mechanical Treatments

Mechanical treatments are conducted on both public and private land. For the public lands, treatments are implemented using commercial timber sales, wildlife stand improvement thinning, public firewood cuts, and salvage sales to remove oak-decline affected trees. For private lands, the Forest Land Enhancement Program, Stewardship Incentive Program, and the Forest Incentive Program are being used. The treatments reduce overstory basal area and stem density and move the overstory structure and composition toward the desired condition. To accomplish a reduction in overstory basal area (BA), oak-dominated and mixed oak-pine stands are thinned to a BA of 40 to 60 square feet per acre. Pine-dominated stands are thinned to a BA of 50 to 70 square feet per acre. All thinnings remove the smaller diameter mid-story and co-dominant trees. Hardwood leave trees are selected to favor the historically dominant white and post oaks. As of mid-2008, 12,000 acres have been thinned to the desired condition.

## Monitoring and Adaptive Management

Collaborative landscape-scale monitoring and adaptive management protocols have been developed for the restoration project. Monitoring components include fire effects on vegetation, fuel loading, and birds. The ecological monitoring program was developed by

the Big Piney Ranger District, TNC, and Arkansas Natural Heritage Commission and reviewed by the Oak Ecosystem Restoration Team. The monitoring program documents and quantifies movement toward the desired condition, fuels reduction, and forest health. Specifically, the program includes monitoring goals, project success criteria, macro-plots sampling methodology, and nine individual monitoring protocols to determine whether the project is meeting success criteria defined by all partners.

The plant community monitoring component was established to answer two questions: (1) Are project activities reducing hazardous fuels within the project area; and (2) are the treatments moving the project area toward the structural and compositional desired ecological conditions? The monitoring utilizes a nested quadrat method with four, 3.25-ft x 3.25-ft herbaceous quadrats and two 11-ft radius shrub quadrats nested within one 33-ft radius tree plot. Analyses indicate treated areas (one to two prescribed fires) have fewer stems per acre, fewer shade-tolerant species, and increased herbaceous diversity.

## CONCLUSION

The Oak Ecosystem Restoration and Fire Learning Network teams and Big Piney Ranger District identified 60,000 acres for a long-term woodland ecosystem restoration project in 2002. This is one of the largest, most successful restoration projects in the Forest Service Southern Region. It serves as a model for designated Oak and Pine Woodland Management Areas (252,333 acres) in the Revised Land and Resources Management Plan for the Ozark-St. Francis National Forests (USDA Forest Service 2005).

Collaborative landscape-scale fire restoration in the Ozark Highlands of Arkansas depends on a multi-partner approach, a defined project vision, quantification of current and desired conditions, information transfer, and a monitoring program to track progress toward achieving the desired condition. Partners bring expertise from a variety of backgrounds with diverse skill sets, resources, and expertise and are key to the success in landscape-scale restoration projects. A collaboratively developed project plan and vision outlining the steps needed to achieve the desired ecological outcomes are crucial for successful partnerships. This project integrates the ecological rationale for restoration with education and outreach to the public and a diverse suite of partners. A successful partnership has been formed with a common vision for sustainable restored ecosystems of oak and pine woodlands. Public support for restoring historic fire regimes and reducing hazardous fuels has strengthened. The project demonstrates the successful restoration of ecosystem structure and function in oak and shortleaf pine ecosystems within the Ozark - St. Francis National Forest and responds to the need to implement landscape-scale treatments on woodland ecosystems administered by the USFS (USDA FS 2005).

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