TITLE: Effects of prescribed fire on upland oak forest ecosystems in Missouri Ozarks

(THIS REQUEST IS FOR RENEWAL FUNDING: (YEAR 2 OF 3)
LOCATION: North Central Region
DURATION: 3 years **FUNDING SOURCE:** Fire Plan EM

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PROJECT OBJECTIVES:

1. Compare the structural and compositional characteristics of unburned and burned upland oak forests using repeated measures data with treatments ranging from no fire to 8 years of annual burning.
2. Develop indicators and/or indices which predict the impact of fire treatments on forest size structure, species composition, and ecosystem function. Evaluate the effects of ecological land type (ELT) on forest response.
3. Assist the The Nature Conservancy (TNC) to collect down woody material (DWM) data on the 250 burned plots (repeated prescribed fires) in Chilton Creek Unit in order to quantify the effects of fire on DWM across the full range of burning treatments. Utilize the FIA and FHM DWM sampling protocols to ensure the results are compatible with a wide range of other short- and long-term monitoring programs.
4. Design a generalized mixed model (GMM) statistical framework for analysis of both short- and long-term fire effects on forest size structure and/or woody species composition.

JUSTIFICATION:

Historically fire played an important role in establishing the upland oak ecosystems that dominate much of the Midwest. Fire and associated disturbances shaped the current forest size/age structure and species composition; the absence for fire is now shaping the composition and structure of future forests. Understanding the ecological effects of different fire regimes and their interactions with ecological land type/site factors is critical to the health of the upland oak forest ecosystems managed for timber, wildlife, recreation, and biodiversity. Two long-term, ecosystem-scale studies in the Ozark Highlands provide a unique opportunity to compare and quantify the effects of no treatment, even-aged timber management, uneven-aged timber management, and prescribed fire (at multiple intervals) on forest species composition, size structure, and down woody material.

DESCRIPTION:

a. Background: Prior to the 1950s, wildfires were frequent and widespread in the Ozark Highland and much of the eastern deciduous forests (Russell 1983; Guyette and Cutter 1991, 1994; Abrams 1992; Jenkins et al. 1997). The Ozark Highlands (Ecological Section 222, Keys et al. 1995) maintained a mosaic of oak/pine

woodland-savanna-glade vegetation which originated from fire regimes that varied in terms of frequency, intensity and season (which in turn were affected by topography, fuel load condition, and other natural and anthropogenic factors). Today, the Ozark Highland woodland-savanna-glade mosaic is being gradually replaced by a large contiguous block of high-density oak-hickory forest due to extensive fire suppression and widespread application of other management practices that have relatively little impact on the forest overstory. The transition of vegetation structure and composition has resulted in a series of conservation and forest health concerns such as habitat loss for early successional species (Thompson 2003), red oak decline (Fan et al. in review), and loss of biodiversity.

In 1989, the Missouri Department of Conservation launched a century-long project, the Missouri Ozark Forest Ecosystem Project (MOFEP), to understand effects of even-aged, uneven-aged, and no harvesting management on multiple ecosystem attributes in the Ozark Highland through a landscape-scale experimental approach (Brookshire et al. 1997, Shifley and Brookshire 2000, Shifley and Kabrick 2002). In 1996, the Nature Conservancy initiated an adjacent long-term Chilton Creek Prescribed Burning Project (CCPBP) to study response of forest ecosystems to prescribed burning alternatives. In total, 898 half-acre permanent plots were established on a landscape of 15,000 acres for data collection and monitoring. Over the years, both MOFEP and CCPBP have comprehensively inventoried forest vegetation and great amounts of data have been accumulated for analysis. Many researchers have used subsets of the MOFEP and CCPBP data to examine specific ecosystem components including cavity trees (Jensen et al.2002, Fan et al. 2003a, 2003b, 2004a, 2004b), snags (Shifley et al. 1997), down woody material (Spetich et al. 1999), acorns (Vangilder 1997, Sullivan 2001), oak regeneration (Dey and Hartman 2005) and composition and abundance of herbaceous and woody species (Kabrick et al. 2002, Grabner and Zenner 2002), and biological diversity. To date, however, no studies in this region have been conducted to compare and contrast forest changes in response to a full range of disturbance effects from no treatment, to timber harvesting (two treatments), to prescribed burning (5 treatments) in an integrated and comprehensive way, nor to link these findings with FIA/FHM data, nor to uncover ecosystem responses to prescribed burning and timber management alternatives. The proposed objectives are designed to make those comparisons.

b. Methods: Compile data from MOFEP, CCPBP and FIA/FHM sources. Initiate new field inventories to sample DWM for CCPBP plots. For each of nearly 1,000 inventory plots organize estimates of DWM, ecological land type, species composition, forest size structure, forest density, site quality, and recent disturbance history. Estimate mean values for DWM and live tree species composition by treatment type and stand size class. Use categorical regression tree analysis (CART) and other parametric and non parametric procedures to identify the plot-level factors (including harvest and prescribed fire treatments) that are the best indicators of statistically different levels of DWM and of seedling/sapling tree species composition.

c. Products: Reports and manuscripts on the following topics:
1. Summaries (mean and variation) of DWM, forest size class, and species composition by for treatments of no harvest, even-aged management with clearcutting, uneven-aged management with selection and group selection, and prescribed fire repeated at an interval of 1 to 8 years
2. Analyses of the factors that result in statistically significant differences in DWM, forest size structure, and seeding/sapling tree species composition.
3. Tools or guidelines that help forest managers select management disturbance regimes that are compatible with their goals for DWM, forest size structure, and species composition of forest regeneration.

d. Schedule of Activities: (Based on elapsed time from date of award)

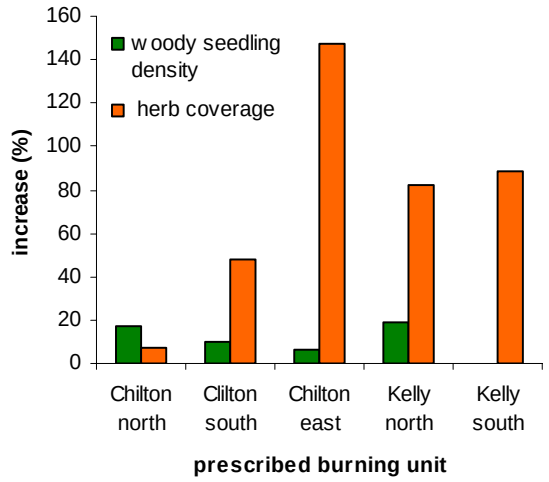
Year 1:	Month 1 to 8:	Exploratory data analysis to identify down and dead woody material pattern and associated stand/site factors for MOFEP and FIA/FHM data. Begin field inventory of DWM on CCPBP sites.
	Month 9 to 12:	Develop confirmatory statistical/computer models. Continue field inventory.
Year 2:	Month 1 to 7:	GIS work and generate dead and down woody material maps at appropriate scales based on current FIA/FHM and intensive monitoring plots.

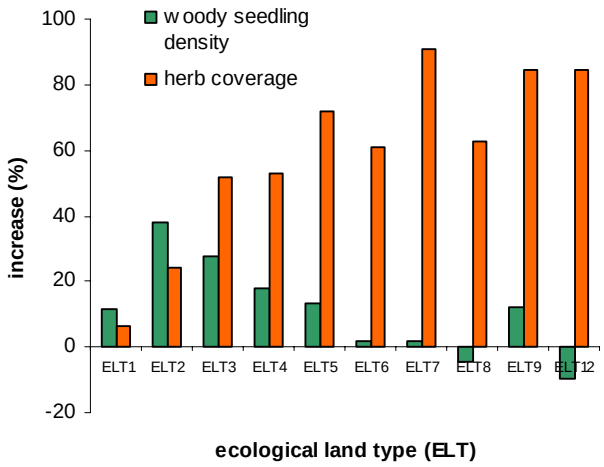
Month 8 to 12 Simulate down and dead woody material change under management alternatives
Year 3: Month 1 to 6: Model evaluation and quantify prediction accuracy across scales
Month 7 to 12 Study reports, graduate thesis, and manuscript preparation

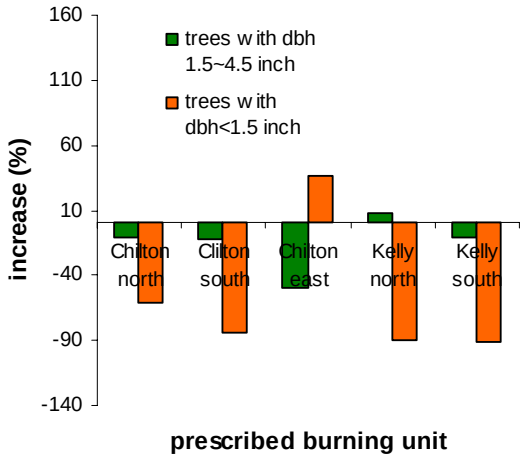
e. Progress/Accomplishments: We analyzed changes of DWM, overstory (>4.5 inch dbh), mid-story (1.5-4.5 inch dbh), understory (<1.5 inch dbh, but height>4.5ft) and ground layer (woody seedling and herbaceous species) under 5 fire regimes and on 10 ecological land types. We found fire had a significant impact on ground layer, mid- and under- story vegetation characteristics but not on the DWM and overstory. Fire effects changed with ecological land type and pre-vegetation condition. On most ecological land types, fire reduced the density of mid- and under-story trees, but increased the coverage of herbaceous species and the density of woody seedlings (<4.5 ft) (Figure 1).

We extensively analyzed the effect of fire on overstory tree mortality and built a statistical model to show how ecological land type, fire regime and stand and tree characteristics interact and influence mortality. Given a longer time period, fire will change overstory characteristics based on this model. This has important implications for using fire to reduce stand stocking to restore historical vegetation types such as oak and pine woodlands and savannas in the Ozark Highlands.

In the coming year we will use multivariate techniques to analyze responses of species and/or functional groups to prescribed burning and the distribution of DWM by species and decay classes.







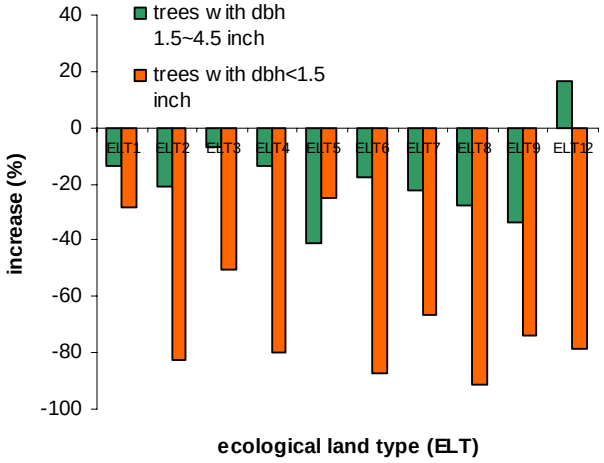


Figure 1. Impact of fire on ground layer, under- and mid-story vegetation on Chilton Creek's prescribed burning sites, Missouri. (ELTs 1 to 7 have low water and nutrient capacity compared with ELTs 8, 9 and 12 (good sites); Chilton north and east burned once in 1998, Chilton south burned three times (1998, 1999, 2002), Kelly south burned three times (1998, 2000, 2001), and Kelly north burned four times (1998, 1999, 2000, 2001)

COSTS:

		Item	**Requested Funding**	**Other-Funding**	**Source**
Year 1	**Administration**	Salary and Benefits Research Assoc. (4 mo.) Graduate student (12 mo.)	$20,326 $15,000	$25,000	Contributed salary and benefits for cooperators
		Travel	$,2800	$2,000	Cooperators
		Overhead Univ of MO (25%) NCRS (5%)	$12,809 $2,697		
	Procurements	Supplies	$ 300		
	TOTAL YEAR 1		**$53,931**		
Year 2	**Administration**	Salary and Benefits Research Assoc. (4 mo.) Graduate student (12 mo.)	$21,663 $15,900	$25,000	Contributed salary and benefits for cooperators
		Travel	$3,000	$2,000	Cooperators
		Overhead Univ of MO (25%) NCRS (5%)	$13,688 $2,882		
	Procurements	Supplies	$ 500		
	TOTAL YEAR 2		**$57,632**		
Year 3	**Administration**	Salary and Benefits Research Assoc. (4 mo.) Graduate student (12 mo.)	$23,803 $16,854	$25,000	Contributed salary and benefits for cooperators
		Travel	$3,000	$2,000	Cooperators
		Overhead Univ of MO (25%) NCRS (5%)	$14,791 $3,099		
	Procurements	Supplies	$ 500		
	TOTAL YEAR 3		**$61,975**		
Total Project			**$173,538**		

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