The influence of pre-burn stand variability on prescribed fire success

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Introduction

The southern Appalachians have seen a dramatic increase in prescribed burning during the past decade, much of it designed to recreate conditions that have been altered by approximately 80 years of fire suppression. While fuel reduction is often cited as a primary objective, an overarching goal of many prescribed burns is to restore or maintain fire-adapted plant communities. Partner organizations within the Southern Blue Ridge Fire Learning Network (SBRFLN) are exploring the role of prescribed fire in the southern Appalachians. The SBRFLN has identified four forest communities in greatest need of fire restoration. These include shortleaf pine-oak, pine-oak heath, dry-mesic oak-hickory, and high-elevation red oak. SBRFLN is monitoring fire effects on 13 burn units extending from eastern Tennessee through western North Carolina and into north Georgia (Fig. 1, Table 1). Forest overstory, forest regeneration, vegetative life forms, and fuels data are being collected from permanent plots located both within and adjacent to each burn unit. Pre-burn condition has been assessed for all burn units. Initial burns have been completed on 10 units, and fire effects (assessed during the 2nd growing season post-burn) have been evaluated on 7 units. Monitoring results indicate there is considerable variability in preburn forest condition within each target community, and this variability has the potential to significantly affect (1) changes in stand structure required to achieve desired condition, (2) fire behavior, and (3) post-burn stand condition. This variability must be considered when assessing the role of fire as a restoration tool at the landscape level.

Methods

Field Methods

All sites are being monitored to evaluate the effects of operational prescribed burns on restoration and other management objectives. Sampling is conducted using a series of 1/10th acre permanent plots. For most units,15 plots are located inside the proposed burn unit. Plots are randomly located in areas dominated by the target restoration communities as defined by Simon (2011). An additional 5 control plots are located outside burn unit. Baseline data were collected prior to burning in all units. A brief description of the data collected in each plot includes:

•***Overstory***: Species, DBH, crown class, and condition for all tree species > 2 inches DBH

•***Regeneration*** (data collected in 1/50 ac subplots). Species and height of all tree species > 1 ft tall and < 2 in. DBH were recorded. Sprout clumps were treated as a single stem.

•***Ground cover*** and ***vegetative life forms*** (estimated in 1/50 ac subplots): percent cover was estimated.

Plot and Burn Unit Characterization

Ecozone were identified Simon (2011) using a number of topographic and ecological variables to model ecological units. We used GIS to estimate the area of each ecozone in each burn unit (Table 2), and assign an ecozone to each field plot.

An ***Arboreal Moisture Index (AMI)*** was developed based on procedures developed by McNab et al. (2003) Each tree > 2 inches DBH in a plot was assigned a moisture index value based on site conditions where that species is typically found in the southern Appalachians. An AMI was then calculated for each field plot by averaging the values for all trees in the plot.

A ***Mesophitic Index (MesIND)*** was developed to allow consideration of the potential mesophication of forest communities postulated by Nowaki and Abrams (2008), and to relate current forest condition to predicted ecozone. MesIND was calculated as the percent of BA in a plot made up of trees indicative of mesophication, such as red maple, sugar maple, beech, blackgum, and cherry.

Fire Effects measured soon after a single burn are typically short-lived and rarely initiate long-term changes in stand composition (Brose et al, 2012). For the purposes of this paper we considered 2 variables that are likely directly effected by fire and may lead to changes in stand composition of structure. These include:

•**Understory mortality** estimated by (1) post-burn mortality of stems in the 2 to 6 inch DBH class, and (2) post-burn reduction in basal area in trees in the Intermediate and Overtopped crown classes.

•**Changes in advanced regeneration density** following the burn.

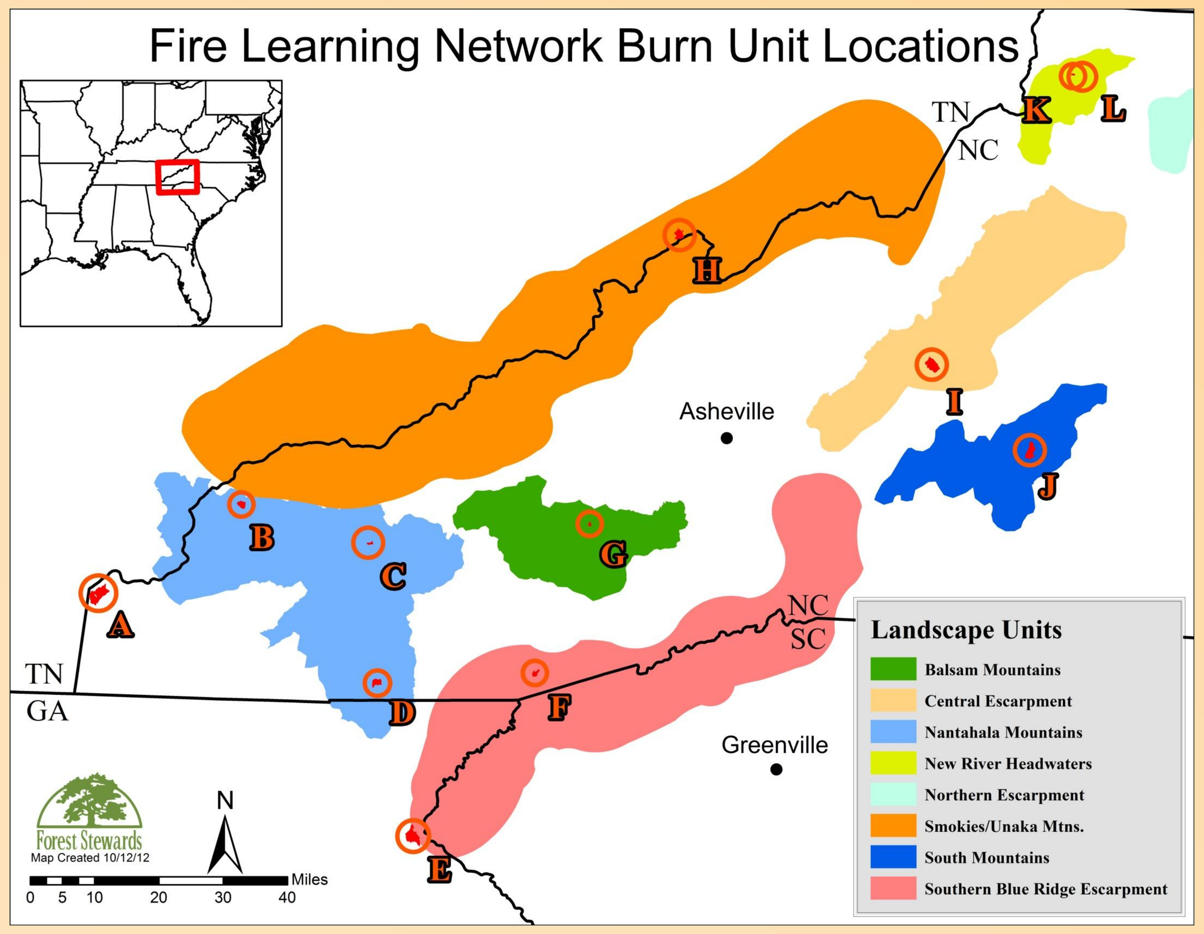

Figure 1. Location and description of SBRFLN burn units

Table 1. Characteristics of Southern Blue Ridge Fire Learning Network demonstration units

Map code	Burn unit name	Target communities		Pre-burn Sampling	1st Burn	Post-1st burn#1 sampling	2nd burn	Post-2nd burn sampling
A	Flat Branch	Shortleaf pine-oak		Summer 2010	SPR 2011	SUM 2012		
B	Yellow Creek	Shortleaf pine-oak	Pine-oak-heath	Summer 2010	Apr 2010	SUM 2011		
C	Needmore	Shortleaf pine-oak	Pine-oak-heath	Summer 2010	SPR 2011	SUM 2012	SPR 2014	SUM 2016
D	Steeltrap Knob	High elevation red oak	Dry mesic oak-hickory	Summer 2010	Nov 2011	SUM 2012		
E	Tugalo Village	Shortleaf pine-oak		Summer 2010	SPR 2013	SUM 2014		
F	Silver Run	Dry mesic oak-hickory		Summer 2010	SPR 2013	SUM 2014		
G	Cold Mountain #1	High elevation red oak	Dry mesic oak-hickory	Summer 2006	Mar 2007	SUM 2007[1]	Apr. 2010	July 2011
G	Cold Mountain #2	High elevation red oak	Dry mesic oak-hickory	Summer 2009	Apr 2010	SUM 2011	SPR 2013	SUM 2015
H	Davis Creek	High elevation red oak	Dry mesic oak-hickory	Summer 2010	SPR 2013	SUM 2014		
I	Lake James	Shortleaf pine-oak		Summer 2010	Mar 2011	SUM 2012		
J	Woods Gap	Dry mesic oak-hickory		Summer2011	SPR 2012	SUM 2013		
K	Bluff Mountain	High elevation red oak		Summer 2009	F 2011	SUM 2013		
L	3 top Mountain	High elevation red oak		Summer 2010	F 2011	SUM 2013		

Completed   Scheduled

Map code	Burn Unit	Area of different forest cover types in each burn unit (acres)							
		Acidic Cove	Dry Mesic Oak	HERO	Montane Oak Hickory	Pine-Oak Heath	Rich Cove	Shortleaf Pine Oak	Total unit area
A	FlatBranch	228	180		116			755	**1,279**
B	YellowCreek	148	190		102	101	183	5	**728**
C	Needmore	78	5		14	2		105	**205**
D	Steeltrap	166	151	120	385	1	12		**835**
E	Tugalo Vil	91	892		127	1	4	1,311	**2,426**
F	SilverRun	73	334		56		0		**463**
G	ColdMtn1	0		0	59	1	11		**70**
G	ColdMtn2	0		4	49	1	38		**92**
H	DavisCrk	174	55	29	471	198	118		**1,045**
I	LakeJames	516	895		23	180		339	**1,954**
J	WoodsGap	185	759		448	208	31	1	**1,632**
K	Bluff Mtn			57	16				**73**
L	3 Top Mtn	1		40	52		1		**94**
Cover type area		**1,660**	**3,462**	**250**	**1,919**	**693**	**398**	**2,515**	**10,897**

Table 2. Area of major ecozones within each burn unit (note, Acidic Cove areas were avoided during plot location)

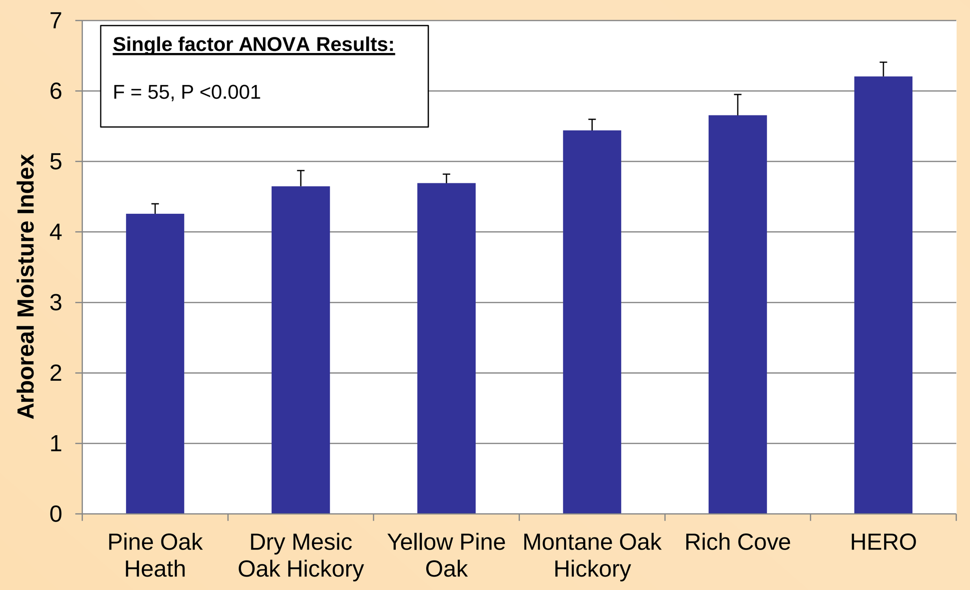

Figure 2. Mean and standard error of the Arboreal Moisture Index for each ecozone

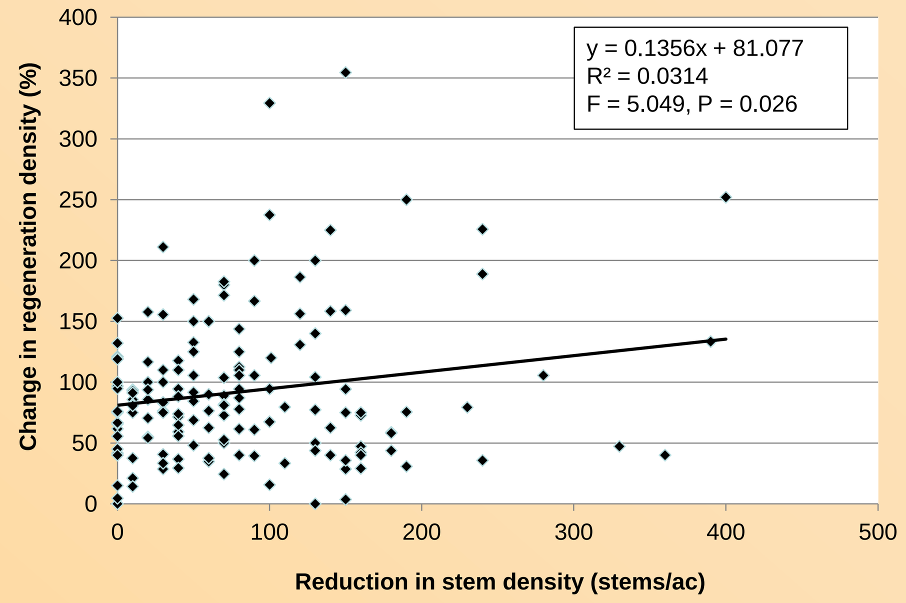

Figure 5. Relationship between the reduction in density of trees between 2 and 6 inches DBH and the percent change in regeneration density following a single burn

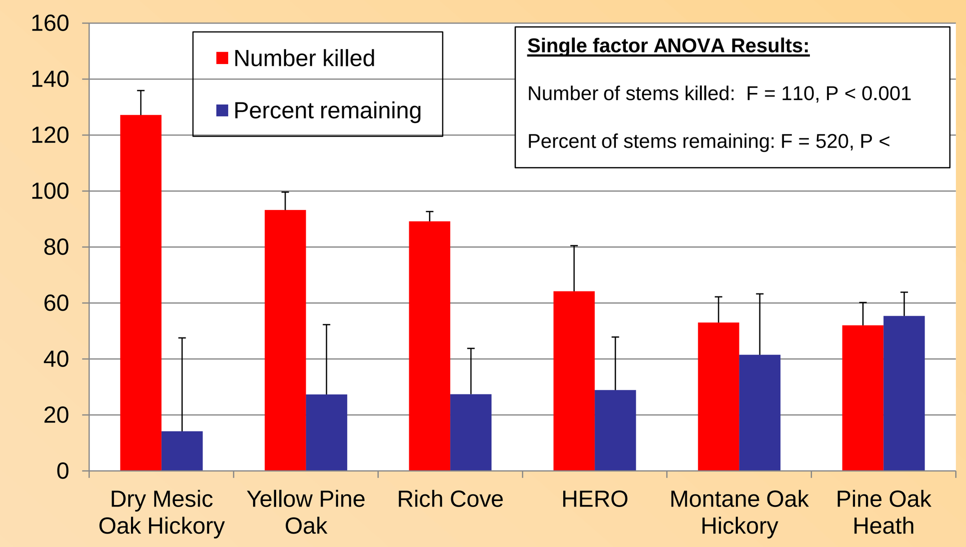

Figure 3. Mean and standard error for the number of 2 to 6 inch DBH trees killed (stems/acre) and the percent of trees 2 to 6 inches DBH remaining after a single burn for each ecozone

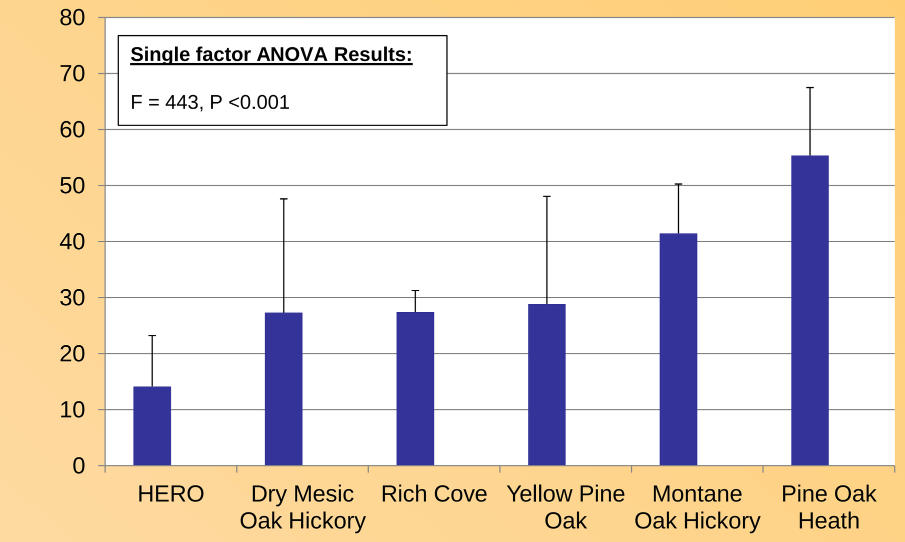

Figure 4. Mean and standard error for percent in basal area reduction in intermediate and overtopped crown classes following a single burn for each ecozone

Results

- Higher elevation burn units are dominated by Dry Mesic Oak and Montane Oak Hickory ecozones while units and lower elevations are dominated by Shortleaf Pine Oak (Table 2)
- The current vegetative composition seemed consistent with the ecozone model. High Elevation Red Oak and Rich Cove ecozones contained more mesophitic vegetation than did the drier pine communities (Fig. 2)
- Initial prescribed burns appeared to affect stand structure in all community types. In most cases this was evidenced by decreases in understory density and increases in advanced regeneration (Figs 3, 4, and 5).
- Ecological units responded differently in terms of understory mortality, though the number and percent of understory stems killed by a single burn did not appear to follow a logical ecological gradient. Drier communities represented both ends of the spectrum (Figs. 3 and 4)
- There was evidence that increasing amounts of understory mortality increased the density of post-burn regeneration. In many cases the post burn regeneration exceeded preburn regeneration densities.
- Our preliminary results did not show any major shift in species composition away from more mesophitic species for either the overstory or advanced regeneration.

Conclusions

- It is difficult to identify clear and consistent trends when analyzing the effects of large, landscape scale prescribed burns. This is likely due to a number of interacting factors including variability in stand and topographic properties, weather conditions, and fire behavior. Fire behavior is also greatly affected by lighting strategies and other fire implementation practices.
- While the complexity of factors will continue to make it difficult for resource managers to predict prescribed burning outcomes, this study demonstrates that some fire effects may be correlated with landscape and other ecological variables that may ultimately provide more insight at the landscape scale.
- Prescribed fire success is a difficult concept to define and one that must consider long-term changes in stand structure and forest composition. We hope continued monitoring in these sites will help better define success, and provide managers with better information for achieving it.

Literature cited

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Acknowledgements

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