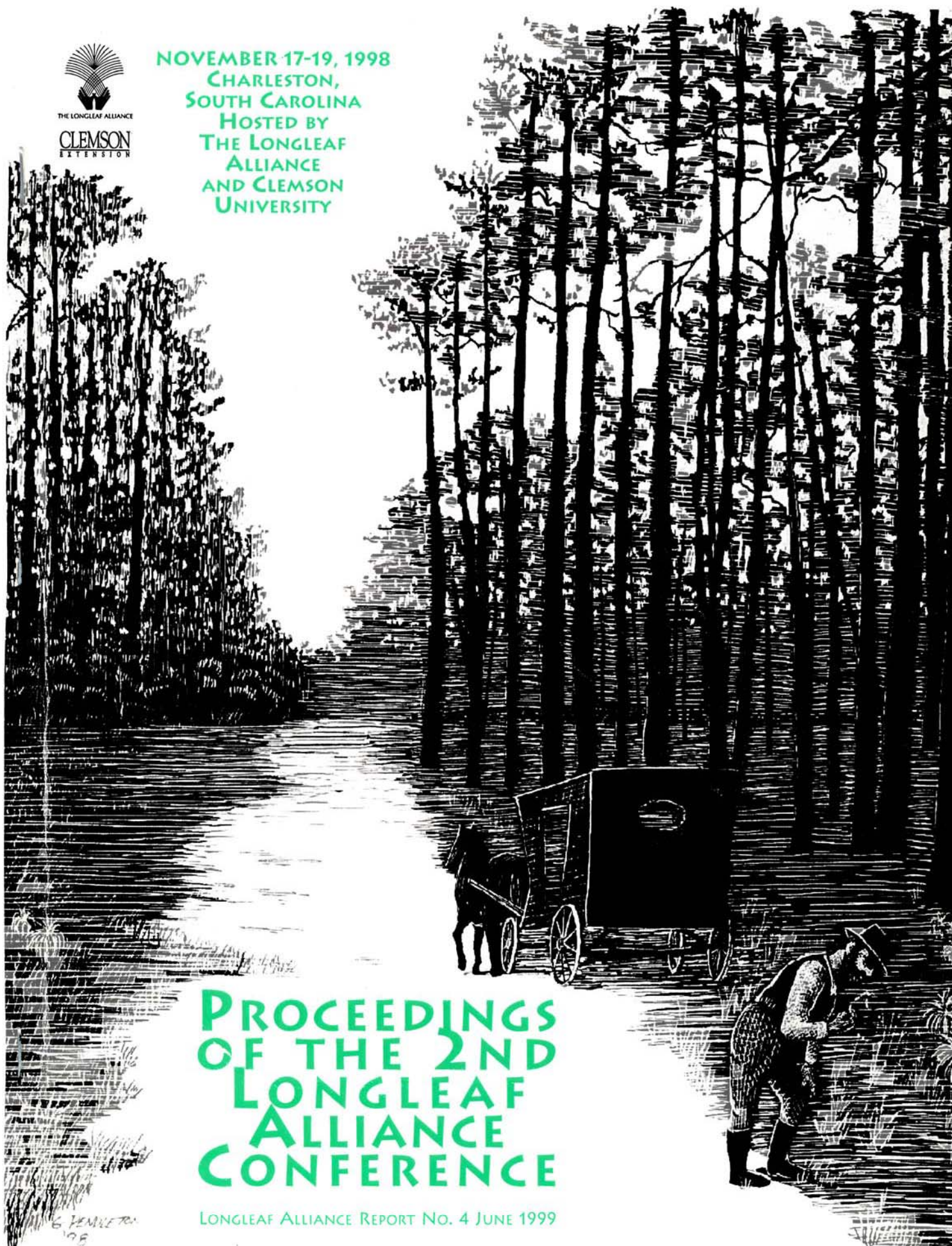




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The influence of vegetation structure and understory composition on burn heterogeneity in longleaf pine forests

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ABSTRACT: Fire created mosaics are important to wildlife and tree regeneration in forests of the southeastern United States. While many factors such as fuel load and weather conditions affect heterogeneity of prescribed fire, the influence of vegetation composition and structure on fire heterogeneity has gone unquantified. Because wiregrass (*Aristida* spp.) burns so easily, understories in longleaf pine (*Pinus palustris*) forests dominated by wiregrass may burn more homogeneously than desired while "old-field" understories (those dominated by *Andropogon* spp.) may produce the desired mosaic of burned and unburned patches. We examined burn heterogeneity following operational prescribed fire in large areas classified as having either wiregrass or "old-field" understories. Vegetation characteristics were sampled before and after prescribed fires, and unburned patches were delineated. As postulated "old-field" areas produced a more heterogeneous burn pattern, but heterogeneity was predominantly generated by fine scale variation in vegetation structure (e.g., hardwood clusters) rather than being a function of the larger-scale understory classification. Based upon these results we initiated additional studies to quantify the importance of patch characteristics to wildlife diversity and abundance, and to longleaf pine regeneration.

INTRODUCTION

Longleaf pine forests have declined drastically from their historical range (Myers 1990, Stout and Marion 1993) and recently much consideration has been given to restoring this forest type in its natural habitat. Current longleaf restoration efforts emphasize the importance of wiregrass in the understory (Brockway and Lewis 1997, Streng et al. 1993). Unfortunately, wiregrass restoration is costly, and the functional and ecological role of wiregrass in longleaf forests is unclear.

While weather conditions and fuel loads can affect heterogeneity of the burn pattern, vegetation characteristics likely affect the pattern as well. Wiregrass dominated understories burn more completely and under more diverse weather conditions than other understory communities (Noss 1989, Myers 1990). Given this, we would expect fewer and smaller unburned patches (i.e., lower structural heterogeneity) following prescribed fire in wiregrass understories relative to other vegetation. However, this relationship may be confounded by structural characteristics of the vegetation.

Although many studies have addressed vegetation response to prescribed fire, few studies have investigated effects of vegetation composition and habitat structure on fire heterogeneity. Further, there has been little work that describes effects of unburned patches within a burned matrix on forest regeneration and wildlife communities, especially at an "operational" scale. The objective of this study was to identify structural and compositional characteristics of vegetation that promote or retard the formation of a heterogeneous burn pattern following prescribed fire. We hypothesized that habitat structure and composition can largely explain the presence of unburned patches in a burned matrix.

METHODS

This study was conducted at the Joseph W. Jones Ecological Research Center in Baker County, Georgia, on the southern portion of the property. Twenty burn units scheduled for prescribed fire in 1998 were chosen for study (1893 ha total area). Vegetation of these units was classified in the site GIS as dominated by wiregrass or other vegetation. Prior to the application of prescribed fire in the burn units, we systematically installed 356 plots throughout units, roughly covering 1% of the total area. Plot locations were recorded using GPS. Individual plots were circular with 10 m radius, and all trees in each plot that were ≥ 10 cm diameter at breast height were measured for diameter and identified to species. In addition, four 1-m² subplots per plot were utilized to measure understory cover in categories of wiregrass, other grass, forb, vine, woody, fern or debris. The understory of each plot was broadly classified as wiregrass, old-field, shrub-scrub, or combinations of these categories.

All or part of 18 of the original 20 units were burned as part of the prescribed burning program for the property. The prescribed fires occurred under a variety of weather conditions. After the burn unit was

burned, the preburn plots were revisited to assess whether or not they had burned. Also, unburned patches larger than 0.2 ha (0.5 acres) were mapped using GPS. Additional vegetation plots were sampled in these unburned patches to characterize their composition and structure.

The analyses were conducted at two different scales: at the level of a burn unit and an individual plot. At the burn unit-level the understory vegetation of unburned patches was compared to that in burned areas using the GIS vegetation coverages. At the individual plot level comparisons were made between measured overstory and understory characteristics in burned and unburned plots. In addition, a logistic regression model was developed to examine the combined effects of overstory and understory characteristics on the probability of a particular plot burning.

RESULTS

An analysis of the mapped patches at the burn unit-level showed that, within burn units, unburned patches occurred in wiregrass less than expected (Figure 1). Similarly, the plot-level analyses indicated that grass and grass/shrub-scrub dominated sample plots (where the grass category included both wiregrass and other grasses) burned more often and shrub-scrub dominated plots burned less often than expected (Figure 2). A comparison of understory vegetation between burned and unburned patches indicated wiregrass, other grasses, and debris were more abundant in burned areas while woody plants were more abundant in unburned areas (Table 1).

Plots that burned had high basal areas in longleaf pine, while those that did not burn had high basal areas in live oak or hardwoods other than southern red oak (Table 2). In general, the burned and unburned areas separated based upon the ratio of pine to hardwood (Table 3). The logistic regression analyses indicated that unburned patches are not likely in understories dominated by grasses, and wiregrass understory appears to produce a more homogeneous pattern than other grasses. Increasing hardwood dominance greatly increases the occurrence of unburned patches.

DISCUSSION AND CONCLUSION

More homogeneous burns associated with wiregrass may have negative impacts on certain management goals. For instance, although longleaf pine is fire adapted, frequent homogeneous fires may be detrimental to longleaf regeneration (Boyer and White 1990, Stout and Marion 1993). Also, it is thought that fire created mosaics benefit wildlife by increasing edge and providing greater vegetation diversity (Chandler et al. 1991). If homogeneous burn patterns are predominant with wiregrass, wiregrass understories may make the desired fire-created mosaics difficult to obtain.

Our results indicate that fire burns relatively easily in understories dominated by both wiregrass and other grasses. Thus, if a heterogeneous burn pattern is desired for regeneration or wildlife concerns and the understory is predominantly grass, other measures will be required. In our study scattered patches of hardwoods and shrubs served to break the progress of fire and create heterogeneity. Interestingly, these hardwood patches are frequently targeted for removal during restoration efforts in longleaf pine forests. Given our results this strategy may warrant further study.

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Table 1. Percent of vegetation types in burned and unburned plots, with significance values.

Vegetation Type	Burned	Unburned	P-value
Wiregrass	16.5	1.1	0.05
Other Grass	30.2	9.3	0.01
Forb	0.8	1.7	0.14
Vine	3.3	9.6	0.13
Woody	5.6	27.2	0.01
Fern	1.4	0.7	0.41
Debris	42.2	50.3	0.03

Table 2. Average tree basal areas ($m^2 ha^{-1}$) in burned and unburned areas, and associated significance values. Standard errors are in parentheses.

Basal Area Component	Burned	Unburned	P-value
Pinus palustris	9.85 (0.43)	1.47 (0.30)	0.0001
Other pines	0.24 (0.08)	0.48 (0.26)	0.30
Quercus virginiana	0.17 (0.06)	6.76 (1.17)	0.0001
Quercus falcata	1.79 (0.25)	1.16 (0.31)	0.05
Other hardwoods	0.44 (0.14)	7.64 (1.09)	0.0001

Table 3. Ratios of hardwood and pine basal areas in burned and unburned areas, and associated significance values. Standard errors are in parentheses.

<u>Proportion of Total Basal Area</u>	Burned	Unburned	P-value
Hardwood component	0.19 (0.02)	0.83 (0.006)	0.0001
Pine component	0.81 (0.02)	0.17 (0.006)	0.0001

Figure 1. Burn unit-level analysis for occurrence of unburned patches in wiregrass versus other understory types.

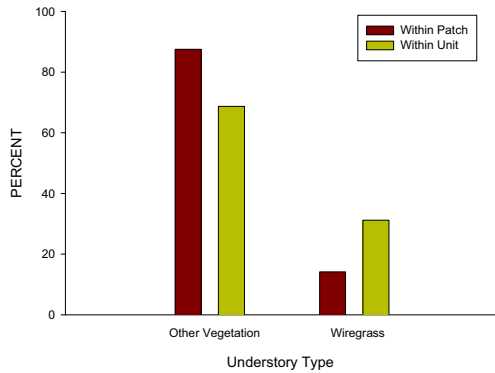


Figure 2. Plot-level analysis comparing percentage burned, by understory type, to expected distribution of burned plots.

