Fire effects monitoring: Tracking ecological change due to fire-caused disturbance

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Summary of the Abstract

Premise: Pre-burn data from a prescribed fire in October 2011 show that, in decreasing order of importance, *Schizachyrium scoparium* (little blue stem), *Solidago canadensis* (canada goldenrod), and *Andropogon gerardii* (big bluestem) are three dominant species. Fire-caused disturbance may aid in a shift of dominance from a weedy species such as canada goldenrod back to a dominant prairie grass big bluestem.

Methods: Prior to burning, our study site was measured for the vertical structure and frequency of vegetation. Other variables including weather conditions, fuel loading and composition, and burn severity, will be used to predict fire behavior which could help explain any observed changes. One year from its treatment date, the site will be measured for the same vegetative and fuel attributes.

Results: Statistical analysis of site variability was used to evaluate our sample size in order to allow for adjustments to monitoring efforts. Analysis and comparison of the pre- and post-burn vegetative data, in fall 2012, will indicate any changes in vegetative characteristics that occur.

Discussion: Here we present a synthesis of all data, hypothesize possible associations between variables, and provide examples of the practical uses of a fire monitoring program.

Introduction

Wisconsin has suffered an almost complete loss of native tallgrass prairie (Samson 1994). Big bluestem is a typical and widespread species of tallgrass prairie, with little bluestem as a strong associate (Curtis 1959, Henderson 1995).

Fire has been a defining feature in the development and maintenance of the prairie ecosystem (Pyne 1982). In the absence of fire, the accumulation of dead plant material above and within the plant canopy may significantly lower productivity (Knapp and Seastedt 1986). Many studies indicate that spring and autumn fires favor warm-season species such as big bluestem which are dormant at the time of fire (Howe 1994, Gibson and Hulbert 1987, Bragg 1982).

Numerous studies confirm the regenerative effect of fire on both bluestem species (Gibson and Hulbert 1987, Henderson et al 1982, Towne and Kemp 2003). Studies of fire effects on canada goldenrod are more variable. Studies of fire effects on canada goldenrod are more variable. Studies have shown both a regenerative effect (Towne and Kemp 2003) and a strongly suppressive effect of annual spring fires (Kucera and Koelling 1964).

Our current study focuses on a mesic prairie in Portage County, Wisconsin. The site was treated with prescribed fire in October 2011. Prior to burning, Canada goldenrod and little bluestem were dominant relative to big bluestem. While both are native tallgrass prairie associates, their dominance over big bluestem is not characteristic of Wisconsin mesic prairie stands (Curtis 1959, Henderson 1995). The purpose of this study is to determine whether or not annual fall burning will aid in bringing big bluestem to dominant status at this site.

Materials and Methods

Vegetation Sampling (Table 1)

A point intercept sampling method was used to collect vegetation data on September 25, 2011. Measurements were taken at 0.3-m intervals along two transects measuring 0-30-m. A total of 197 points were sampled. Our method was adapted from the National Park Service's Fire Monitoring Handbook (NPS-FMH).

Treatment Weather Conditions (Fig. 1)

Relevant weather conditions were recorded on November 7th, 2011 at 1500 and 1615. Ambient air temperature (°F) and relative humidity were measured with a sling psychrometer. Wind speed (mph) was measured with Dwyer brand wind meter and direction was noted using a compass. Qualitative cloud cover observations were based on codes outlined by the NPS-FMH.

Materials and Methods Continued

Fuel Loading and Composition (Fig. 2)

Fuel loading data was collected by counting the number of 1hr-1000hr fuels intersecting each transect and by collecting 10 duff and litter layer depth measurements every 3-m. These methods were closely adapted from the Fire Effects Inventory and Monitoring (FIREMON) protocol.

Burn Severity (Fig. 3)

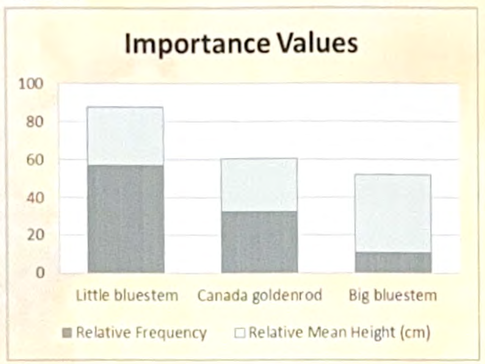
Burn severity monitoring was conducted by assigning any remaining vegetation and substrate a burn severity class rating based on a scale of 1-5 (NPS-FMH). Both vegetation and substrate received independent ratings. Seven measurements were made along each 30-m transect. Our burn severity sampling method was adapted from the NPS-FMH.

Numerical and Statistical Analysis

Importance values (Table 1) used to express dominance were calculated for our study species by summing each species' relative frequency and relative mean height. Relative frequency was calculated by considering all points at which the species was encountered along each transect regardless of vertical occurrence. Mean depth of the duff and litter layers was calculated. Our sample size was tested independently for each species of concern by using a Maximum Error of Estimate calculation, $n = \left[\frac{\sigma * z_{\alpha/2}}{E}\right]^2$. The same $z_{\alpha/2}$ value (α=0.02) was used to estimate sample size for all species and E was made to equal 5-cm.

Results

Table 1





Little bluestem

Weather Conditions	Temperature	Relative Humidity	Windspeed(Gusts)/Direction	Cloud Cover
Pre-burn	53 °F	29%	2-3(4)mph	0≤10%
Post-burn	50 °F	33%	1-2(3)mph	0≤10%

Fig. 1

Fuel Composition and Loading		
Transect	Mean Duff Depth	Mean Litter Depth
Transect 1	1.1-cm	1.2-cm
Transect 2	0.1-cm	2.6-cm
Transect 1&2	0.59-cm	1.9-cm

Fig. 2

Burn Severity	
Substrate	Vegetation
93% (4)	58% (3)
7% (5)	42% (4)
3-Lightly Burned	
4-Scorched	
5-Unburned	

Fig. 3



Canada goldenrod

Big bluestem



Results Continued

Statistical Analysis

Sample sizes of n=79 for little bluestem, n=100 for canada goldenrod, and n=175 for big bluestem were shown to be large enough to calculate an observed mean within 5-cm of an expected mean with a 0.98 probability. Our original sample size of n=197 surpasses all of these calculations.

Discussion

Sampling indicated that 93% of the sites substrate was left with the duff nearly unchanged and the litter partially blackened. Likewise, treatment weather conditions indicated that our prescribed fire was of moderate intensity with a high rate of spread. Little heat per unit area was likely received by the substrate which would explain the minimal consumption of the duff and litter layers. This may result in little increase in productivity favoring big bluestem. Different weather conditions may be required for more effective treatments.

Both big bluestem and canada goldenrod as well as the duff and litter layers showed an uneven distribution across this site. A higher presence of big bluestem correlated with shallow duff and deeper litter layers while a higher presence of canada goldenrod correlated with deeper duff and shallower litter layer. This may be relevant to a successful shift in dominance back to big bluestem and should be considered during post-burn data analysis. Developing specific objectives targeting these layers may be necessary to ensure effective treatments.

Continuing monitoring efforts will provide landowners with specific ecological information relevant to their property that may not otherwise be obtained. This information may then assist landowners in developing specific goals for their property as well as determining appropriate means to achieve those goals.

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