Measuring the Effects of a Single Prescribed Fire on Canopy Structure in an Appalachian Hardwood Forest on the Cumberland Plateau, KY

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Abstract

In the past 50 years there has been a documented decline in advanced oak (*Quercus* spp.) regeneration. One explanation for this phenomena is that with the absence of periodic natural and anthropogenic disturbances such as fire, shade tolerant species such as red maple (*Acer rubrum*) and American beech (*Fagus grandifolia*) have increased in abundance, successfully out competing oak seedlings and saplings in the low light levels created by closed canopies. In conjunction with an ongoing long-term study, we examined the effects of a single prescribed fire on canopy structure through a comparison of two different methods. Hemispherical photography was used to measure canopy cover before and after a single prescribed fire (repeated fires will be implemented next year), while spherical densiometer readings of canopy cover were taken after the fire. The effects of fire resulted in an overall decrease in stem density, due to the extensive removal of the midstory stratum. Although both hemispherical photography and spherical densiometer readings were significantly correlated with midstory density, increases in canopy openness due to fire were only detected using hemispherical photography. With increased interest in the potential use of prescribed fire as a tool to improve oak regeneration, this study shows the need for the development of both practical and accurate methods for measuring the effects of fire on canopy structure.

Introduction

- Documented lack of advanced oak regeneration coincides with the advent of successful fire suppression, as well as the loss of American chestnut and other changes in the disturbance regime.
- Intermediate shade tolerant oaks are being out competed in closed canopies with low light levels, where shade tolerant, fire susceptible species make up the midstory stratum.
- **Goal: To assess the effects of a single prescribed fire on canopy structure and compare two methods of measuring canopy cover.**

Methods

Study description

- The study was conducted on the Morehead District of the Daniel Boone National Forest, KY.
- Three study sites (~300 acres ea): Buck Creek, Chestnut Cliffs, and Wolf Pen
- Approximately 10 permanent plots (10m x 40m) were established on each treatment site, for a total of 92 plots.
- Burn treatments (control, frequent, less frequent) were applied according to a randomized complete block design.
- Prescribed fires were conducted by Forest Service personnel in March and April, 2003.
- Midstory (2-9.9cm dbh) and overstory (≥ 10cm dbh) stem densities were measured on all plots in 2002 and 2003.
- Statistical analyses were conducted using PROC REG and PROC GLM (SAS 2000).

Canopy Cover

2002

2003

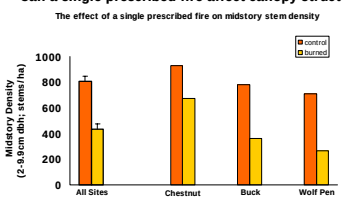
Hemispherical Photography

- Hemispherical photographs were taken only on the Buck Creek site due to topographic and time constraints, leading to pseudoreplication (N=32).
- Photographs were taken at 80cm height, in three locations per plot.
- Photographs were taken in July, 2002 and 2003.
- Photographs were analyzed using GLA 2.0 (Frazer et al. 1999).
- SAS was used to conduct a repeated measures analysis and univariate linear regressions (SAS 2000).

Spherical Densiometer

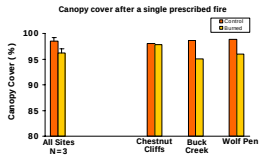
- Spherical densiometer readings were taken at 80cm height, in three locations per plot on all 92 plots.
- SAS was used to conduct univariate linear regressions and an ANOVA (SAS 2000).

Can a single prescribed fire affect canopy structure?

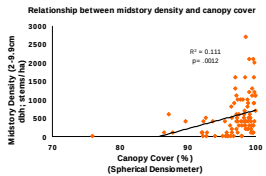


- Yes, but only at the midstory level, where smaller stems are more susceptible to mortality due to fire.
- Fire decreased midstory stem density, p=.0481.
- Although we cannot test it statistically, there appear to be differences in the effect of fire across the three sites, due to the time and intensity of the burn.

How well does the spherical densiometer reflect the midstory change?

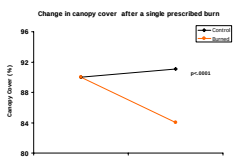


- Spherical densiometer estimates of canopy cover show no difference between the control and burned treatments (p=.3640).

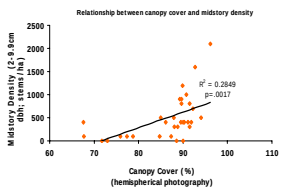


- Spherical densiometer estimates of canopy cover show a weak, yet significant correlation to midstory density.

How well does hemispherical photography reflect the midstory change?



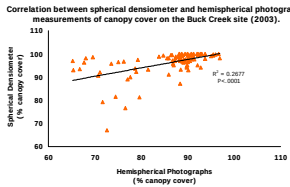
- Hemispherical photography shows that canopy cover decreased on burned plots after a single prescribed fire (p<.0001).



- Hemispherical photography estimates of canopy cover show a weak, yet significant correlation to midstory density.

- These results suggest that unlike spherical densiometer readings, hemispherical photography is sensitive to reductions in midstory.
- This perceived difference in the sensitivity of the two methods for measuring canopy cover may be an artifact of having only hemispherical photographs on the Buck Creek site, a site with high reduction in midstory density.

How well do the two methods correlate with each other?



- Measurements of canopy cover for the two methods are more similar at full canopy closure.
- Measurements do not show agreement at lower values of canopy cover.

Conclusions and Questions

- A single prescribed fire can significantly affect the midstory stratum, which is a potentially large source of competition for light-suppressed seedlings. **Will the implementation of repetitive prescribed fires successfully remove or control this competitive layer?**
- **Does the removal of the midstory stratum actually result in more light to the understory, or is it equally important to produce gaps in the overstory?**
- Spherical densiometer measurements were taken only in the summer following burn treatment. **Will future measurements show a more pronounced change in canopy cover and a better correlation between this method and hemispherical photography?**
- Our results suggest that although the spherical densiometer is a very easy tool for measuring changes in canopy structure, it is not as robust a method as hemispherical photography, which requires more time and technical knowledge. **Is there a more practical, midstory sensitive method for measuring change in canopy cover?**

Literature Cited

Frazer, G.W., C.D. Canham, and K.P. Lertzman. 1999. Gap Light Analyzer (GLA), Version 2.0: Imaging software to extract canopy structure and gap light transmission indices from true colour fisheye photographs, users manual and program documentation. Copyright © 1999: Simon Fraser University, Burnaby, British Columbia, and the Institute of Ecosystems Studies, Millbrook, New York.

SAS Institute. 2000. SAS Procedures Guide, Version 8. SAS Institute, Inc. Cary N.C.

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