Burn Forest Burn: Effects of Burning on Forest Soils

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Introduction

Burning is a common forest management technique to control invasive plants and promote oak regeneration. However, little is known about how controlled burns impact soils. Alterations to the soil can change plant community composition and enhance or dampen the desired impacts of burning. Furthermore, much of the biogeochemical variation within forests can be attributed to plant and microbial traits. We aim to understand how burning impacts soil properties because this will affect how the trees get the nutrients they need to grow.

Methods

Soil cores were collected from 32 different plots. Lab analyses were run to test the following factors: ammonium, nitrate, carbon, nitrogen, enzymes, pH, carbon and nitrogen mineralization rates, soil moisture and organic content.

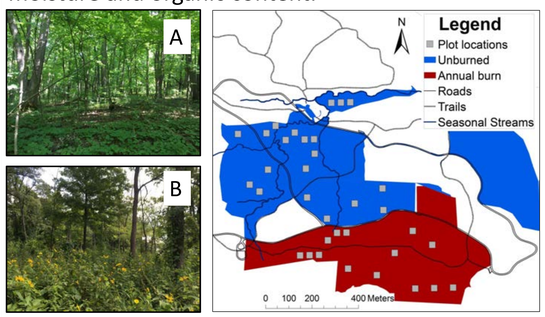

Figure 1. Map of study site in The Morton Arboretum East Woods with images from (a) unburned plots and (b) burned plots.

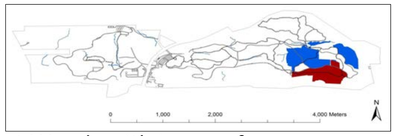

Figure 2. Collecting soil cores.

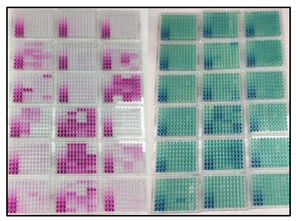

Figure 3. Colorimetric ammonium and nitrate analysis.

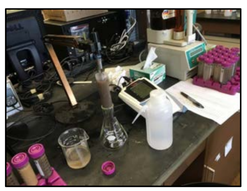

Figure 4. Soil pH testing with a pH meter.

1. Does annual burning alter soil biogeochemistry? YES!

Annual burning alters pH, carbon, and nutrient availability.

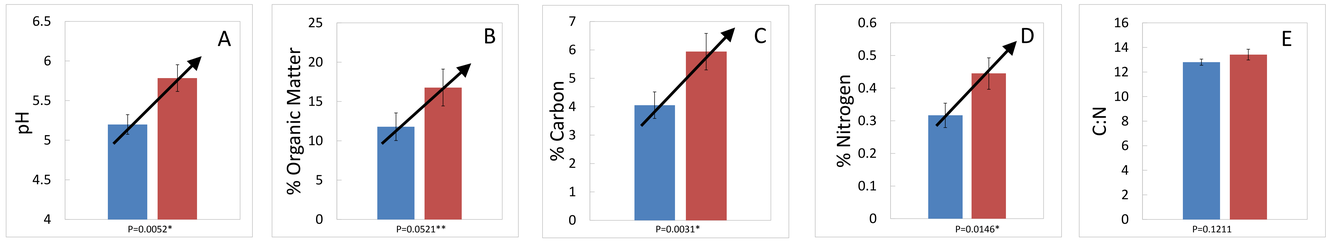

Figure 5.
A-D) Soil pH, percent organic matter, total carbon, and total nitrogen are higher in burned plots.
E) Carbon: Nitrogen ratio is similar in burned and unburned plots.

Annual burning decreases phosphorus-degrading enzyme activity.

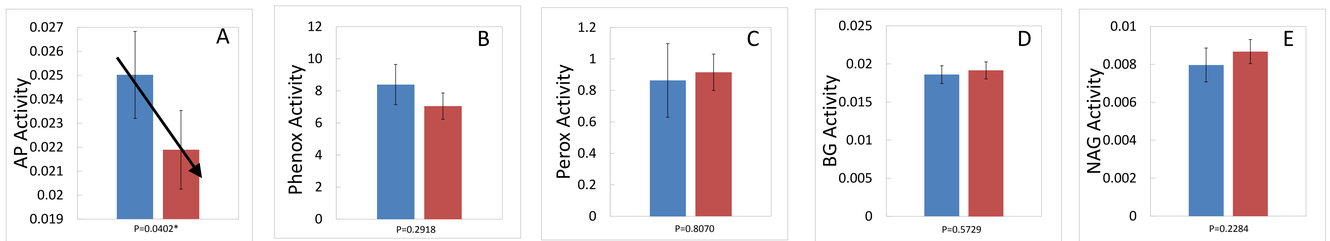

Figure 6.
A) AP activity is lower in burned plots.
B-E) BG, Phenox, Perox, and NAG enzyme activity is similar in burned and unburned plots.

Hypothesis: Burned areas have higher nitrification, NAG, BG, Phenox, Perox, pH, Nitrogen mineralization rate, total carbon and nitrogen, ratio of carbon to nitrogen, soil moisture, and soil organic matter; unburned areas have higher AP activity; and carbon mineralization rate is similar in burned and unburned plots.

2. Are the effects of burning mediated by tree composition? NO

Tree mycorrhizal associations had little effect on soil properties in burned and unburned sties.

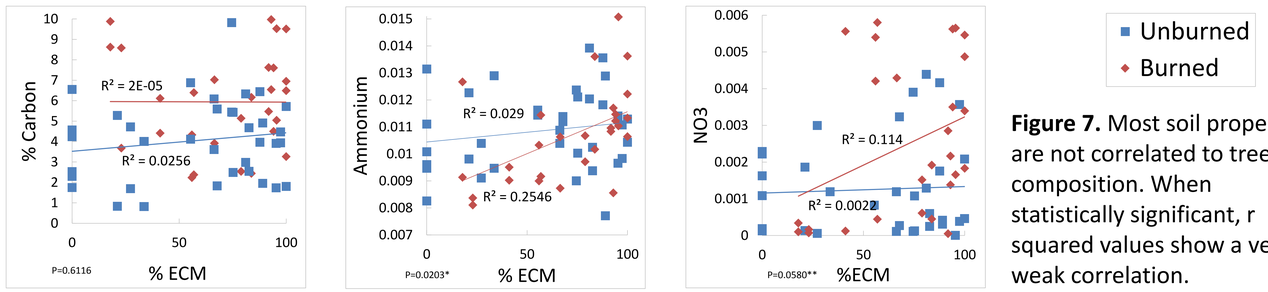

Figure 7. Most soil properties are not correlated to tree composition. When statistically significant, r squared values show a very weak correlation.

Hypothesis: Nitrification, and pH are higher in plots with less ECM trees; NAG, BG, Phenox, Perox, AP, carbon mineralization rate, total carbon, C:N, soil moisture, and soil organic matter are higher in plots with more ECM trees; nitrogen mineralization rate and total nitrogen are similar in plots regardless of tree type.

* Denotes statistical significance (anova p<0.05)
**Denotes marginal statistical significance (anova 0.05<p<0.06)

References:
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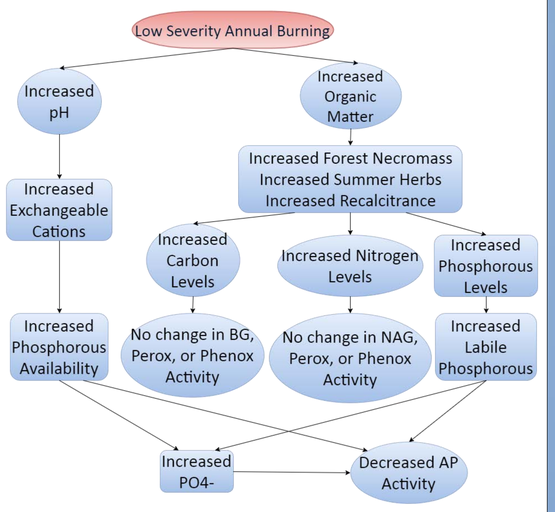
Conceptual Diagram



Management Implications

Because of the observed higher pH and lower AP activity, it is inferred that there is an increased abundance of phosphorous in the soil of burned areas. This increased phosphorous may promote phosphorous rich species, such as maples. Controlled burning is a treatment option for increasing light available on the forest floor, which may promote shade intolerant understory plants and seedlings. The increased organic matter, carbon and nitrogen in the burned areas is potentially beneficial to oak regeneration, but is not necessarily promoting oaks. Increased understory herbaceous plants observed in the burned areas are likely shading out many of the oak seedlings.

Future Directions

- Measure phosphate levels to confirm increase.
- Quantify understory plant communities in burned and unburned areas to rule out impact of understory plants on soil nutrient composition.
- Analyze microbial community structure, use of enzymes to break down C, N, and P and the inorganic nutrient requirements of the microbes.

Acknowledgements

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