Tallgrass prairie dynamics are moderated by prescribed burning: Case study at Concordia's Long Lake Field Station

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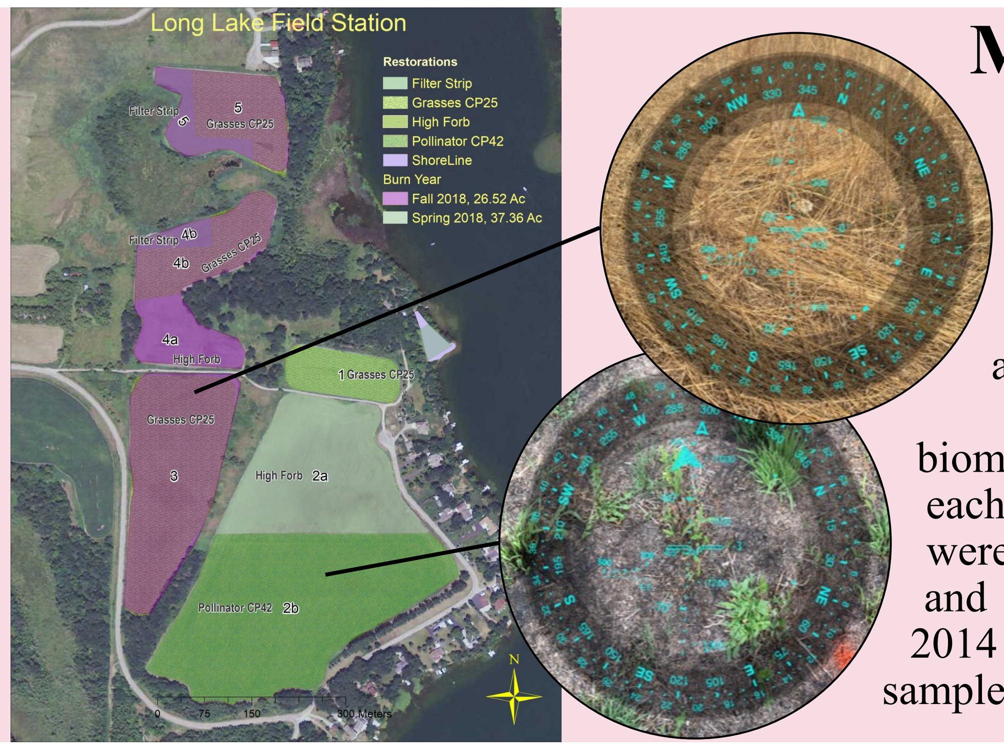
Introduction

Fire is an essential part of the health of an ecosystem, specifically affecting the biodiversity of the plant community. More competitive, dominant plants are usually not preferred by herbivores and contribute a large amount of biomass to an ecosystem. Additionally, these species tend to use a large amount of resources and infringe on resource availability of other species. Recently, the push for fire suppression has lead decreasing prairie plant diversity and the accumulation of biomass, which eventually leads to more intense and destructive wildfires. Though many ecosystems require regular, consistent burns, this project specifically studies a Minnesota prairie ecosystem.

The objective of this project is to determine the effect of the spring burn on understory biomass and diversity at Concordia's Long Lake Field Station (see map to the right).

Hypotheses:

- The spring burn will decrease understory biomass due to the combustion of pre-burn understory material.
- The spring burn will decrease the ratio of litter to total understory biomass due to the release of resources for new growth.
- The spring burn will increase understory species diversity since the stimulation of understory growth will allow for more understory species.



Methods

This project is a part of a broader project quantifying standing carbon stocks at Concordia's Long Lake Field Station, including carbon in understory species, trees and shrubs, and major carbon fluxes.

In this study, we collected understory biomass samples from 3 subplots within each of 12 prairie plots. Half of the plots were recently burned in spring of 2018, and the others had not been burned since 2014 (see map to the left). The biomass samples included all of the understory plants (live and dead) within a 30 x 30 cm quadrat. We then sorted live plants to species and weighed the biomass after drying it in an oven for 48+ hours at 60°C.

We analyzed our data in Program R using a linear mixed model with burn status as the treatment, plots as the experimental units, and prairies as blocks. Our data and analysis scripts are archived on GitHub.

Spring burn decreased total biomass

The plots that were burned in the spring of 2018 had a significantly lower average total biomass than the plots that had last burned in 2014 (unburned) ($p < 0.01$; Fig. 1).

Our results indicate that the burn did decrease total biomass which we expected because of the combustion of standing plant biomass, especially the dead litter layer.

Furthermore, although the live biomass of burned and unburned plots were similar ($p = 0.37$), the dead litter biomass was significantly lower in the burned prairies ($p < 0.01$) .

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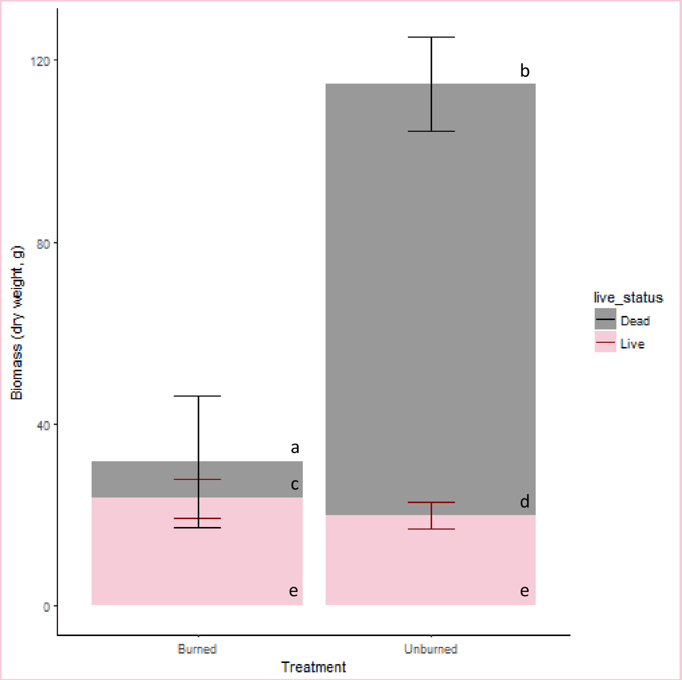

Figure 1. Total prairie biomass (live and dead) versus burn status across 12 plots at Concordia's Long Lake Field Station. Prescribed burns were conducted in spring 2018, and unburned prairies were last burned in 2014. Lowercase letters indicate treatment effects at $p < 0.05$. Error bars are +/- 1 SE.

Spring burn increased prairie species diversity

The burned plots had a higher species richness (number of species) than unburned plots ($p < 0.05$; Fig. 3A).

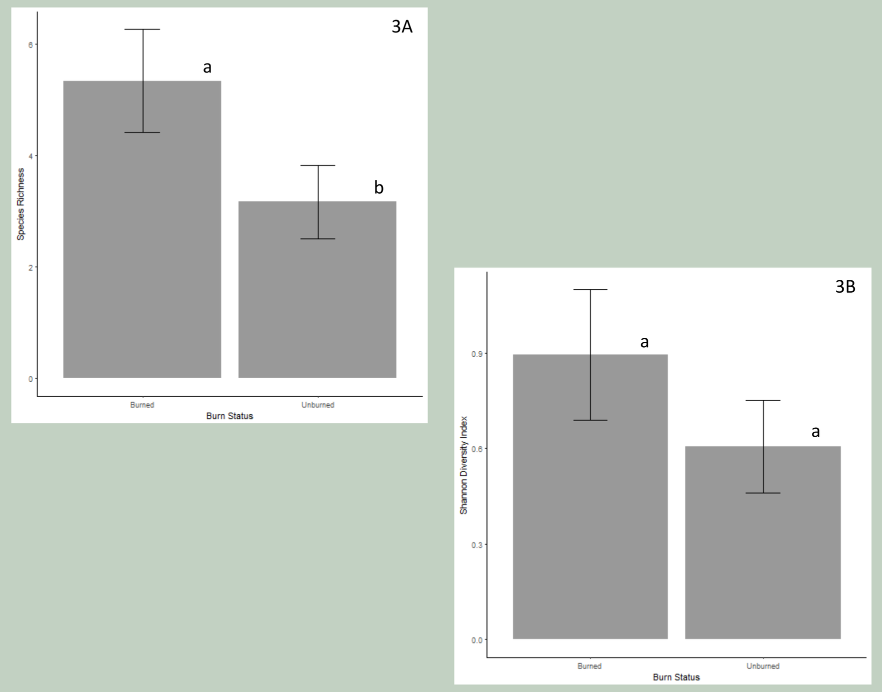

Figure 3. Species richness (3A) and Shannon Diversity index (3B) versus burn status across 12 plots at Concordia's Long Lake Field Station. Prescribed burns were conducted in spring 2018, and unburned prairies were last burned in 2014. Lowercase letters indicate treatment effects at $p < 0.05$. Error bars are +/- 1 SE.

In addition to quantifying species richness, we calculated and analyzed Shannon diversity index. The Shannon diversity index was used to characterize the diversity within the prairies based on the biomass of each individual species. Shannon diversity index data was not significantly higher in the burned plots ($p = 0.19$; Fig. 3B).

The burning had a smaller overall affect on the Shannon diversity index than on species richness, which was likely explained by the increase in overall biomass after burning. We hypothesized that this would occur because burns decrease the biomass of more competitive species, allowing space and nutrients for less competitive species to grow.

Spring burn decreased the ratio of litter to total biomass

The plots that burned in the spring had a lower ratio of litter to total biomass ($p < 0.01$, Fig. 2).

Our results from the first hypothesis lead us to analyze whether prescribed burns significantly impacted the amount of litter relative to live biomass.

These results support our hypothesis that burns decrease the ratio of litter to total biomass.

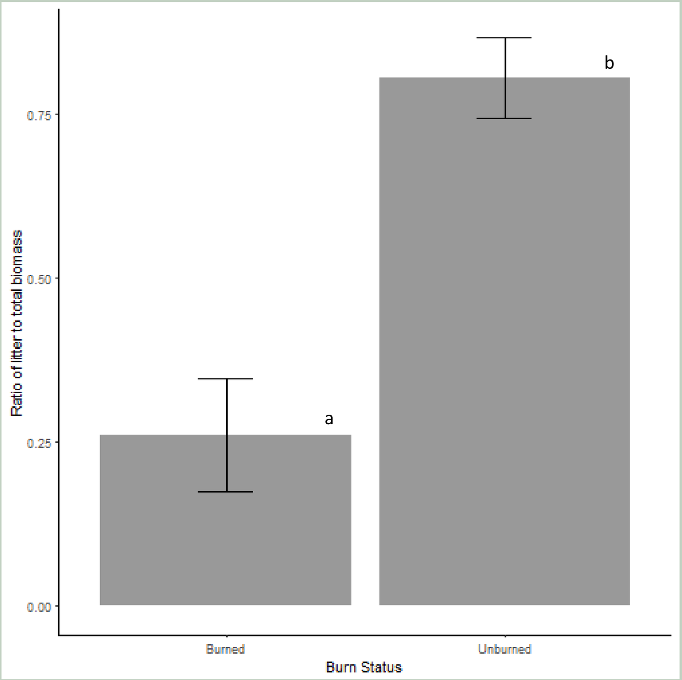

Figure 2. The ratio of litter to total biomass versus burn status across 12 plots at Concordia's Long Lake Field Station. Prescribed burns were conducted in spring 2018, and unburned prairies were last burned in 2014. Lowercase letters indicate treatment effects at $p < 0.05$. Error bars are +/- 1 SE.

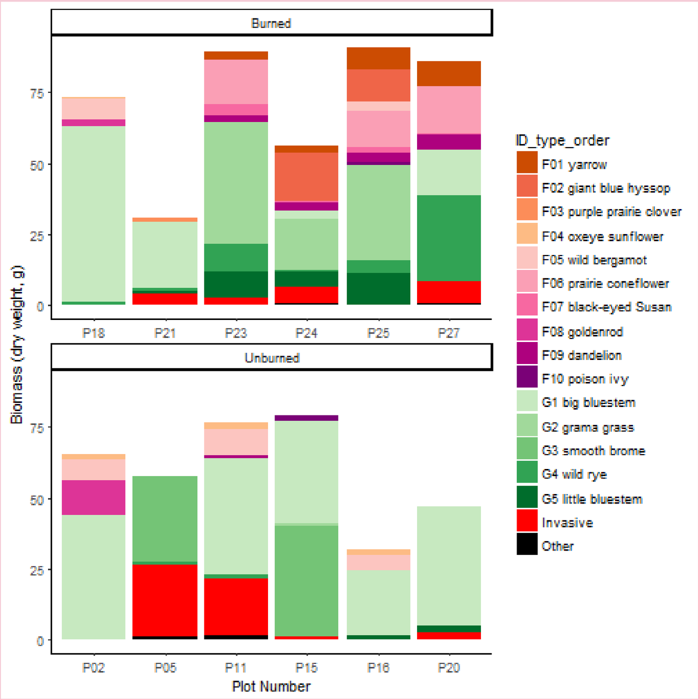

Figure 4. Total live biomass by species and plot versus burn status across 12 plots at Concordia's Long Lake Field Station. Prescribed burns were conducted in spring 2018, and unburned prairies were last burned in 2014. Lowercase letters indicate treatment effects at $p < 0.05$. Error bars are +/- 1 SE.

Conclusion

The live species were notably different between burned and unburned plots (Fig. 4). Though the biomass of the more competitive species was relatively the same, the ratio between forbs (warm colors) and grasses (green colors) increased in the burned prairies. There also was a increased presence of invasive species in the unburned prairies (bright red color).

Each of our hypotheses were supported by our data, and our study demonstrates the importance of prescribed burning management in tallgrass prairies such as those at Concordia's Long Lake Field Station.

Acknowledgements

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