Carbon Dynamics of Prairie Ecosystems

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Introduction

Increasing levels of atmospheric carbon dioxide and other greenhouse gases (GHG) are responsible for contemporary global climate change patterns. The accelerated rate at which the climate is changing is negatively impacting both terrestrial and marine ecosystems. Scientists investigate the dynamics of the carbon cycle and look for ways to reduce atmospheric CO_2 by sequestering, or trapping, the carbon in solid (i.e. plants, soil) or liquid (i.e. the ocean) forms. Prairie plants are particularly adept at carbon storage, as most of their biomass (vegetative material) is underground in extensive root systems and therefore not subject to aboveground decay.

In this study we compare the carbon dynamics of two restored prairie plots at Nachusa Grasslands in Franklin Grove, Illinois (Figure 1). One plot (Figure 2) is of higher quality, as measured by native species diversity, and the other plot (Figure 3) is of lower quality.

Our goals are **1) to determine greenhouse gas emissions of differing qualities of prairie and 2) to analyze landscape positional features of prairie plots to determine optimal locations for prairie restoration efforts.** Results can be used to advise landscape managers in their efforts to conserve and restore prairie ecosystems.

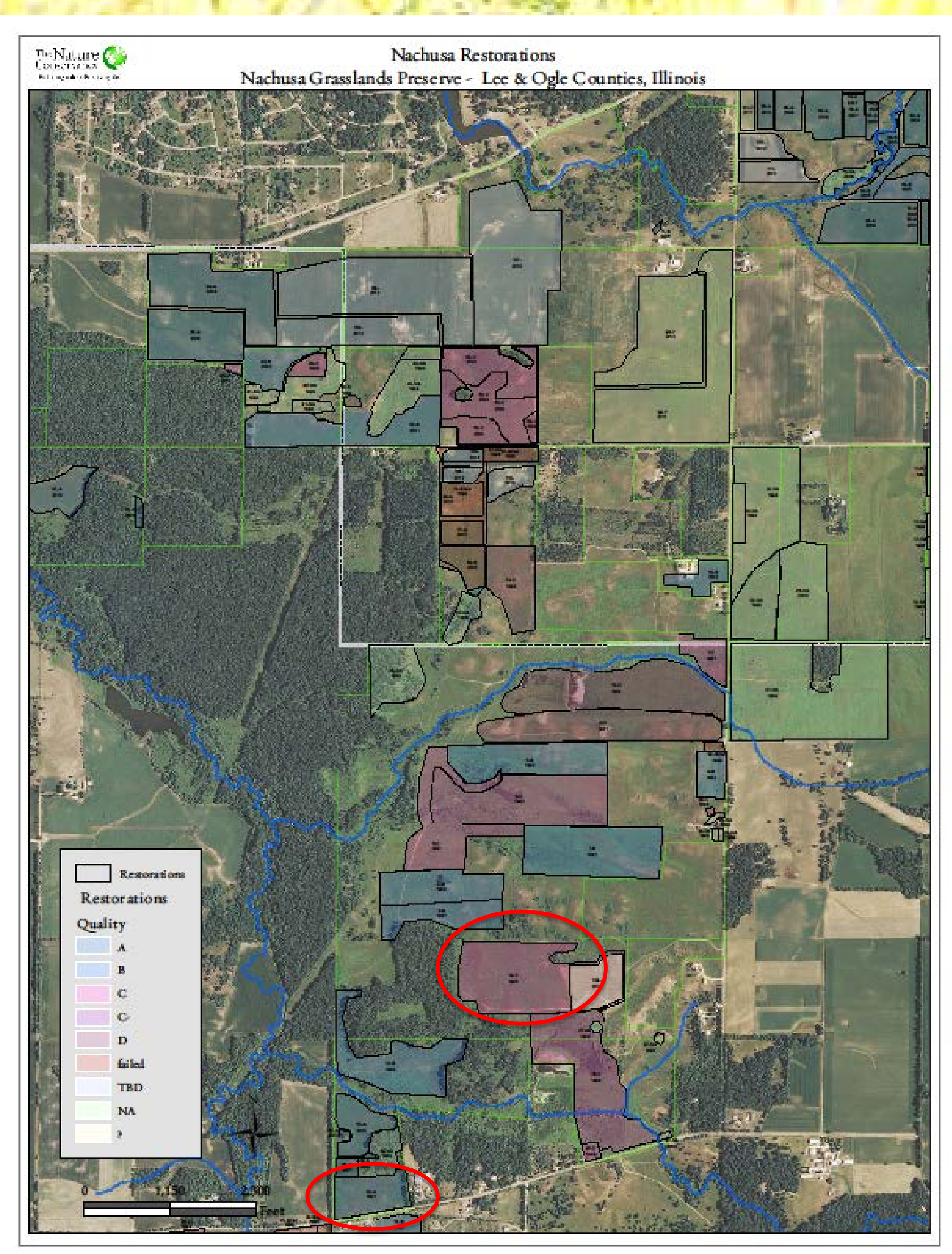

Figure 1. Map of Nachusa Grasslands Preserve. Source: Nachusa Grasslands and The Nature Conservancy.

Figure 2. Plot 20-A, Nachusa Grasslands.

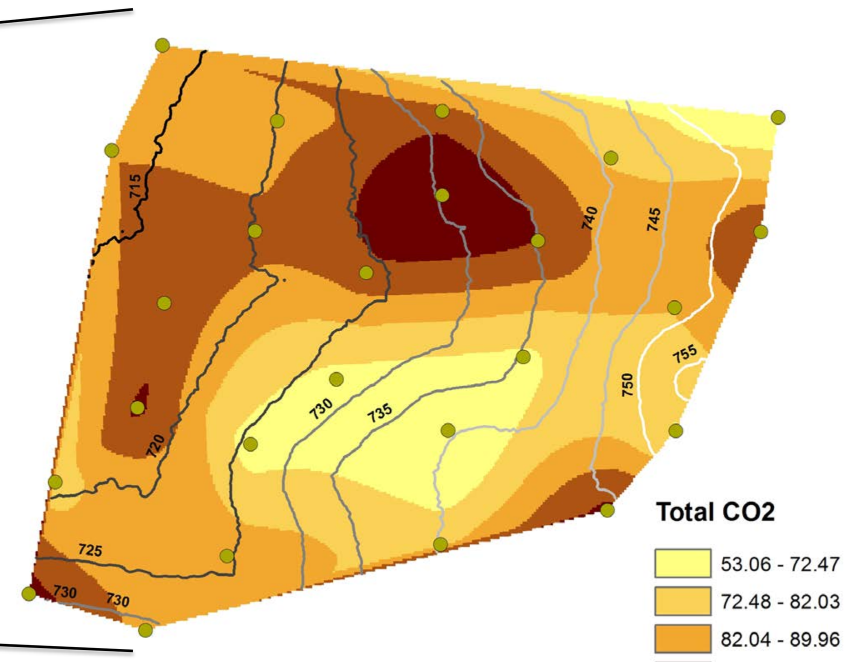

Figure 4. Plot 20-A, CO_2 equivalent emissions.

Figure 3. Plot 19-C, Nachusa Grasslands.

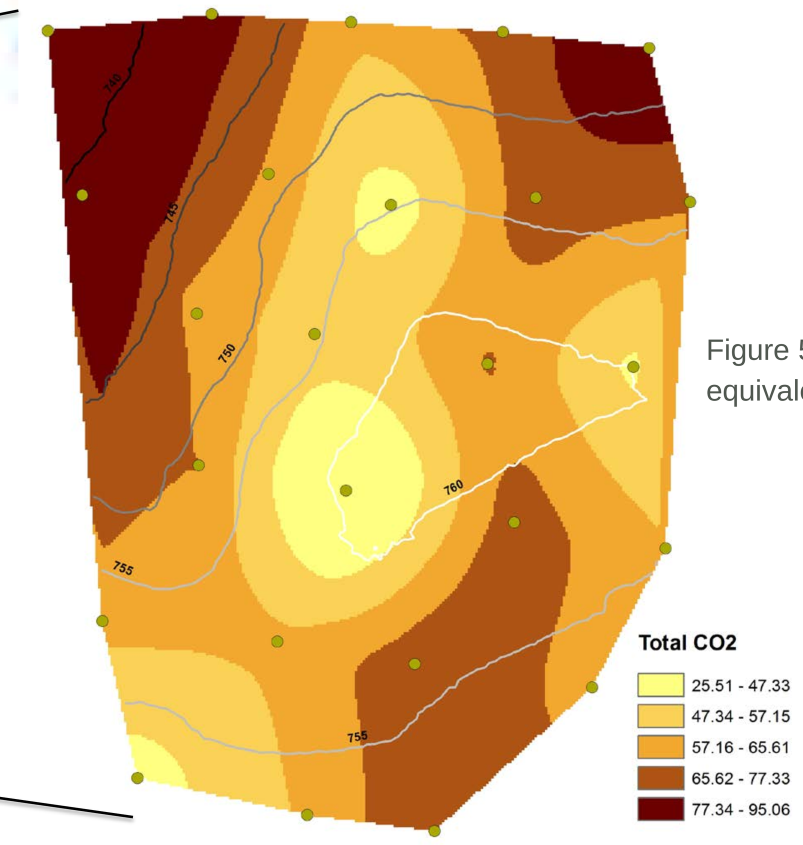

Figure 5. Plot 19-C, CO_2 equivalent emissions.

Methods

We installed PVC rings in a grid-like formation across each prairie plot (Figures 2 and 3) and used these to collect soil respiration gas samples for carbon dioxide, methane, and nitrous oxide analysis. We extracted soil cores from the immediate vicinity of each PVC ring for belowground biomass and soil bulk density analyses. In order to analyze aboveground biomass, we collected vegetation in close proximity to each ring. Plant species were identified and quantified to determine species richness (diversity and cover) for each of the 50 ring locations.

Our research team analyzed the soil respiration gas samples, soil samples, and above- and belowground biomass samples to quantify carbon emissions and retention. Gas samples were processed using a gas chromatograph, and soil and biomass samples were dried and weighed. Additionally, landscape analyses are being conducted based on topographic and GPS measurements to determine optimal spatial orientation (i.e., slope, elevation, and exposure). All the data has been input into a GIS and is being analyzed in combination to determine optimal prairie conditions for carbon sequestration (Figures 4 and 5).

Results

Plant species richness is appreciably higher in the high quality prairie plot than in the lower quality restoration (Figure 6). Analysis of the gas samples reveals that there was a significant difference in CO_2 emissions between the high and low quality prairie restorations in May and August of the 2014 growing season (Figure 7). Aboveground and belowground biomass accumulations, as well as soil bulk densities, were significantly greater in the high diversity plot compared to the low diversity plot.

Discussion

Results of this study indicate that carbon dynamics of prairie ecosystems are directly related to plant species richness. There were significantly higher levels of biomass production and soil quality in the high diversity plot compared to the low diversity plot. These findings imply the importance of restoring prairies with a variety of high quality native grasses and forbs, and of ensuring ongoing stewardship of restored areas. As this and future studies progress forward, we will gain a clearer picture of the ideal locations for prairie restoration and conservation in order to better guide land managers in wise decision making. Ultimately, prairie ecosystems will once again play an important role in mitigating the effects of global climate change.

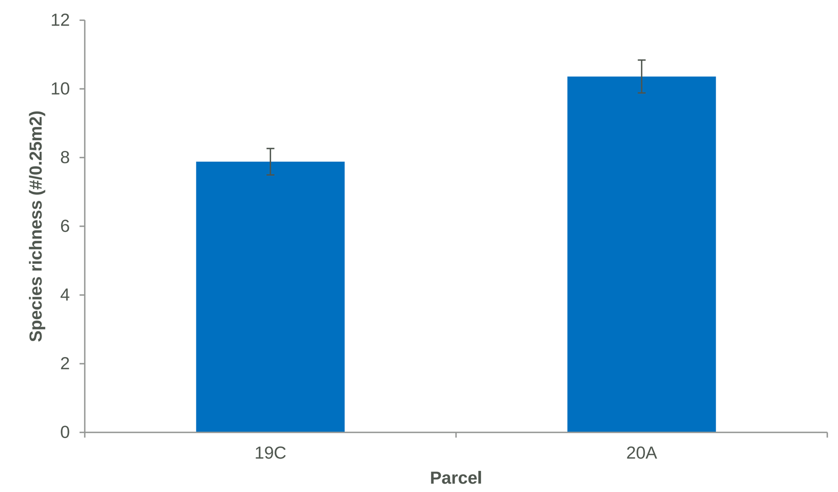

Figure 6. Species richness comparison of prairie plots.

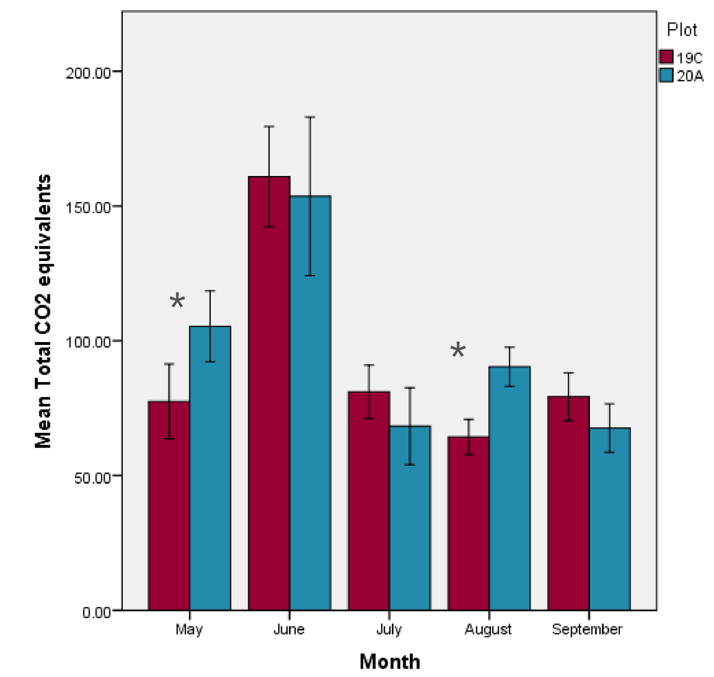

Figure 7. Combined soil flux (gas emissions) of CO_2, CH_4, and N_2O in CO_2 equivalents by month for the 2014 growing season. *Significant difference

Selected Resources

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Acknowledgments

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