How Constructed Prairies Help Cool the Landscape: Insights from Field Measurements and Drone Imagery

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Introduction

Anthropogenic warming and land-use change have led to increasing summer temperatures (Gao et al., 2019; Moncada-Morales et al., 2025), more frequent and prolonged heatwaves (Hintz et al., 2018; Hulley et al., 2019), and intensified drought events (Stolte et al., 2023; Zhang et al., 2019). In the midwestern US, small-scale prairie restoration has been identified as a nature-based solution to several ecosystem disruptions such as declining insect diversity (Coleman & Wait, 2022), and flooding caused by stormwater runoff (Rivera et al., 2025). Additionally, these small-scale prairies could also provide a local cooling benefit through the process of evaporative cooling, as canopy structural and functional complexity have been linked to temperature variation in other ecosystems. Although many ecosystem services of remnant and restored prairies are understood, little is known about their role in reducing local surface and air temperatures through evaporative cooling. Here, we quantify the cooling potential of constructed prairies with combined half-hourly eddy covariance measurements, monthly unpiloted aerial systems (UAS) thermal imagery, and Light Detection and Ranging (LiDAR) over a constructed prairie and an adjacent non-prairie in Iowa City, Iowa, USA.

Method

We tracked plant community structural controls over surface temperature and energy exchange within a constructed tallgrass prairie at the Ashton Prairie Living Laboratory at University of Iowa, which consists of 8.5 acres of constructed prairie and 10-acre section of non-prairie grass and forbs situated directly north. An eddy covariance flux tower is situated at the border of the two sections, allowing for flux data collection from both distinct plant communities. We combined monthly unoccupied aerial system (UAS) based thermal and LiDAR data, continuous flux tower observations, and plant biodiversity survey data to track seasonal and diurnal surface temperature, sensible and latent heat fluxes, and plant canopy surface roughness from May through September 2025.

Results

Mean surface temperatures in the constructed prairie were consistently lower than temperatures originating from the non-prairie, with peak differences appearing near midday (up to 5°C). Sensible heat fluxes were lower in the prairie, while evaporative fraction was higher in the constructed prairie than in the non-prairie, indicating that a greater proportion of energy was used to evaporate water within the constructed prairie than the non-prairie. Plant biodiversity surveys showed 3 times greater species richness within the restored prairie, with greater quantities and diversity of tall and structurally complex plant species. Monthly LiDAR data showed that this greater species richness led to greater vegetation height, surface structural complexity, and roughness within the prairie, and that this roughness increased as the growing season progressed, which likely facilitated near-surface cooling by enhancing land-atmosphere coupling.

Discussion and Conclusion

This research suggests that small-scale prairie construction can produce measurably lower local temperatures and that the mechanisms driving these temperature differences can be quantified using geospatial analysis. We found that small-scale constructed prairie may be a nature-based solution to anthropogenic warming at a local scale within the midwestern US due to the biogeophysical functioning of these structurally complex and biodiverse plant communities.

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