Title: Using root and soil traits to forecast woody encroachment dynamics in mesic grassland

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Project Abstract:

Grasslands are a widespread and globally important biome providing key ecosystem services including C storage and regulation of the water cycle. Grasslands face multiple threats, including increasing drought intensity and woody encroachment, a process that results in increased woody plant abundance and decreased herbaceous plant abundance. Reduced soil moisture and shifts from herbaceous to woody plant dominance are likely to alter C pools in the soil. Our project combines observational, experimental, and modeling approaches to project ecosystem consequences of woody encroachment in the central Great Plains region.

Complex interactions between root inputs, water loss, and C pools were evident when comparing belowground C pools among plant cover types. A shift from grassy to woody cover resulted in an increased soil C pool, mostly notably at 50-100 cm deep. Priming occurred in grassy, but not woody soils, and grass-derived SOM was more available than woody-derived SOM. We used large rain-out shelters to reduce water availability for shrubs and grasses growing in annually and infrequently burned (every 4-yr) locations. In general, physiological and morphological responses to reduced rainfall were less pronounced than responses to fire frequency. For the first two years of this project, leaf gas exchange rates, water potential, and turgor loss point were lower in the woody encroached 4-yr burn treatments. Stable isotopic analyses of xylem water in shrubs in 4-yr burn treatments had lower values; indicative of water use from deeper soils depths. Deeper-water reliance by the shrubs buffered seasonal photosynthetic variability and mitigated water stress compared to grasses that showed greater reliance on surface soil moisture.

Fine root length and biomass in surface soils (0-25 cm) was highest under grassy cover compared to woody, and generally declined with increasing fire frequency. At greater depths (25-100 cm), fine root biomass was relatively low (< 1 g/cm^3) under all cover types and burn treatments. Drought reduced the ability of grass roots to move water but had no impact on shrub

roots. Shrub roots were less vulnerable to water stress when grown under drought compared to control conditions.

Finally, these data have been used to parameterize a numerical terrestrial ecosystem model (the Functionally Assembled Terrestrial Ecosystem Simulator, FATES) for the Konza Prairie. Preliminary results indicate that our calibration of the model can accurately represent vegetation responses to frequent fire for both shrub and grass functional types.