What grassland managers want to know about the carbon cycle

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Outline



Carbon Stocks versus Accumulation Rates

- Both measures are helpful
- Rates help us understand dynamics
- Stocks tell us how much carbon we have in our hands
- Both help us understand where the carbon is and how it got there

Carbon Accumulation (tons per acre per year)

Soil Carbon Stock (tons per acre)

Carbon stocks in shortgrass steppe, from Burke et al. (2008)



Grassland Carbon Stocks

Paired Land Use Study-

Does conversion from cultivated crops to perennial grasses increase soil carbon?

- 20 years in Conservation Reserve Program vs no-till small grains
- No grazing at CRP sites
- How do carbon stocks compare for paired sites?
- Depth profile analysis







Mixed Grass Prairie Carbon Stocks under CRP Compared to Adjacent Crop



From Phillips et al. (2015)

What about carbon stocks under native prairie? Intensive core study separating carbon into aggregates pools



From Wick, Phillips et al. (2012)



NATIVE PRAIRIE ROOTS BY DEPTH

Wick 2013, unpublished data

Greater oxygen diffusion where roots are deep, dense and soil porosity is high

Why do we care about soil oxygen?



Methane is just another form of carbon that diffuses into soil for use by microbes in oxygenated environment





Methane is used by methanotrophs

- 1. Methane consumers in soil are sensitive to tillage and ammonium
- 2. Diffusivity into soil and methane concentration determines methane uptake rate



Carbon rate measurements

Narrow down how specific controls on carbon sources and sinks





Rate Measurement Intensive Studies



Grassland Carbon and Grazing

Great Plains Grazing Effect Meta-Analysis Wang et al. (2016)

Results suggest sustainable grazing management improved carbon stocks in soils in the northern Great Plains by about 70 lbs per acre.





Intensive Carbon Tracer Study Wilson et al. (2018)

- 1. Quantified allocation of carbon to root tissue and measured root exudation across grazed and ungrazed plots.
- 2. Found grazing exclusion was associated with dramatically less overall belowground allocation, with lower root biomass, fine root exudates, and microbial biomass.
- 3. Found grazed pasture contained greater total SOC-much of which came through plant roots.
- 4. Concluded that positive grazing effects on SOC rely on root system biomass.

The importance of grasslands as carbon sinks

How do forests and grassland compare under extreme weather?

Daas et al. (2018) Grasslands vs Forests

Given four scenarios, how much carbon is predicted in grassland vs forest biomes? If droughts and wildfires continue, will forests continue as an optimal carbon sink?

Predicted grasslands and forests carbon sink capacity in California



"Indicates that, from a cap-and-trade, carbon-offset perspective, conserving grasslands and promoting rangeland practices that promote reliable rates of carbon sequestration could help more readily meet the state's emission-reduction goals."

SUMMARY: To optimize carbon sink in grasslands



Maximize Leaf Area to Increase Productivity and Carbon Capture



Maximize Root Density to Increase Porosity, Soil Oxygen, Root Exudates



Minimize Soil Disturbance and use Grazing as a Tool to Support Methanotrophy, Root Growth and Turnover



Grazing as a Tool to Encourage Plant Diversity

Work Cited

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