


Land Use Impact on Ecosystem *Carbon* & *Water*

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Land use plays a key role in carbon sequestration and climate change mitigation

- 15% of atmospheric CO_2 fluxes through terrestrial ecosystems annually
- Increasing terrestrial C pools is an important part of climate change mitigation strategies
  - Which land use is effective in C sequestration?
  - Trade-off of C sequestration and other ecosystem services (e.g., water)?


U.S. DEPARTMENT OF AGRICULTURE

USDA / MEDIA / PRESS RELEASES / USDA TO INVEST $1 BILLION IN CLIMATE SMART COMMODITIES, EXPANDING MARKETS, STRENGTHENING RUR...

USDA to Invest $1 Billion in Climate Smart Commodities, Expanding Markets, Strengthening Rural America

Funding Opportunity Opens to Pilot New Revenue Streams for America's Climate-Smart Farmers, Ranchers and Forest Landowners

Prairie in Cross-timber Experimental Range
Photo credit: Jacob Johnson

Objective 2 - Trade-offs between ecosystem carbon uptake and water loss and how these are affected by climate and ecosystem type

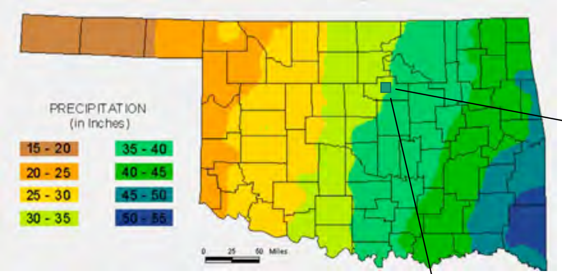
2.1 Quantify watershed-scale water balance and carbon gain related to land cover and climate variability

2.2 Understand tradeoffs between water use and carbon gain for grassland and forest

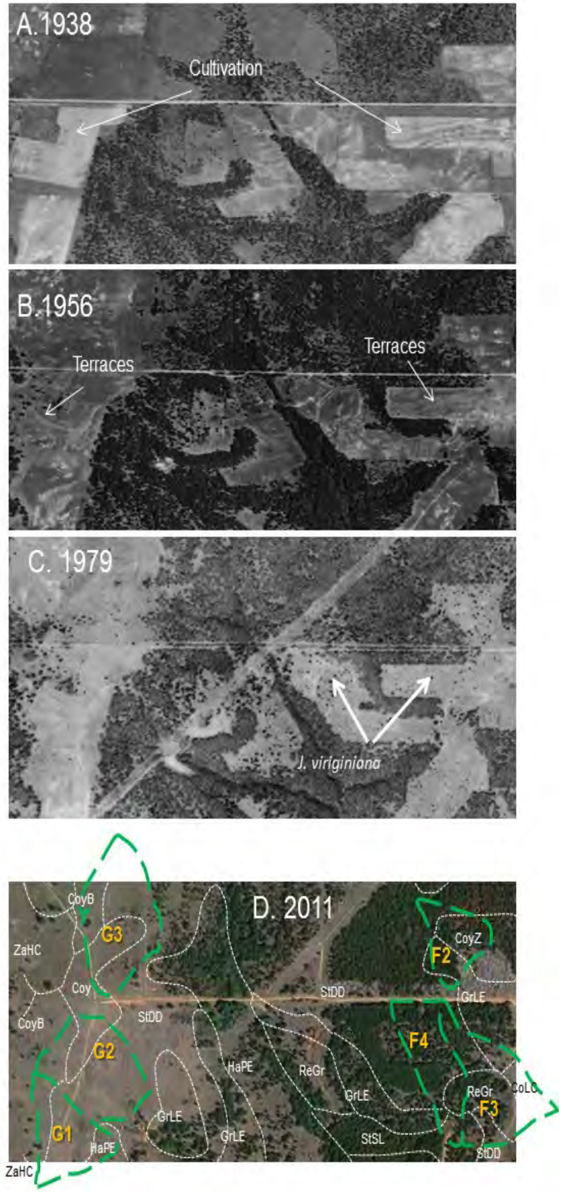
Switchgrass in Cross-timber Experimental Range

Photo credit: Jacob Johnson

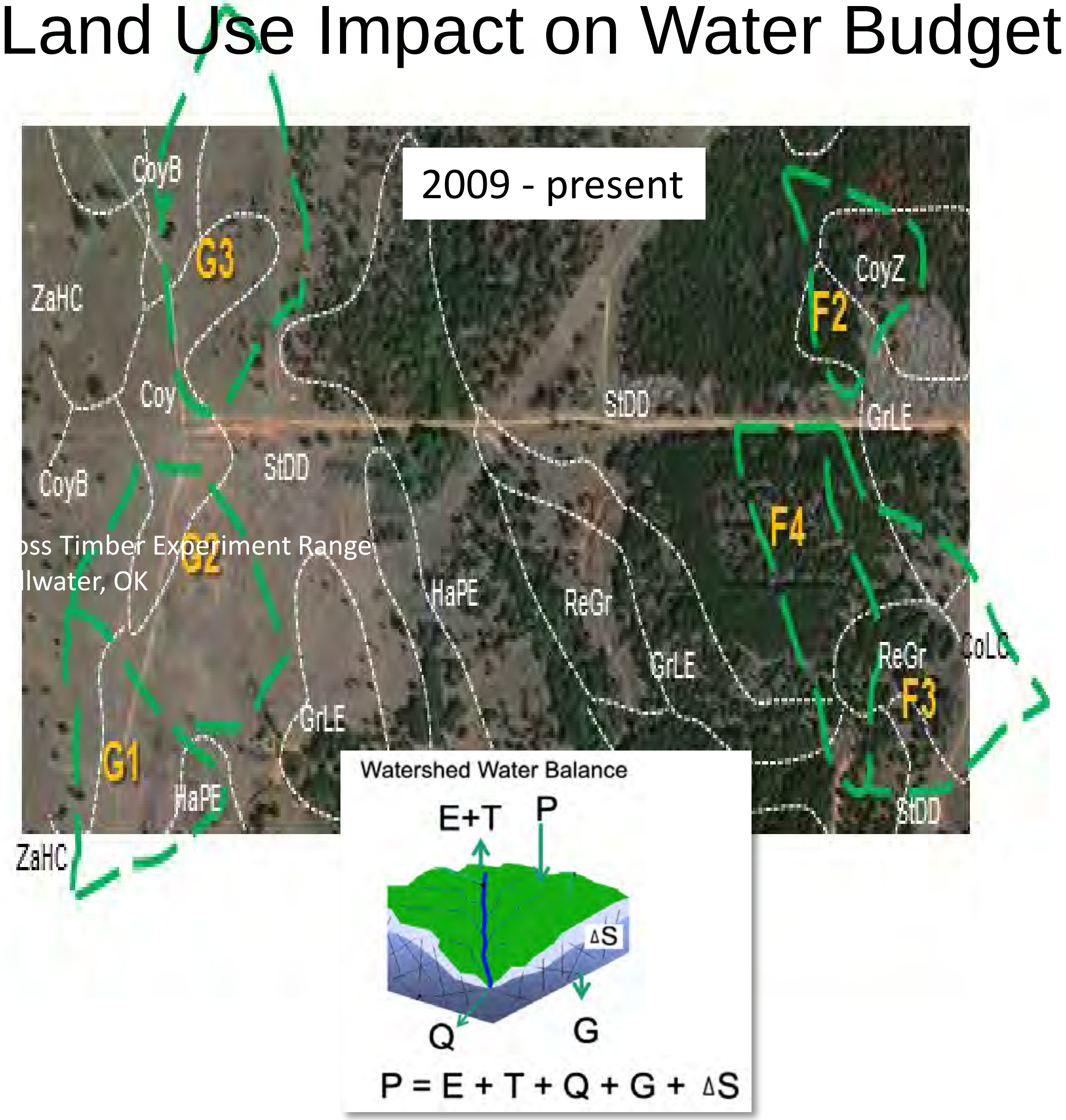
Site and History



OSU Range Research Station
(5000 acres, 11 miles southwest of Stillwater)

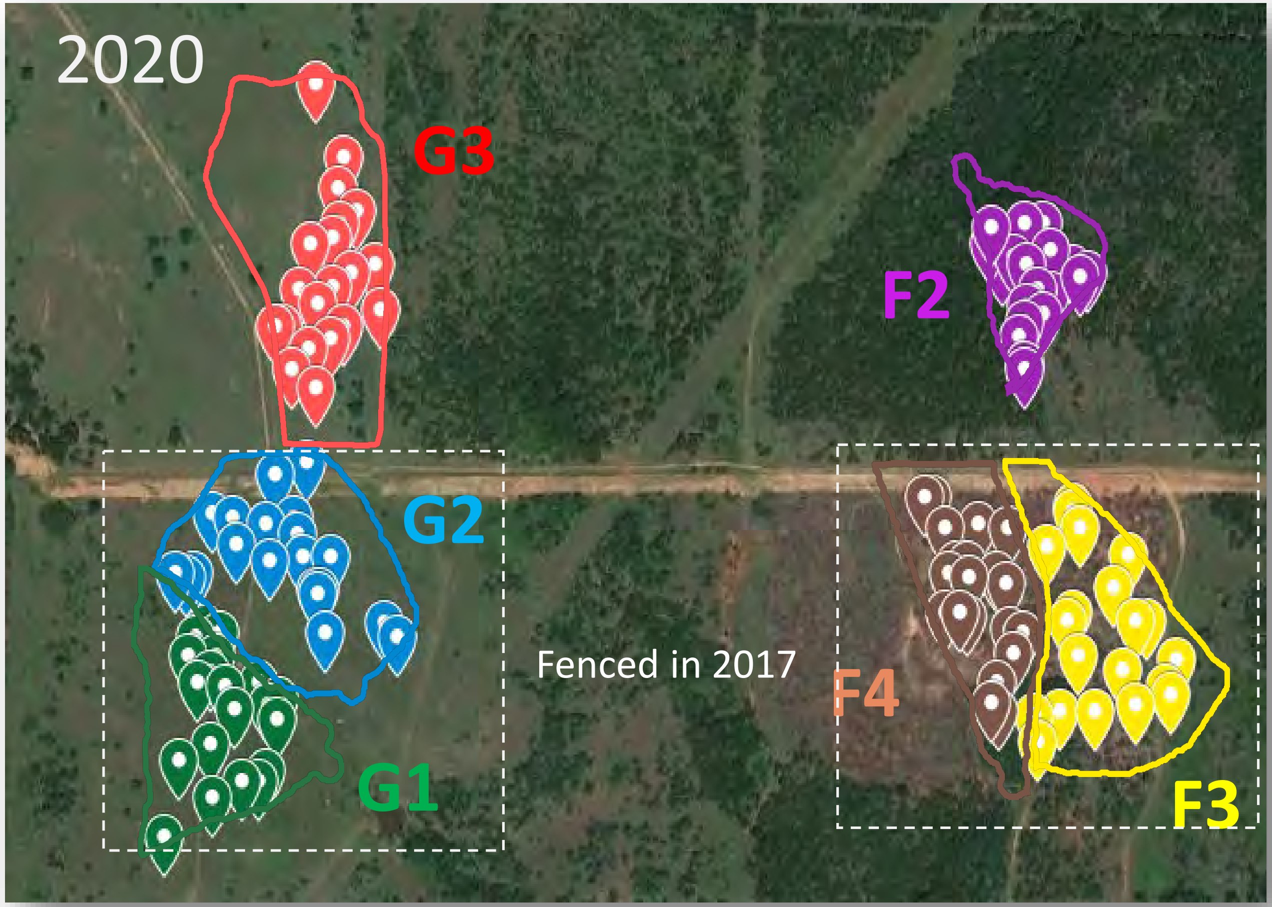


Land Use Impact on Water Budget - Experimental Watersheds



Multiple Hydrological Approaches

Land Use Change, ANPP, Soil C, and Ecosystem C Dynamics



20 random sampling points for each land use

G1 Grassland - Native ungrazed grassland species

G2 Grassland to Switchgrass - 2015 herbicide; 2017 switchgrass

G3 Pasture - Native grassland species grazed by cattle

F2 Redcedar – Intact redcedar woodland

F3 Redcedar to Switchgrass - 2015 redcedar removal; 2016 herbicide; 2017 switchgrass

F4 Redcedar to Grassland - 2015 redcedar removal; naturally revegetated

ANPP, Soil Organic Carbon Stock

Aboveground Net Primary Productivity

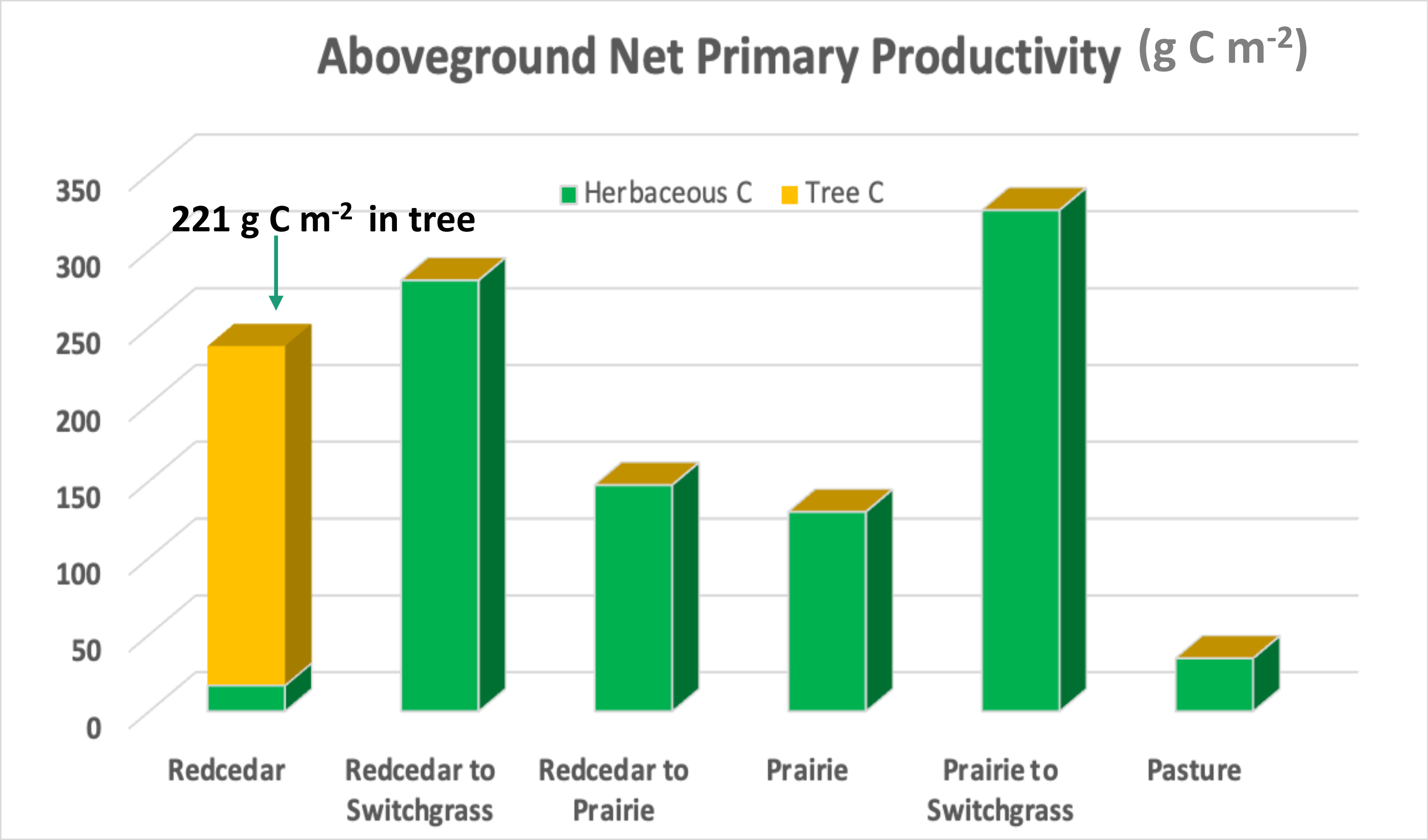
- Clipping plot to determine herbaceous biomass
- DBH for tree and determine woody biomass by allometric equation
- Biomass converted to C based on 0.5 ratio

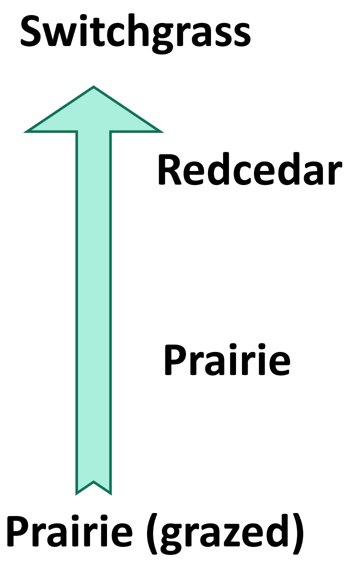
Soil Organic Carbon

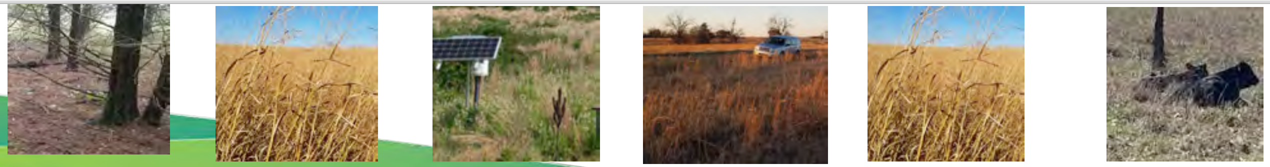
- 0 - 30 cm intact soil core
- 0-2, 2-10, 10 – 20, 20 -30 cm
  - Bulk density, soil carbon, and nitrogen content (%)
    - **Carbon stock** for 0 -30 cm ($g\ C\ m^{-2}$, $Mg\ C\ ha^{-1}$)

FAO. 2019. *Measuring and modelling soil carbon stocks and stock changes in livestock production systems: Guidelines for assessment (Version 1).* Livestock Environmental Assessment and Performance (LEAP) Partnership. Rome, FAO. 170 pp.

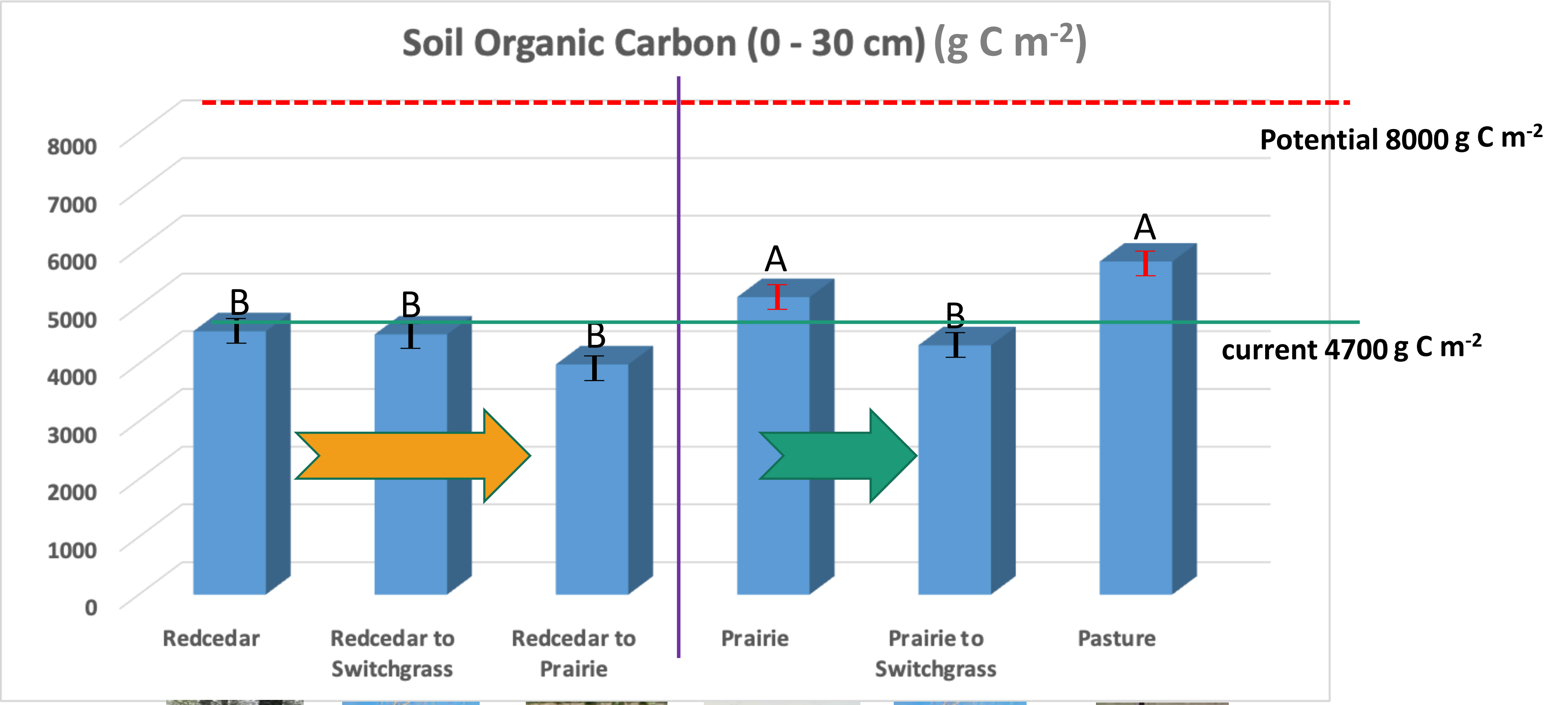
Aboveground Net Primary Productivity in 2020

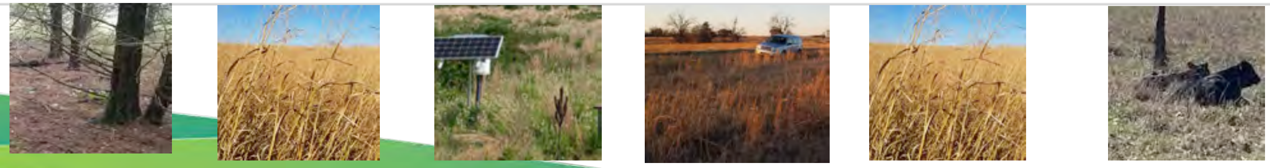




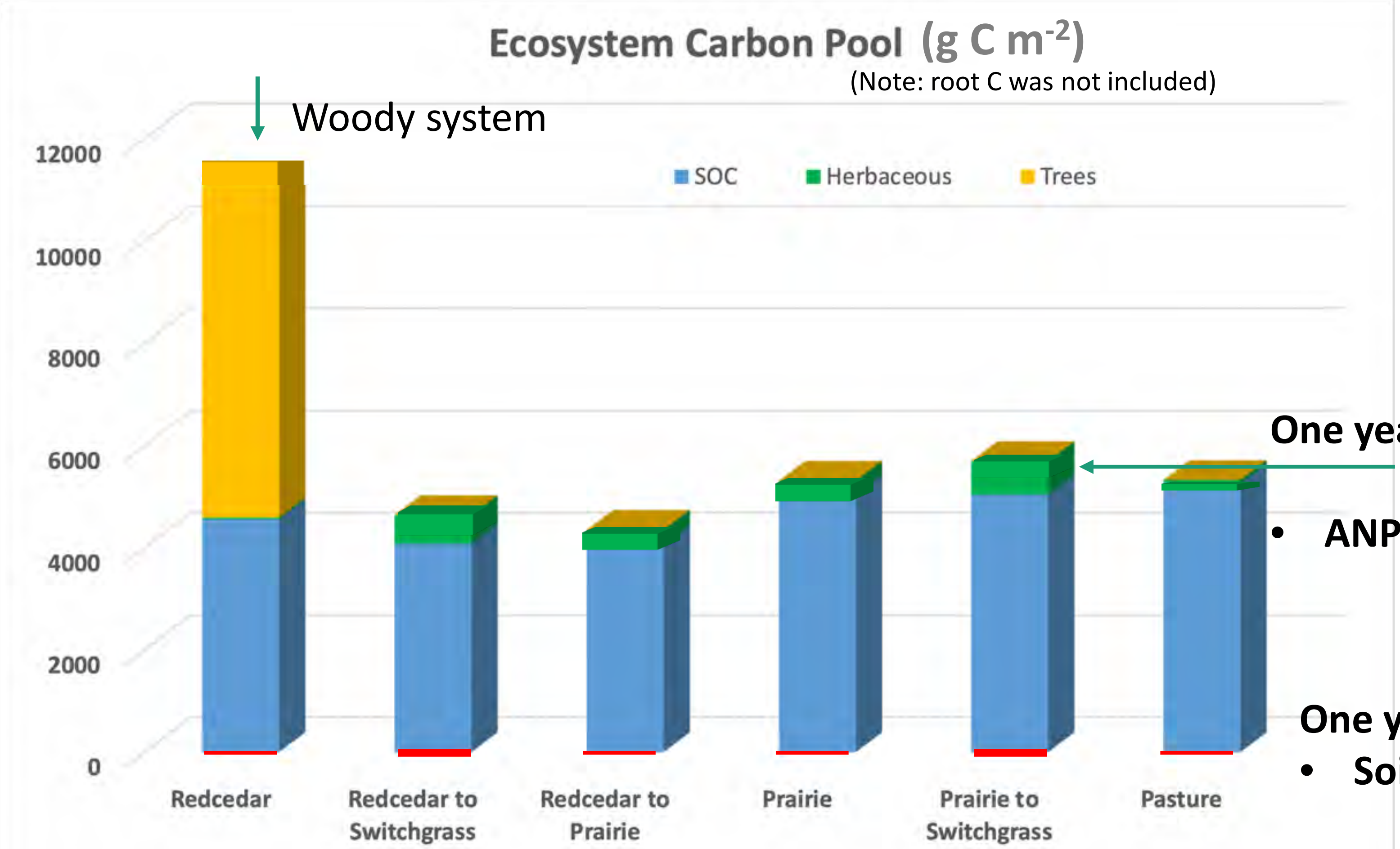


Soil Carbon Pool in 2020 (0 – 30 cm)





Ecosystem Carbon Pool in 2020








One year later

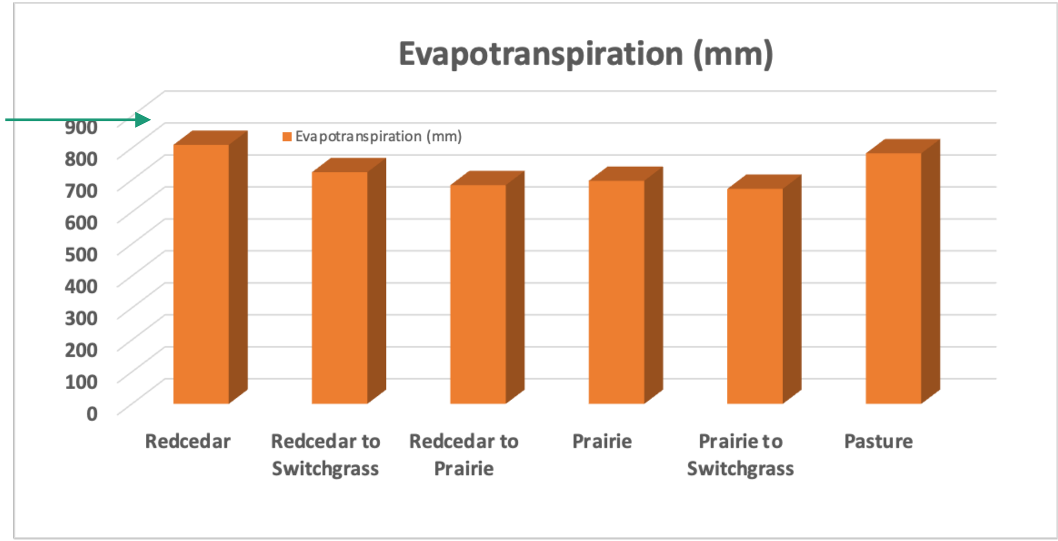
- **ANPP**

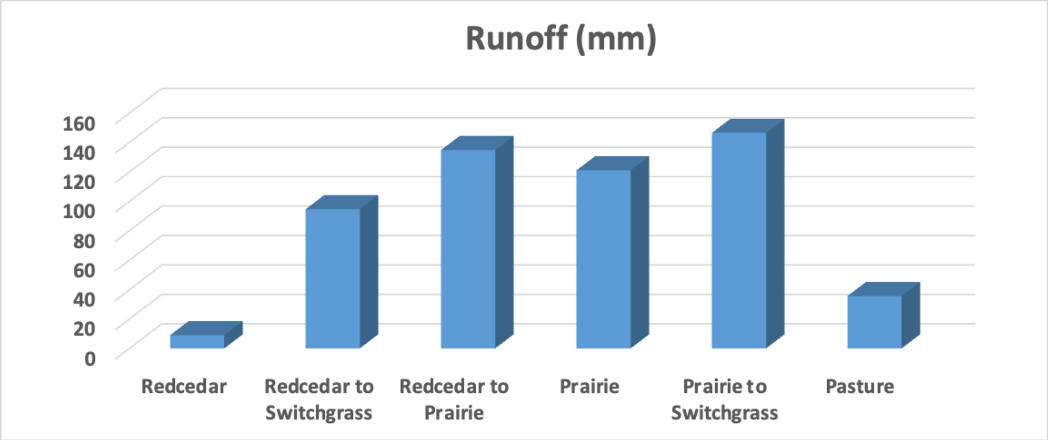
One year later

- **Soil Organic C**

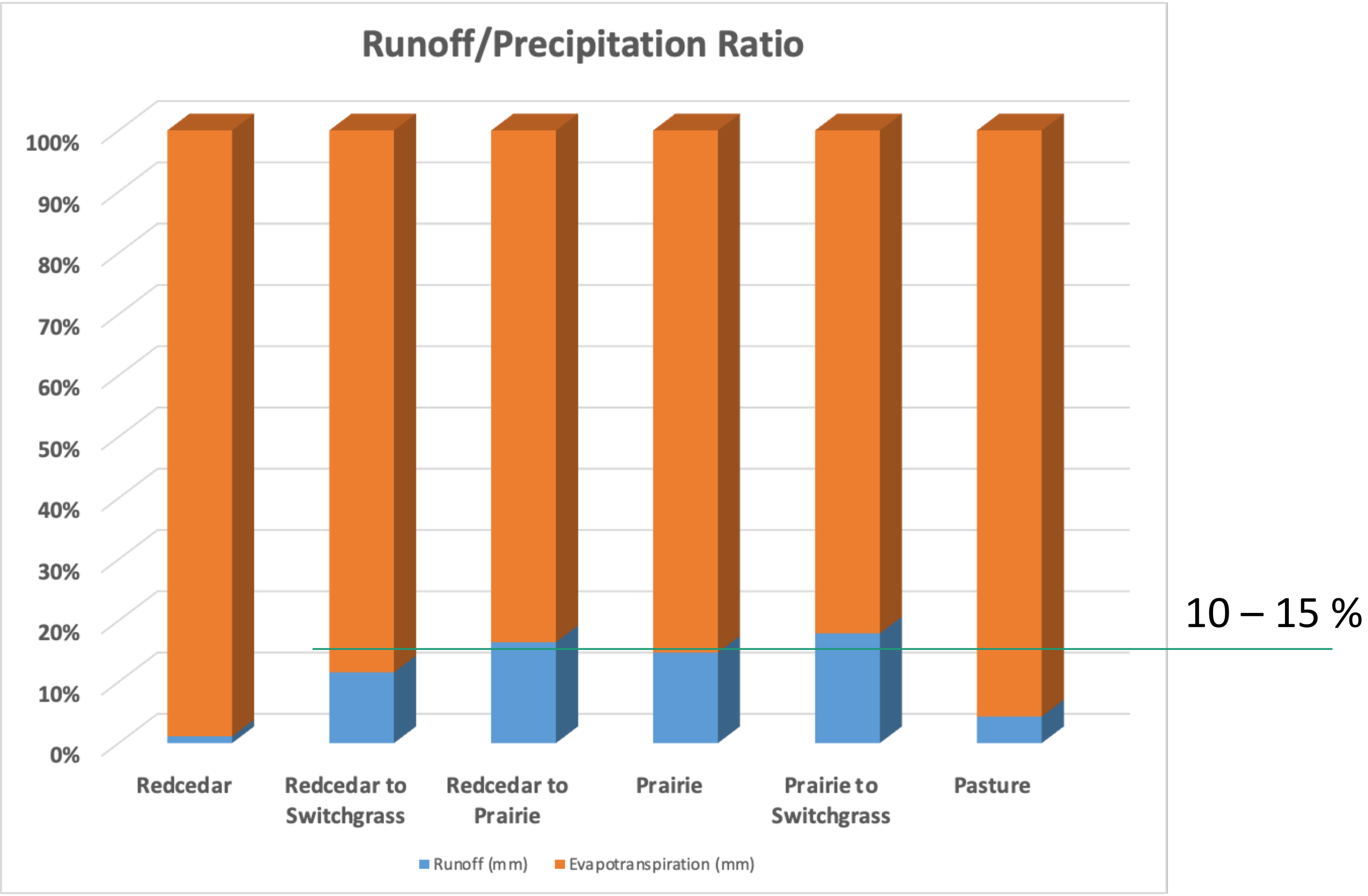
Water Cost in 2020

Precipitation
(819 mm)





Runoff Coefficient (Runoff/Precipitation) in 2020



Preliminary Conclusions

- **Soil organic carbon stock (0 – 30 cm) is the largest component in C pools across land uses except for redcedar**
- **Switchgrass and redcedar are more effective to fix carbon on annual basis**
- **Redcedar woodland has the largest ecosystem C pool due to the largest C component in standing biomass.**
- **Redcedar has less runoff**
- **Switchgrass has the greatest water use efficiency**

Socio-economic & Magmt Implications

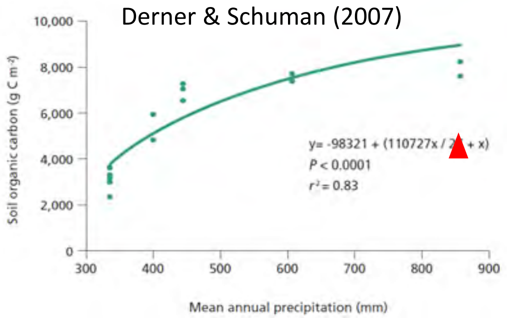
Tallgrass soils, especially from previous cultivation, have a great capacity to sequester carbon

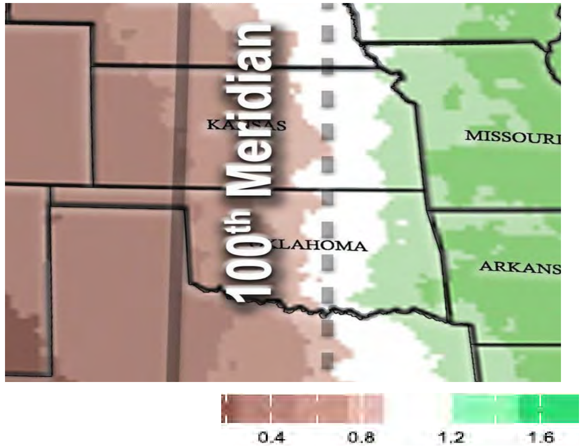
Switchgrass is effective to sequester carbon without greatly affecting water, but the market opportunity is unclear

Trees are relatively effective to sequester carbon into standing biomass at a great cost of water **in the transition zone**

- The trade-off may shift with climate
- Or along the climate gradient
- Fire risk and other ecosystem service loss with redcedar

Derner & Schuman (2007)





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Year 3 - forward

- Dynamics of ecosystem carbon gain (NEE) and water use at seasonal and sub-seasonal scale
- Tradeoff of carbon gain and water use after woody plant encroachment and its interaction with the precipitation gradient
- Calibrate, validate carbon gain and water use for regional projection

Questions?

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