CARBON STORAGE AND CYCLING IN RANGELANDS OF THE CANADIAN PRAIRIES

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SASKATCHEWAN SOIL CONSERVATION ASSOCIATION
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FACULTY OF AGRICULTURAL, LIFE & ENVIRONMENTAL SCIENCES
Rangeland Research Institute

"uplifting the whole people"
— HENRY MARSHALL TORY, FOUNDING PRESIDENT, 1908

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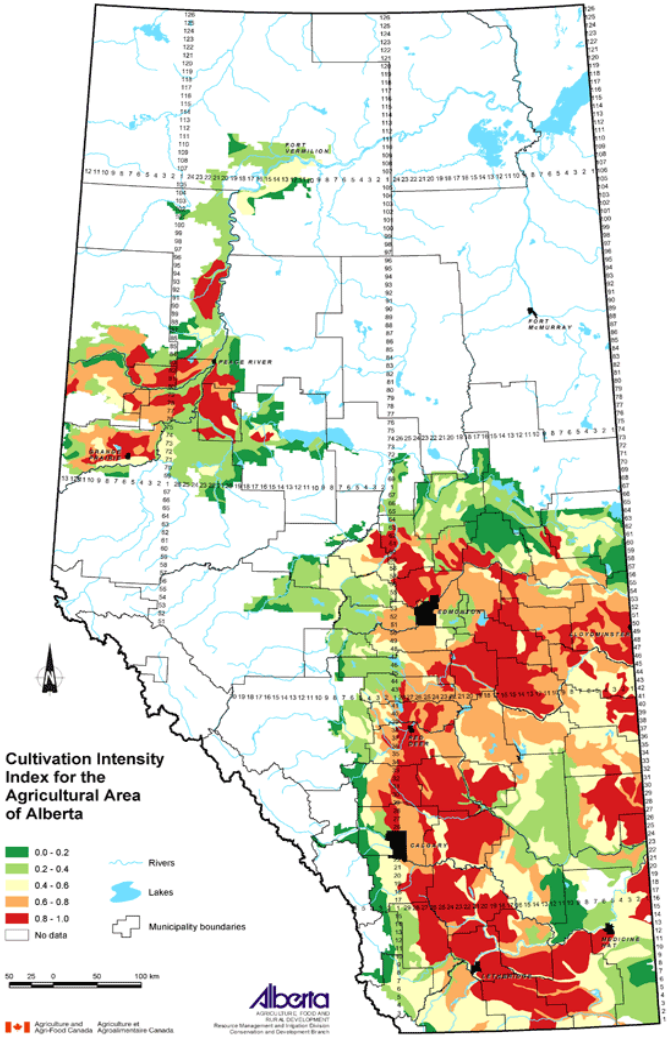
AEP
ABMI

Research Support:

Grassland loss

60- 83% grassland conversion

- 2% / year loss of great plains (WWF, 2016)
- Alberta grasslands: +1.8% human footprint (ABMI,1999 to 2013)
- 40,000 fewer acres of natural area used for livestock (2016 Census)



Grassland Ecosystem Goods and Services

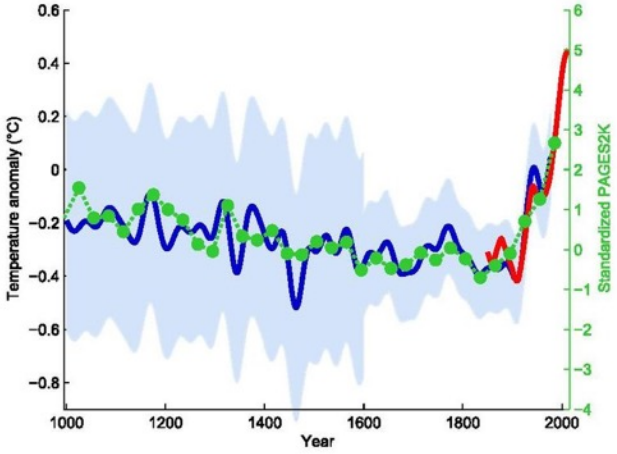
"the services and benefits from ecological functions provided to humans"

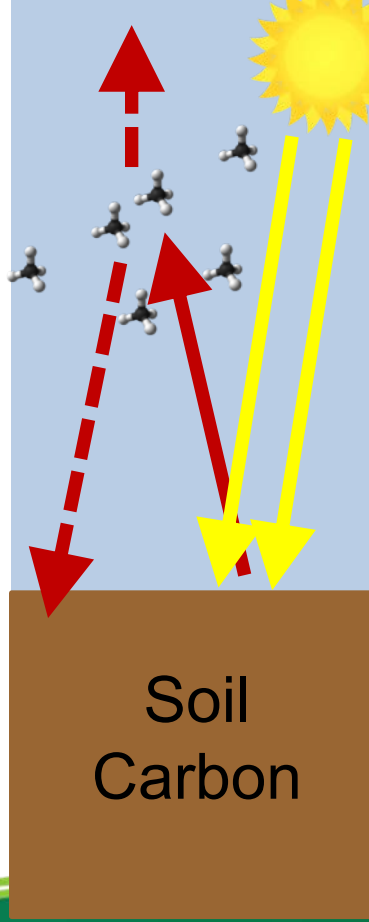




Cattle, GHG, soil carbon, climate change

- Increased GHG
- Concern over GHG from cattle
- The risk of drought is increasing
- Managing for soil carbon benefits forage production
- **No offset protocol for perennial vegetation**





Land use, cattle, stocking rates and grazing systems

How does land use affect EG&S?

Land use, cattle, stocking rates and grazing systems

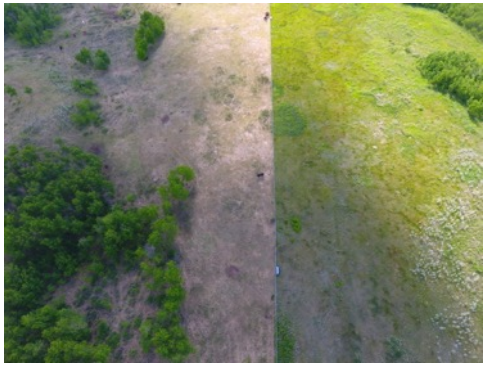
Do cattle affect EG&S?

Land use, cattle, stocking rates and grazing systems

Can we identify cattle management practices that improve EG&S?

Stocking rates: intensity, the amount of use by cattle

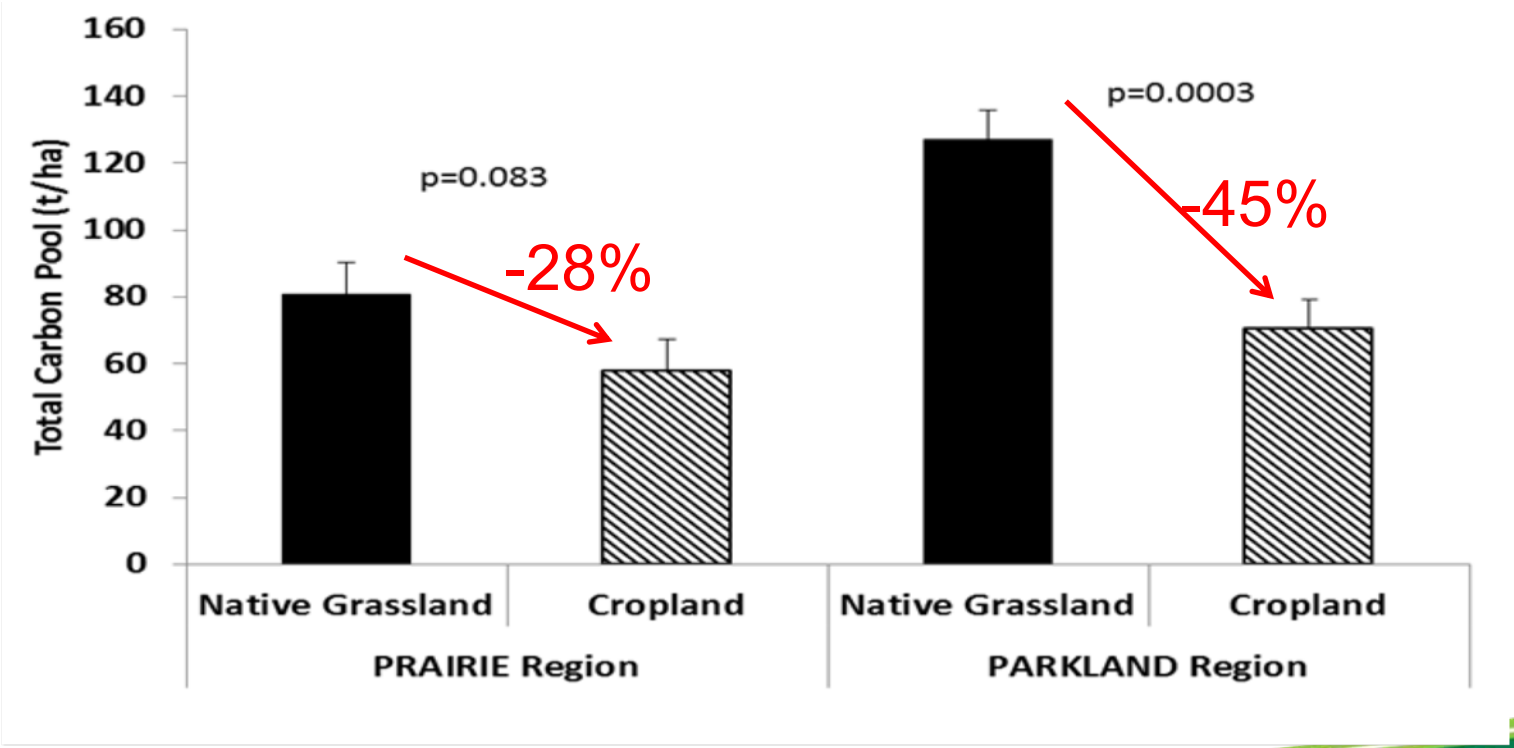
Grazing systems: the season, duration, cattle density



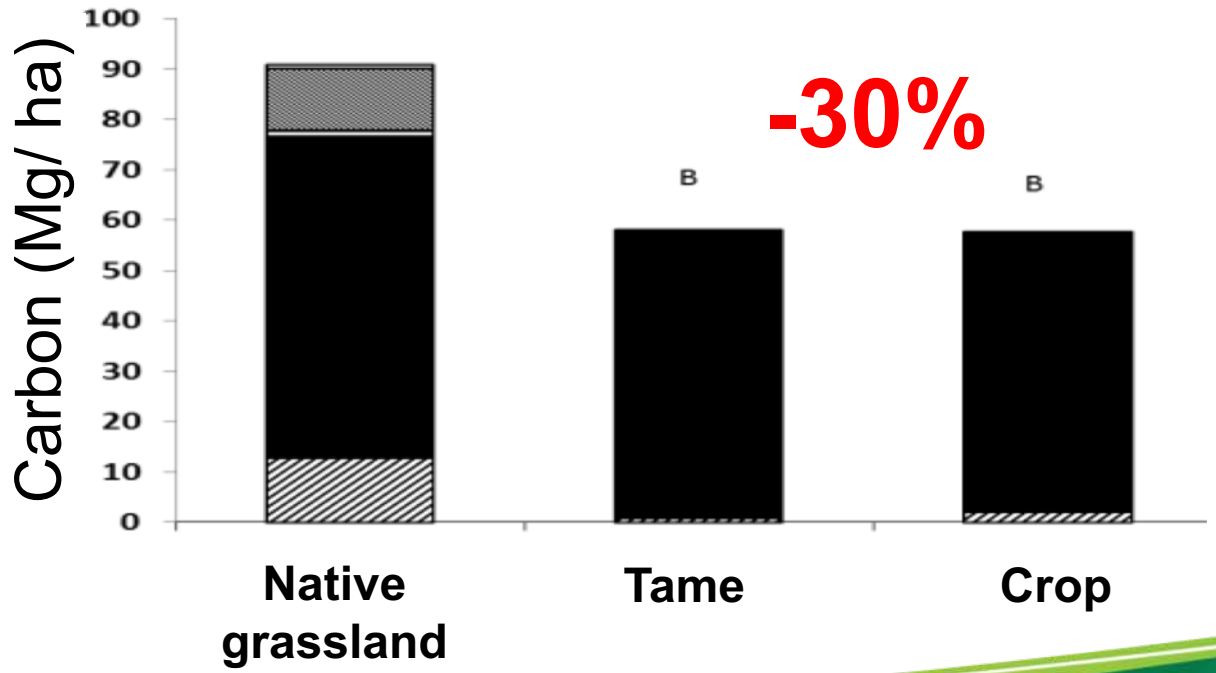
Land use, cattle, stocking rates and grazing systems

What are the reasons for the changes we observe?

Cultivation reduces carbon storage



Tame pastures didn’t recover carbon after 20 years



Native grasslands have higher soil physical quality than tame pasture and cropland

LAND USE TYPE	Max Water Availability ($cm^3\ cm^{-3}$)	Soil Porosity	Fractal Index (e.g. aggregation)
Native Grassland	0.14^{b}	0.54^{b}	0.048^{b}
Introduced Pasture	0.099^{a}	0.46^{a}	0.033^{ab}
Annual Cropland	0.096^{a}	0.47^{a}	0.020^{a}

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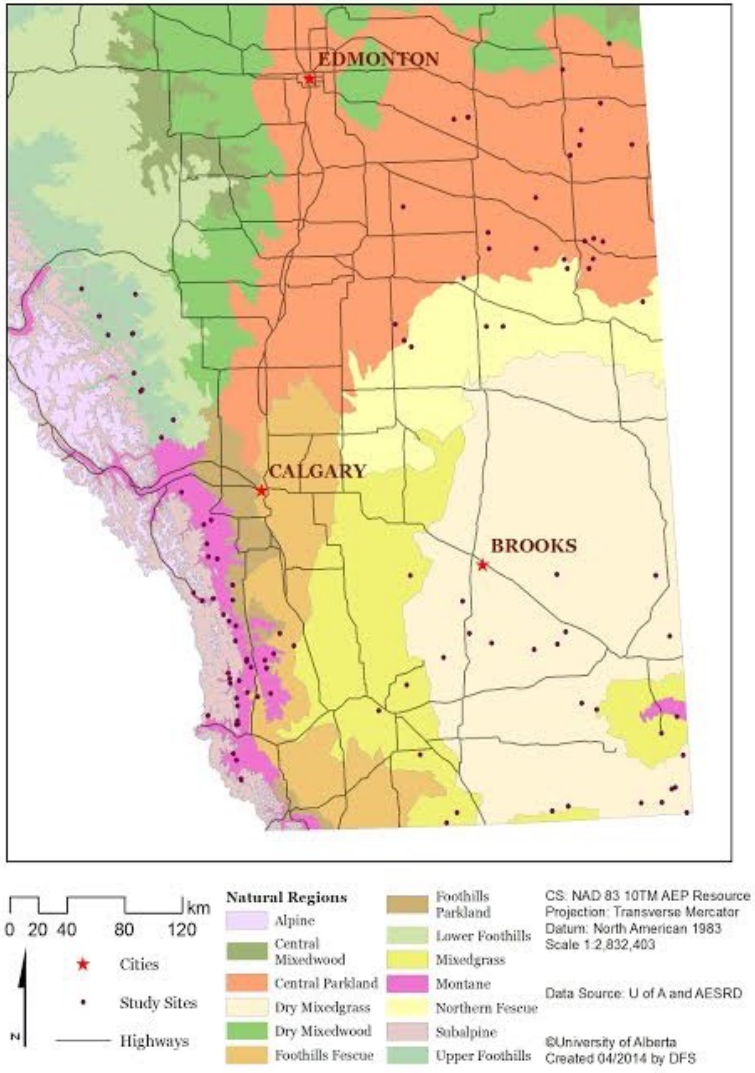
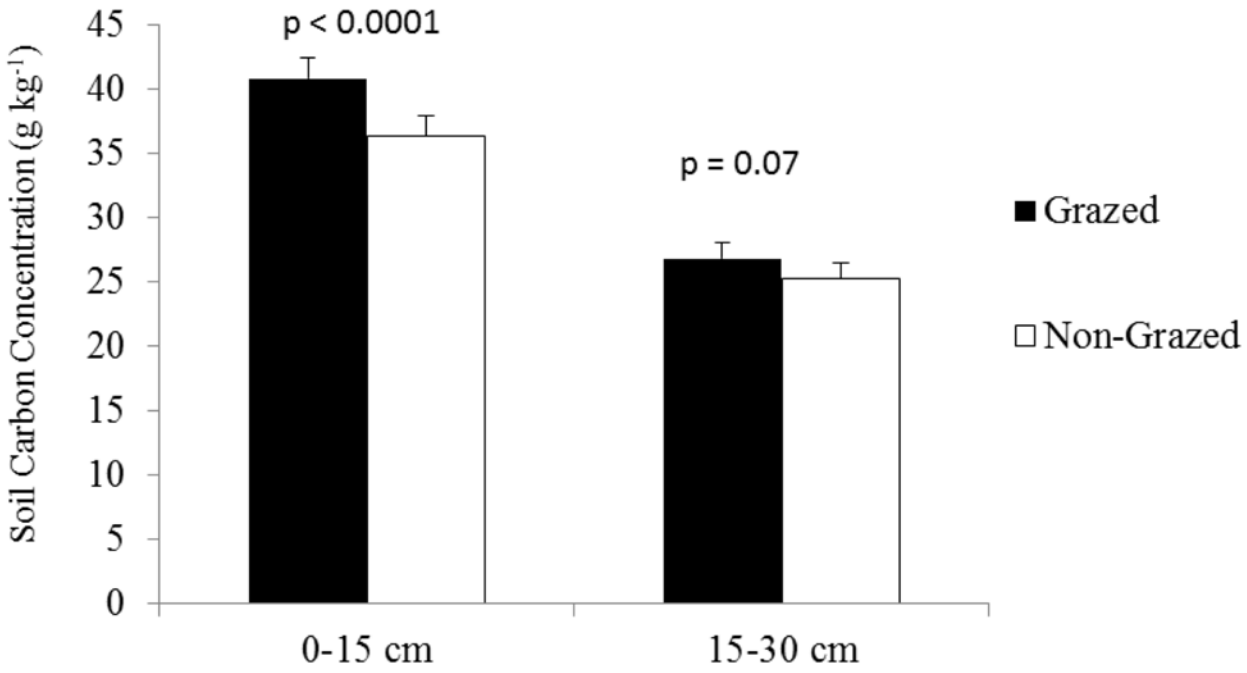
Hebb et al. 2017

Carbon Benchmarking Study

Compared areas inside and outside long-term cattle exclosures (n=107)



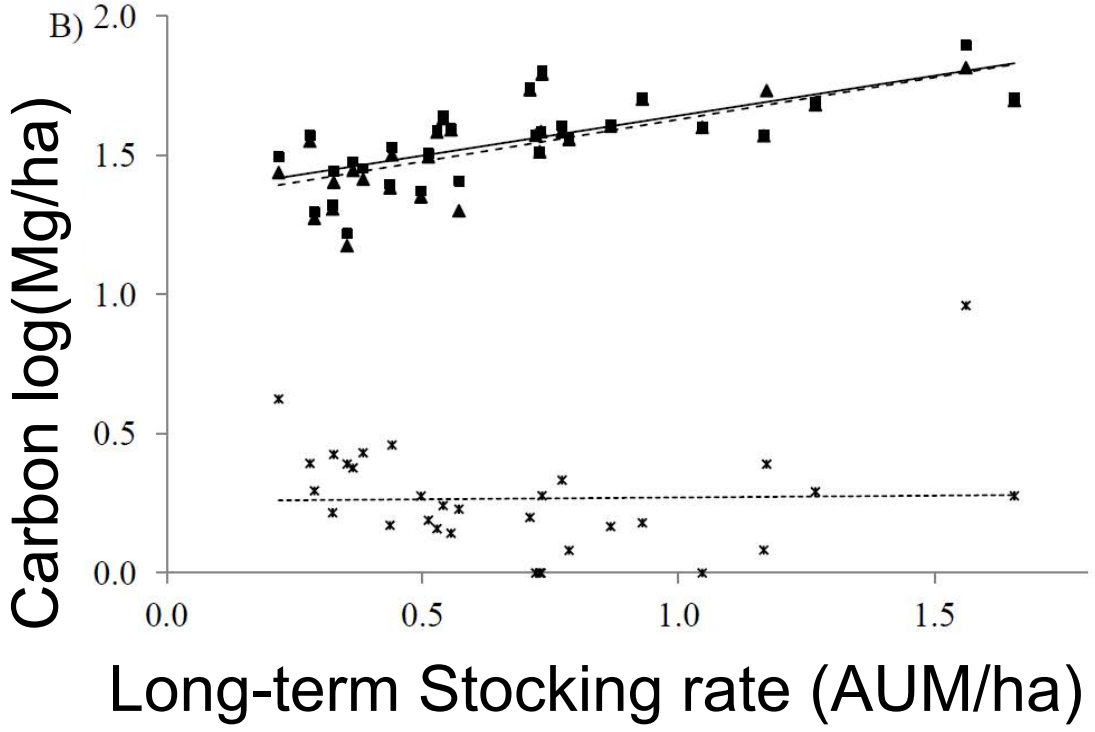
Moderate grazing increased carbon storage



Hewins et al. 2018. Scientific Reports.

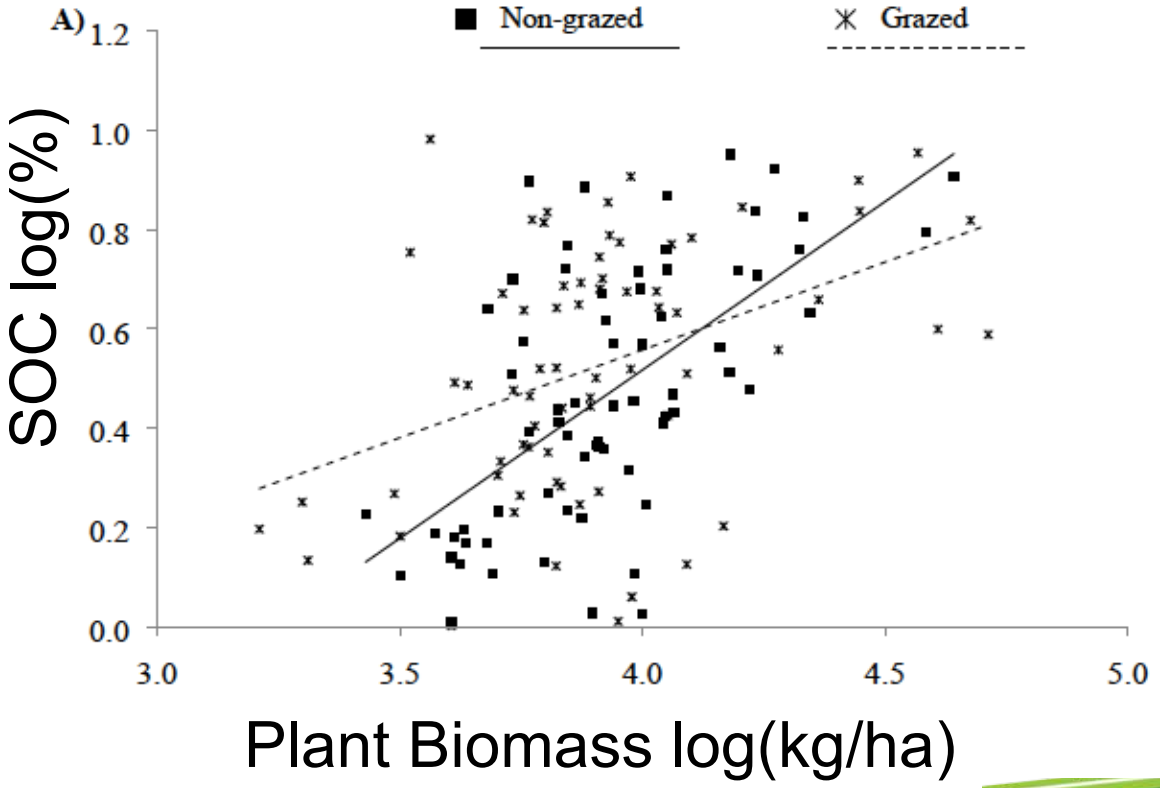
Stocking rate increased soil carbon in community pastures

- Mixed and Moist-Mixed grassland
- 9 Community pastures
- Long-term cattle data
- 60 cm deep
- **Low stocking rates**



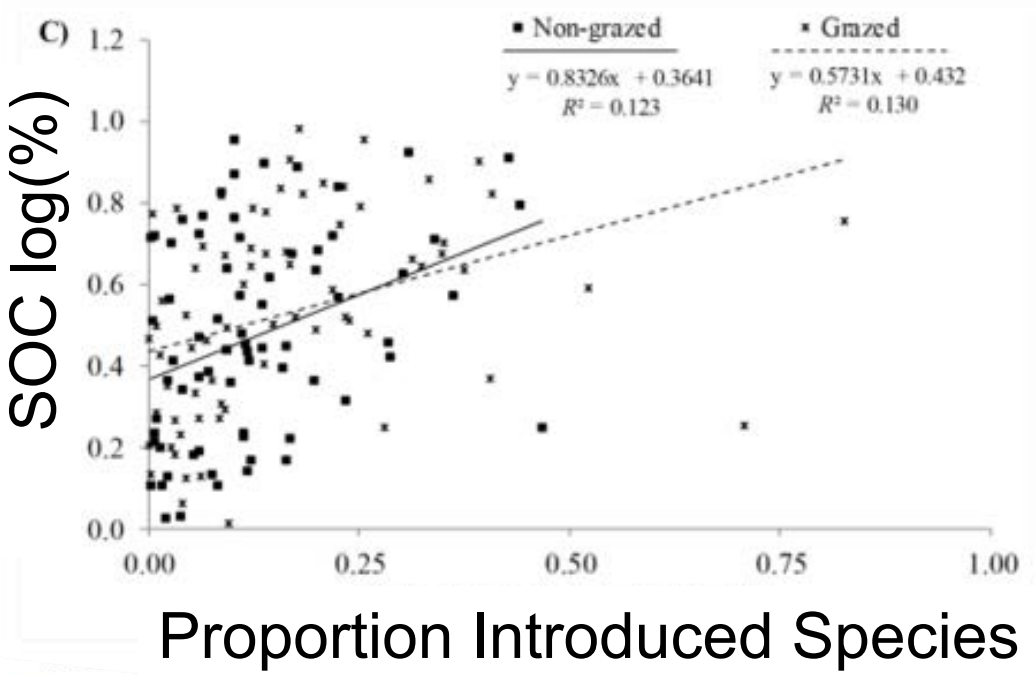
Bork, Raatz, Carlyle, Hewins, Thompson. In Press. Soil Use and Management.

Grazing alters the relationship between plants and SOC



Bork E, Lyseng M, Hewins DB, Carlyle CN, Chang S, Willms W, Alexander M. In press. Canadian Journal of Plant Science.

Grasslands with greater proportion of non-native plants had higher soil carbon and forage



Bork E, Lyseng M, Hewins DB, Carlyle CN, Chang S, Willms W, Alexander M. In press. Canadian Journal of Plant Science.

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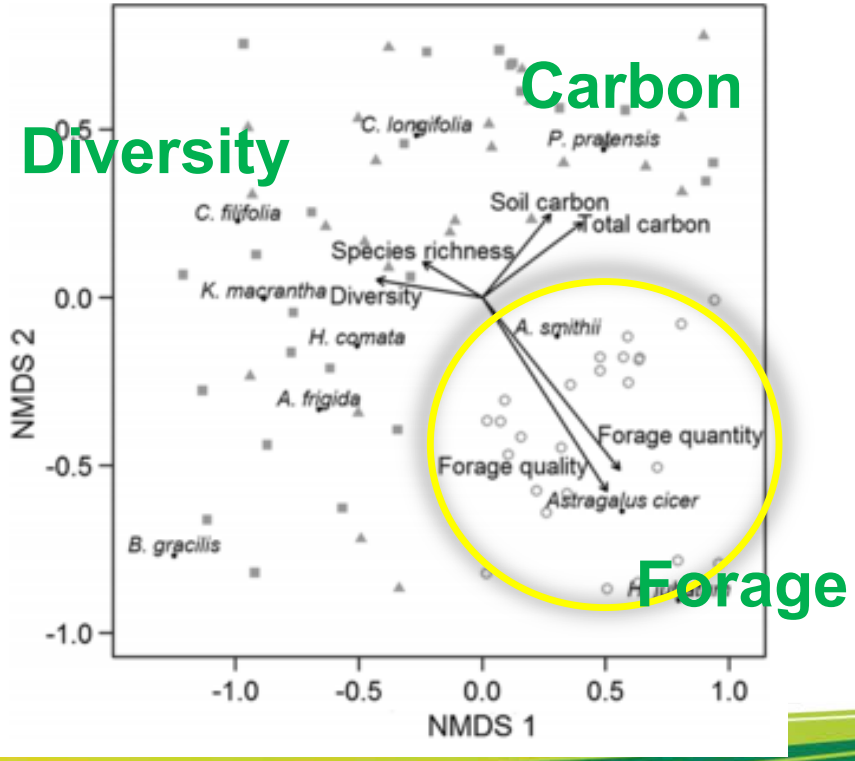
Astragalus cicer increased forage but reduced diversity and soil carbon



Le K, Carlyle CN. 2018. Biological Invasions 21.

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Centaurea stoebe altered soil and vegetation

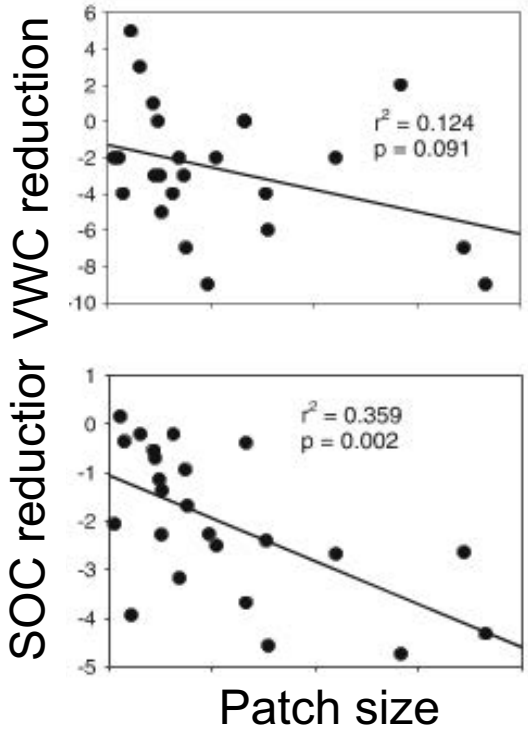
Soil temperature ↑

Soil moisture ↓

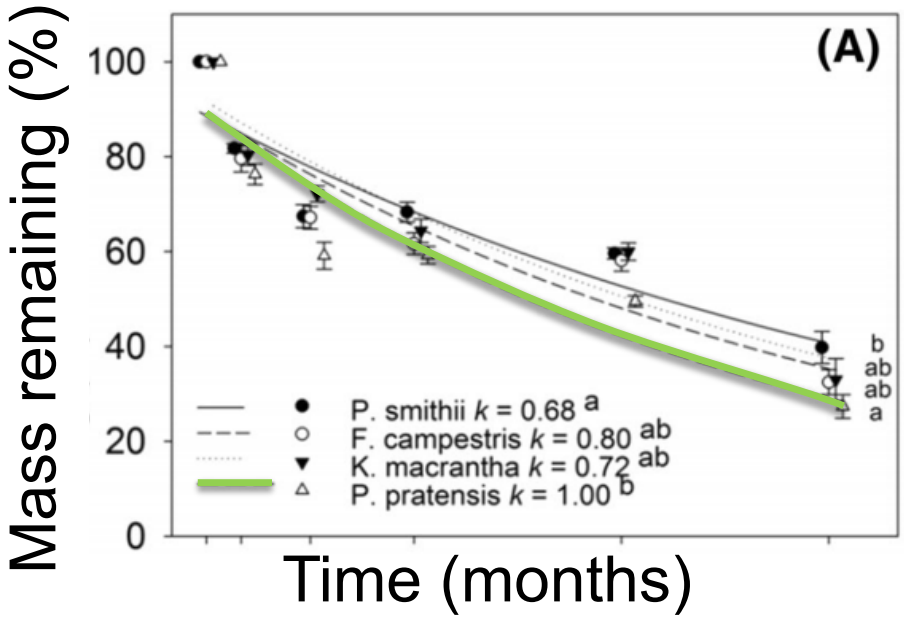
Soil C & N ↓

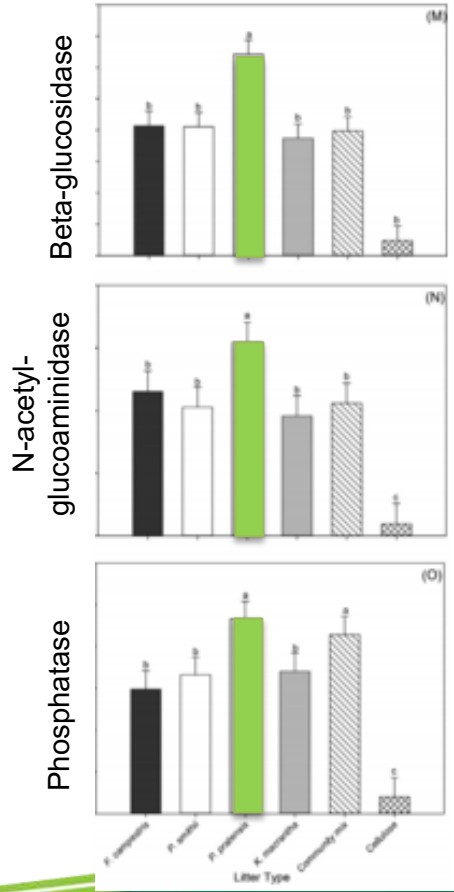
Litter ↓

Species richness & Diversity ↓



Poa pratensis increased litter decomposition through increased microbial activity





Chuan X et al. 2018. Ecosystems.
Chuan X et al. 2020. Science of the Total Environment.

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Ongoing Research: What is the optimal grazing system to increase carbon storage?

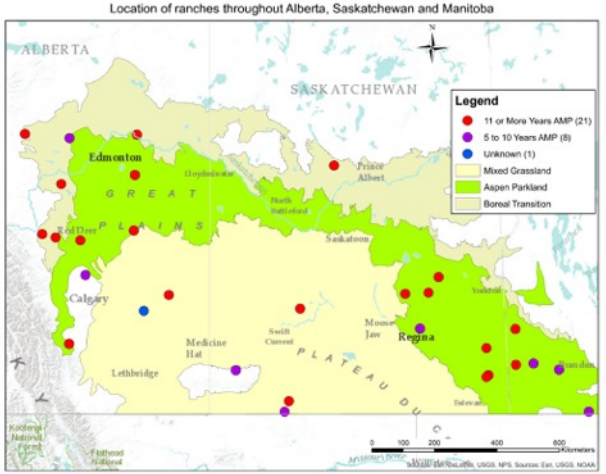
Adaptive multi-paddock grazing (AMP):

- high animal density
- fast rotations
- long rest periods

Preliminary results show:

- Limited effects on soil carbon
- Slight increase in GHG soil flux and soil microbial activity

Stocking rates



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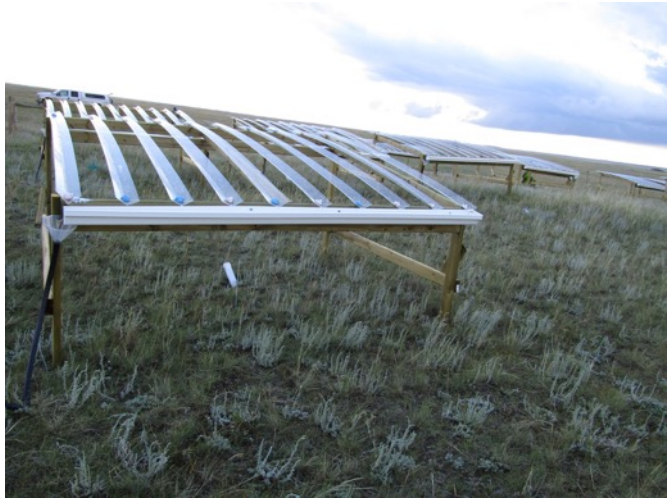
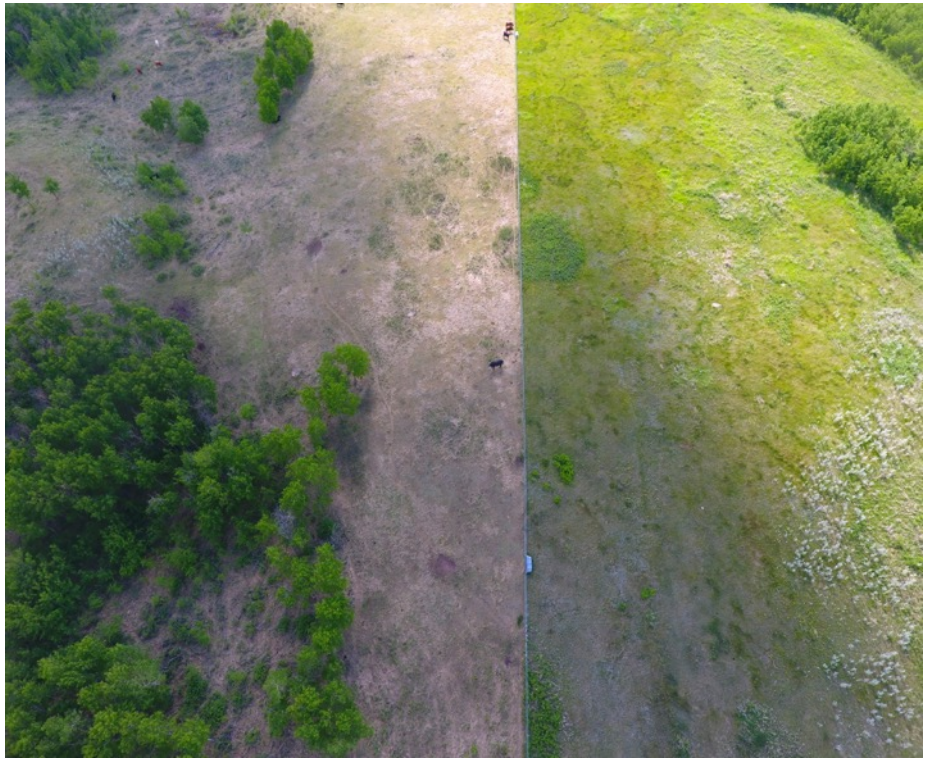
Ongoing research: Grazing and drought effects on roots and carbon cycling



Summary:

- Native grasslands store more carbon
- Moderate grazing increases carbon
- Changes in plant composition are an important driver
- Effects of grazing system are forthcoming



Thank you

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