

# An Overview of Current Research on Environmental Goods & Services in Alberta Grasslands

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*Western Beef Development Center*

*Lanigan, SK*

# Brief Outline

- **Introduce the Rangeland Research Institute**
- **Define environmental goods & services (EG & S)**
- **Review main findings of recent carbon benchmarking study done in Alberta grasslands**
- **Introduce new studies assessing grazing impacts on GHG emissions and other EG & S's**

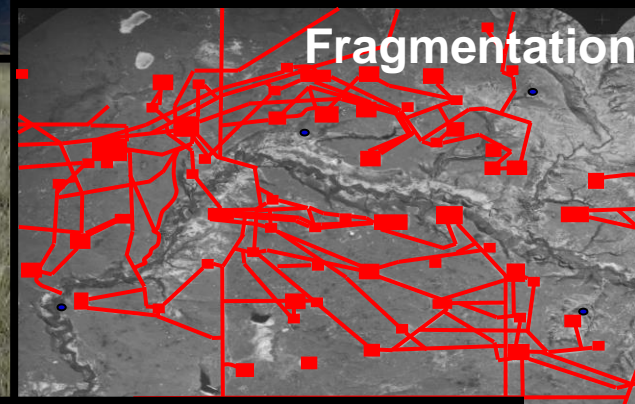
# Rangeland Research Institute



**UNIVERSITY OF ALBERTA**  
**FACULTY OF AGRICULTURAL,  
LIFE & ENVIRONMENTAL SCIENCES**  
Rangeland Research Institute

*Organization dedicated to promoting and conducting leading edge research and teaching on rangelands, with the ultimate goal of improving the sustainability of rangeland use and management*

# Threats to Rangelands are on the Rise



# Previous Advances in Range Science for the Cow/Calf Sector are Evident ...



**Increased grazing efficiency (use)**



**Understanding grassland ecology**



**Improved forage agronomy (production)**

# EG & S: “Tangible benefits all of society receives from the existence of grasslands”

Water Purification/Flood Mitigation



Carbon Storage & GHG Uptake



Pollination



Forage & Livestock Production



Biodiversity & Wildlife Habitat



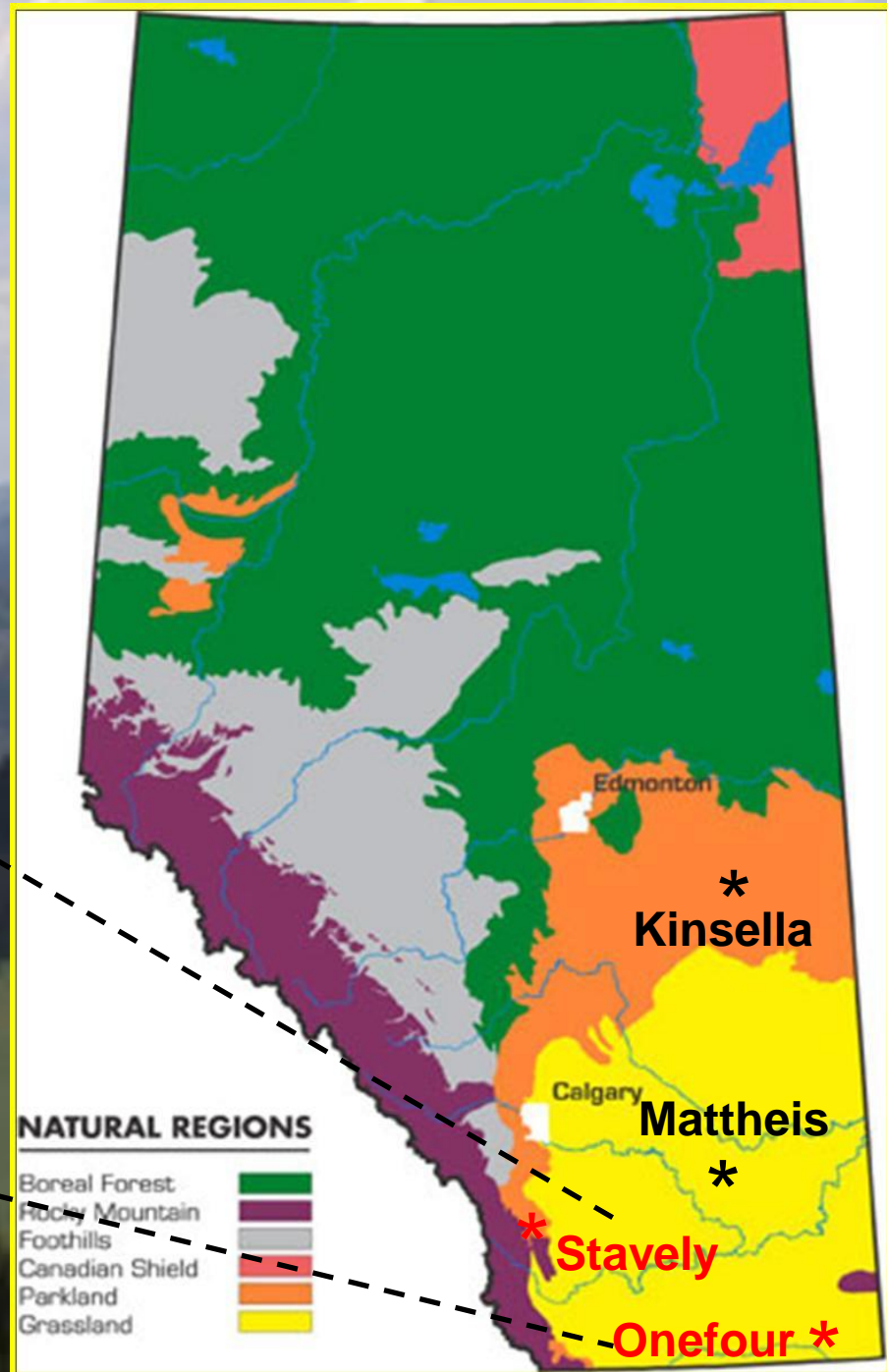
# University of Alberta

## *Primary Rangeland Research Facilities (Kinsella and Mattheis Ranches)*



# University of Alberta

*Collaboration with Alberta  
Environment and Parks  
(former Ag Canada Sub-stations)*





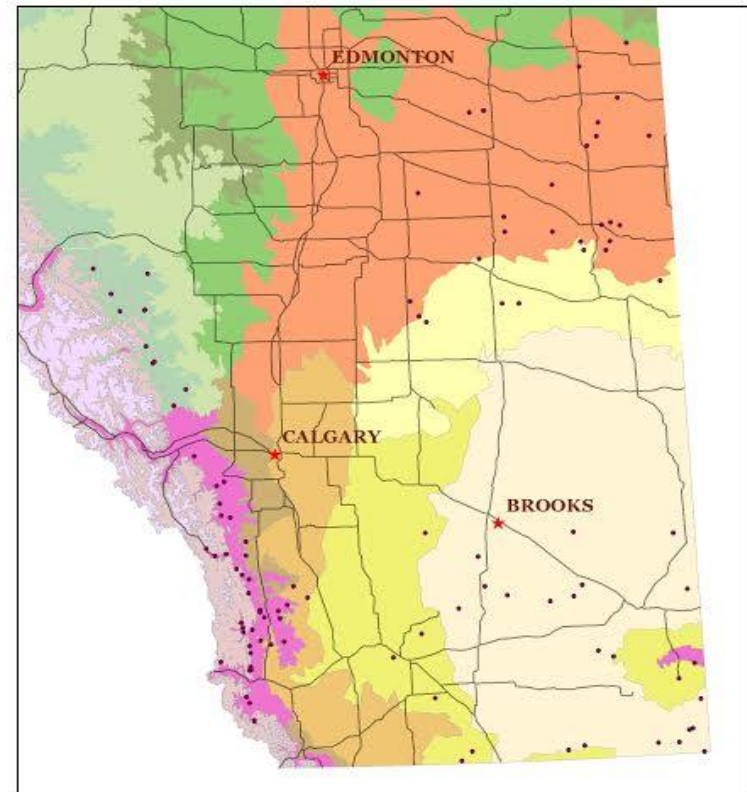
# Rangelands and EG & S:

Recent findings of a University of Alberta/AEP Collaboration

**ALMA**  
Alberta Livestock  
and Meat Agency Ltd.

- Sampled 114 grasslands managed by Alberta Environment & Parks

Carbon Benchmarking Sites in Alberta



# Quantified Various EG & S

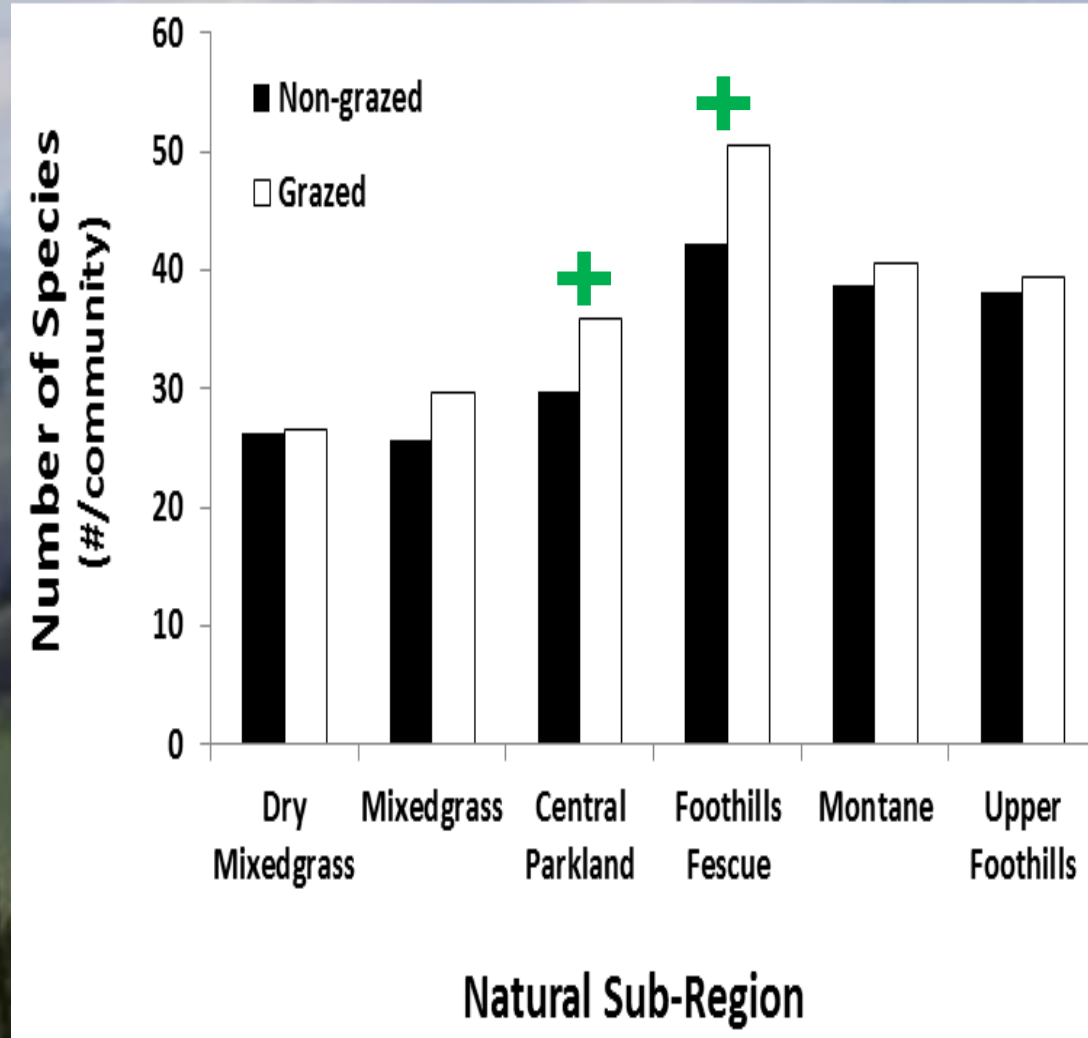
- Examined exclosures (15-70 yr old)
- Enabled long-term assessment of presence/absence of livestock grazing
- Measured biomass, plant diversity & carbon stores



# Grazing & Plant Diversity



- Plant diversity peaked in mod-high rainfall areas
- Diversity increased with long-term exposure to grazing by releasing plant species suppressed in the absence of ungulates
- Largest increases were in Parkland and Foothills Fescue

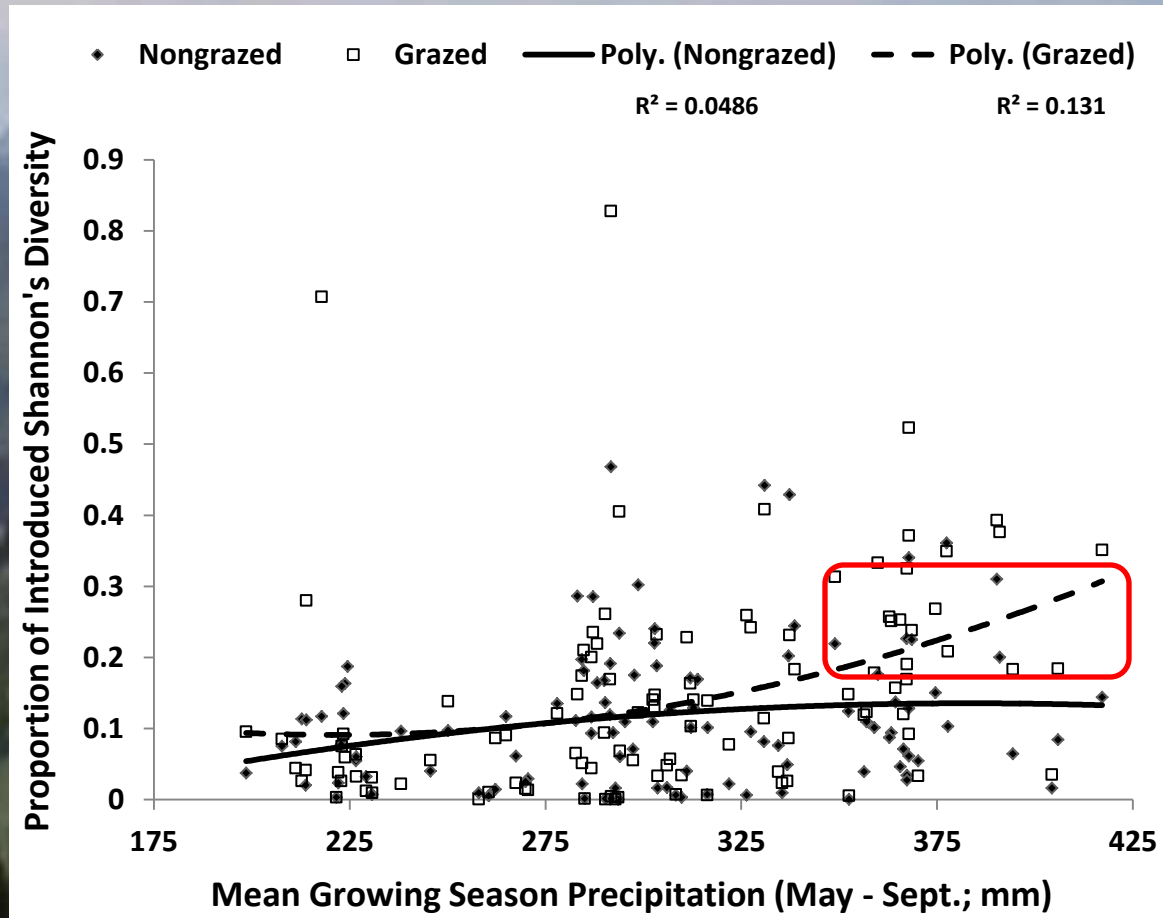


# Does Grazing Alter Introduced Plant Species?

➤ Introduced species  
~10% of composition

➤ Semi-arid grasslands  
with < 300 mm (12")  
had greater resistance  
to invasion

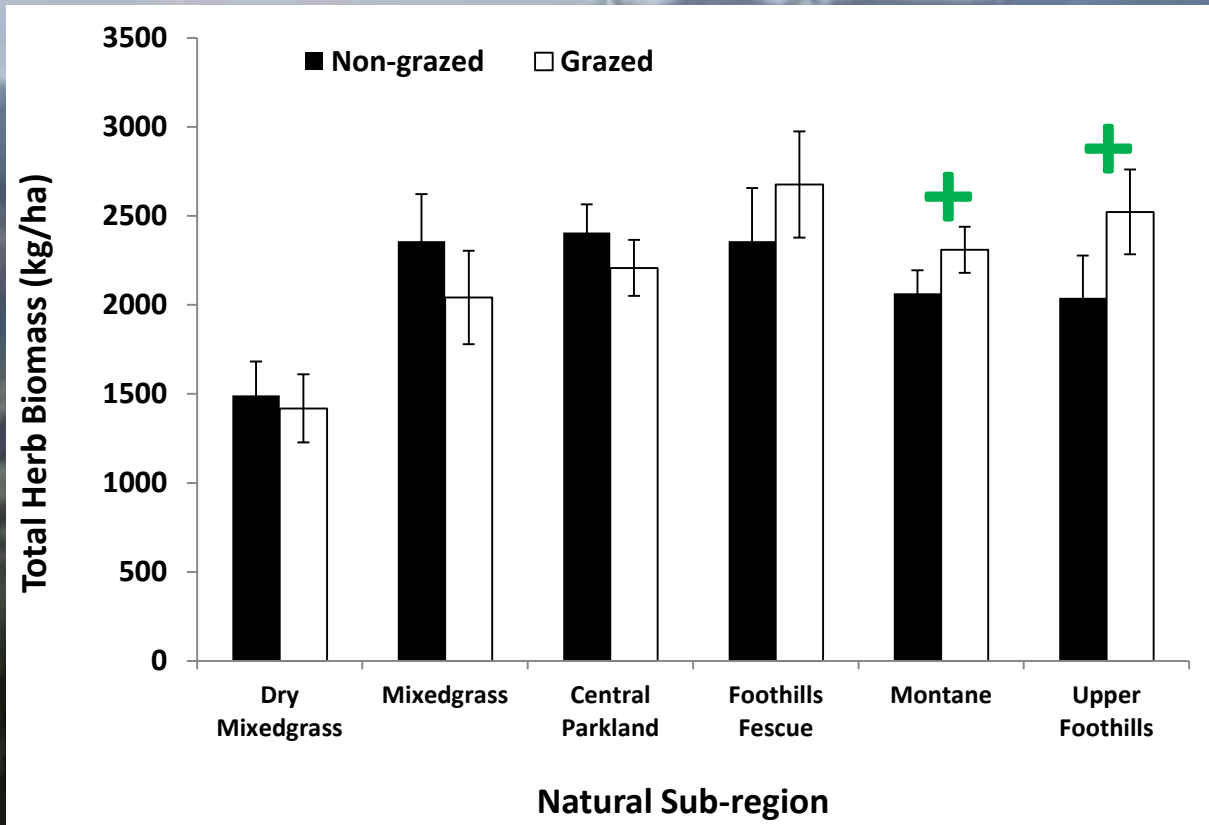
➤ Grazing increased  
introduced spp., but  
only under moist  
conditions (>350 mm)



# Grazing Impacts on Total Above-ground Grassland Productivity

➤ Grazing enhanced production in high rainfall grasslands of SW Alberta

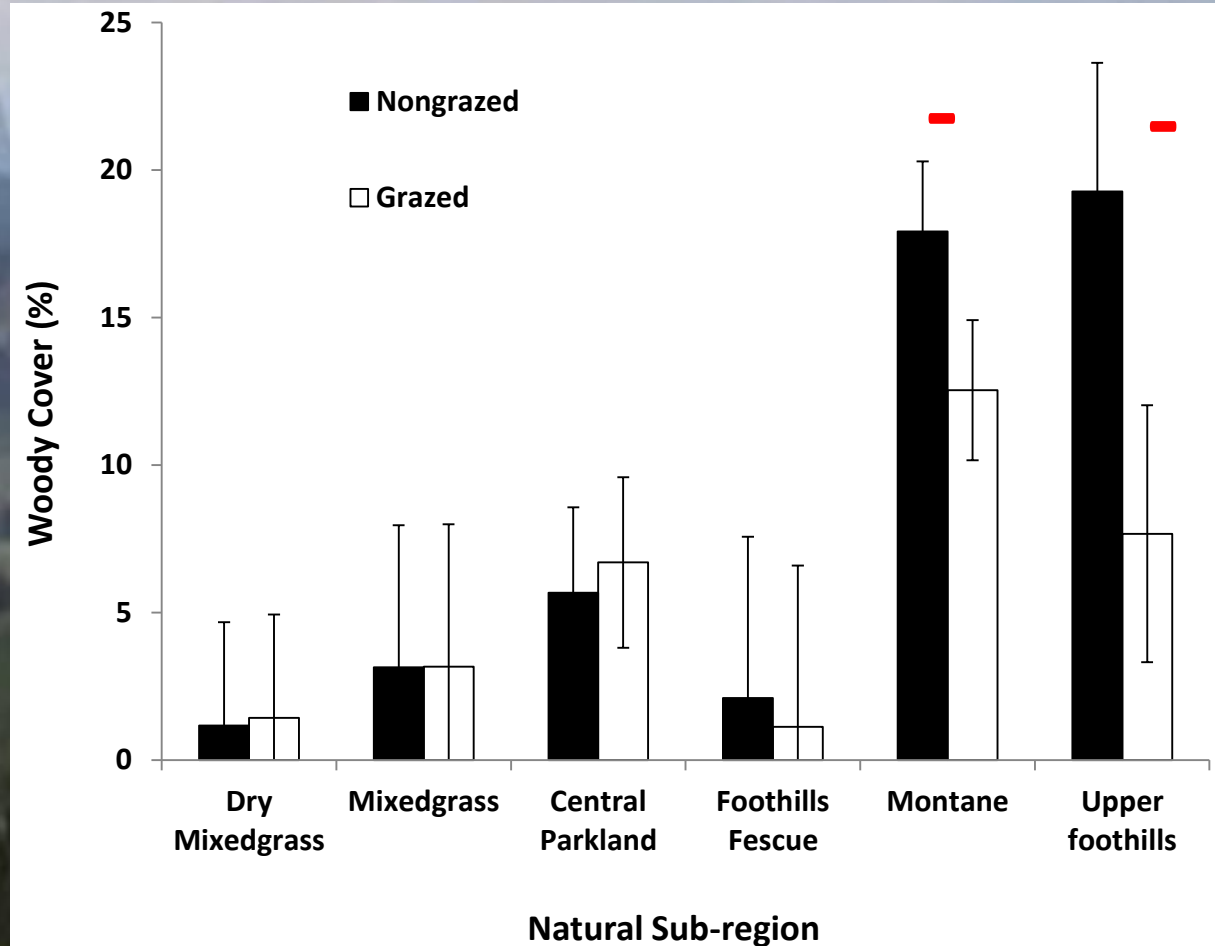
➤ Introduced species likely play a role in boosting herbage productivity!



# Grazing May Help Limit Shrub Encroachment



- Grazing was tied to lower shrub cover in the Rocky Mountain Forest Reserve
- The largest reductions were in grazing allotments of the Upper Foothills



# Rangelands & Carbon Storage

(Mitigation of Rising CO<sub>2</sub> Levels – “Greenhouse Effect”)

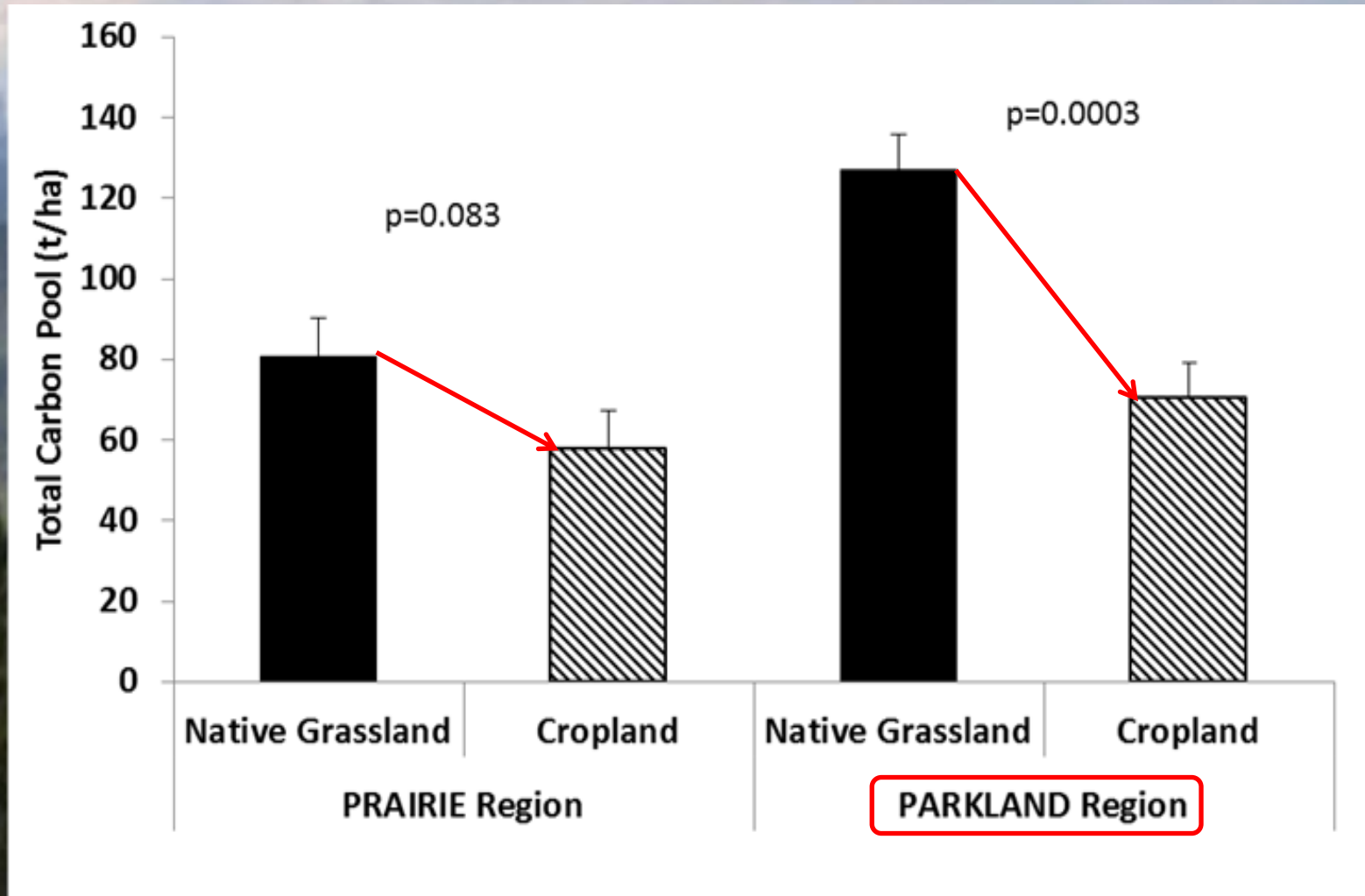
Grasslands store 10-30% of the world's organic carbon (C)

Temperate grasslands (~8% of earth's surface) contain more than 300 Gt C:

- 9 Gt in plants (3%)
- 295 Gt in soils (97%)



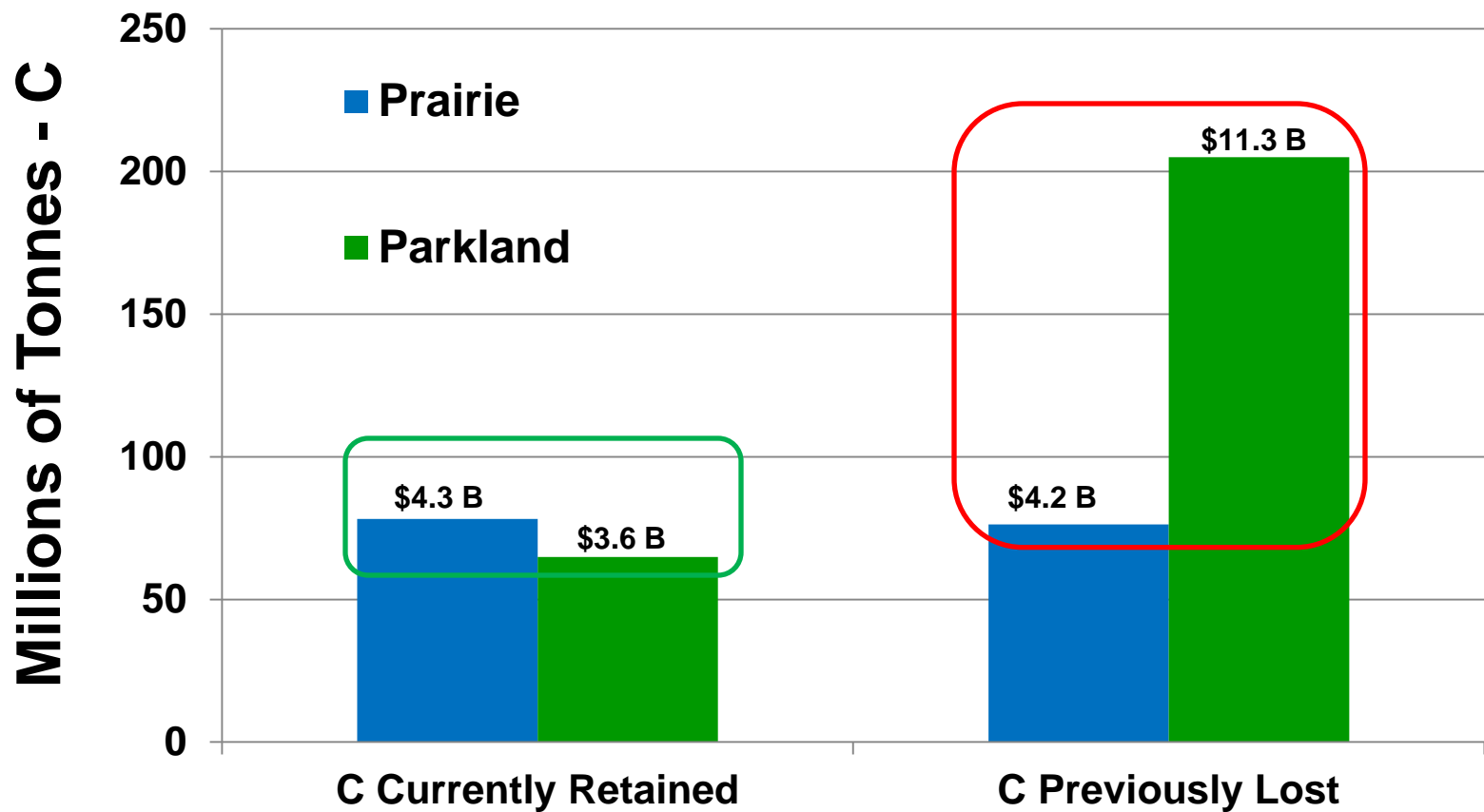
# Annual Cropping Reduced Total Carbon Compared to Native Grassland (Benchmarking Study)





# What is the Value of C Retained/Lost from Native Grasslands?

*Carbon values derived using ABMI land areas for each land use change and a C-valuation of \$15/t-CO<sub>2</sub>e (CCEMC)*



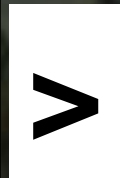
**Comparison of Grassland VS Cropland**

# Land Use Conversion Also Reduced Soil Health (e.g. water delivery)

*Native grasslands have comparatively better metrics of soil quality!*

(Hebb et al., submitted)

LAND USE	Max Water Availability (cm <sup>3</sup> cm <sup>-3</sup> )	Soil Porosity	Fractal Index (e.g. aggregation)
Native Grassland	0.14 <sup>b</sup>	0.54 <sup>b</sup>	0.048 <sup>b</sup>
Introduced Pasture	0.099 <sup>a</sup>	0.46 <sup>a</sup>	0.033 <sup>ab</sup>
Annual Cropland	0.096 <sup>a</sup>	0.47 <sup>a</sup>	0.020 <sup>a</sup>



# What About Grazing and Carbon?



# Grazing Effects on Total Carbon Have Been Inconsistent & Difficult to Predict ...



Mixedgrass under grazing

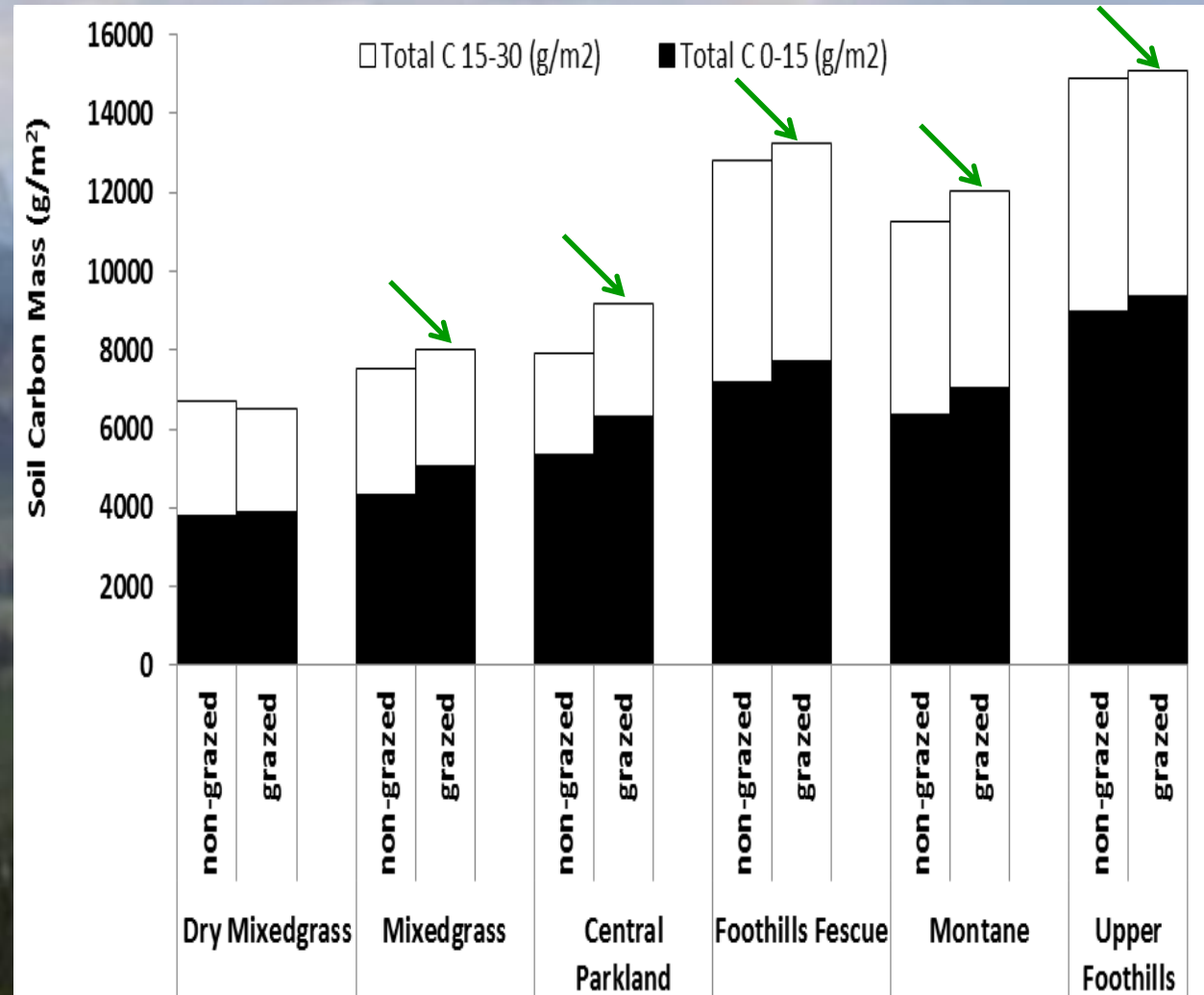


Fescue under grazing



# Grazing and Soil Carbon

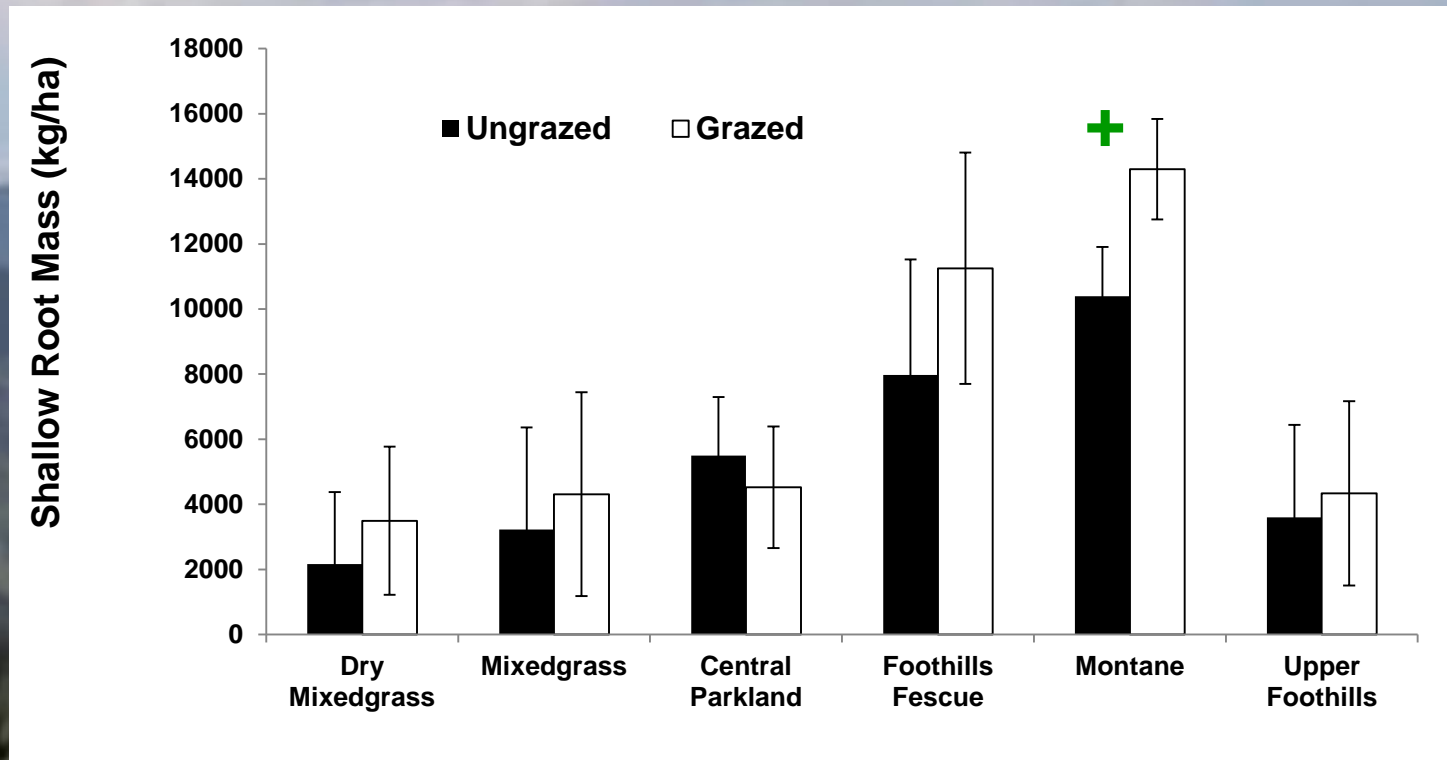
**\*\* Note trend for greater SOC in 5 of 6 regions:**



➤ Reductions in veg C (litter, mulch) are offset by consistent increases in soil C

**\*\*\* Soil C is the largest pool of ecosystem C due its large mass (60 – 140 t/ha)**

# Grassland Carbon Responses to Grazing May be Linked to Production



- Grazing stimulated root biomass (parallel to shoot biomass), particularly in moister environments

# Next Steps Underway ...

## *Nutrient Cycling Studies*



Collecting litter in the fall



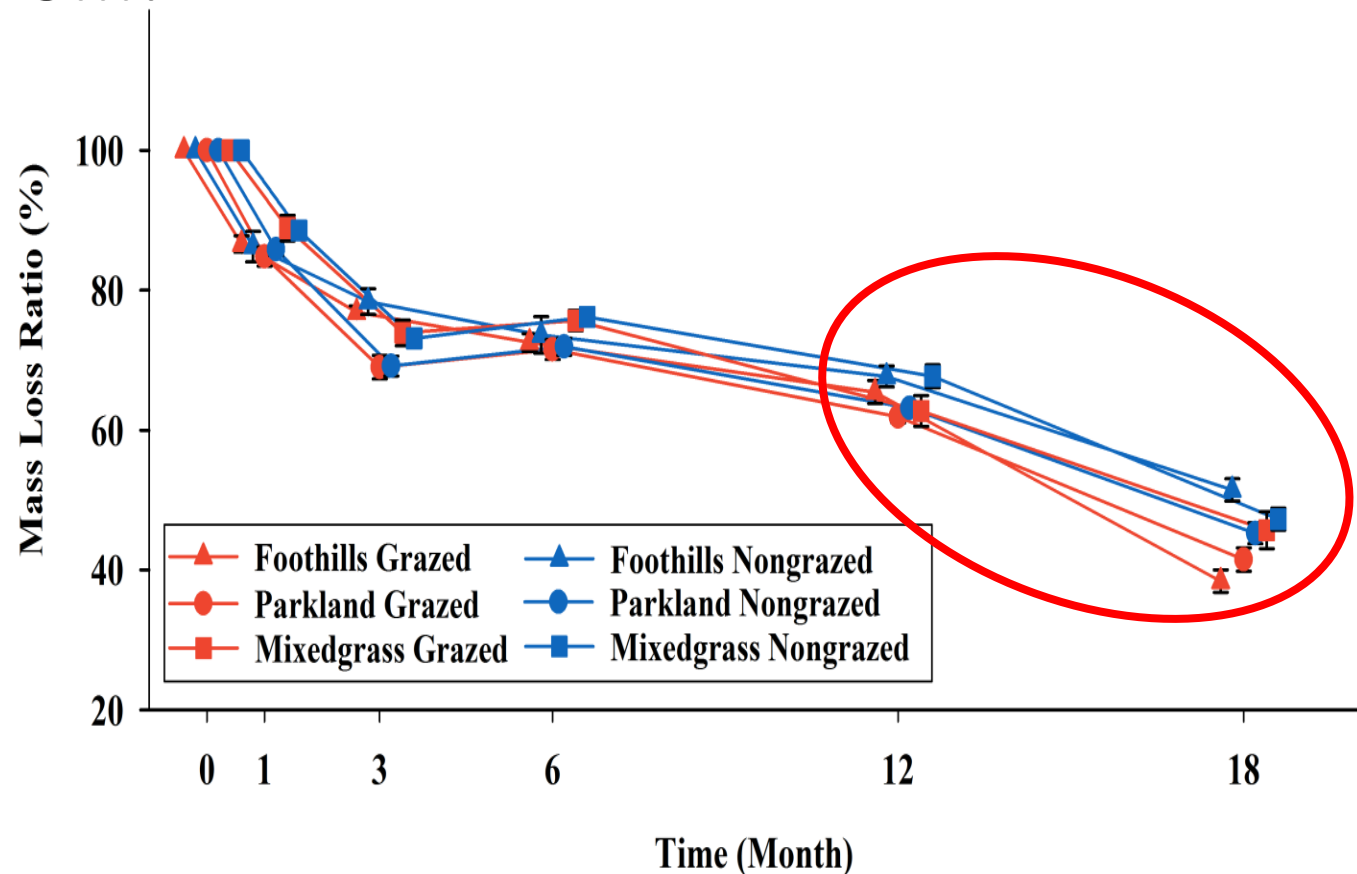
Litterbag filled with grass placed in the field



Sample soils to measure *in-situ* belowground processes

# Grazing Effects on Decomposition

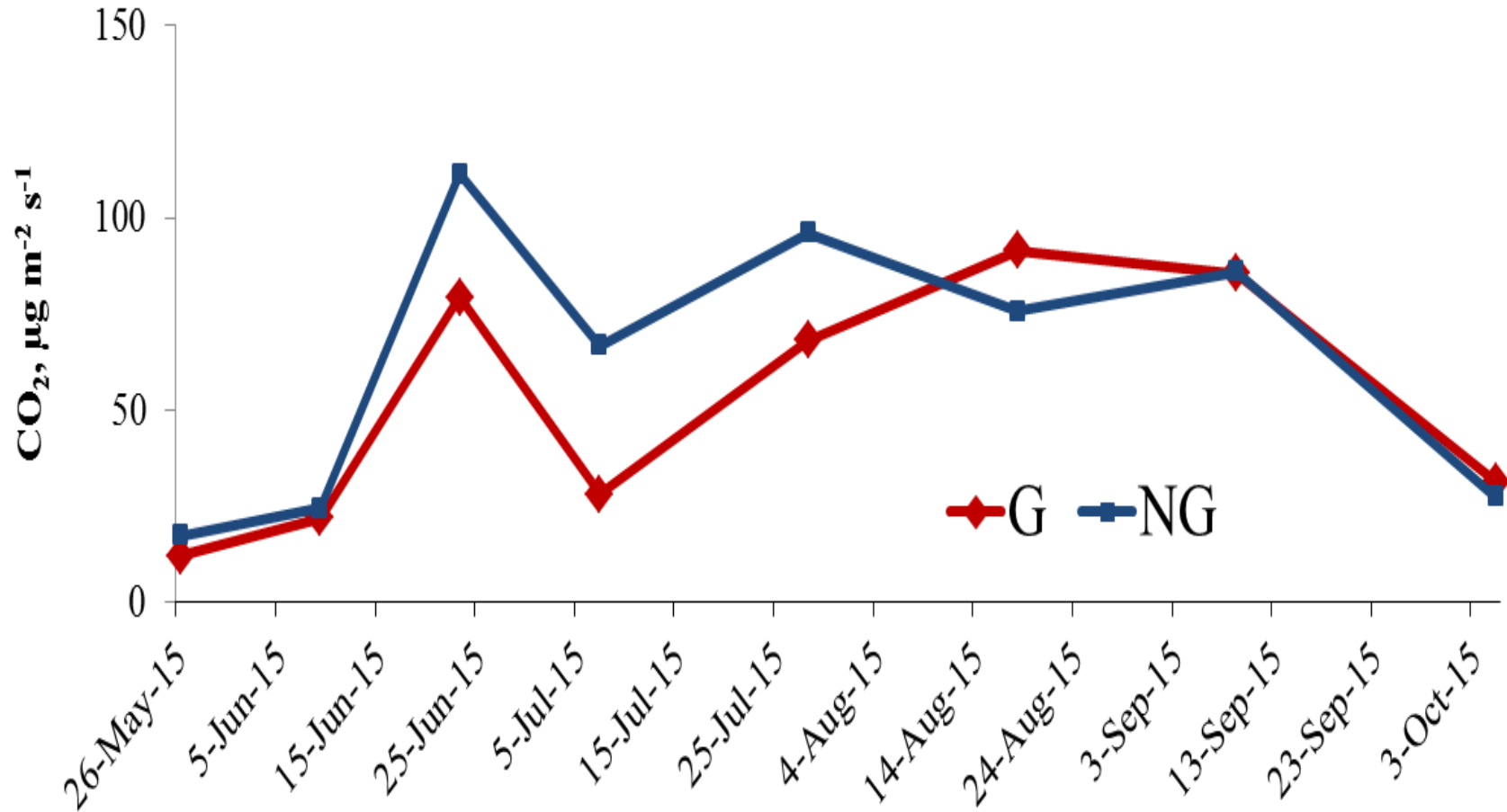
- After 12 months, litter loss was enhanced by grazing ... could this reflect greater incorporation of C into soil OM?





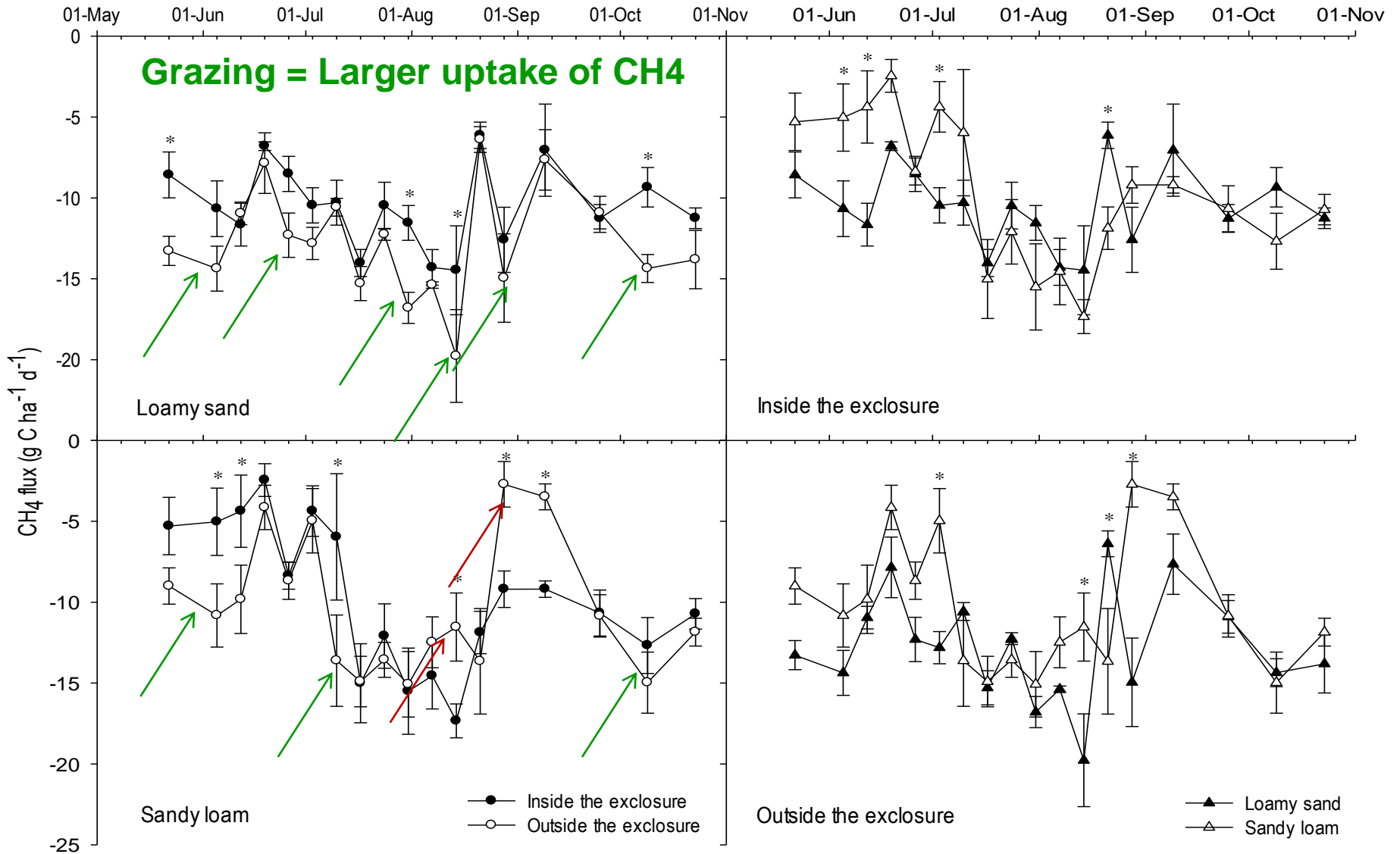
# What About GHGs?

*Preliminary Results Show Lower CO<sub>2</sub> Emissions in Grazed Soils ...*



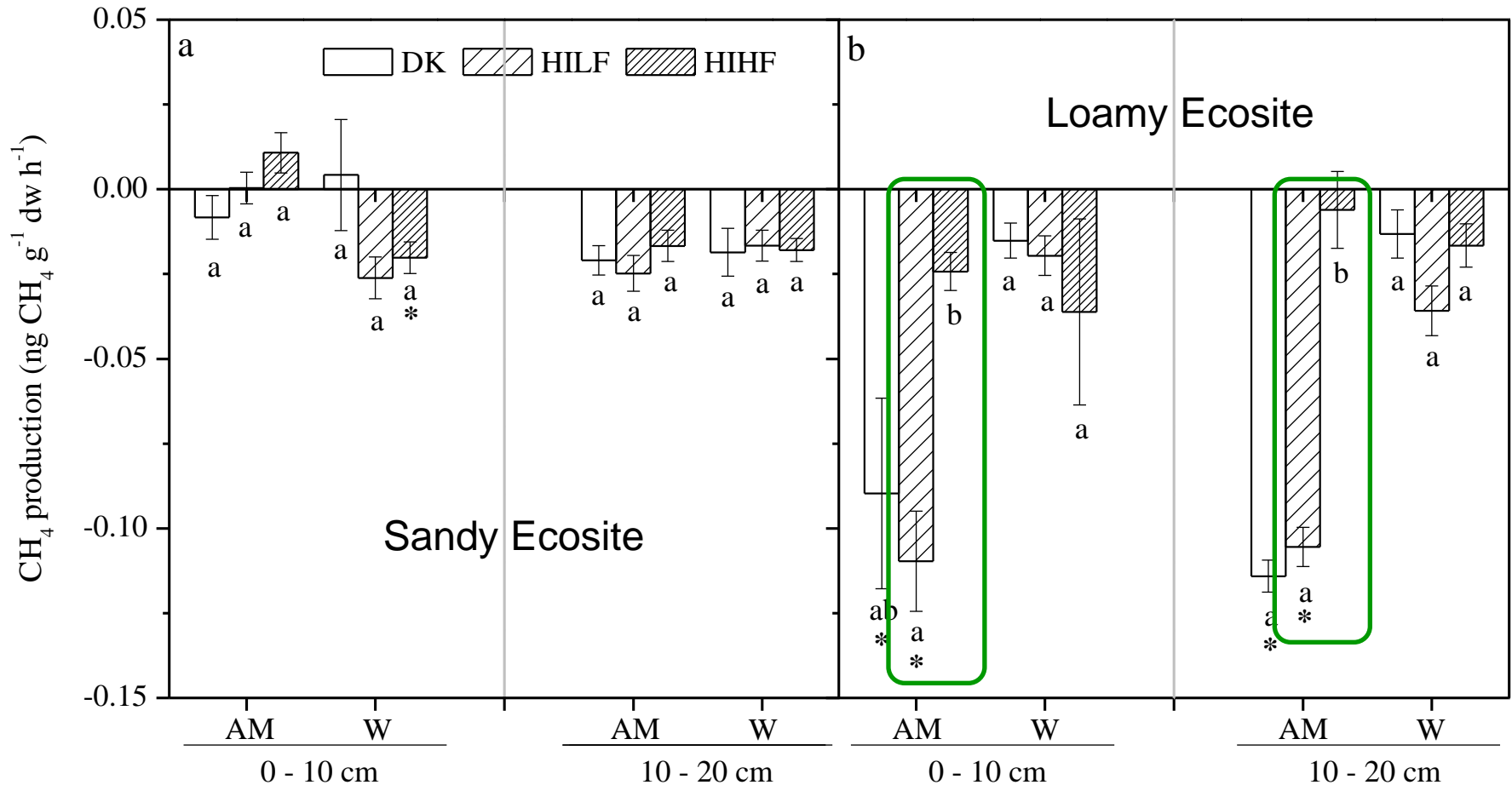
# Trend for Greater CH<sub>4</sub> Uptake in Grazed MGP

(Gao et al., in prep; 2014 data)



# More CH<sub>4</sub> Appears to be 'Removed' by Soil Under HILF Defoliation (~ Mob Grazing)

Source: Wang et al. (in prep); 2013 data; Lab incubations



**CH<sub>4</sub> UPTAKE: High Intensity–Low Frequency > High Intensity–High Frequency**

# Policy Implications for Carbon Storage/GHG in Grasslands ... ???

- 1) Need economic incentives to maintain existing native grassland ...
- 2) Convert marginal cropland to grassland where feasible ...
- 3) Explore how & when grazing increases C stores ...



# Impacts of Climate & Defoliation on Grassland Function

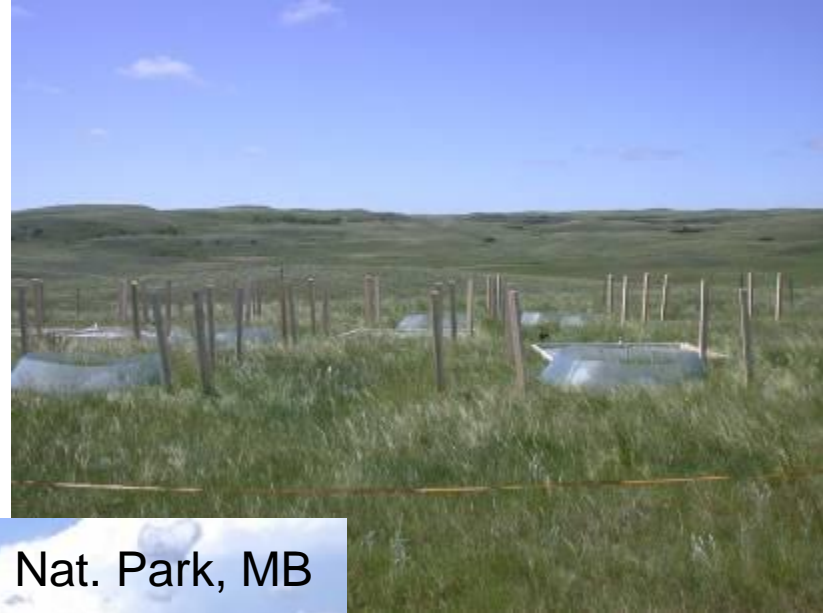


# Field Sites (3 Prairie Provinces)

Kinsella, AB



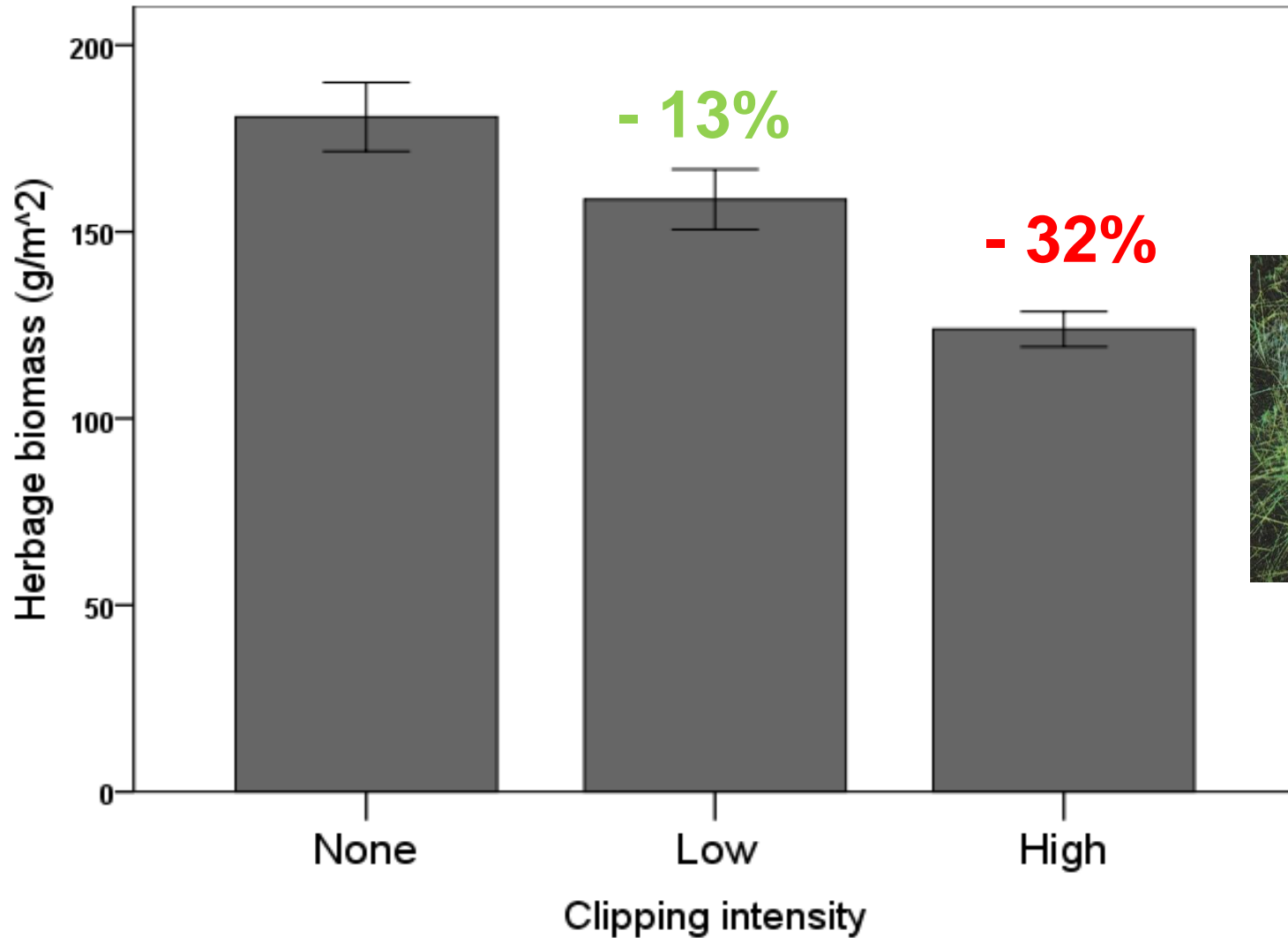
PFRA GAP Community Pasture, SK



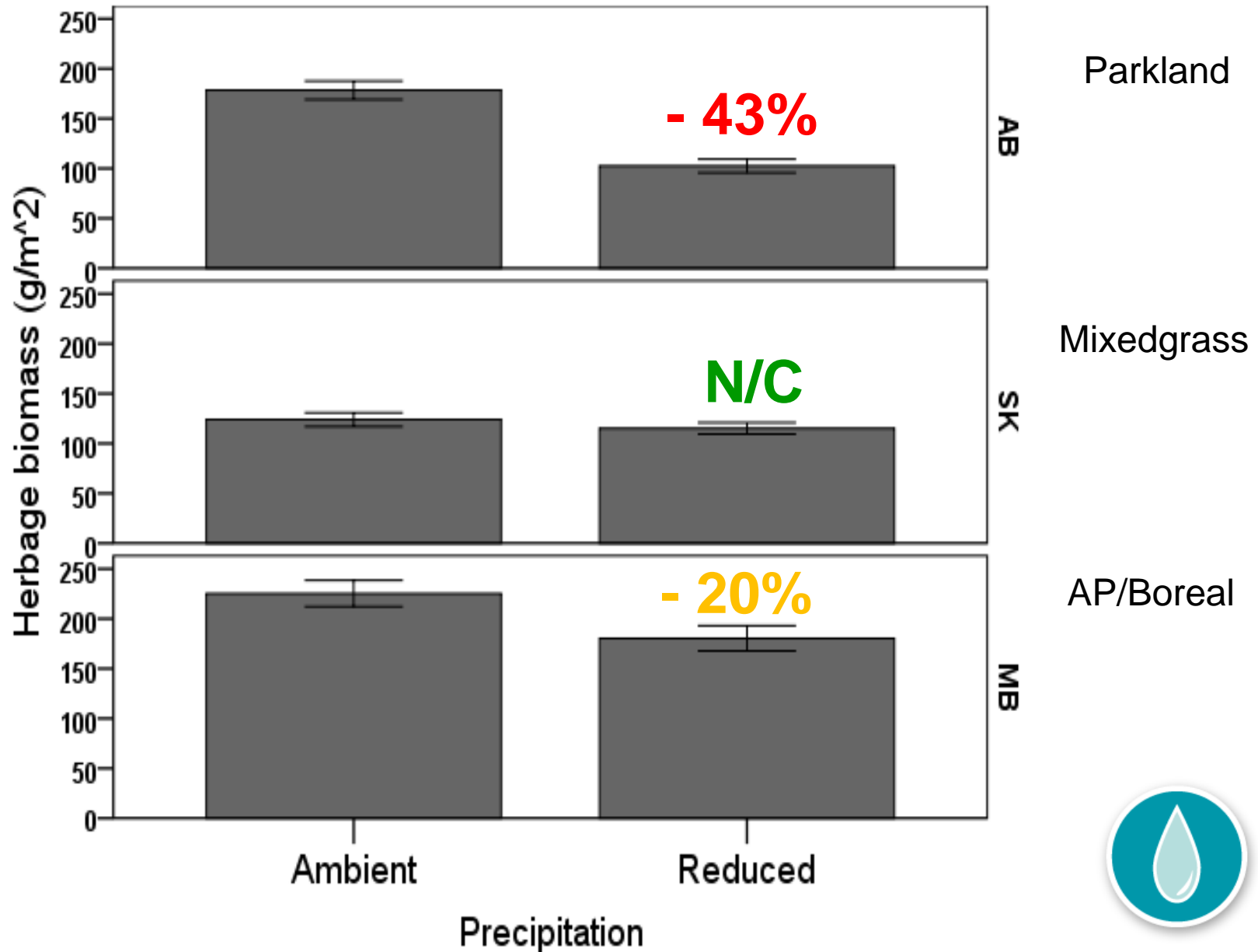
Riding Mountain Nat. Park, MB



# Excessive Defoliation Reduces Forage Production

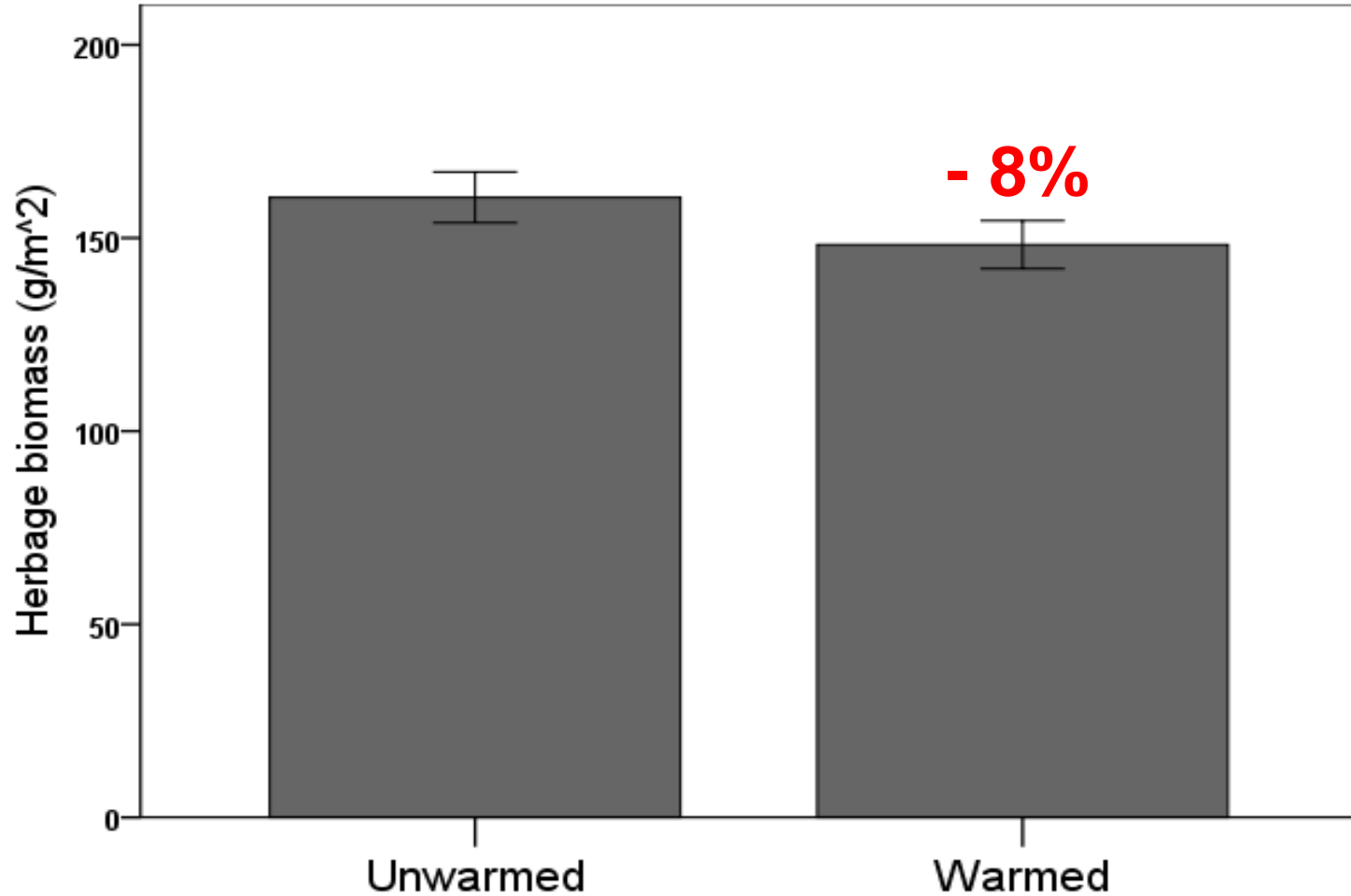


# Drought Effects Varied Regionally ...





# Warming Also Reduced Average Forage Availability



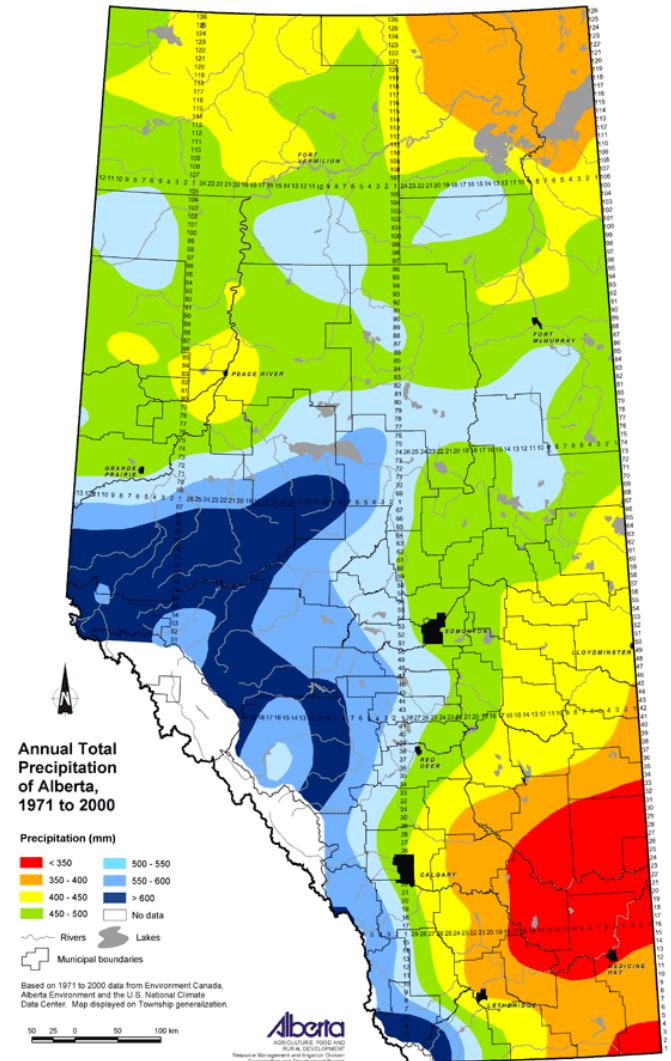
**+1.3 to 2.2 deg C throughout the growing season**



# New Study (6 Regional Sites in AB):

## Impact of defoliation regimes and drought on EG & S (forage, biodiversity, C and GHG)

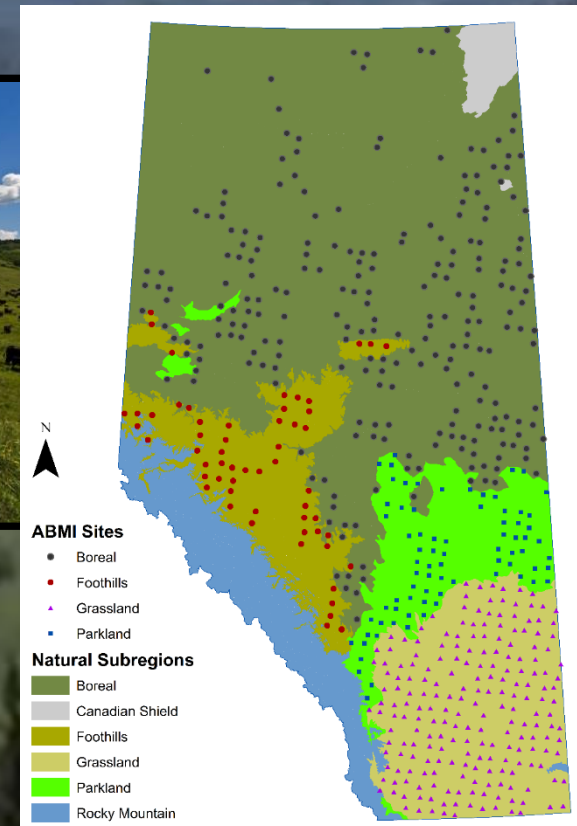
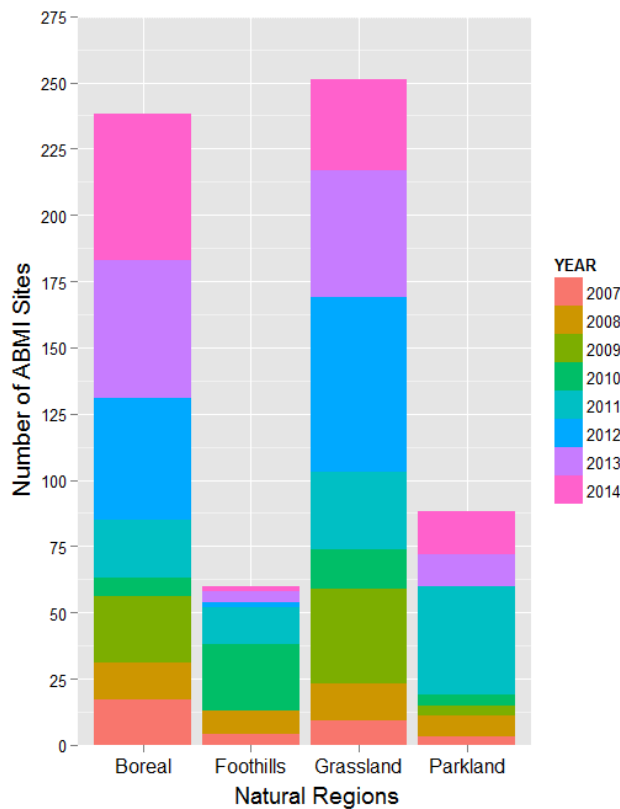
- Ideal grazing systems under drought may vary with soil, vegetation, etc.



# Beef & Biodiversity



- Will directly link comprehensive biodiversity data with beef management info at ~200 sites in AB



# Relating Plant Diversity to Forage Production & Ecosystem Function

- Results support notion that more floral diversity leads to greater total production



# Bird Distribution & Abundance in Mixedgrass Prairie

- Using visual and song counts to link data from >200 plots at the Mattheis Ranch to vegetation type, grazing history, and oil & gas extraction



# Pollinator Abundance & Diversity in Alberta's Agricultural Landscape

- Found over 140 bee species
- Bee abundance and diversity are positively related to grassland presence, range health, and forage quality



# Field Testing Residual Feed Intake (RFI) in Cow/Calf Systems

- RFI measures cattle feed efficiency (drylot)
- Do current beef cattle genetic selection practices translate to benefits under open-range grazing ... ?



# Many Funders

