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

Edward Bork

Mattheis Chair, Rangeland Ecology & Management

Dept. of Agricultural, Food and Nutritional Science

June 21, 2016

Western Beef Development Center

Lanigan, SK

Brief Outline

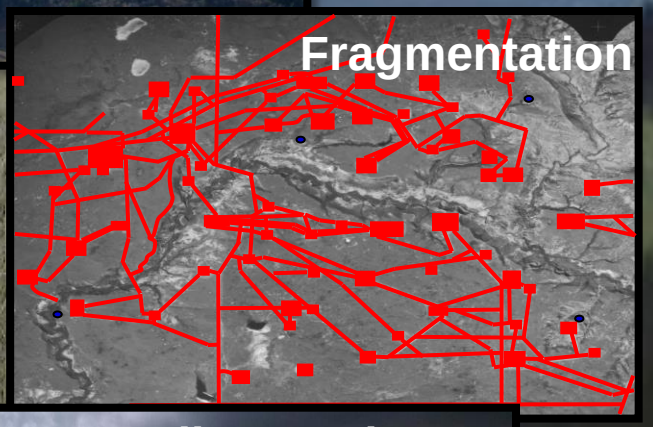
- Introduce the Rangeland Research Institute
- Define environmental goods & services (EG & S)
- Review main findings of recent carbon benchmarking study done in Alberta grasslands
- Introduce new studies assessing grazing impacts on GHG emissions and other EG & S's

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

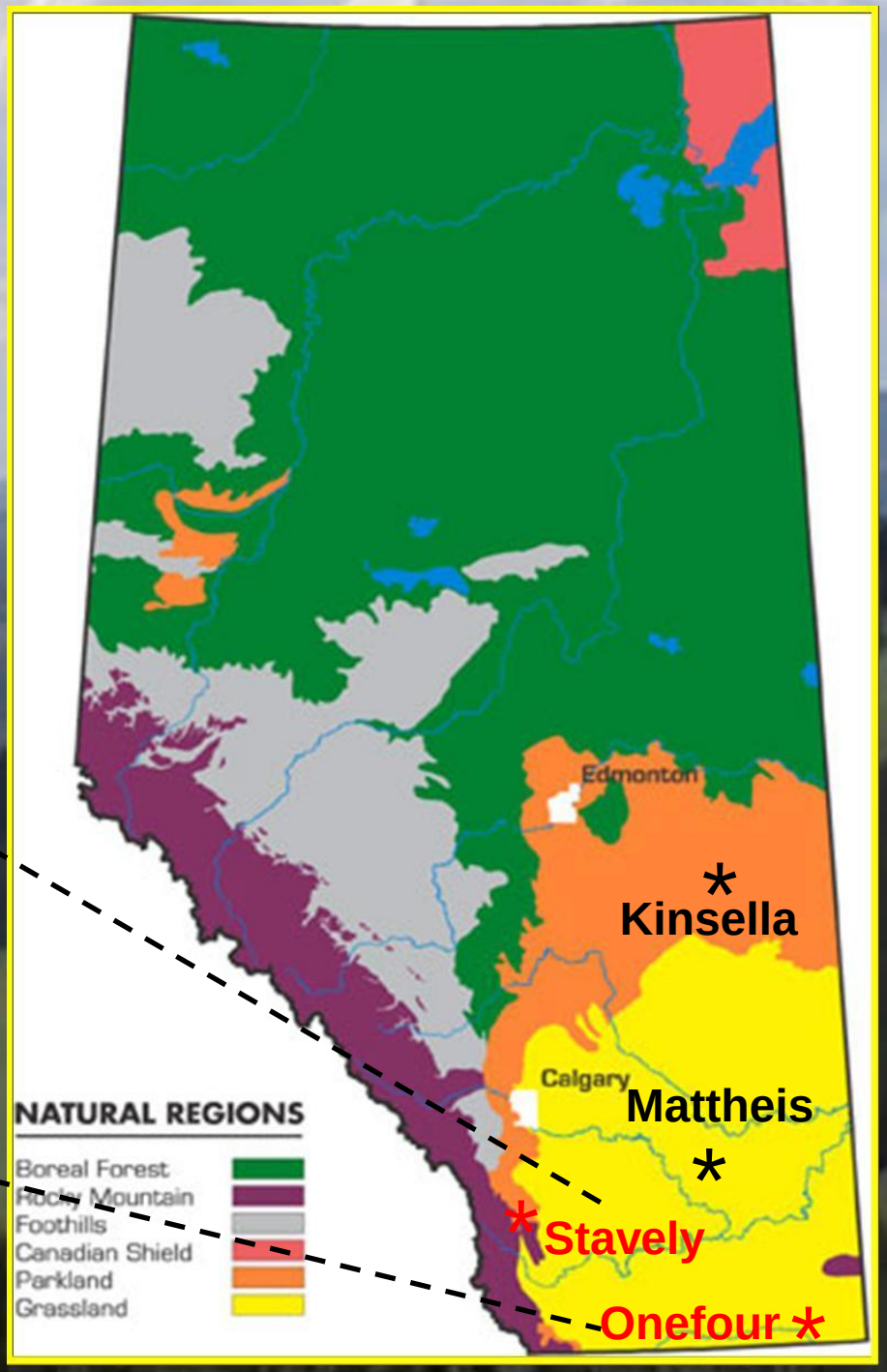
Biodiversity & Wildlife Habitat

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)

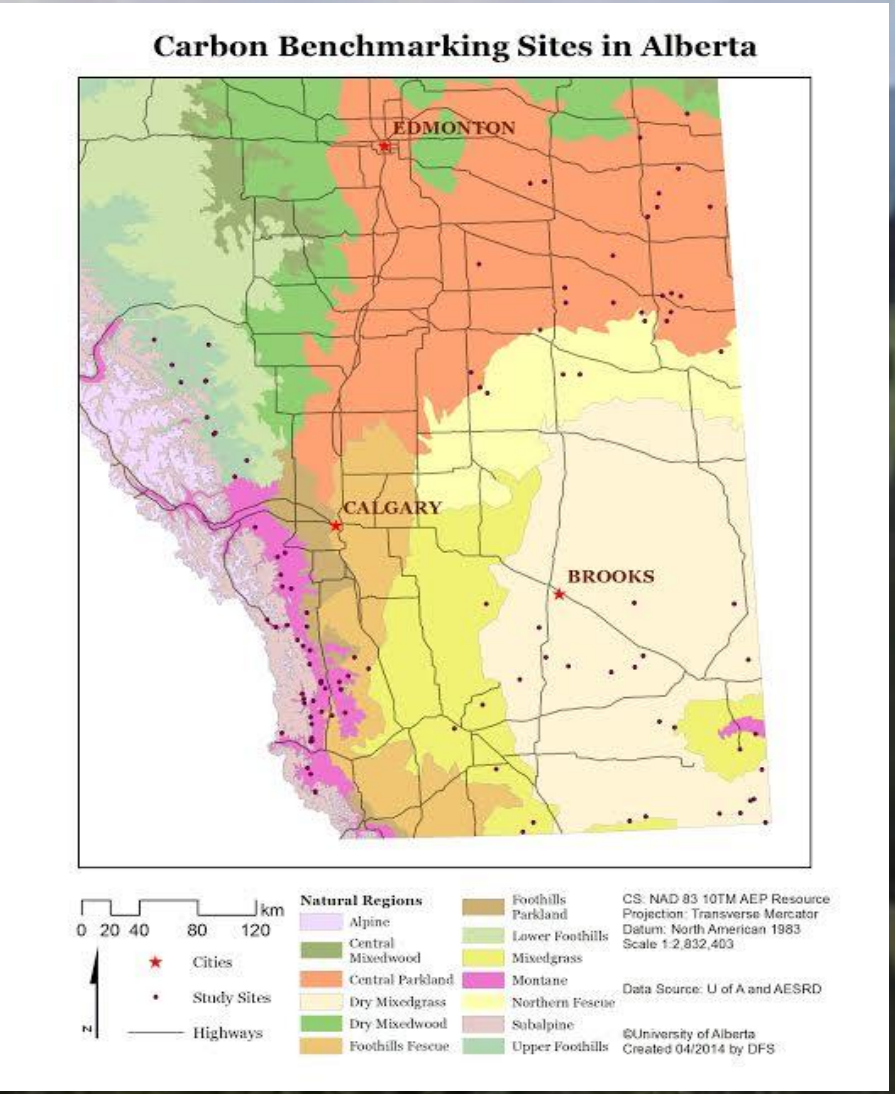


Rangelands and EG & S:

Recent findings of a University of Alberta/AEP Collaboration

ALMA
Alberta Livestock and Meat Agency Ltd.

- Sampled 114 grasslands managed by Alberta Environment & Parks

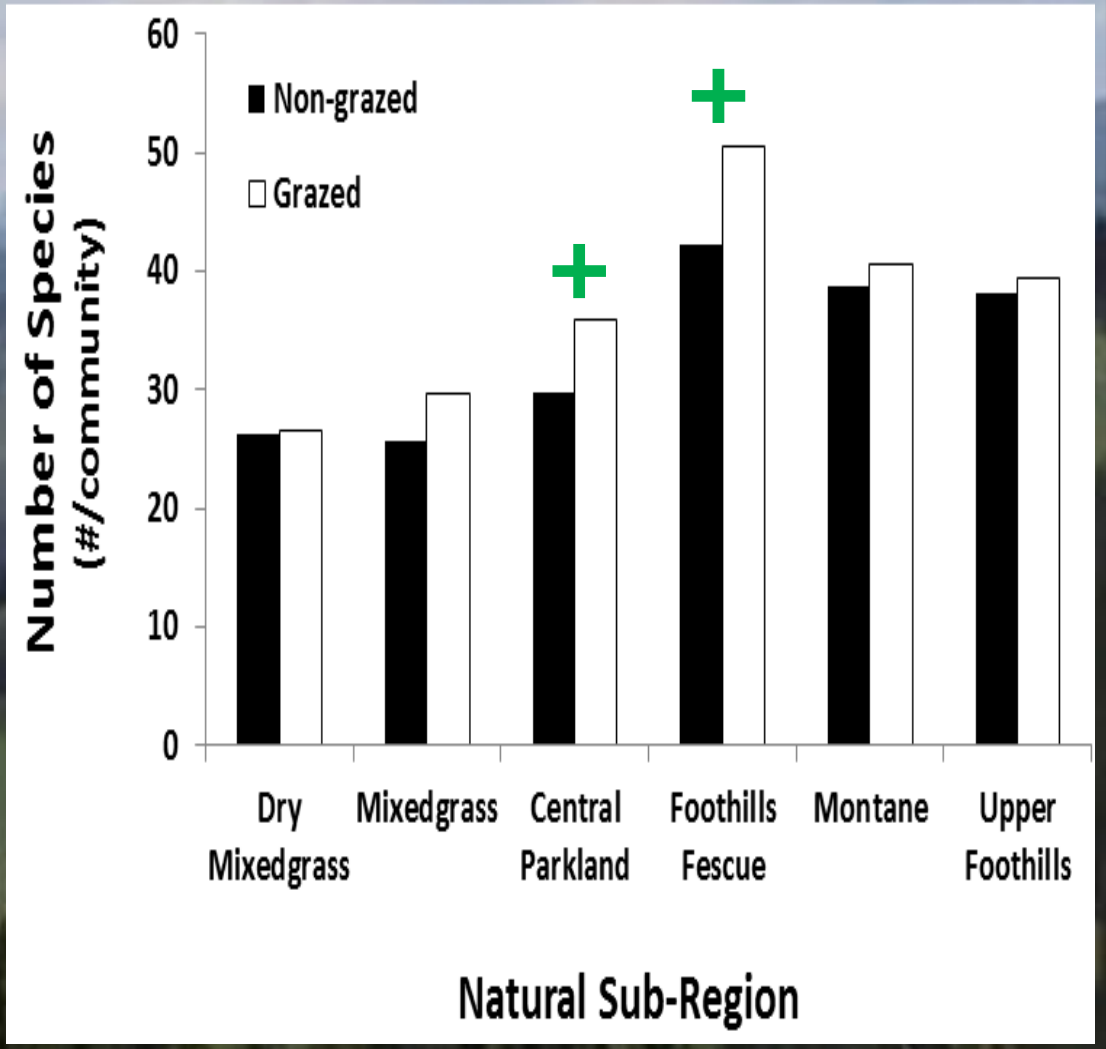


Quantified Various EG & S

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

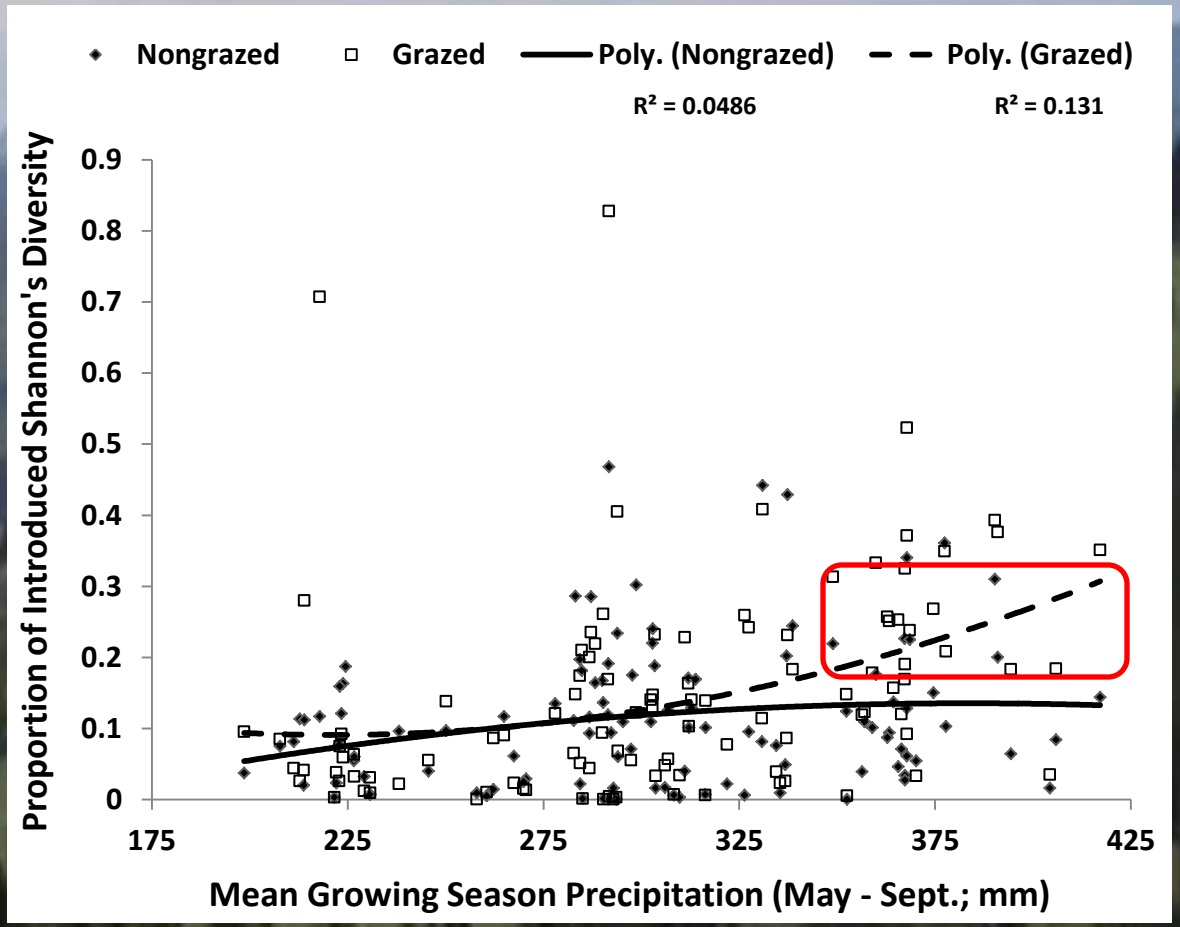
Grazing & Plant Diversity

- 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



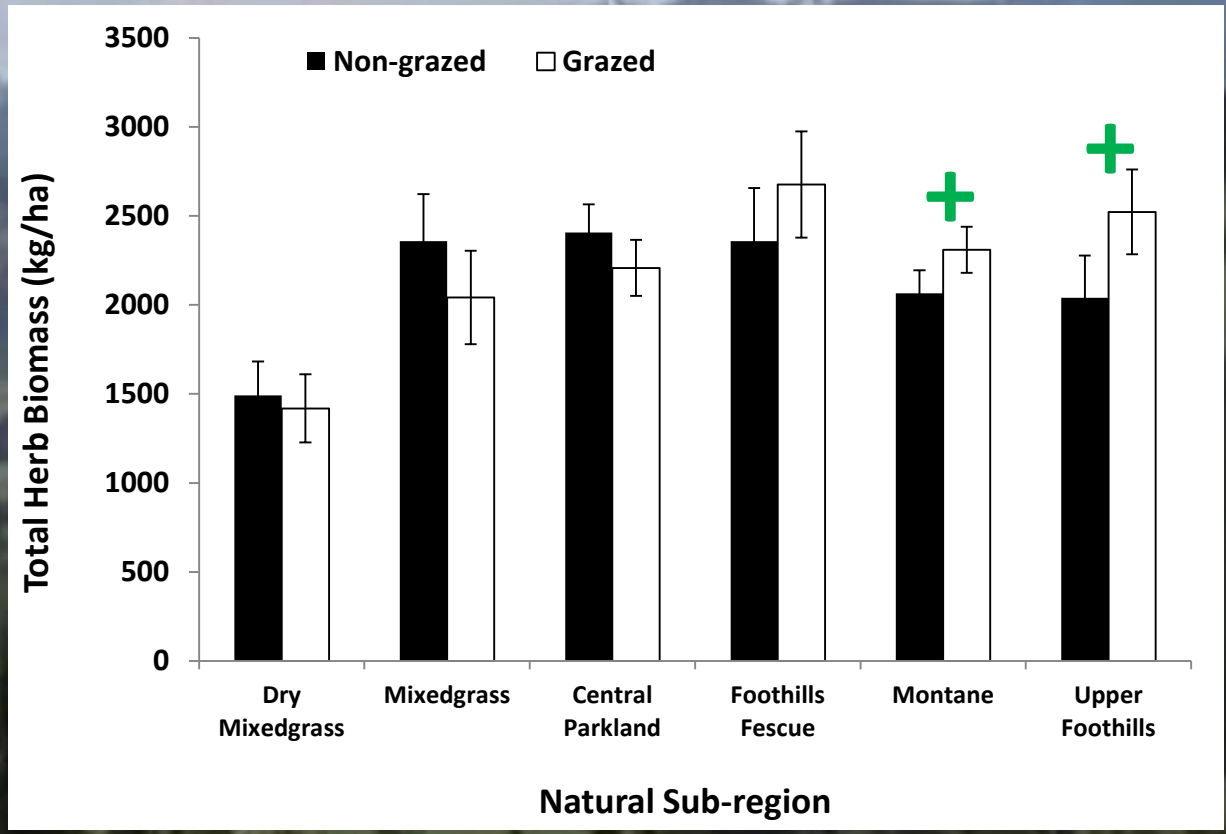
Does Grazing Alter Introduced Plant Species?

- Introduced species ~10% of composition
- Grazing increased introduced spp., but only under moist conditions (>350 mm)



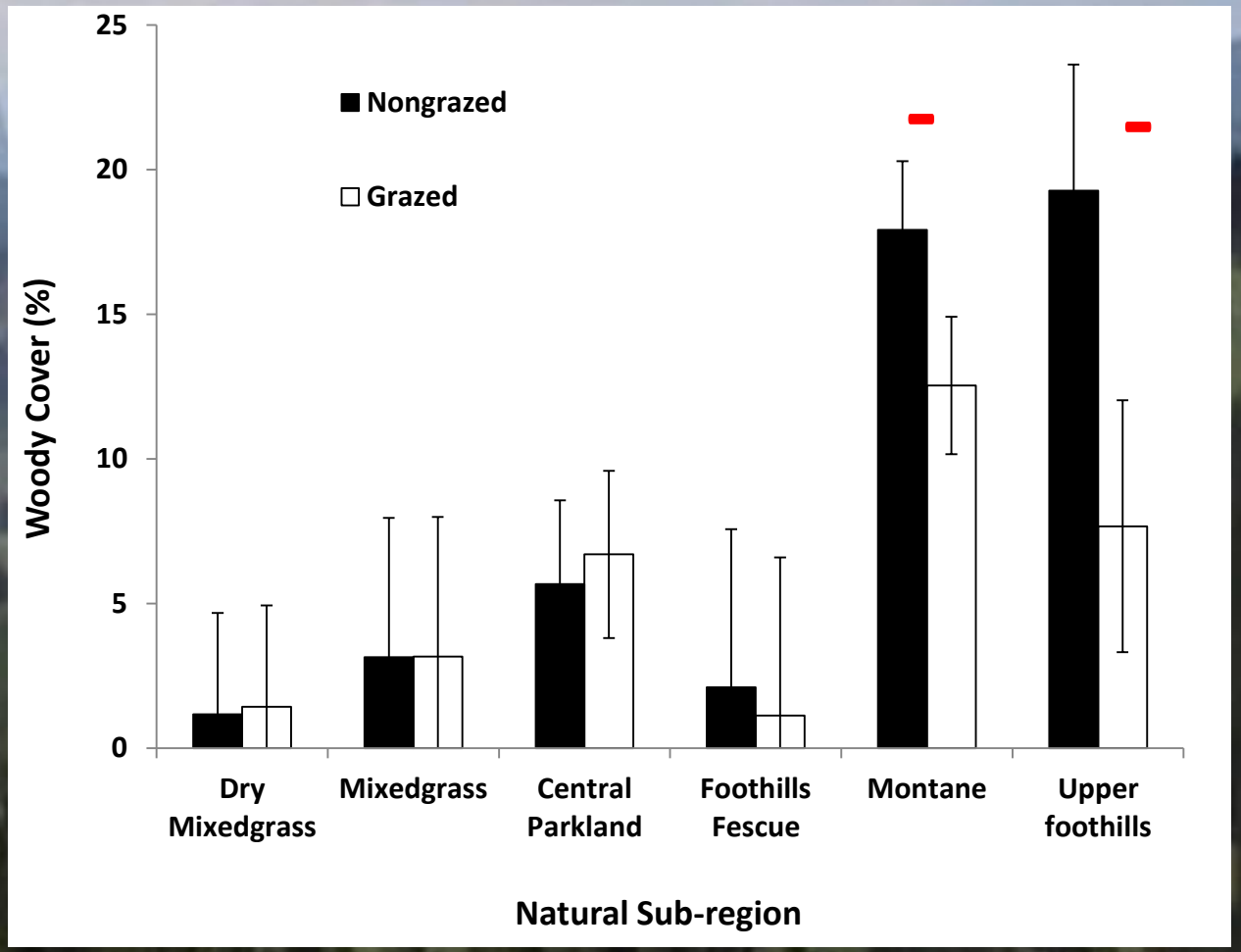
Grazing Impacts on Total Above-ground Grassland Productivity

- 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_2 Levels – "Greenhouse Effect")

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

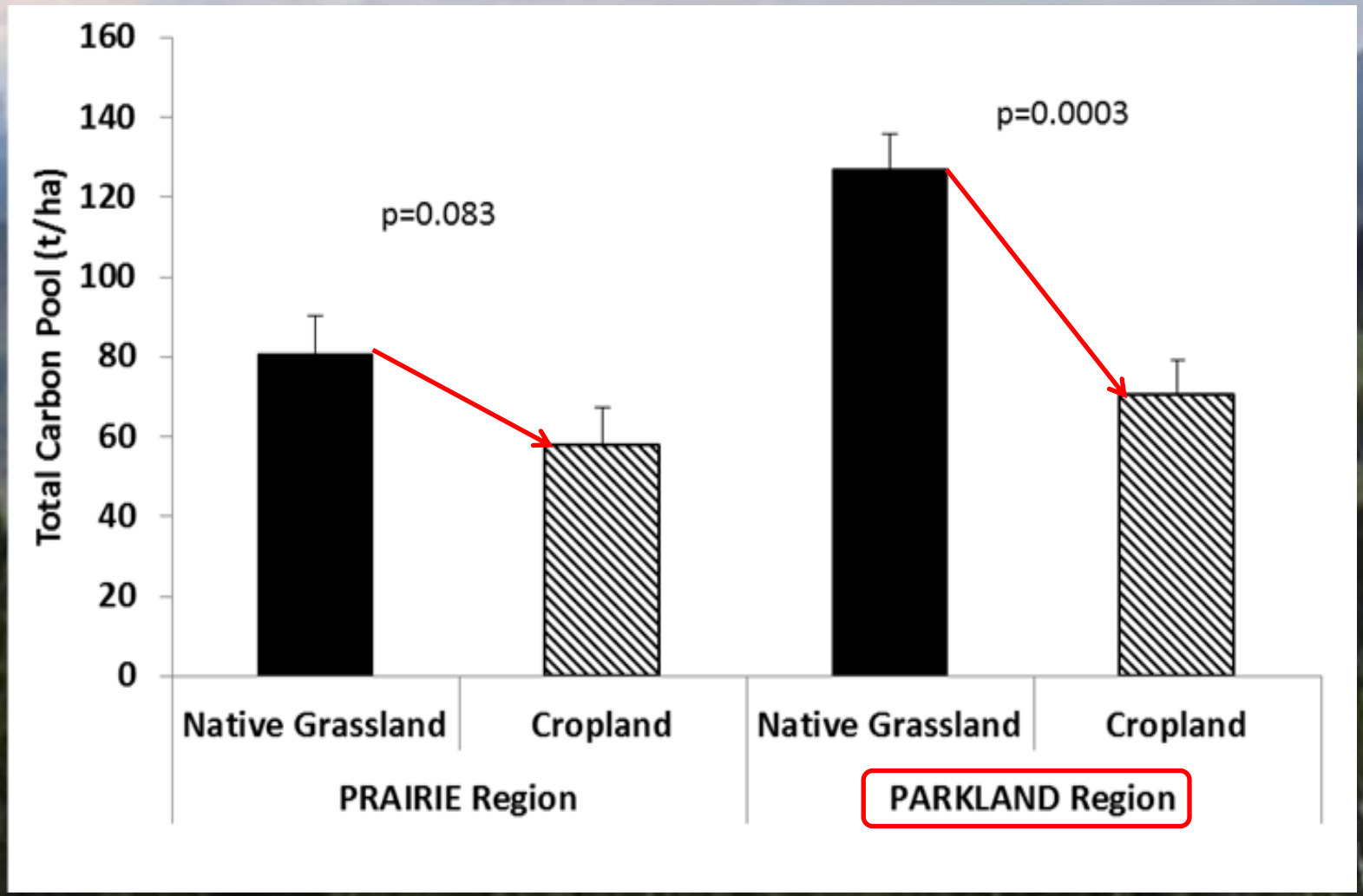
Temperate grasslands (~8% of earth's surface) contain more than 300 Gt C:

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

Sources: Schuman et al. (2002); Lal (2002); IPCC (2000)

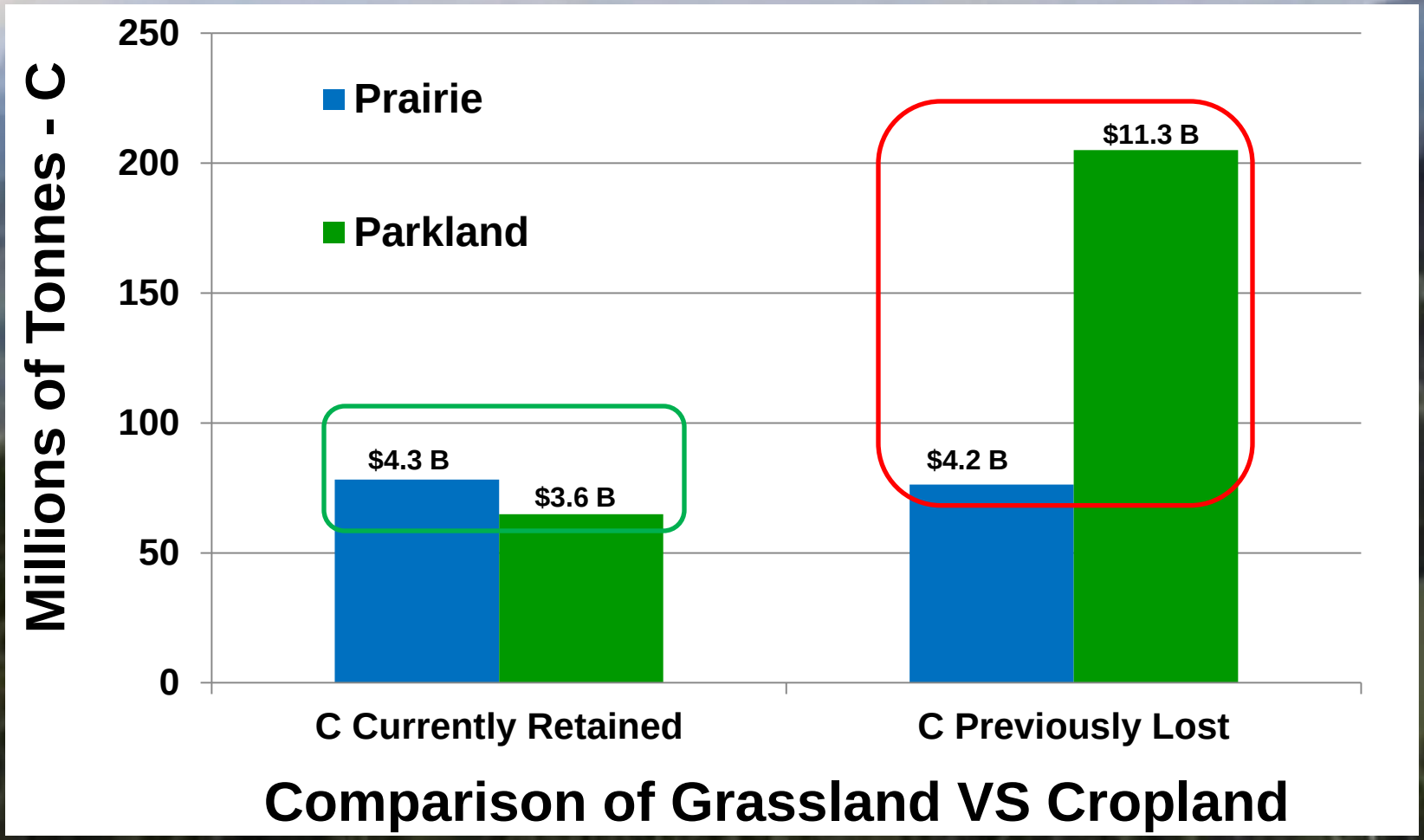
Annual Cropping Reduced Total Carbon Compared to Native Grassland

(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_2$e (CCEMC)



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 ($cm^3\ cm^{-3}$)	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}

What About Grazing and Carbon?

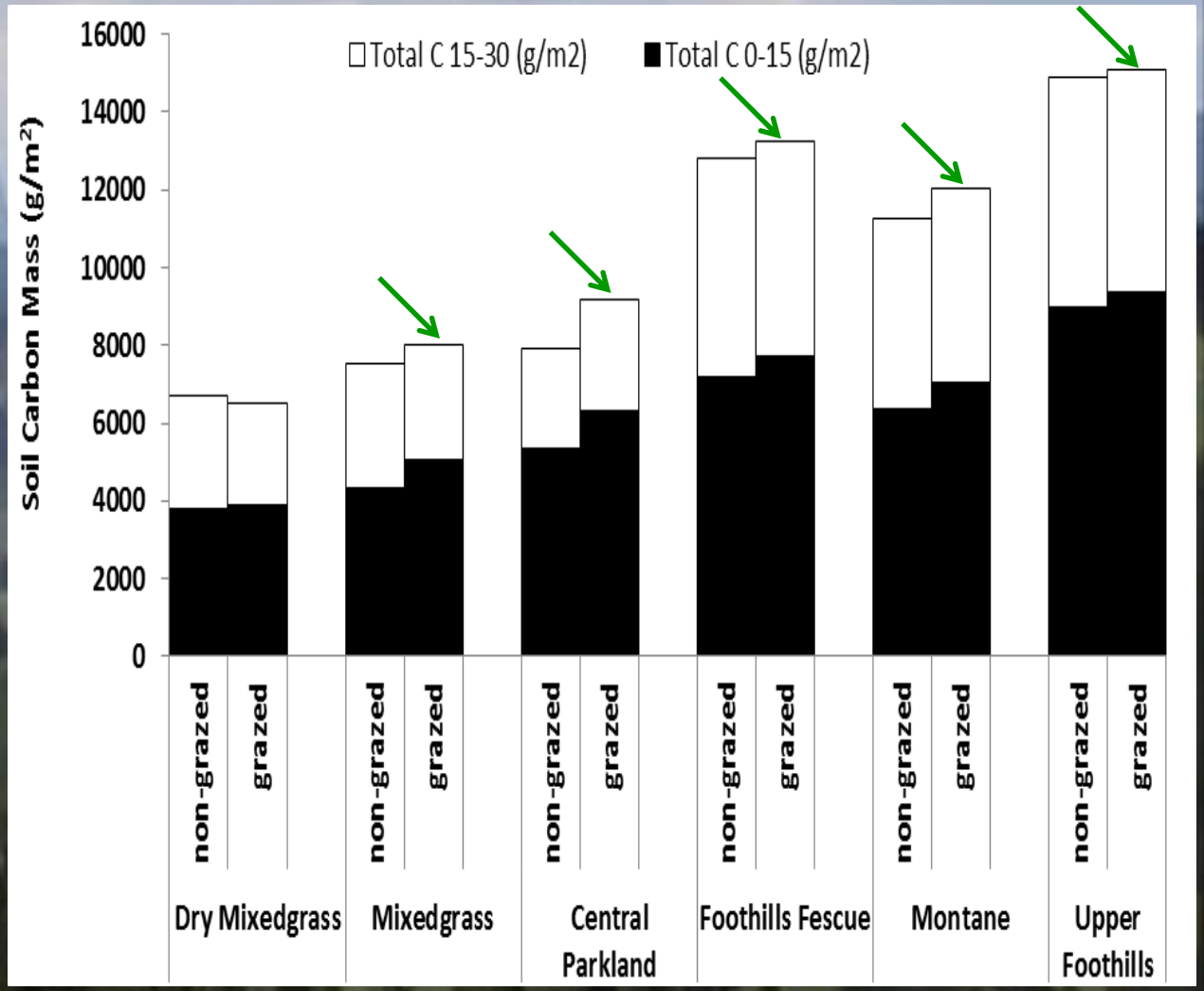
Grazing Effects on Total Carbon Have Been Inconsistent & Difficult to Predict …

Mixedgrass under grazing

Fescue under grazing

Grazing and Soil Carbon

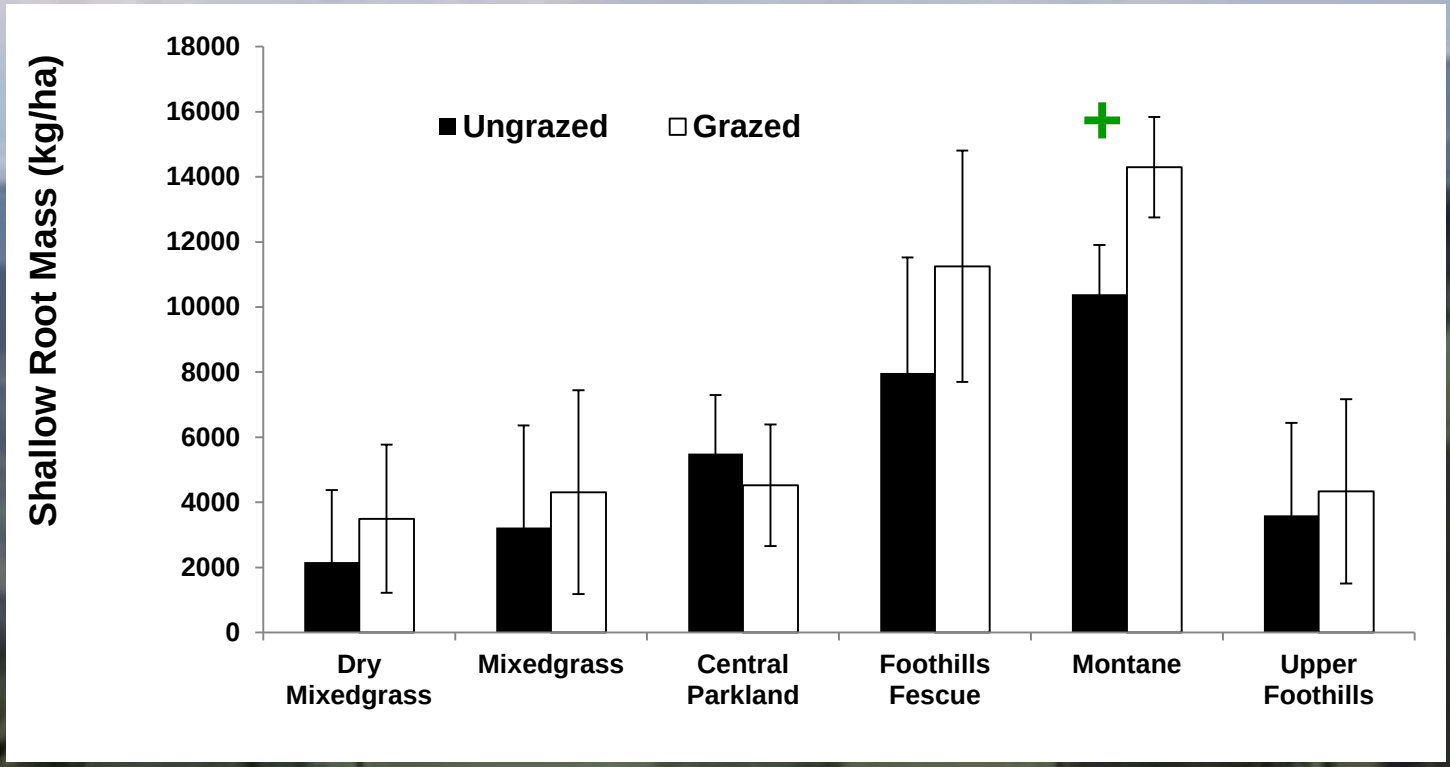
***** Note trend for greater SOC in 5 of 6 regions:***



- **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

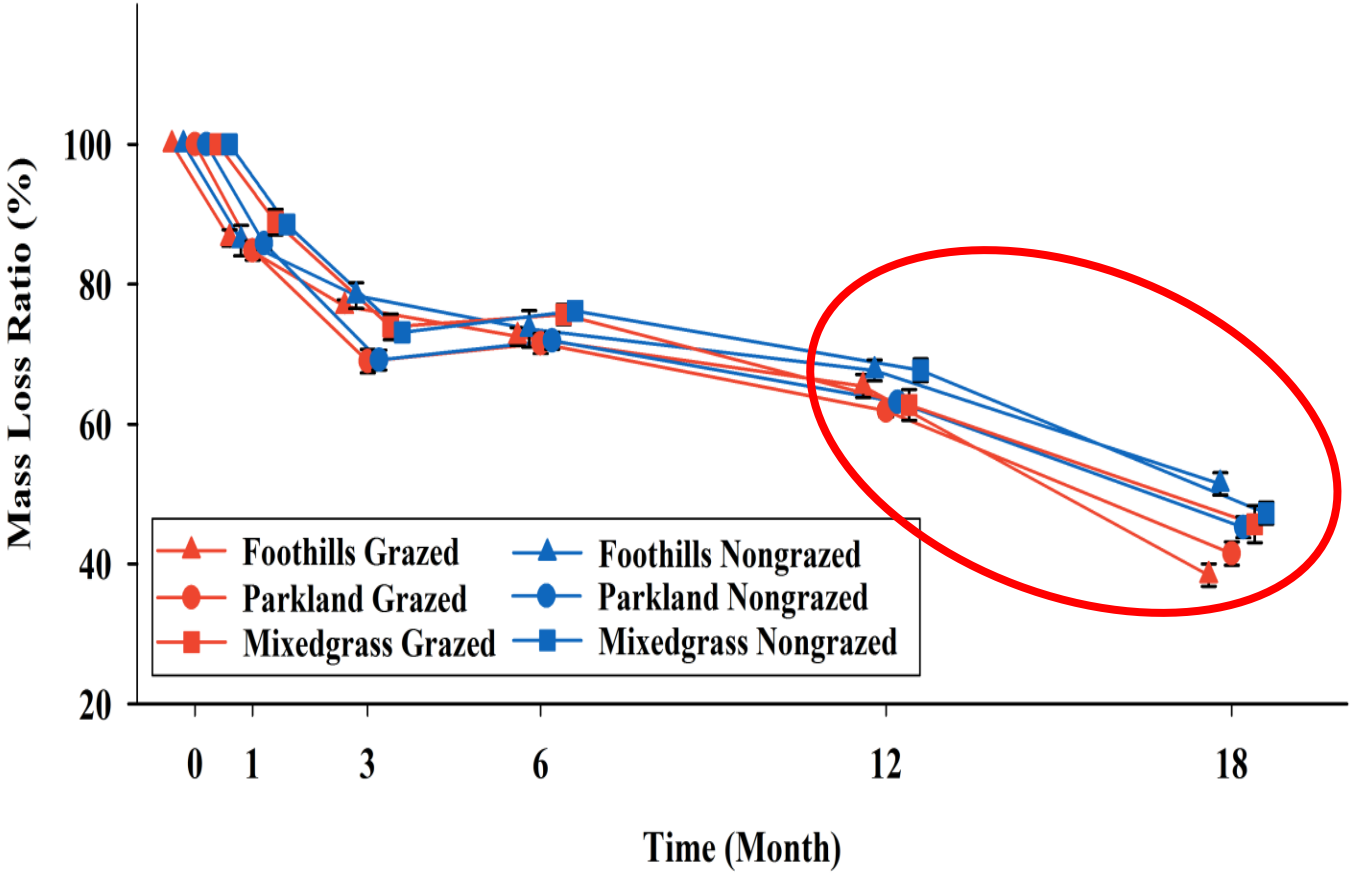
Collecting litter in the fall

Litterbag filled with grass placed in the field

Sample soils to measure *in-situ* belowground processes

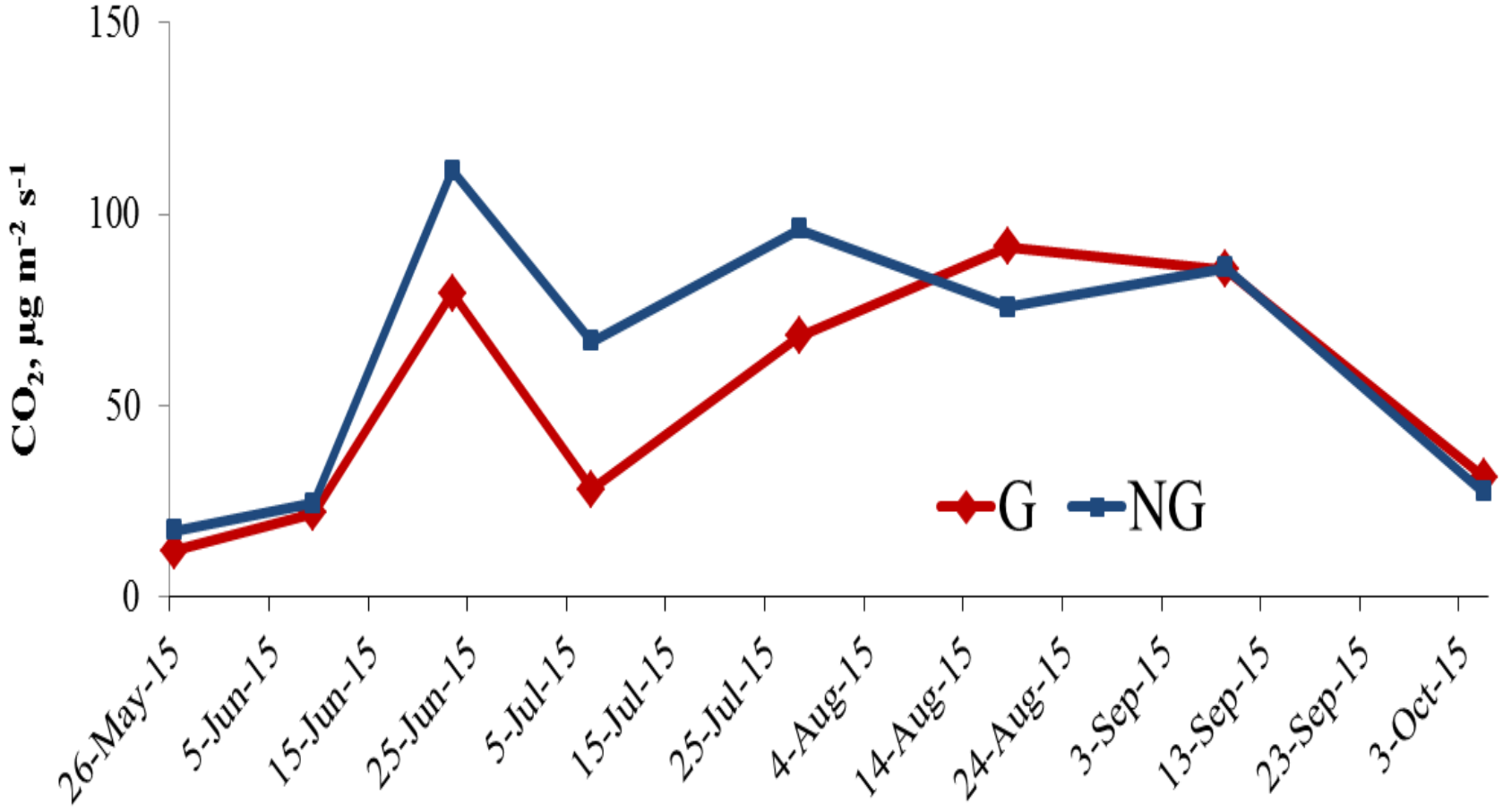
Grazing Effects on Decomposition

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



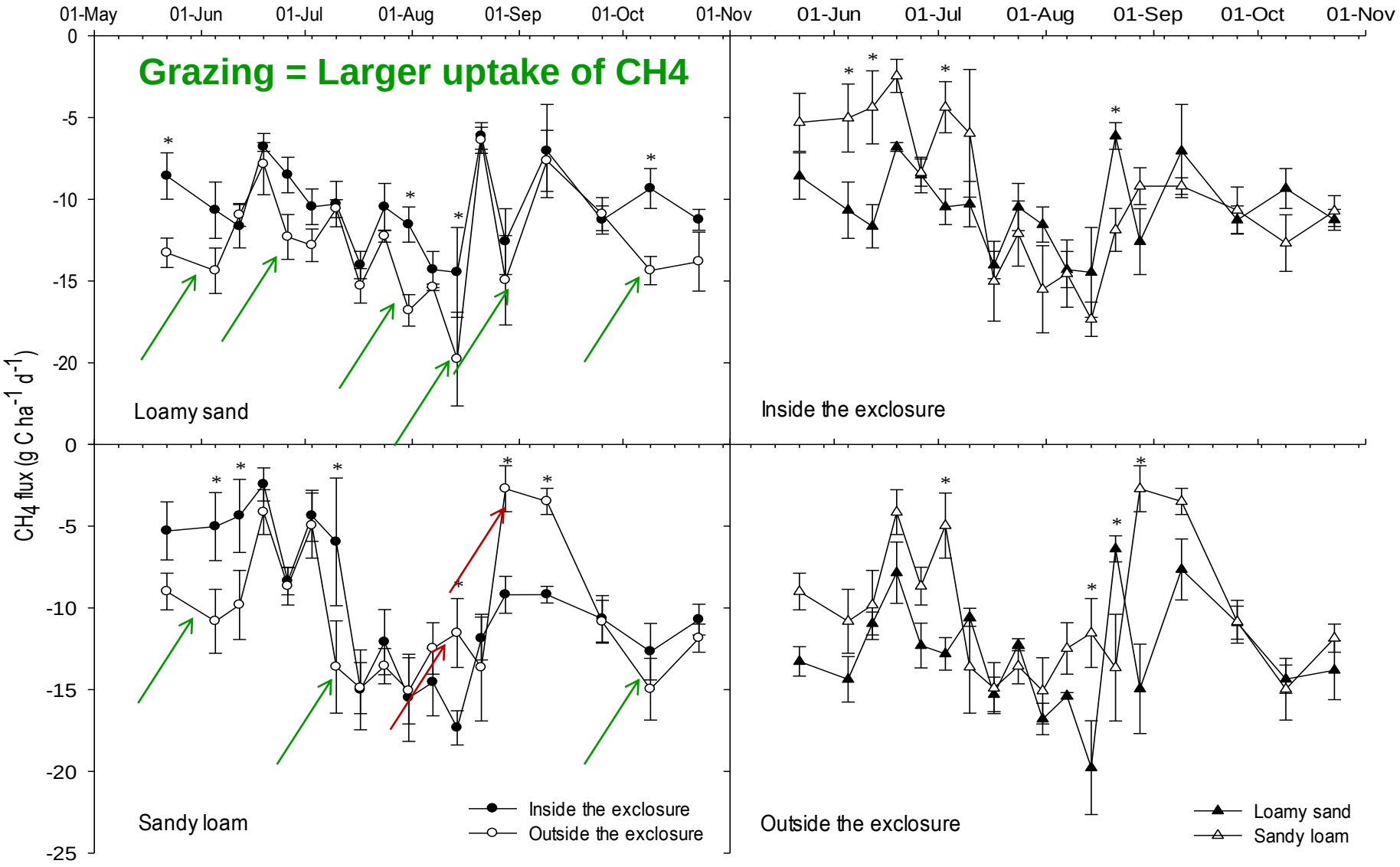
What About GHGs?

Preliminary Results Show Lower CO_2 Emissions in Grazed Soils …

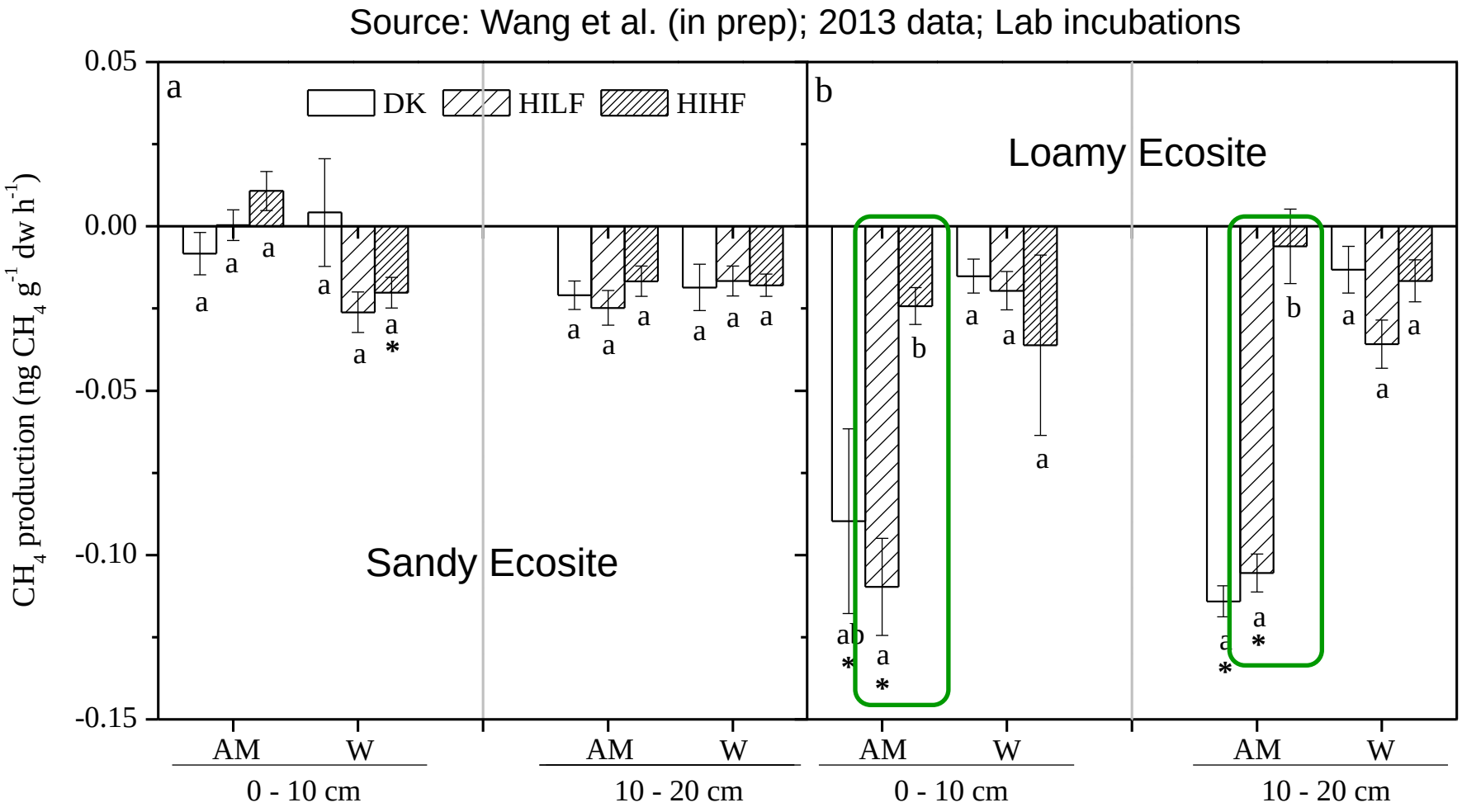


Trend for Greater CH_4 Uptake in Grazed MGP

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



More CH_4 Appears to be 'Removed' by Soil Under HILF Defoliation (~ Mob Grazing)



CH_4 UPTAKE: **High Intensity–Low Frequency > High Intensity-High Frequency**

Policy Implications for Carbon Storage/GHGs in Grasslands … ???

1) Need economic incentives to maintain existing native grassland …

2) Convert marginal cropland to grassland where feasible …

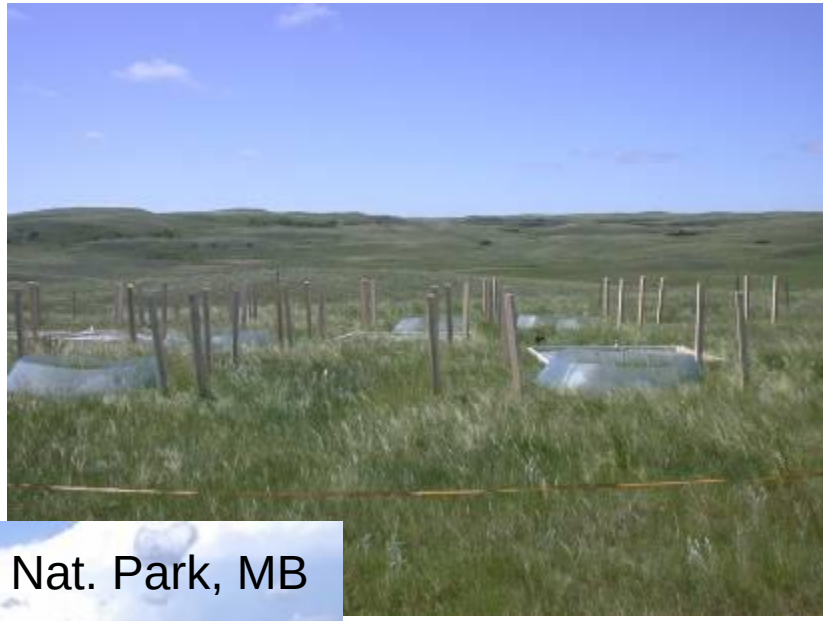
3) Explore how & when grazing increases C stores …

Impacts of Climate & Defoliation on Grassland Function

Field Sites (3 Prairie Provinces)

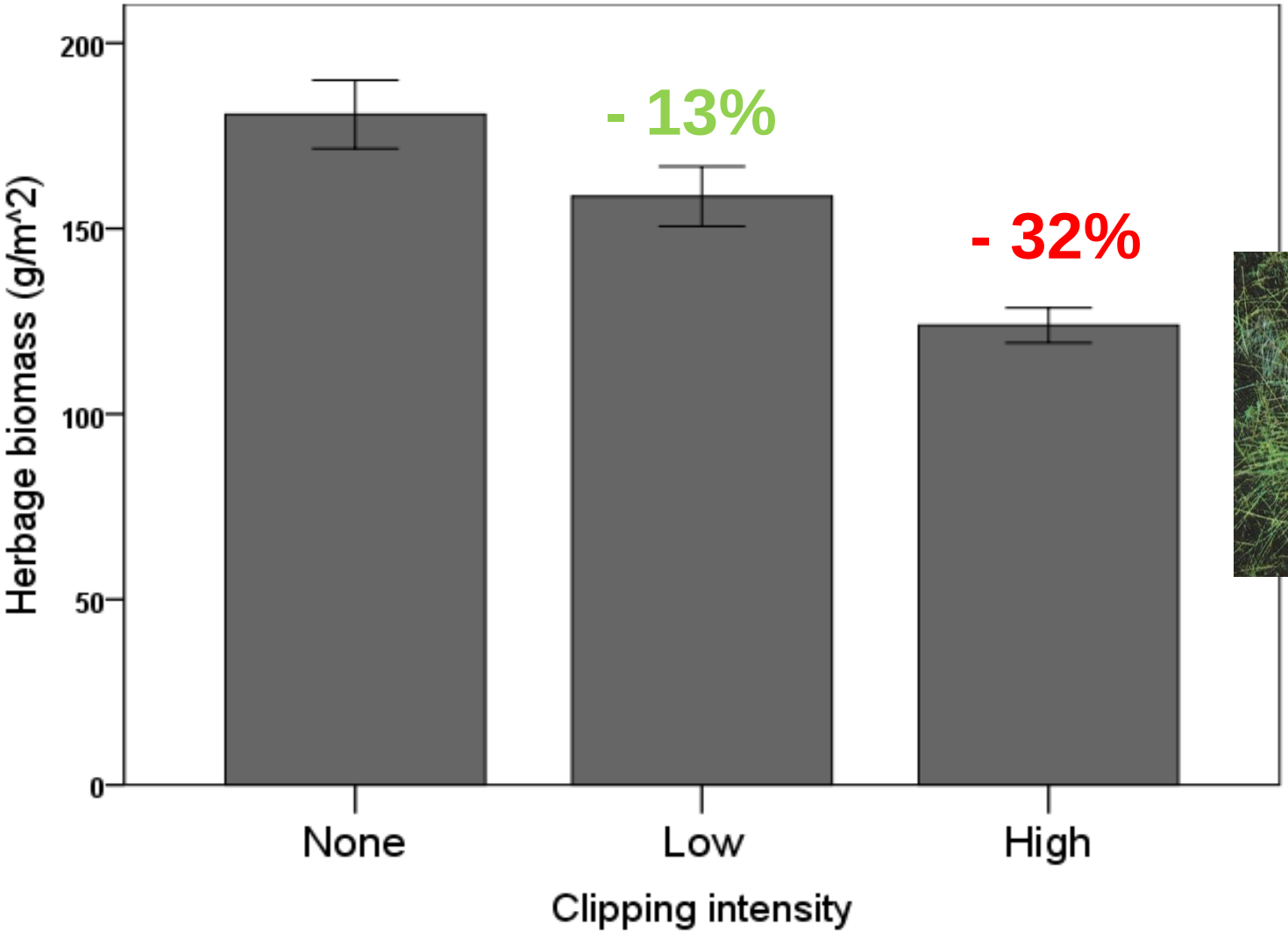
Kinsella, AB

PFRA GAP Community Pasture, SK

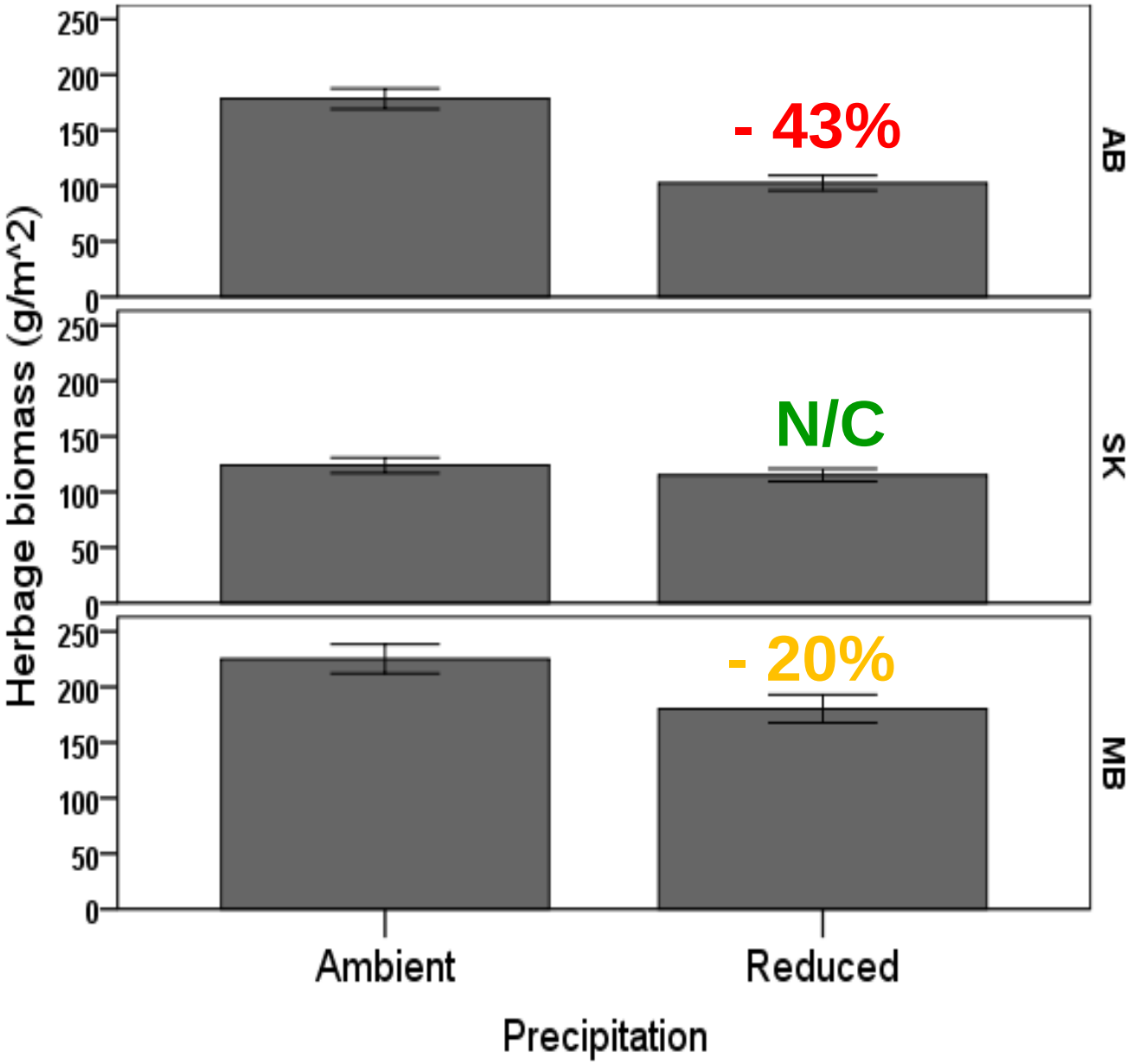


Riding Mountain Nat. Park, MB

Excessive Defoliation Reduces Forage Production



Drought Effects Varied Regionally …

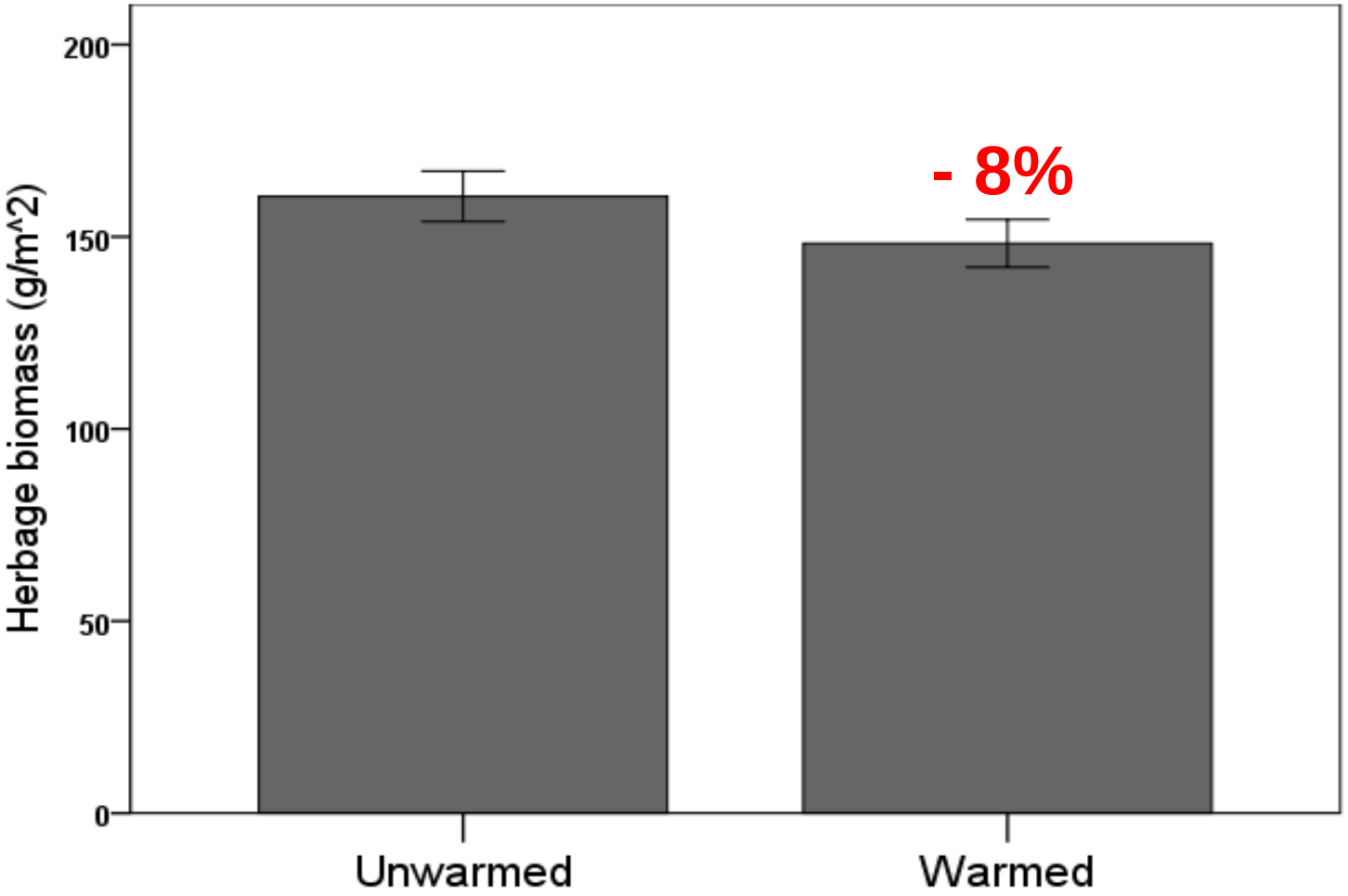


Parkland

Mixedgrass

AP/Boreal

Warming Also Reduced Average Forage Availability

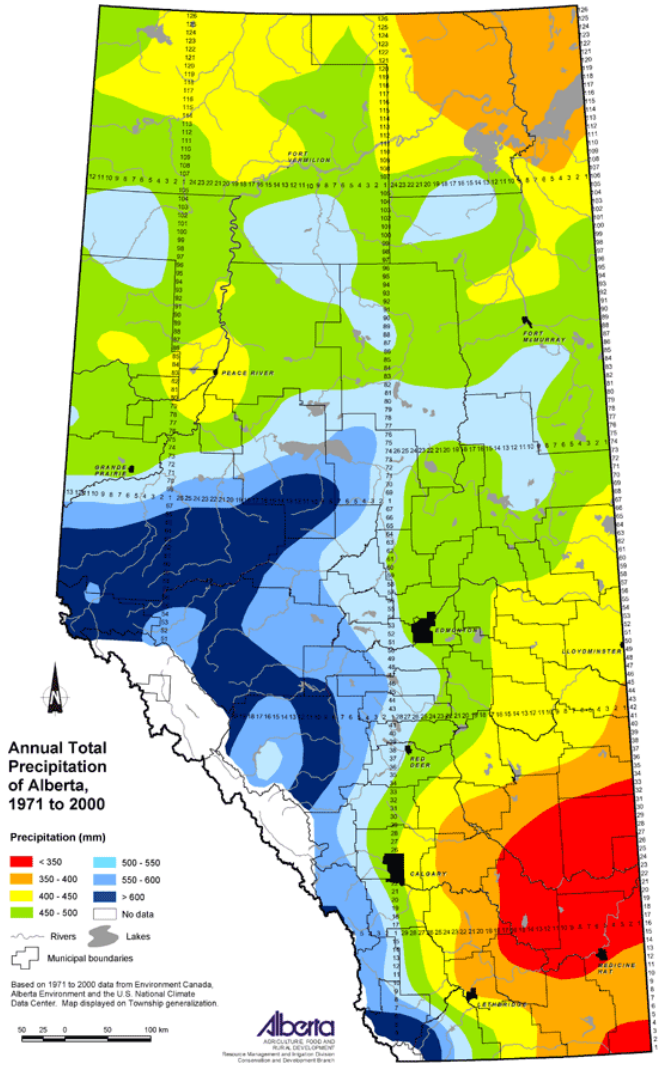


+1.3 to 2.2 deg C throughout the growing season

New Study (6 Regional Sites in AB):

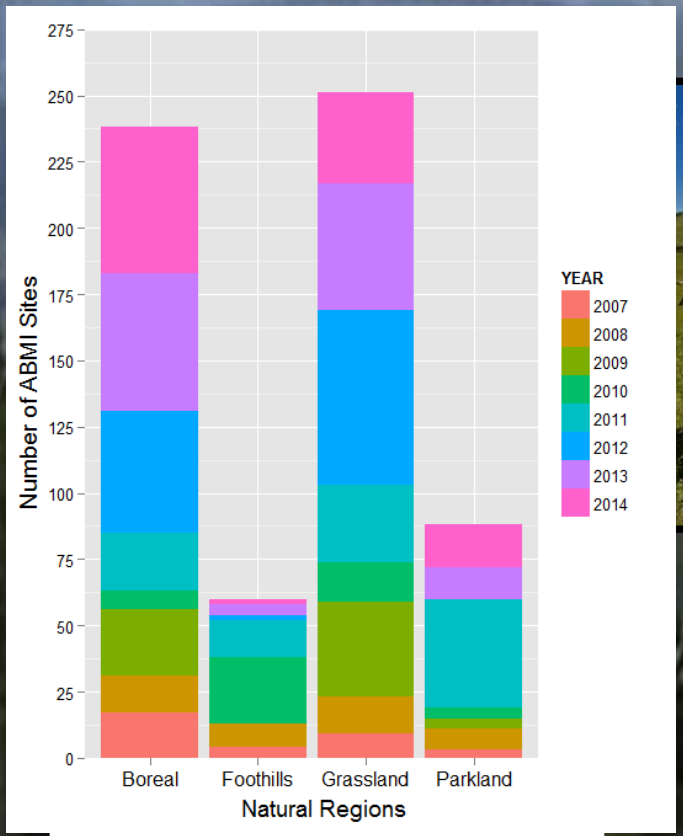
Impact of defoliation regimes and drought on EG & S (forage, biodiversity, C and GHG)

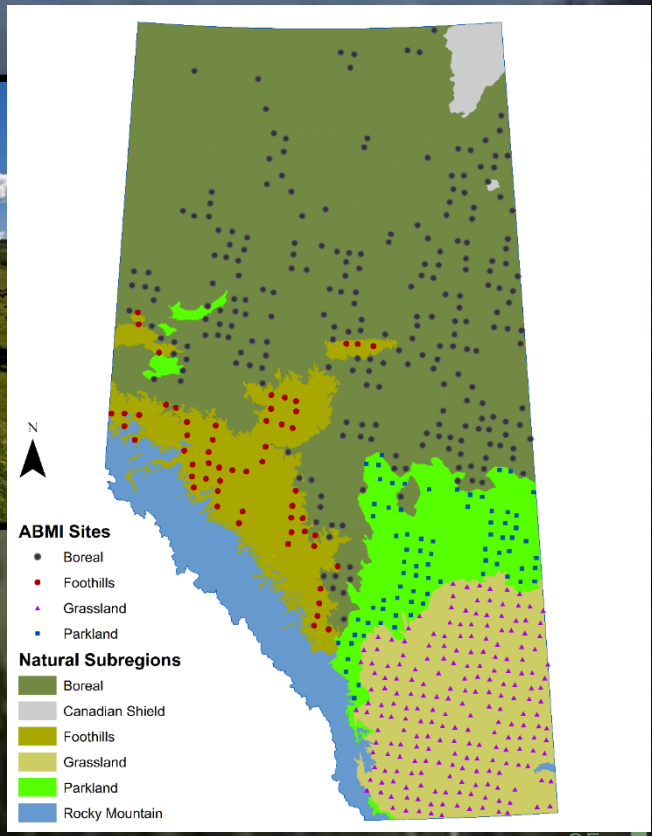
- Ideal grazing systems under drought may vary with soil, vegetation, etc.



Beef & Biodiversity

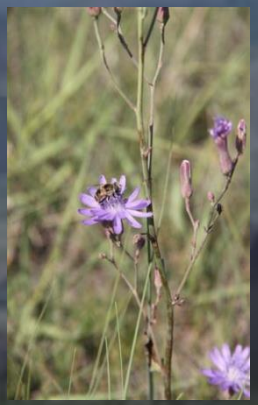
- Will directly link comprehensive biodiversity data with beef management info at ~200 sites in AB

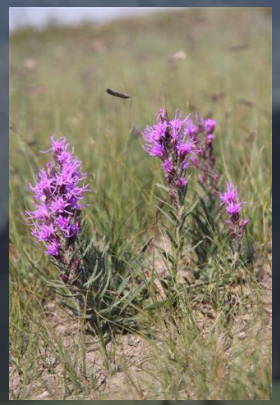




Relating Plant Diversity to Forage Production & Ecosystem Function

- 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

ALMA
Alberta Livestock and Meat Agency Ltd.

CCEMC
Climate Change & Emissions Management Corporation

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

Alberta
Environment and Sustainable Resource Development

Alberta Innovates Bio Solutions