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

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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
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

Energy Extraction

Fragmentation

Grassland Loss

Endangered Spp.

Competing Land Use

Recreation

Climate Change
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

- 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
- 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)

![Graph showing the relationship between proportion of introduced Shannon's diversity and mean growing season precipitation. The graph indicates that there is a significant increase in introduced species under moist conditions (R² = 0.131) compared to non-grazed conditions (R² = 0.0486).]
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.
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)

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)

<table>
<thead>
<tr>
<th>LAND USE</th>
<th>Max Water Availability (cm³ cm⁻³)</th>
<th>Soil Porosity</th>
<th>Fractal Index (e.g. aggregation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Grassland</td>
<td>0.14ᵇ</td>
<td>0.54ᵇ</td>
<td>0.048ᵇ</td>
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<tr>
<td>Introduced Pasture</td>
<td>0.099ᵃ</td>
<td>0.46ᵃ</td>
<td>0.033ᵃᵇ</td>
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<tr>
<td>Annual Cropland</td>
<td>0.096ᵃ</td>
<td>0.47ᵃ</td>
<td>0.020ᵃ</td>
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</tbody>
</table>
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)
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
• 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)

Grazing = Larger uptake of CH$_4$
More CH₄ Appears to be ‘Removed’ by Soil Under HILF Defoliation (~ Mob Grazing)

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

**CH₄ 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

- 13%
- 32%
Drought Effects Varied Regionally ...

- 43% decrease in Parkland
- N/C in Mixedgrass
- 20% decrease in AP/Boreal
Warming also reduced average forage availability by -8%.

Herbage biomass (g/m²):

- Unwarmed: 150 g/m²
- Warmed: 140 g/m²

+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

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