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Livestock grazing increase litter decomposition among plant species across Alberta rangelands

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Introduction

Grasslands cover more than 40% of Earth's terrestrial surface and provide many critical ecological goods and services (EG&S), including carbon (C) storage (Schuman et al 2002). The vast majority of terrestrial C is transformed from plant litter into soil organic carbon (SOC) via decomposition, which is regulated by climate and litter chemistry (Aerts 1997) Grazing alters vegetation by changing plant species composition leading to increase the amount of grazing tolerant species, but also affects the micro-environment such as temperature and moisture (Augustine and McNaughton 1998). Grazing tolerant species may have a different chemical composition than less tolerant species, which results in altered decomposition rates (Derner et al. 2006). The resulting changes in litter decomposition and rates of C residence time and nutrient cycling may ultimately alter ecosystem C accumulation. Understanding the effects of grazing on these ecological processes may provide opportunities for C conservation by Canada's livestock industry.

Litter bag layouts in the field

Study sites at Kinsella Research Ranch

Materials and Methods

We conducted a field study to better understand how livestock grazing and regional climate influence decomposition. We placed litterbags containing the leaf litter from seven typical grass species that represent a range of grazing tolerance, plant community litter from each study site and pure cellulose paper at 15 study sites stratified across three Alberta natural subregions including Aspen Parkland, Foothills Fescue and Mixedgrass Prairie. All study sites had a grazed and non-grazed comparison. Litterbags were constructed using mesh screen (1 mm^2 openings) and filled with 2 g of one of seven litter types. The litterbags were retrieved after 0, 1, 3, 6, 12 and 18 months. Litter samples were weighed to determine ash-free dry mass loss. Data were analyzed with mixed model analysis of variance with species, natural subregion and grazing as fixed effects using retrieval times as repeated measures.

Results and Discussion

Grazing increased litter mass loss (p=0.01) over the 18-month study (Fig. 1). This suggests that direct (e.g. herbivory, trampling, excrement input) and indirect (e.g. changes to local environment) effects of grazing may enhance the controls of litter decomposition (Adler et al. 2001). Additionally, mass loss varied among litter species (Fig. 2; p<0.0001), such that *Bouteloua gracilis*, *Poa pratensis* and *Festuca hallii* (Fig. 2) had the least mass remaining after 18 months, while *Festuca campestris* and *Agropyron smithii* had the greatest mass remaining, which indicate that may be due to the inherent chemical composition of different species (Aerts 1997). Decomposition was also affected by the interaction with natural subregion (p=0.005), such that Aspen Parkland/Grazed and Foothills Fescue/Grazed had the least mass remaining while the arid Mixedgrass Prairie had the greatest mass remaining at both nongrazed and grazed treatment after 18 months. This shows that litter decomposed more rapidly at cooler and more humid areas suggesting that litter decomposition may be affected by local environment (i.e. temperature and precipitation).

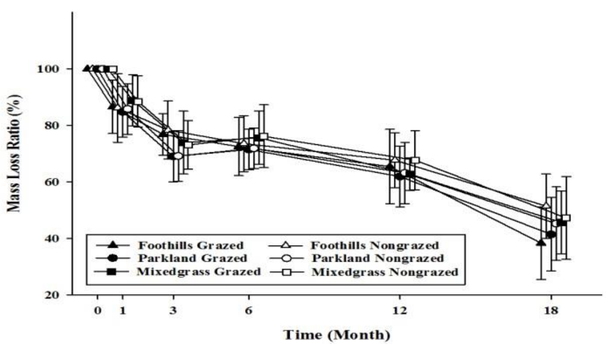

Figure 1. Effect of natural subregion and grazing on litter mass loss over 18 months (mean±SE)

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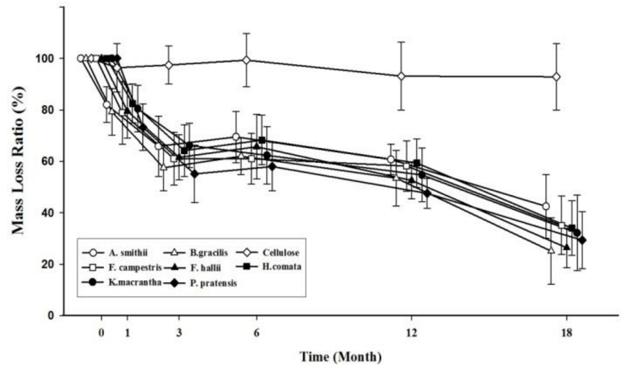

Figure 2. Litter mass loss (mean±SE**)** by species. Data are pooled across natural subregions at each month (mean±SE)

Conclusions and Implications

Our results indicate that long-term grazing increased litter decomposition, which in turn may alter C and nutrient cycling. Moreover, mass loss varied markedly among species, raising questions as to how shifts from grazing intolerant to tolerant species may alter litter turnover and C storage dynamics. Our continued research aims to understand if grazing could be managed in a way to increase SOC formation.

References

Adler P.B., Raff D.A. and Lauenroth W.K. 2001. The Effect of Grazing on the Spatial Heterogeneity of vegetation. Oecologia. 128:465-479.

Aerts, R. 1997. Climate, leaf litter chemistry and leaf litter decomposition in terrestrial ecosystems: A triangular relationship. Oikos. 79: 439-449.

Augustine, D.J. and McNaughton, S.J. 1998. Ungulate effects on the functional species composition of plant communities: herbivore selectivity and plant tolerance. J. of Wildlife Management. 62(4): 1165-1183.

Derner J., Boutton T.W., and Briske D. 2006. Grazing and ecosystem carbon storage in the North American Great Plains. Plant and Soil. 280:77-90.

Schuman G.E., Janzen H.H. and Herrick J.E. 2002. Soil carbon dynamics and potential carbon sequestration by rangelands. Environmental Pollution. 116(3): 391-396.