Structure, Function and Drought Tolerance of Northern Prairie Communities, 50 Years After Grazing

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Northern fescue grasslands provide important ecosystem services that depend on the resilience of prairie communities to the changing climate. The worldwide leaf economics spectrum provides an axis that separates plant traits between aquisitive and conservative strategies,[5] but how do plant strategies converge in grazed grasslands? Here, we examine the legacies of historic grazing on the diversity and composition of northern fescue grasslands. More importantly, we test whether historic grazing can explain the leaf trait composition of grasslands and predict the resilience of grasslands to drought.

METHODS

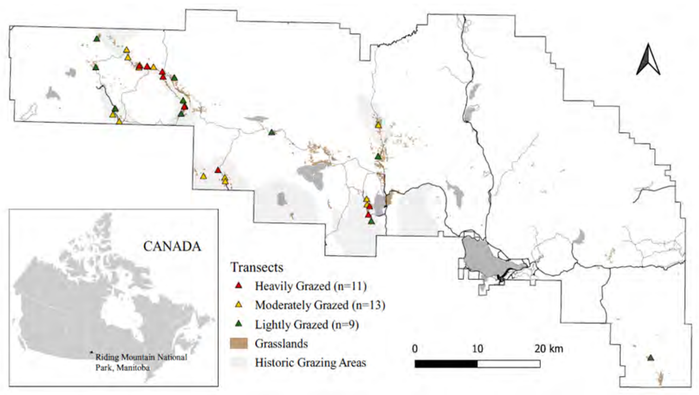

Figure 1. Locations of 33 long-term monitoring transects in historically grazed northern fescue grasslands in Riding Mountain National Park, Manitoba (14U 413619 5623702).

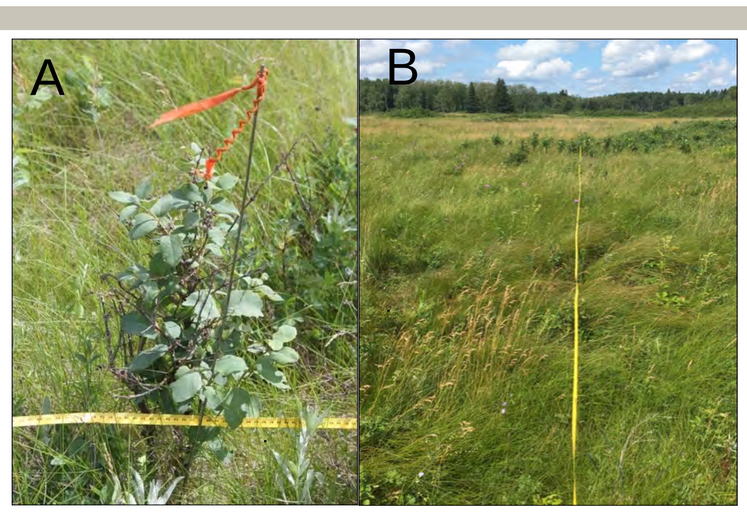

Figure 2. Vegetation community data was collected in 1973, 2010 and 2020 by recording every species in contact with a metal pin (A) at every 1ft (30.5cm) on a 100ft (30.5m) transect (B).

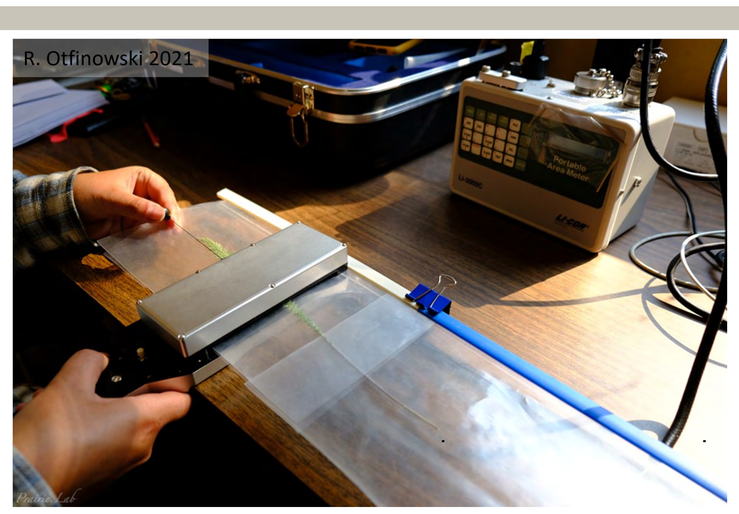

Figure 3. Species contributing to 70% of the plant community in 1973, 2010 and 2020 (30 species) were measured for specific leaf area (SLA), leaf density and leaf C:N.[1] Leaf traits were multiplied with abundance data for community weighted means.[4]

RESULTS

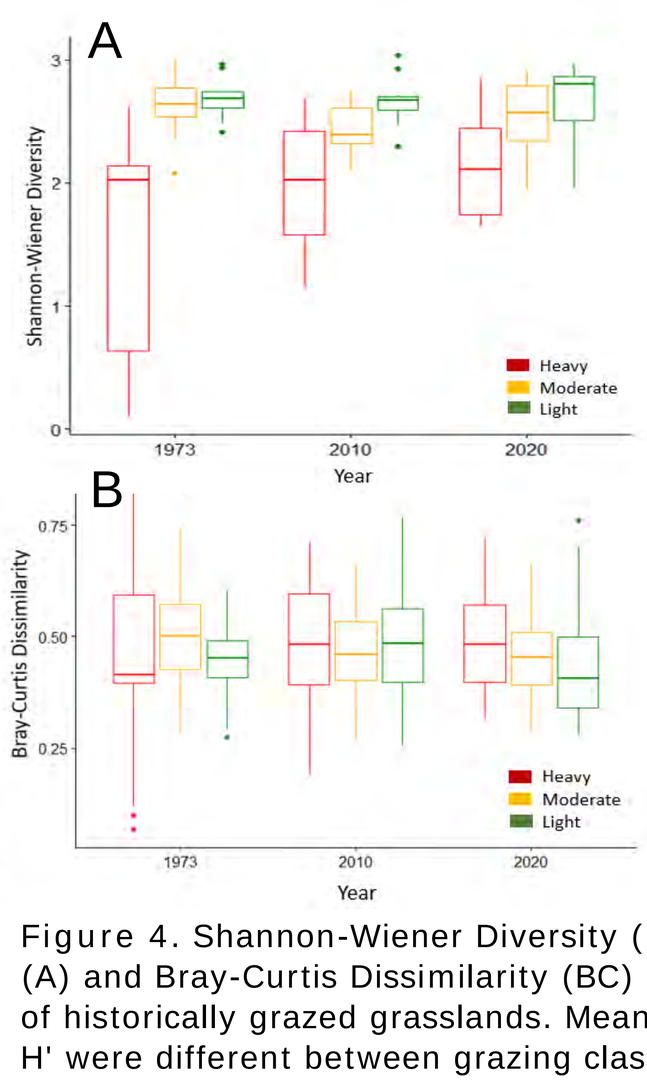

Figure 4. Shannon-Wiener Diversity (H') (A) and Bray-Curtis Dissimilarity (BC) (B) of historically grazed grasslands. Means of H' were different between grazing classes in 1973 ($p<0.001$), 2010 ($p<0.001$) and 2020 ($p=0.013$). Means of BC were different between grazing classes only in 2020 ($p=0.006$).

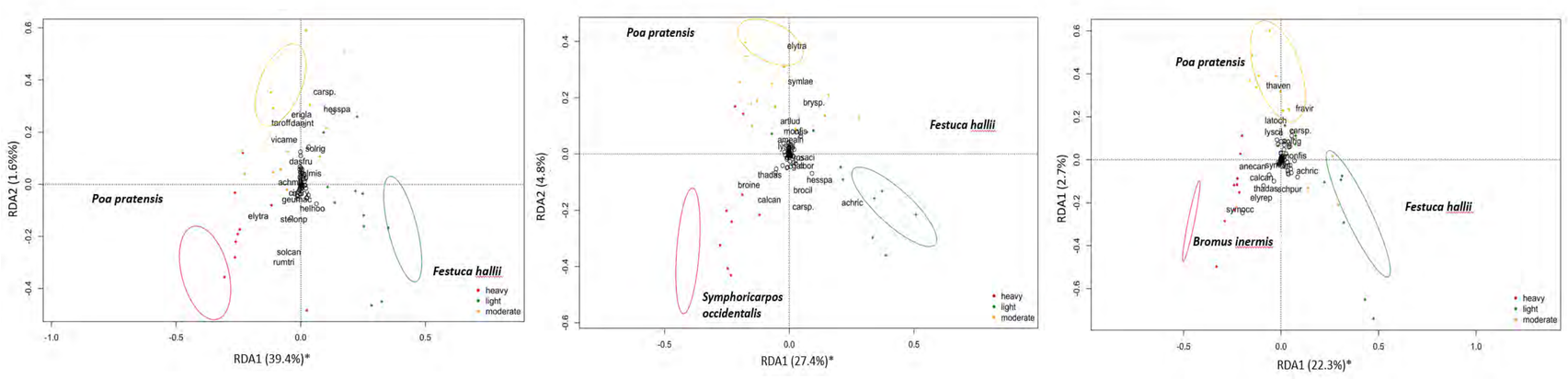

Figure 5. Redundancy Analysis (RDA) of vegetation communities and historic grazing classes in 1973 (A), 2010 (B) and 2020 (C). Ellipses represent 95% confidence standard error for each grazing group. RDA1 was significant in 1973 ($p=0.001$), 2010 ($p=0.047$) and 2020 ($p=0.001$).

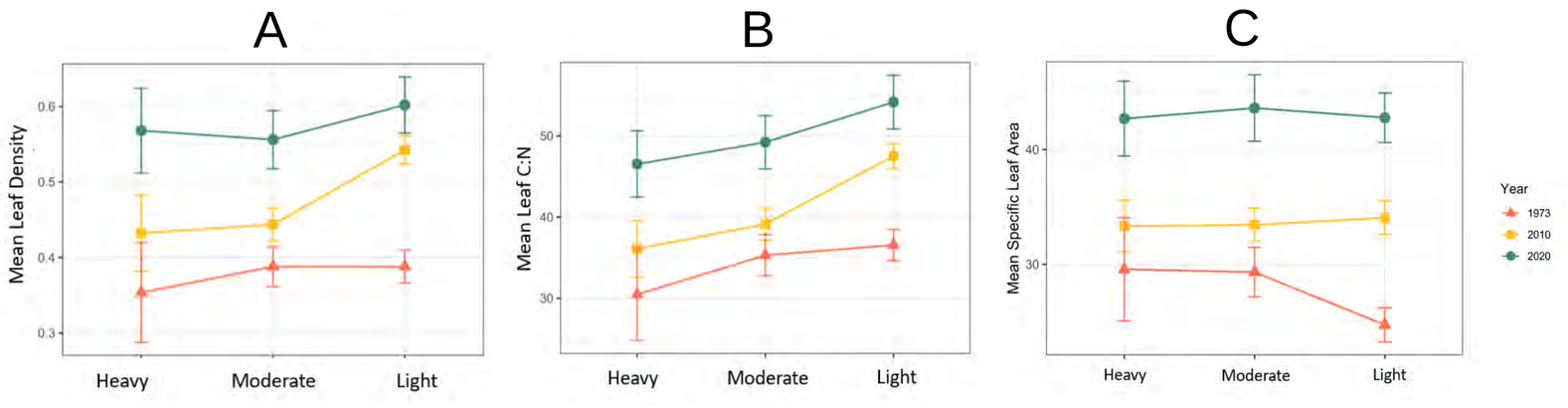

Figure 6. Interaction plots of community weighted mean SLA (A), leaf density (B), and leaf C:N (C) measured in three grazing classes in 1973, 2010 and 2020. SLA ($p<0.001$), density ($p<0.001$) and C:N ($p<0.001$) increased significantly from 1973 to 2020, however, the means of leaf density ($p=0.024$) and C:N (0.007) were different between grazing classes only in 2010.

SIGNIFICANCE

- Fifty years after grazing, legacies of intense grazing decreased alpha diversity and beta diversity declined in lightly grazed grasslands that lacked disturbance.
- Conservative leaf traits (high leaf density, high C:N) converged in lightly grazed grasslands in 2010, but not 1973 or 2020.
- Invasions by exotic species, rather than grazing legacies, affected the trait composition of grasslands:
  - Invasions by Bromus inermis increased SLA (acquisitive trait) in all grasslands.
  - Invasions by Poa pratensis increased leaf density and C:N (conservative traits).
  - Conservative leaf traits of exotic Poa pratensis and native Festuca hallii are creating functionally similar communities.
- Acquisitive traits in grasslands invaded by Bromus inermis in will decrease their tolerance to drought.[3]
- Conservative traits in grasslands invaded by Poa pratensis will slow down litter decomposition and may reduce nitrogen availability in grassland soils.[2]

REFERENCES

1. Cornelissen, J. H. C., Lavorel, S., Garnier, E., Diaz, S., Buchmann, N., Gurvich, D. E., Reich, P. B., Steege, H.. Morgan, H. D., Heijden, M. G. A., van der Pausas, J. G., and Poorter, H. (2003) A handbook of protocols for standardized and easy measurement of plant functional traits worldwode. Austrailian Journal of Botany, 51(4), 355.
2. Cornwell, W. K., Cornelissen, J. H. C., Amatangelo, K., Dorrenpaal, E., Eviner, V. T., Godoy, O., Hobbie, S. E., Hoorens, B., Kurokawa, H., Perez-Harguindeguy, N., Quested, H. M., Santiago, L. S., Wardle, D. A., Wright, I. K., Aerta, R., Allison, S. D., van Bodegon, P., Brovkin, V., Chatain, A., ... Westoby, M. (2008). Plant species traits are the predominant control on litter decomposition rates within biomes worldwide. Ecology Letters, 11(10), 1065-1071.
3. Onoda, Y., Wright, I. J., Evans, J. R., Hikosaka, K., Kitajima, K., Niinemets, U., Poorter, H., Tosens, T. and Westoby, M. (2017) Physiological and structural tradeoffs underlying the leaf economics spectrum. New Phytologist, 214(4), 1447-1463.
4. Sonnier, G., Shipley, B. and Navas, M-L. (2010) Quantifying relationships between traits and explicitly measured gradients of stress and disturbance in early successional plant communities. Journal of Vegetation Science, 21(6). 1014-1024.
5. Wright, I. J., Reich, P. B., Westoby, M., Ackerly, D. D., Baruch, Z., Bongers, F., Cavender-Bares, J., Chapin, T., Cornelissen, J. H. C., Diemer, M., Flexas, J., Garnier, E., Groom, P. K., Guilas, J., Hikosaka, K., Lamont, B. B., Lee, T., Lee, W., Lusk, C., ... Villar, R. (2004) The worldwide leaf economics spectrum. Nature, 428(6985), 821-827.

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