Bird Community Responses to Rest-Rotation Grazing in Western Canada's Grasslands

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Abstract

Western Canada's native grasslands support high levels of avian diversity including both resident and migrant species. Many grassland specialist bird populations, however, are in serious decline due to widespread habitat loss resulting from agricultural conversion and adverse land management. As the primary use on remaining grasslands, cattle grazing largely determines the availability and quality of bird species' habitat, depending on the timing, intensity, and frequency of livestock use. While adaptive multi-paddock grazing (AMP, a short-duration, high-intensity grazing system that prioritises plant recovery between grazing events) is growing in popularity, comprehensive assessments of bird diversity in relation to AMP grazing practices are largely lacking. As part of a larger grazing management study, we examined how AMP grazing practices influence the taxonomic and phylogenetic diversity of bird species, compared to neighbouring (n-AMP) properties managed with more conventional grazing practices. In addition to the AMP/n-AMP contrast, we used rancher survey information to test for the influence of specific grazing practices over and above biophysical effects. Bird communities were surveyed at 309 point count locations across 38 ranches (set up as matched pairs) using visual and acoustic detection. Overall, we identified 96 bird species, of which 81 species were recorded on AMP-grazed ranches compared to 84 species on grasslands under n-AMP grazing, ranging from 10-32 species per ranch. We observed a considerable grazing management signal on species abundance and diversity including significant associations between some threatened species and n-AMP grazing. Moreover, AMP grazing, and specifically the use of higher rest-to-grazing ratios early in the growing season (prior to August 1), was associated with phylogenetically more clustered bird communities. Overall, this study highlights the potential of specialized rotational grazing systems to alter the composition and phylogenetic diversity of grassland bird communities. In conclusion, we stress the importance for prioritisation of strategic management plans to safeguard and restore North America's grassland bird communities.

Introduction

The majority of North America's grassland bird populations have suffered serious declines over past decades (Correll et al., 2019), largely driven by the widespread conversion of grasslands to croplands (Rosenberg et al., 2019). Those native and cultivated grasslands that remain are primarily used for cattle grazing (Bailey et al., 2010), with the consequence that grazing practices largely determine ecosystem function and the habitat quality for wildlife (Milchunas et al., 1998). Hence, identifying those grazing practices that enhance ecosystem function and safeguard native biodiversity is critical (Teague and Barnes, 2017). Rest-rotation grazing, that mimics the 'herd effect' of large keystone herbivores in grasslands, has been suggested as a viable management approach to reverse grassland degradation, restore ecosystem function and improve heterogeneity in wildlife habitat (Savory, 1983). Across North America, adaptive multi-paddock (AMP) grazing is being increasingly adopted to mimic native grazers, with particular reference to migratory bison (Teague and Kreuter, 2020). A core attribute of AMP grazing is the use of very short grazing pulses at high stocking densities, followed by lengthy rest periods to facilitate plant recovery (Holechek et al., 2000). While a number of studies have noted

the environmental benefits of rest-rotation grazing, large-scale research on the effects of AMP grazing on bird communities remains scarce. We investigated whether taxonomic and phylogenetic diversity of bird species in grasslands under AMP grazing differed from neighbouring sites that were subject to more conventional livestock grazing management. Moreover, we assessed the influence of various nuanced grazing practices including metrics composed of rest and cattle density on bird diversity, over and above biophysical effects.

Methods and Study Site

This study was conducted on grasslands associated with 38 beef cattle ranches across western Canada's prairie provinces, namely Alberta (n = 14), Saskatchewan (n = 18) and Manitoba (n = 6), as part of a larger interdisciplinary grazing management project (Fig. 1). Ranches were distributed across several ecoregions spanning wide gradients in climate, soil and vegetation type and land management. We used a paired design in which AMP ranches were initially identified through select grazing criteria, with each AMP ranch matched to a neighbouring ranch (n-AMP) employing regionally representative conventional grazing practices for comparison (within 5 km typically) on similar ecosites (e.g., landform, slope, soil texture, and soil series). Ranch pairs required comparable cultivation history (i.e., both non-cultivated, or both cultivated in the past).

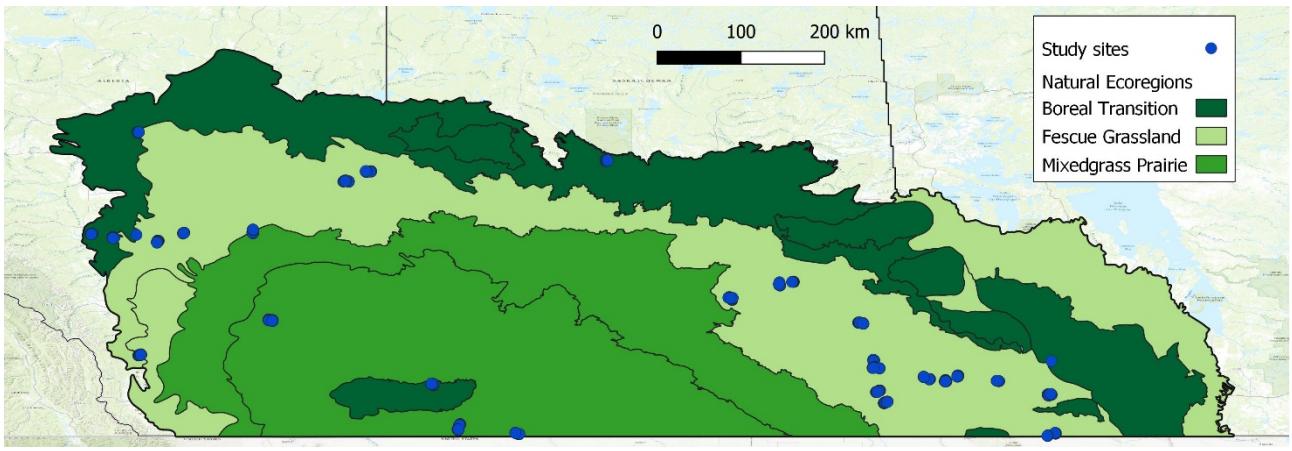

Fig. 1. Map of the Canadian prairie grasslands spanning three provinces: Alberta, Saskatchewan and Manitoba (from left to right). Natural ecoregions include the Boreal Transition (dark green), Fescue Grasslands of the foothills and parkland regions (light green) and Mixedgrass Prairie (bright green). Also shown are the 38 ranch pairs comprising 38 adaptive multi-paddock (AMP) grazing ranches and an equal number of ranches employing region-representative conventional grazing for comparison. Ecoregion data were obtained from Natural Resources Canada (https://www.nrcan.gc.ca/maps-tools-publications/tools/geodetic-reference-systems/forest-maps/16874).

We conducted acoustic and visual surveys during the first 4.5h after sunrise of the 2017 peak breeding season (between 31 May and 5 July) using five minute passive point counts at up to 12 locations (minimum of 500 m apart) per ranch. To assess variation in bird community composition we used non-metric multidimensional scaling (NMDS), by converting a site-by-species matrix with counts as a measure of relative dominance, into a community dissimilarity matrix using the function *metaMDS* in the R package 'vegan' (Oksanen et al., 2019). We used permutational multivariate analysis of variance to test for treatment differences (AMP/n-AMP) using function *adonis* in the R package 'vegan' (Oksanen et al., 2019). We then reconstructed a phylogenetic tree by using a subsetting algorithm with a Hackett phylogeny backbone (Jetz et al., 2012). The phylogenetic dispersion of bird communities was then quantified as the net relatedness index (NRI) using the 'ape' (Paradis et al., 2004) and 'picante' (Kembel et al., 2010) packages in R. We investigated the effects of grazing management on bird species richness and community phylogenetic dispersion using (generalized) linear mixed effects models in the R package 'lme4' (Bates et al., 2015). Akaike Information Criterion adjusted for small sample size (AICc) were used to identify the most parsimonious candidate models (i.e. those within 2 AIC units) (Symonds and Moussalli, 2011).

Results

Across the 38 study ranches, we identified 96 bird species, of which 81 species were recorded on AMP-grazed ranches compared to 84 species on grasslands under n-AMP grazing, ranging from 10-32 species per ranch. Five of the 18 grassland specialist birds are listed as threatened on the IUCN Red List of Threatened Species, three of which are positively associated with n-AMP ranches, yet none with AMP-grazed properties (Table 1).

Table 1. List of 18 grassland specialist bird species recorded across 38 cattle ranches throughout western Canada. AMP and n-AMP present bird counts per species. Significant (**) and strong (*) indicate species associations with a particular grazing practice (AMP/n-AMP). Threat status according to the IUCN Red List of Threatened Species is provided.

Scientific name	Vernacular name	AMP	n-AMP	Status
Ammodramus savannarum	Grasshopper Sparrow	15	13	
Ammodramus leconteii	LeConte's Sparrow	25	11	
Anthus spragueii	Sprague's Pipit	6	**15****	**Threatened**
Bartramia longicauda	Upland Sandpiper	3	6	**Threatened**
Buteo regalis	Ferruginous Hawk	1	1	**Threatened**
Buteo swainsoni	Swainson's Hawk	4	4	
Calcarius ornatus	Chestnut-collared Longspur	0	**17****	**Threatened**
Ammodramus bairdii	Baird's Sparrow	11	14	
Dolichonyx oryzivorus	Bobolink	**51****	6	
Eremophila alpestris	Horned Lark	15	14	
Numenius americanus	Long-billed Curlew	0	**2***	**Threatened**
Passerculus sandwichensis	Savannah Sparrow	174	143	
Pooecetes gramineus	Vesper Sparrow	69	44	
Dendroica_pensylvanica	Chestnut-sided Warbler	0	2	
Sturnella neglecta	Western Meadowlark	139	92	
Catoptrophorus semipalmatus	Willet	1	6	
Tympanuchus phasianellus	Sharp-tailed Grouse	3	2	
Tyrannus verticalis	Western Kingbird	**1***	0	

The NMDS ordination indicated comparatively little difference in bird community composition between AMP and n-AMP grazing practices (Fig. 2), supported by a non-significant test of treatment differences ($P = 0.52$).

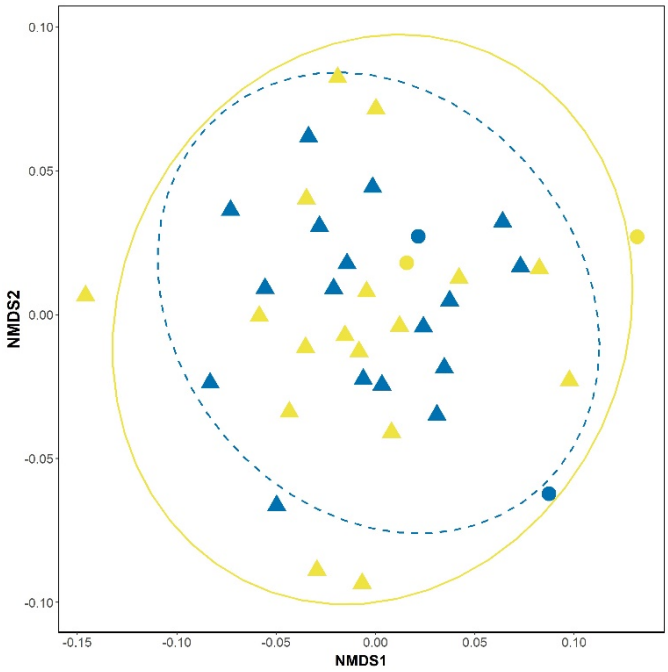

Fig. 2. Biplot of non-metric multidimensional scaling (NMDS) axes 1 and 2 showing the variation between 19 adaptive multi-paddock (AMP) ranches and an equal number of neighbouring properties (n-AMP) displayed with illustrative ellipses based on a 95th percentile threshold. AMP ranches are indicated in blue and n-AMP in yellow. Circles illustrate non-cultivated ranches and triangles cultivated ranches.

None of the variation in bird species richness between grassland communities could be explained by AMP/n-AMP grazing practices, nor by the other detailed grazing practices (data not shown). Instead, we found a significant relationship between NRI and grazing practices, indicating a trend towards phylogenetically more clustered bird communities under AMP-grazed ranches, yet more divergent community structure on n-AMP ranches (Fig. 3a). Moreover, there was a significant pattern of greater phylogenetic clustering with increased rest-to-grazing ratio thereby closely reflecting the pattern observed for AMP grazing in general (Fig. 3b).

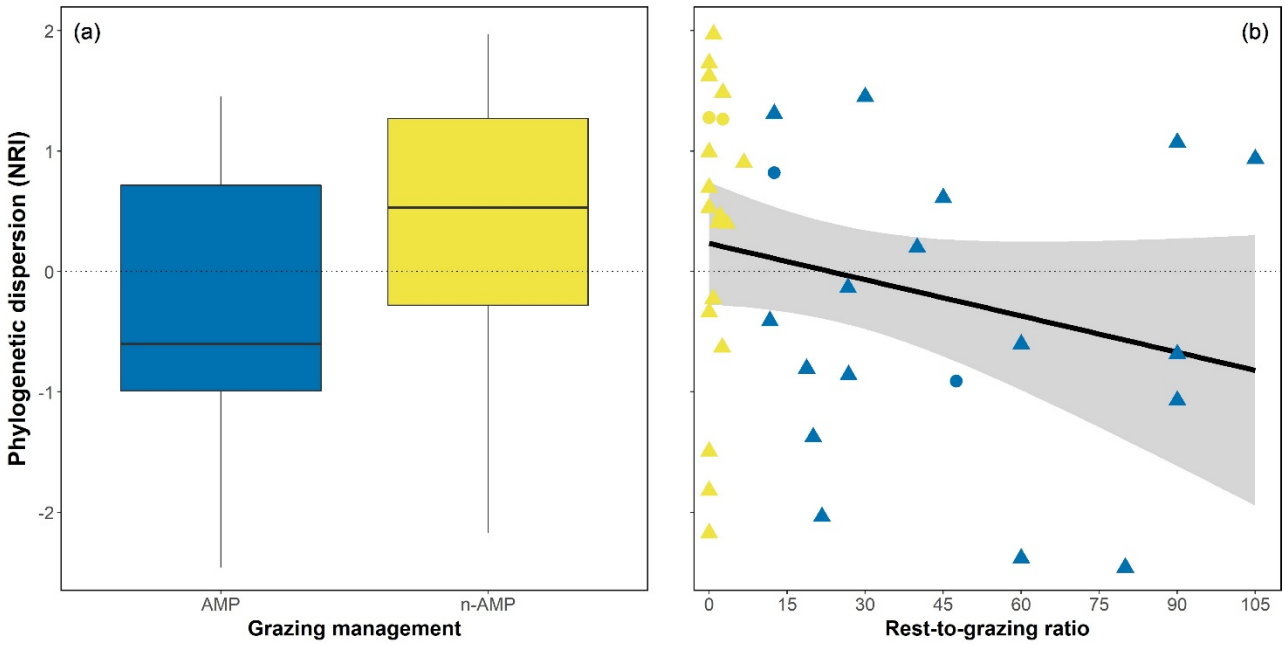

Fig. 3. a) Boxplot of the differences in phylogenetic dispersion distinguished between AMP and n-AMP based on 38 grazed cattle ranches. Negative values suggest clustering while positive values suggest overdispersion in evolutionary space. Lower quartile, median and upper quartile are indicated by horizontal lines. b) Relationship between rest to grazing days ratio and phylogenetic dispersion (NRI). The rest-to-grazing ratio was defined to be the number of days of rest per day of early season grazing (prior to August 1). AMP ranches are indicated in blue and n-AMP in yellow. Circles illustrate non-cultivated ranches and triangles cultivated ranches. Linear regression line and standard errors (shaded area) provided.

Discussion [Conclusions/Implications]

This study provides novel insights into the way grazing management, both of AMP and more nuanced grazing practices, affect bird communities and highlights the importance of including phylogenetic diversity metrics in assessments of bird responses to grassland management, over and above taxonomic diversity indices.

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References

Bailey, A.W., McCartney, D., Schellenberg, M.P., 2010. Management of Canadian Prairie Rangeland.

Bates, D., Mächler, M., Bolker, B.M., Walker, S.C., 2015. Fitting linear mixed-effects models using lme4. J. Stat. Softw. 67, 1–48.

Correll, M.D., Strasser, E.H., Green, A.W., Panjabi, A.O., 2019. Quantifying specialist avifaunal decline in grassland birds of the Northern Great Plains. Ecosphere 10, e02523.

Holechek, J.L., Gomes, H., Molinar, F., Galt, D., Valdez, R., 2000. Short-duration grazing: the facts in 1999. Rangelands 22, 18–22.

Jetz, W., Thomas, G.H., Joy, J.B., Hartmann, K., Mooers, A.O., 2012. The global diversity of birds in space and time. Nature 491, 444–448.

Kembel, S.W., Cowan, P.D., Helmus, M.R., Cornwell, W.K., Morlon, H., Ackerly, D.D., Blomberg, S.P., Webb, C.O., 2010. Picante: R tools for integrating phylogenies and ecology. Bioinformatics 26, 1463–1464.

Milchunas, D.G., Lauenroth, W.K., Burke, I.C., 1998. Livestock Grazing: Animal and Plant Biodiversity of Shortgrass Steppe and the Relationship to Ecosystem Function. Oikos 83, 65.

Oksanen, J., Blanchet, F.G., Friendly, M., Kindt, R., Legendre, P., McGlinn, D., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Stevens, M.H.H., Szoecs, E., Wagner, H., 2019. vegan: Community ecology package. R package version 2.5-6.

Paradis, E., Claude, J., Strimmer, K., 2004. APE: Analyses of phylogenetics and evolution in R language. Bioinformatics 20, 289–290.

Rosenberg, K. V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.C., Panjabi, A., Helft, L., Parr, M., Marra, P.P., 2019. Decline of the North American avifauna. Science. 366, 120–124.

Savory, A., 1983. The savory grazing method or holistic resource management. Rangelands 5, 155–159.

Symonds, M.R.E., Moussalli, A., 2011. A brief guide to model selection, multimodel inference and model averaging in behavioural ecology using Akaike's information criterion. Behav. Ecol. Sociobiol. 65, 13–21.

Teague, R., Barnes, M., 2017. Grazing management that regenerates ecosystem function and grazingland livelihoods. African J. Range Forage Sci. 34, 77–86.

Teague, R., Kreuter, U., 2020. Managing grazing to restore soil health, ecosystem function, and ecosystem eervices. Front. Sustain. Food Syst. 4, 534187.