Response of Grassland Songbirds to Grazing System Type and Range Condition

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ABSTRACT Much of the remaining prairie in Canada is grazed by cattle and most grassland birds of conservation concern occupy such habitat. Identifying vegetation features related to grassland bird habitat selection that can be easily understood and measured by professional range managers and livestock producers on private lands is an important step towards conserving and restoring remaining grasslands. We conducted grassland bird surveys on 28 native mixed-grass prairie pastures in southern Saskatchewan to determine whether grazing system type (season long vs. rotational) influenced avian abundance. Grazing system had no influence on abundance of grassland passerines. Conservation agencies that promote particular grazing systems without consideration of recommended stocking rates, season of use and duration and frequency of grazing will likely fall short of achieving their objectives. Our results also demonstrate that intensive and rapid assessments of rangeland vegetation (i.e., range condition and visual estimation of plant vigor and residual cover, respectively) commonly used by professional range managers and ranchers may be useful indicators of abundance for horned lark (*Eremophila alpestris*), Sprague's pipit (*Anthus spragueii*), Baird's sparrow (*Ammodramus bairdii*), and chestnut-collared longspur (*Calcarius ornatus*). Range condition strongly influenced Baird's sparrow and Sprague's pipit abundance at the pasture level and therefore may be a useful tool for identifying important breeding habitat for these species.

KEY WORDS grassland passerines, grazing, mixed-grass prairie, range assessment, rangeland condition, rangeland health, Saskatchewan, vegetation structure

Native grasslands have been recognized as an important grazing resource for cattle producers and an essential component in maintaining the remaining biodiversity in the northern Great Plains (West 1993). Although the cattle industry has, and continues to play an important role in preventing cultivation of native grassland, inappropriate grazing by domestic cattle can have negative consequences for grassland systems and species (Bock et al. 1992, Freilich et al. 2003). Consequently, conservation organizations spend a great deal of resources working with ranchers to adopt management practices that benefit both wildlife and cattle producers.

Rotational grazing systems in general have been touted as being more productive for cattle and producers, although there is little empirical support for such claims (Holechek et al.1999, Derner and Hart 2007, Briske et al. 2008) except possibly for more mesic sites (Holechek et al. 1999). A common management regime promoted by conservation organizations involves rotating cattle among a series of paddocks or fields with grazing on some fields deferred until later in the season or subsequent years (Anderson et al. 1996, Dormaar et al. 1997). Rotational grazing systems that use moderate stocking rates and defer grazing at different times of the year on relatively large paddocks, are thought to provide cattle producers and other land managers the opportunity to cater to the diverse requirements of breeding grassland birds by providing an array of sites from relatively low, sparse vegetation to tall, dense vegetation with increased amounts of residual cover in the spring (Anderson et al. 1996, Knopf 1996). This prospective win-win scenario may positively influence the conservation of grassland bird populations, many of which have undergone drastic population declines in North America (Sauer et al. 2007) largely because of habitat loss and degradation (Askins et al. 2007). Several studies have evaluated the response of non-game birds to different grazing systems (Temple et al. 1999, Stanley and Knopf 2002, Driscoll 2004), but few studies have been conducted in the northern mixed-grass prairie (Buskness et al. 2001, Koper and Schmiegelow 2006, Ranellucci et al. 2012) and results have been equivocal.

Identifying vegetation features important in grassland bird habitat selection is an integral step towards managing and restoring remaining rangelands (i.e., grassland grazed by livestock). Vegetation structure is an important predictor of grassland bird abundance (Fisher and Davis 2010). However, structural measures are time-consuming, costly to collect, and provide little information relevant to most range managers and ranchers. Vegetation structure also can change dramatically within a season or between years along with the relationships between vegetation structure and bird abundance or reproductive success (Dale 1983, Davis 2004, Winter et al. 2005).

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Cattle producers on private lands often use somewhat subjective visual estimates of rangeland integrity such as grazing use, plant vigor, and residual cover or carry-over, to inform management. While these measures can be subjective, they provide an efficient means of assessing the condition of their pastures and are commonly used and understood by cattle producers. Professional range managers typically use more objective and rigorous means of assessing rangeland integrity. Range condition is commonly used to set stocking rates and monitor the integrity of pastures in Canada (Abouguendia 1990) and has a long history of use in the U.S (Task Group on Unity in Concepts and Terminology 1995). It involves intensive vegetation sampling to assess the current composition of plant species that increase or decrease in the presence of heavy grazing relative to what would be expected based on the type of soil or ecological site. Range condition does not vary substantially over short time periods and has been found to be a good indicator of both plant species and structural diversity (Bai et al. 2001). Such characteristics may make it a useful predictor of grassland bird abundance.

Our objectives were to determine 1) the magnitude to which grassland bird abundance differs in native mixed-grass pastures under a season-long and rotational grazing system, and 2) the extent to which intensive sampling (range condition) and rapid assessments (visual estimates of plant vigor, grazing use, carry-over) of rangeland integrity measurements commonly used by range managers and ranchers, respectively, are associated with songbird abundance compared to vegetation measurements typically collected by grassland bird researchers.

STUDY AREA

We chose seven different season-long and seven rotationally grazed pastures in each of 1994 and 1995 (*n* = 28 pastures) within an 86,000 km^2 area in south-central Saskatchewan. Our study area extended north from Val Marie (107° 43’ 57” W; 49° 14’ 50” N) to Rosetown (107° 59’ 46” W; 51° 33’ 15” N) and east to Semans (104° 43’ 32” W; 51° 24’ 12” N) and south to Ceylon (104° 36’ 20” W; 49° 27’ 50” N). We selected pairs of season-long and rotational pastures within 20 km of each other to minimize differences in soil, topography, vegetation, and precipitation. Season long pastures were grazed continuously from mid-May until temperatures were typically below 0° C in the fall and rotational pastures were variable in their rotation schedule but involved rotating the cattle such that paddocks were grazed once during the season. The region was characterized by semiarid conditions and dark brown soils with a flat to gently rolling topography. Mean annual precipitation ranged from 25 to 40 cm. Paddocks within pastures ranged from 65 to 3,000 ha. Both grazing systems had similar stocking rates (Table 1) which in most cases were

Table 1. Vegetation structure and range condition (mean, lower and upper 95% confidence limits) characteristics of rotational and season-long grazed pastures in the mixed-grass prairie of southern Saskatchewan, Canada, 1994–1995.

Vegetation characteristic[a]	Rotational (*n* = 14)[b]	Season-long (*n* = 14)
Standing dead	3.2, 2.5–3.9	2.8, 1.9–3.7
CV standing dead	88.6, 75.5–101.7	89.9, 75.9–103.8
Forbs	0.3, 0.2–0.4	0.2, 0.1–0.4
Shrubs	0.7, 0.3–1.1	0.6, 0.3–1.0
Live grasses	2.2, 1.7–2.7	2.1, 1.6–2.7
Litter depth (mm)	3.6, 1.6–5.6	3.4, 0.5–6.3
Last dm	1.6, 1.4–1.7	1.5, 1.3–1.7
CV last dm	40.9, 38.8–43.0	41.1, 37.2–44.9
Shrub distance (m)	46.6, 23.1–70.1	46.4, 29.3–63.5
Bare ground (%)	7.4, 3.7–11.6	8.2, 4.1–12.4
Stocking rate (AUM/ha)	0.9, 0.7–1.1	1.0, 0.7–1.2
Range condition	69.5, 64.4–74.6	67.1, 60.6–73.6

[a] Standing dead = mean number of standing dead vegetation contacts with the Wiens pole; CV standing dead = mean coefficient of variation of standing dead vegetation contacts; Forbs = mean number of flowering plant contacts; Shrub = mean number of shrub contacts; Live grasses = mean number of live grass contacts; Last dm = mean of the highest decimeter interval contacted by any vegetation type; CV last dm = mean coefficient of variation of the highest decimeter interval contacted by any vegetation type; [b] = number of pastures sampled.

at or above levels recommended by Abouguendia (1990) for their respective range/ecological sites. Pastures included in our study were predominantly comprised of native vegetation and included *Stipa* (spp.), *Agropyron* (spp.), blue grama grass (*Bouteloua gracilis* [HBK.] Lag.), June grass (*Koeleria gracilis* Pers.), and pasture sage (*Artemisia frigida* Willd.). Some paddocks had been seeded with crested wheatgrass (*Agropyron cristatum* [L.] Gaertn.) for spring pasture but were not included in the study. Trembling aspen (*Populus tremuloides* Michx.) and green ash (*Fraxinus pennsylvanica* Marsh) were primarily restricted to coulees and western snowberry (*Symphoricarpos occidentalis* Hook.) and silverberry *(Eleagnus commutata* Bernh.) occurred in mesic upland areas. Plant authorities follow Looman and Best (1994).

METHODS

Avian Surveys

Two trained observers quantified relative abundance of singing male songbirds using 100-m fixed-radius point-counts (Hutto et al. 1986) of 5-min duration. We located multiple point count stations within each paddock ensuring point count centers were at least 300 m apart. We distributed point counts as evenly as possible across all paddocks while avoiding wetlands or coulees. Field staff marked point count centers and four perimeter points with surveyor flags to facilitate the relocation of plots and aid in distance estimation, respectively. Surveys commenced 15 min before sunrise and ended no later than 0900 hours CST. The same observers conducted surveys twice at each site between 23 May and 7 July in 1994 and 1995, on days with no fog or precipitation and winds <20 km/hr. Each observer contributed evenly to season-long and rotation samples to minimize observer bias. Avian nomenclature follows the American Ornithologists' Union (2013).

Intensive and Rapid Assessments of Rangeland Integrity

We conducted intensive and rapid assessments of rangeland integrity in each point count circular plot from late June to early August in both years. Our intensive assessment involved calculating range condition scores for each point count circular plot. We quantified range condition by sampling vegetation at eight locations distributed evenly throughout each circular plot and used an ocular estimation of percent dry weight of individual plant species and bare ground coverage within a 0.25-m^{2}quadrat to the nearest 5% (Abouguendia 1990). We defined bare ground coverage as that without basal and without overhead canopy interception within the quadrat. We calculated range condition by summing the estimated percentage dry weight of all decreaser species and an allowable percentage dry weight of increaser species in each range site (Abouguendia 1990). Increaser and decreaser plant species are those native plants which increase or decrease in percent composition when subjected to continued heavy grazing pressure. Our assessment of range condition was meant to represent the relative degree to which the current plant community resembled that of the climax plant community for the site and not as a surrogate for seral stage. Our rapid assessment of rangeland integrity involved an estimation of grazing use, residual cover, and plant vigor by a range ecologist traversing the entire point count circular plot and scoring each point using criteria outlined in Appendix 1.

Vegetation Structure

We quantified vegetation structure each year in late May at 16 randomly selected points within each 100-m radius circular plot. Surveyors dropped a 5–6 mm-diameter metal rod (i.e., Wiens pole painted with black and white decimter increments) vertically at each sample location and recorded the number of contacts at any point on the rod by vegetation types (live grasses, standing dead vegetation [dead vegetation attached to the ground], and forbs [flowering vascular plants]; Wiens 1969). We recorded the highest decimeter that vegetation contacted the rod as an index to vegetation height. We measured litter (unconsolidated plant material) depth (mm) with a 15-cm plastic ruler and estimated distance to the nearest shrub (m). In addition we calculated a coefficient of variation for standing dead vegetation and highest decimeter contacted by vegetation. We used point count means for each vegetation variable in subsequent analyses.

Statistical Analyses

We performed all analyses using SAS (2013). We used generalized linear mixed models (PROC GLIMMIX) with a log-link and Laplace approximation and modeled abundance (greatest number of singing males recorded during one of the visits at a count point) of each species as a random variable with a Poisson distribution. We used pasture as a random effect to account for multiple point counts within a pasture. We used Akaike's Information Criterion (AIC) to rank each of the models (Burnham and Anderson 1998) and considered the model with the lowest AIC score and greatest weight to be the model best fitting the data of the models considered. We combined years for all analyses because we found no support for year-by-treatment interaction models to be better models (i.e., lower AIC values) than additive models, or models without year effects included. We examined three suites of models: 1) grazing system (season-long versus rotational), 2) range models (including range condition, plant vigor, grazing use, and residual vegetation), and 3) vegetation structure (including frequency of live and dead grasses, shrubs and forbs, distance to nearest shrub, litter depth, vegetation height and vegetation height heterogeneity and heterogeneity of dead

Table 2. Comparisons of the best models relating grassland passerine abundance to rangeland assessment measures (plant vigor, residual cover, grazing intensity and range condition), and vegetation structure (frequency of dead vegetation, forbs, and shrubs, distance to shrubs, litter depth, vegetation height, and coefficient of variation of vegetation height and dead vegetation). Models were evaluated using Akaike Information Criterion (AIC; Burnham and Anderson 1998) scores and their relative performance (ΔAIC) to the overall best model for each species and the null model.

Species	Model type	Model	K[a]	AIC	ΔAIC	w_i[b]	Pearson χ^2/df
horned lark							
	Combined model	plant vigor + deadCV - dead - forb	7	878.3	0.0	0.77	0.88
	Vegetation structure	deadCV - dead - forb	5	880.7	2.4	0.23	
	Range	plant vigor	4	893.7	15.4	0.00	
	Null		2	901.3	23.0	0.00	
Sprague's pipit							
	Range	range condition	3	784.4	0.0	0.93	0.71
	Vegetation structure	shrubs	3	790.8	6.4	0.04	
	Null		2	791.1	6.7	0.03	
Savannah sparrow							
	Vegetation structure	vegetation height	3	920.0	0.0	1.00	0.77
	Null		2	936.9	16.9	0.00	
	Range	grazing intensity	4	938.2	18.2	0.00	
clay-colored sparrow							
	Combined model	plant vigor – shrub distance	5	846.1	0.0	0.60	0.85
	Vegetation structure	– shrub distance	3	847.1	1.0	0.37	
	Range	plant vigor	4	853.4	7.3	0.16	
	Null		2	853.8	7.7	0.01	
Baird's sparrow							
	Combined model	residual cover + dead	5	821.7	0.0	0.53	0.68
	Range	residual cover	4	822.0	0.3	0.46	
	Vegetation structure	dead	3	831.8	10.1	0.00	
	Null		2	837.7	16.0	0.00	
vesper sparrow							
	Vegetation structure	vegetation heightCV – shrub distance	4	432.0	0.0	1.00	0.83
	Null		2	499.7	67.7	0.00	
	Range	plant vigor	4	499.9	67.9	0.00	
chestnut-collared longspur							
	Combined model	plant vigor + range condition – litter depth	6	843.1	0.0	0.96	0.96
	Range	plant vigor + range condition	4	849.4	6.3	0.04	
	Vegetation structure	shrubs - forb - litter depth	5	857.0	13.9	0.00	
	Null		2	867.5	23.4	0.00	
western meadowlark							
	Vegetation structure	deadCV – vegetation heightCV	4	349.8	0.0	0.91	0.80
	Null		2	355.6	5.8	0.05	
	Range	grazing intensity	4	355.8	6.0	0.04	

[a] *K* represents the number of parameters considered in the model; [b] w_i represents Akaike weights

vegetation). We reduced the number of variables considered in our analyses by analyzing them individually for each species, retaining the variables with a lower AIC score than the null (intercept only) model. All range and vegetation variables that outperformed the null model were included in our global model. We employed a backward elimination procedure and sequentially removed variables from the global model with the lowest effect size until we obtained the best model (i.e. lowest AIC score). We restrict our discussion to those variables whose 85% confidence intervals do not include zero as we consider these to be most influential (Arnold 2010). We also provide Pearson Chi-square values divided by the degrees of freedom for each model as an indication of model fit with values between 0.6 and 2.0 indicating a reasonable model (S. Baggett, USDA Forest Service, personal communication). Because range condition is usually evaluated at the pasture level, we regressed (PROC GLM) the mean number of birds per point on the mean range condition score of each pasture (n = 28).

RESULTS

We conducted 359 point counts on native sites within 14 season-long and 14 rotational grazed pastures. Vegetation structure and range condition within point counts were similar between rotational and season-long pastures as 95% confidence intervals overlapped in all cases (Table 1). Grazing system had no influence on abundance of grassland passerines as the null model outperformed grazing system models for all species and was not considered in subsequent analyses. Vegetation structure was the most influential factor on songbird abundance for five species and range variables were important for three species (Table 2). Of the range variables evaluated, range condition predicted abundance for two species and rapid assessment measures predicted abundance for three species (Table 2). Combining range assessment and vegetation structure variables improved models for four of eight species. In all cases, the models appeared to fit the data reasonably well (Table 2). Horned lark (*Eremophila alpestris*) abundance increased in areas where vegetation was characterized by poor vigor (Fig. 1) and greater variation in standing dead vegetation (β = 0.004, SE = 0.002) and decreased with increased frequency of standing dead vegetation (β = –0.157, SE = 0.05) and forbs (β = –0.423, SE = 0.2). Chestnut-collared longspur (*Calcarius ornatus*) abundance increased in areas where vegetation was characterized by poor vigor (Fig. 1) and decreased with the depth of litter (β

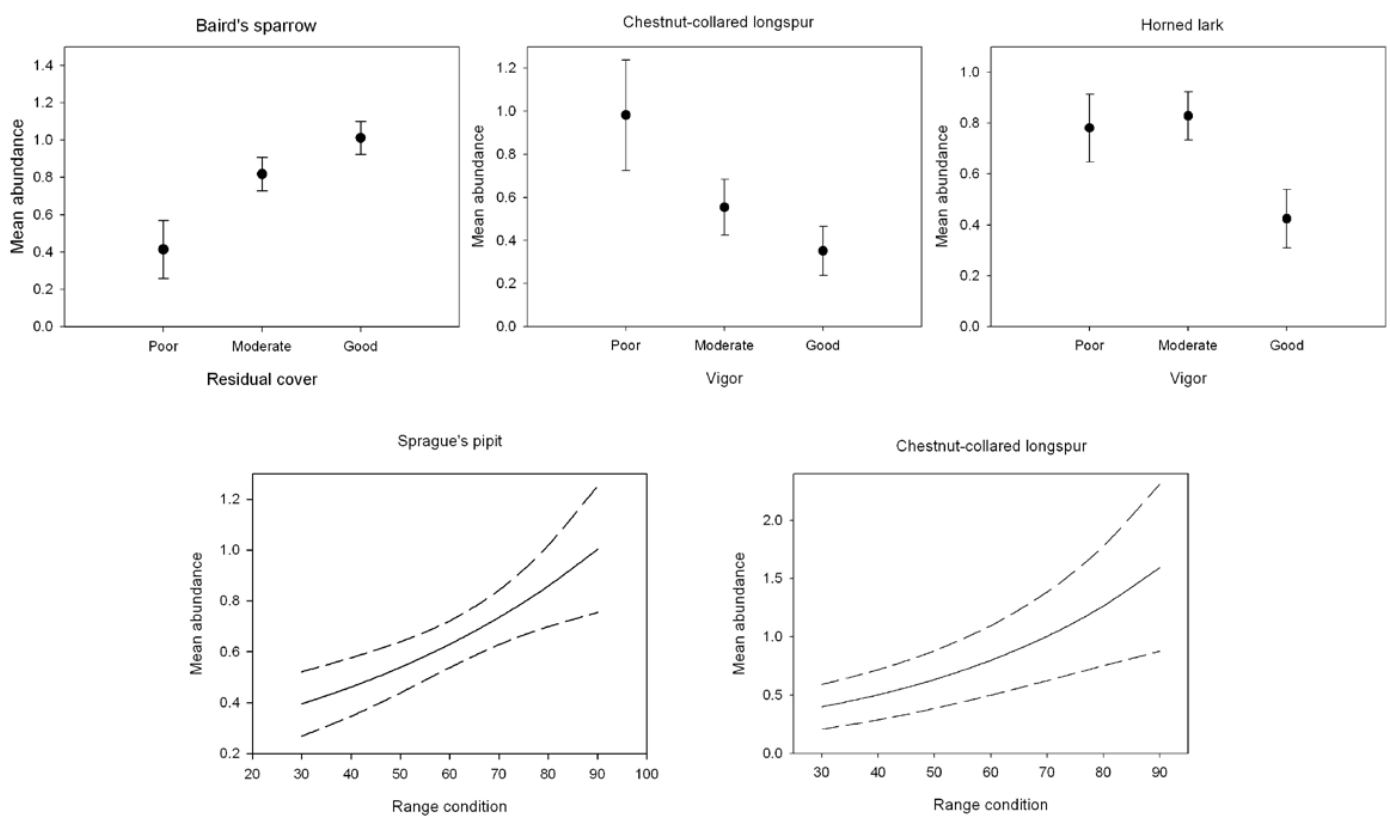

Figure 1. Influence of plant vigor, residual cover and range condition (defined as percent dry weight of biomass comprised of decreaser species and an allowable consideration of increaser species; Abouguendia 1990) on the abundance of four grassland passerines at count points in southern Saskatchewan, Canada, 1994–1995.

= –0.067, SE = 0.018). Longspur abundance also increased with range condition, but the relationship was relatively weak (β = 0.023, SE = 0.01; Fig 1). Clay-colored sparrow (*Spizella pallida*) abundance was greatest in sites with good vigor and with decreasing distance to shrubs (β = –0.005, SE = 0.002). Baird's sparrow (*Ammodramus bairdii*) was least abundant in sites characterized by poor litter cover and increased with the frequency of dead vegetation (Table 2). Vegetation structure had little influence on Sprague's pipit (*Anthus spragueii*) abundance, but their abundance increased with increased range condition (β = 0.017, SE = 0.005). In contrast, Savannah sparrow (*Passerculus sandwichensis*), vesper sparrow (*Pooecetes gramineus*), and western meadowlark (*Sturnella neglecta*) abundance was most strongly influenced by vegetation structure (Table 2). Savannah sparrow abundance increased with vegetation height (β = 0.556, SE = 0.12). Vesper sparrow abundance was most strongly correlated with distance to shrubs (β = –0.009, SE = 0.003) and variation in vegetation height (β = 0.019, SE = 0.006). Similarly, meadowlark abundance was influenced by variation in vegetation height (β = –0.022, SE = 0.009) and the amount of dead vegetation (Table 2).

Sprague's pipit and Baird's sparrow abundance were best explained when we aggregated abundance and range condition to the pasture level. Both species showed a quadratic effect of range condition with mean pasture abundance (Fig. 2). Savannah sparrow was the only other species whose abundance tended to be correlated with range condition (β = 0.026, SE = 0.014, $P = 0.08$, all others $P > 0.29$).

DISCUSSION

Abundance of grassland birds was influenced more by vegetation features than the type of grazing system employed by ranchers in our study. Our results demonstrate that ranchers are able to provide suitable habitat for grassland birds equally well with either grazing system under the stocking rates and management scenarios investigated. Indeed, our sites had similar stocking rates and vegetation structure and range condition was not substantially different between rotational and season-long grazing systems. Similarly, Derner and Hart (2007) found no difference in vegetative cover, litter or bare soil between rotational and season-long systems in Colorado. Lapointe et al. (2003) and Driscoll (2004) also documented no difference in abundance of grassland passerines in pastures grazed under a rotational or season-long grazing system and Buskness et al. (2001) observed limited differences only in the drier of two years. Ranellucci et al. (2012) found no consistent differences in songbird abundance between twice-over and season-long grazing systems. Studies of waterfowl response to rotational grazing systems also have produced equivocal results (Ignatiuk and Duncan 2001, Murphy et al. 2004). Conservation agencies that promote particular grazing systems without consideration of recommended stocking rates, season of use, and duration and frequency of grazing will likely fall short of achieving their objectives. For example, Driscoll (2004) found no difference in abundance or nest survival of Savannah sparrows in rotational and season-long grazed pastures in Minnesota, but found nest survival to be inversely correlated with stocking rates.

Our results also demonstrate that intensive and rapid assessments of rangeland vegetation commonly used by professional range managers and ranchers may be useful indicators of abundance for horned lark, Sprague's pipit, Baird's sparrow, and chestnut-collared longspur. Although plant vigor was the best predictor of the range assessment variables we measured for clay-colored sparrow, the model was only slightly better than the null model suggesting their abundance was influenced mostly by distance to shrubs. Shrubs are an important component of clay-colored sparrow habitat as they provide sites for song perches and nesting (Knapton 1994). Baird's sparrow abundance was highest in sites with greater coverage of residual vegetation. Residual cover has not only been found to influence their abundance (Green et al. 2002), but also nest-site selection (Davis 2005) and nest success (Jones and Dieni 2007). Interestingly, our rapid assessment of residual cover was a better predictor of Baird's sparrow abundance than our quantitative assessment using the Wiens pole. The reasons for this are unknown but may be a function of the observer assessing residual cover over a larger area versus the Weins pole sampling a relatively small number of sites not much bigger than the pole itself. As a result, the visual assessment may have better characterized vegetation conditions within the point count circle that are important habitat selection cues for Baird's sparrow. Our rapid assessment of plant vigor was correlated with abundance of Chestnut-collared longspur and horned lark; their abundance was highest at sites characterized by poor and medium vigor. These sites were characterized by a lower frequency of standing dead vegetation, reduced litter layer, and short, sparse vegetation; structural features commonly associated with these species (Beason 1995, Hill and Gould 1997, Fritcher et al. 2004).

Range condition has been found to influence the abundance of shrubland (Vander Haegen et al. 2000, Joseph et al. 2004) and grassland birds (George et al. 1992, Fritcher et al. 2004). Abundance of Sprague's pipit, and to a lesser extent, chestnut-collared longspur increased with improved range condition at the point count level. Furthermore, range condition strongly influenced the abundance of Sprague's pipit and Baird's sparrow at the pasture level and suggests that these species may reach their highest abundance in pastures categorized as high-good to low-excellent range condition (range conditions scores = 75–80).

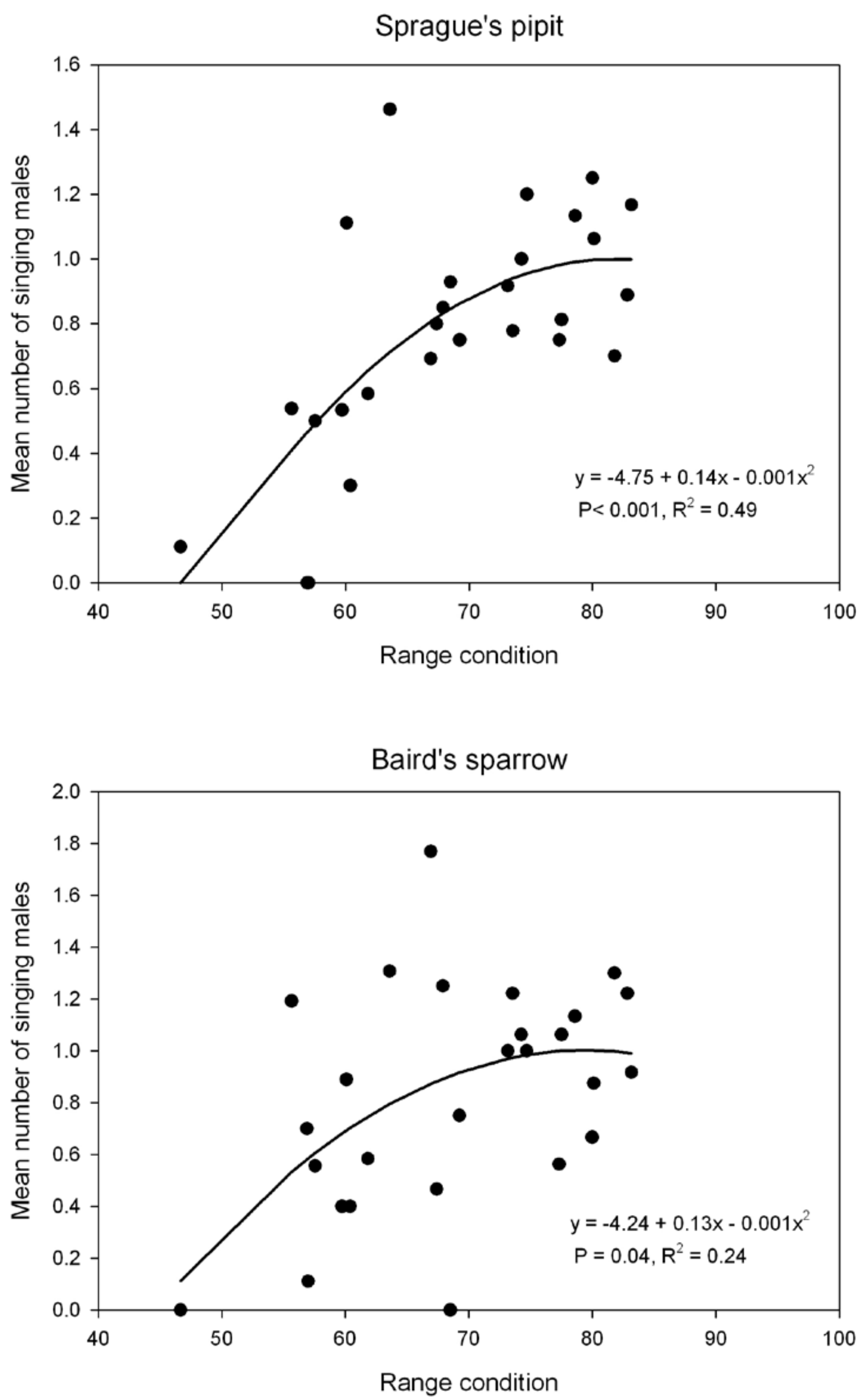

Figure 2. Relationship between Sprague's pipit and Baird's sparrow abundance and range condition at the pasture level (defined as percent dry weight of biomass comprised of decreaser species and an allowable consideration of increaser species; Abouguendia 1990) in southern Saskatchewan, Canada, 1994–1995.

MANAGEMENT IMPLICATIONS

We suggest that wildlife conservation organizations focus more attention on the factors that directly influence native rangeland vegetation (e.g., cattle distribution and densities, timing, season of use and frequency of grazing) than the type of grazing system when working with producers to restore, maintain or improve habitat for grassland birds. The greatest conservation benefit for Baird's sparrow and Sprague's pipit may be in improving range condition in pastures classified as fair and low-good range condition while ensuring that pastures with better range condition are maintained. Although the range condition concept is being used less often by range specialists, it is still one that is better understood by range managers and private producers than vegetation metrics used by ornithologists. Furthermore, because improved range condition is known to yield increased forage production, efforts to improve pastures in poor or fair range condition would be a shared goal for the agricultural and conservation communities.

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Appendix 1. Definitions and criteria used to categorize carry-over, plant vigor and grazing use on native mixed-grass prairie pastures in southern Saskatchewan.

Variable	Category	Criteria
Residual cover		
	Good	Litter amounts are uniform across the area and include standing dead plant material, fallen dead plant material and decomposed plant material on the soil surface. Amounts represent 65–100% of annual production.
	Moderate	Litter amounts appear slightly to moderately reduced and patchy across the area. Standing dead plant material is less frequent. Fallen dead plant material and decomposed plant material still exists on the soil surface. Amounts represent 35–65% of annual production.
	Poor	Litter amounts are greatly reduced or absent. Standing and fallen dead plant material is almost non-existent. Decomposed plant material may exist on the soil surface. Amounts represent <35% of annual production.
Plant vigor		
	Good	Structure and appearance of the individual plants reflect the potential[a] for the given range site. All life forms exist for the given range site.
	Moderate	Structure and appearance of the individual plants are reduced and more basal in nature. Size and appearance of the plant community is 50% of the potentiala for the given range site. Not all life forms exist for the given range site.
	Poor	Structure and appearance of the individual plants are severely reduced and almost always basal in nature. Size and appearance of the plant community is <25% of the potentiala for the given range site. Only 1 or 2 life forms exist for the given range site.
Grazing use		
	Light	Almost all potentiala biomass present. Presence of bare ground due to environmental conditions limiting growth and not a function of grazing.
	Moderate	Close to 50% of the potential[a] biomass present.
	Heavy	Short stubble remaining and almost all potentiala biomass utilized.

[a] Potential is based on ungrazed reference areas approximating a late seral or climax community within the same ecosite and reflect the current year's potential in terms of plant height, robustness and biomass for that particular site.