AN ABSTRACT OF THE THESIS OF

Benjamin Stewart Wilson for the Master of Science Degree in

Biology presented on November 8th 2019

Title: Effects of cattle grazing on bird abundance and diversity in Conservation Reserve Program grasslands

Thesis Chair: Dr. William Jensen

Abstract approved: ______________________________

(Thesis Advisor Signature)

Grassland bird populations have declined across North America, likely due to conversion of contiguous grassland to cropland. The Conservation Reserve Program (CRP) has restored grassland habitat and benefits grassland bird populations. However, cattle grazing as a mid-contract management practice in CRP is currently restricted, despite the important role that large herbivores historically played in grassland ecosystems. Conservative grazing may increase spatial heterogeneity and plant diversity, which might support higher densities of some grassland bird species. My objective was to determine how experimental cattle grazing affected species-specific abundance (density and occupancy), species diversity, and community similarity of grassland birds on CRP grasslands across the longitudinal extent of Kansas during the 2017-2019 avian breeding seasons. Half of the 108 fields were grazed by cattle during the growing seasons of 2017 and 2018 and were rested from grazing in 2019. For all analyses, I ran separate model sets for mesic eastern and arid western Kansas. Using distance sampling methods along line transects, I modeled densities of four songbird species and relative abundance of brown-headed cowbirds (*Molothrus ater*), due to its violation of distance sampling assumptions. Although densities varied for some species between CRP plantings (CP2 versus CP25), grazing had no substantial effects on densities of songbird species analyzed. I modeled multi-season occupancy of three gamebird species and Henslow's sparrow (*Centronyx henslowii*), but grazing did not affect occupancy of any species. Species diversity in eastern Kansas was higher in grazed fields and lower in spring-burned fields. Otherwise, non-metric multidimensional scaling revealed no patterns of community dissimilarity between grazed and ungrazed fields. Conservative stocking of cattle during the nesting season might not detrimentally affect bird abundances in CRP grasslands and might temporarily increase bird species diversity, though these responses would likely vary regionally and across species.

KEYWORDS *Conservation Reserve Program, distance sampling, grassland birds, mid-contract management, multi-season occupancy*

EFFECTS OF CATTLE GRAZING ON BIRD ABUNDANCE AND DIVERSITY IN CONSERVATION RESERVE PROGRAM GRASSLANDS

A Thesis

Presented to

The Department of Biological Sciences

EMPORIA STATE UNIVERSITY

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Benjamin Stewart Wilson

December 2019

Approved by Major Advisor
Dr. William Jensen

Approved by Committee Member
Dr. Alexis Powell

Approved by Committee Member
Kent Fricke

Approved by Department Chair
Dr. Tim Burnett

Approved by the Dean of the Graduate
School and Distance Education
Dr. Jerald Spotswood

ACKNOWLEDGEMENTS

Thank you to the US Fish and Wildlife Service and Kansas Department of Wildlife, Parks and Tourism for funding provided through Wildlife & Sport Fish Restoration funds (W-92-R1 and F16AF00876). These were federal funds from the Fish and Wildlife Service, within the United States Department of Interior, and administered by the Kansas Department of Wildlife, Parks and Tourism. The contents and opinions, however, do not necessarily reflect the views or policies of the United States Department of Interior or the Kansas Department of Wildlife, Parks and Tourism. Thank you to the landowners who gave me access to their property. Thank you to the US Department of Agriculture's Natural Resources Conservation Service and Farm Service Agency for providing landowner information (via cooperative agreement), developing grazing plans for landowners, and writing the grazing plans for each landowner. Thanks to my thesis chair, Dr. William Jensen, for bringing me on this project and securing funding. Thank you to Dr. Jensen and my graduate committee members, Dr. Alexis Powell and Kent Fricke, for their advice and reviews of my proposal and thesis. I thank Dr. Mary-Liz Jameson and Dr. Gregory Houseman for also securing funding and setting up the project and providing support and assistance whenever needed. I thank Molly Reichenborn for being the project manager for all three years. Thank you Bram Verheijen for assistance with analysis. Thanks to the ESU Biology Office Manager, April Dickason, for all her assistance. Thanks to my survey technicians Matthew Mogle, Darien Lozon, Austin Young, Jonathan Eckerson, Brad Langford, and Jenna Atma. Thank you Jackie Baum and Amy Zavala-Garnsey for their assistance contacting landowners throughout the project. Thank you to my wife, Christa, for supporting me throughout graduate school.

PREFACE

My thesis contains one chapter which is formatted for submission to *The Journal of Wildlife Management* for possible publication.

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CHAPTER 1

INTRODUCTION

Grasslands have been in global decline due to agricultural conversion and woody encroachment (White et al. 2000, Briggs et al. 2005, Hoekstra et al. 2005). In North America, grassland habitat has declined 79% since 1830 (Samson et al. 1998) and has been associated with widespread declines of grassland bird populations (Peterjohn and Sauer 1999, Brennan and Kuvlesky 2005, Rosenberg et al. 2019). Habitat restoration programs have been shown to positively affect grassland bird populations in the United States (Herkert 2009). Chief among these has been the Conservation Reserve Program (CRP), administered by the U.S. Department of Agriculture (USDA). Since its creation in the 1985 Farm Bill (Food Security Act of 1985), the CRP has become the leading private-lands conservation program in the United States for restoring grassland habitat (USDA 2016a). In February 2019, 9 million hectares were enrolled in the CRP nationwide (USDA 2019). Many grassland bird species are more abundant on CRP grassland than in cropland throughout the United States (Johnson and Schwartz 1993, Best et al. 1997, Ryan et al. 1998). Consequently, the large scale of grassland restoration through the CRP has played a role in reducing rates of grassland bird population declines (Herkert 1997, 1998, 2007, 2009).

While CRP grasslands provide more perennial vegetative cover than cropland, plant communities in these restored grasslands have lower plant species diversity (Jog et al. 2006) and are fairly uniform in physical structure compared to native, grazed prairies, having tall grasses commonly interspersed with much bare ground (Klute et al. 1997). The simplistic plant communities in CRP could be attributed to lower abundances of forbs and higher cover of dominant grass species, such as big bluestem (*Andropogon gerardii*), yellow indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) in seeding mixtures (Dickason and Busby 2009; but see Rahmig et al. 2009),. High densities of dominant grass species have been found to impede forb establishment (Kindscher and Fraser 2000). The uniformity of habitat structure in CRP might, in turn, limit the abundance and diversity of some grassland birds that might otherwise inhabit these restored grasslands (Millenbah et al. 1996, McCoy et al. 2001a, Rahmig et al. 2009), as grassland bird species vary in their preferences for physical stature of vegetation along structural gradients of available habitat (Knopf 1996, Fuhlendorf et al. 2009, Jacobs et al. 2012). For example, in the Midwestern United States dickcissel (*Spiza americana*) and Henslow's sparrow (*Centronyx henslowii*) abundances respond positively to taller and thicker vegetation, while grasshopper sparrow (*Ammodramus savannarum*) abundances are higher in shorter and sparser vegetation (Jacobs et al. 2012).

A possible solution for improving vegetative diversity (i.e., species and structural) in CRP would be the more liberal application of large grazers, such as domestic cattle (*Bos taurus*), as a management option. Historically, grazing by large herbivores, such as bison (*Bison bison*), was an integral disturbance that maintained the structural diversity of grasslands (Knapp et al. 1999). Grazing creates spatial heterogeneity in grassland habitat structure that subsequently affects faunal diversity (Adler et al. 2001). As domestic cattle have largely replaced bison as the dominant large herbivores in grassland landscapes in the United States, using cattle as a management tool in CRP grasslands might improve habitat heterogeneity of CRP grasslands (Fuhlendorf et al. 2006, Dickson and Busby 2009). Pastures that have been grazed by cattle, as well as native prairie hayfields, have been found to have greater diversity and abundances of grassland birds than CRP grasslands (Rahmig et al. 2009). The structural simplicity of ungrazed CRP grasslands compared to native prairie pastures might explain the relatively low diversity of avian communities of the former. However, some levels of grazing intensity can negatively affect abundances of some grassland bird species (Temple et al. 1999, Dechant et al. 2002a, Powell 2006). Thus, an examination of grazing effects on birds in CRP grasslands would be informative.

The objectives of my research were to compare species-specific abundance (density and occupancy), species diversity, and community similarity of breeding birds between experimentally cattle-grazed and ungrazed CRP grasslands enrolled under the CP2 (Native Grass Planting, consisting of lower plant diversity) and CP25 (Rare and Declining Habitat, higher plant diversity) conservation practices (CP) in Kansas. The CP2 and CP25 options are common in the Midwest with over 550,000 hectares enrolled as CP2 and 410,000 hectares enrolled as CP25 as of February 2019 (USDA 2019). Currently, the mid-contract management options for CRP designated as CP2 and CP25 consist of interseeding, light disking, herbicide spraying, and prescribed burning (USDA 2010a, USDA 2010b, USDA 2017). Grazing and haying are allowed in CP2 but only outside of designated nesting seasons (mid-April to mid-July in Kansas; USDA 2011) and accompanied by a 25% decrease in payment from the USDA (USDA 2018). Grazing is otherwise prohibited in CP25, except in cases of extreme drought (USDA 2010a). Additionally, CP2 fields are commonly older plantings, having first been an option for implementation within the 1985 Farm Bill, versus the introduction of CP25 in the 1996 Farm Bill. Although differences in plant diversity and field age between CP2 and CP25 plantings might be expected to affect density and diversity of consumers (Scherber et al. 2010), such as birds, habitat structure might be a more important driver to grassland bird communities than plant species composition (McCoy et al. 2001b, Fisher and Davis 2010, Jacobs et al. 2012). I therefore expected experimental grazing to have greater impacts on grassland bird communities than CRP conservation practice. The distribution of our study sites across Kansas spanned the longitudinal gradient in 30-year (1981-2010) average annual precipitation, with a 76-cm difference from more arid western Kansas to more mesic eastern Kansas (EPA 2015). Thus, I was able to incorporate the context of regional, long-term climate variability in testing the effects of experimental grazing and CRP conservation practice on bird populations and communities.

STUDY AREA

All study sites were selected from geographic zones surrounding field bases in eastern, central, and western Kansas that were 161 km (longitudinal extent) by 80.5 km (latitudinal extent) (Figure 1). These zones were expanded westward and eastward in order to obtain access to study sites. (Figure 1). These zones were chosen to represent the steepest gradients in average annual precipitation (1981-2010) across Kansas: 41 cm in western Kansas to 117 cm in eastern Kansas (Figure 1; EPA 2015). Fields were selected at random within longitudinal thirds of each study zone (based on precipitation isoclines spanned) from a list of CRP landowners that was provided by the U.S. Department of Agriculture. Access to each site was not random as it depended upon landowner cooperation. I selected sites until attaining balanced replication of grazing (grazed, ungrazed) and conservation practices (CP2, CP25) per each study zone. Field sizes were ≥14.1 ha based upon the minimum area requirements for several grassland bird species (e.g. grasshopper sparrows and eastern meadowlarks [*Sturnella magna*]) (Johnson and Igl 2001, Winter and Faaborg 1999). Fields had been established for least five growing seasons and had contracts that remained active through at least 2019. CP2 seed mixtures contained at least two native grasses and one forb or legume; big bluestem, little bluestem (*Schizachyrium scoparium*), and switchgrass as well as other native grass species were included in the mixture (USDA 2017). CP25 seed mixtures required at least five native warm-season grass species and a mix of 10 native forbs or legumes (USDA 2012). In general, CP2 fields were established earlier (25.26 ± 0.90 years) than CP25 plantings (13.85 ± 0.92 years).

Grazed fields were continuously grazed by domestic cattle (*Bos taurus*) for 120 – 180 days between April and October in 2017 and 2018, for a total of 53 grazed and 55 ungrazed field sites (one landowner failed to release cattle to a field). Landowners that grazed their CRP during the study received experimental grazing allowance from the USDA for the 2017 and 2018 growing seasons. Grazing was implemented for two years versus a single year due to less-than-expected biomass removal on grazed versus ungrazed fields in 2017 (Table 1). All sites, except for one, were not grazed in 2019 to examine latent effects of grazing. Stocking rates were prescribed by the Natural Resources Conservation Services (NRCS), but generally the removal of approximately 50 percent of the above-ground annual net primary production was the goal. Grazing landowners determined the type of cattle (stocker, cow-calf, etc.) that was stocked on their field. Any combination of cattle type was allowed if it abided by the NRCS's prescribed stocking rate. Generally, grazed CRP had shorter-statured vegetation, less vegetative cover, and less aboveground biomass than ungrazed fields (F. Watson, unpubl.

data, Wichita State University; Table 1) (I did not perform hypothesis tests of these data among the habitat treatments but merely show vegetative patterns [Johnson 1999]). Prescribed burning of sites by landowners was unpredictable and uneven between the west-east study regions demarcated in analyses (Table 1); therefore, burning was not purposefully incorporated into the experimental design but rather treated as a covariate in analyses for birds in eastern Kansas (where burning was more common; Table 1). Survey data were categorized into western and eastern regions for analyses (54 sites per region) to capture the longitudinal gradient in the state's precipitation, landscape characteristics, avifauna, and frequency of prescribed burning (Table 1). Generally, there is more forest in eastern versus western Kansas (Table 1), the eastern and western halves of the state roughly represent longitudinal patterns in regional avifauna (e.g., western meadowlark and eastern meadowlark do not regularly occur in eastern vs. western Kansas, respectively; Thompson et al. 2011), and burning occurs more regularly in eastern vs. western Kansas (Table 1). The 36 sites in the zone proximate to our field base in central Kansas were equally divided longitudinally between western and eastern regions and had as equal of representation of the treatments between the two regions as possible.

METHODS

Bird Surveys

Each year (2017-2019) two other observers and I surveyed birds on 108 CRP fields across Kansas (Figure 1). I established 300-m transects within the largest interior block of each CRP field and oriented parallel to the longest axis of the site, if such an axis was apparent from aerial photos (Figure 2). Observers surveyed adult birds using distance sampling where radial distances and bearings were recorded to all birds using habitat within the field (alighted upon vegetation or the ground; i.e., flyovers excluded). These data were used to estimate perpendicular distances of birds to the transect lines. Only birds within 125-m radii were used for analyses. The 125-m cutoff was determined from looking at detection curves. One observer was assigned per study zone (western, central, eastern Kansas) and surveyed three to four sites daily, between 0600 and 1000, six days per week, unless long-duration rainstorms prevented surveying. Different observers, except for myself, participated each year, which homogenized observer bias across the three study zones. Each field was surveyed on three separate dates per year (May 26 – July 11) and order of site visitation was rotated among visits per year. Populations were assumed to be closed during each yearly survey period. Observers recorded wind speed (km/hr) and temperature (°C) before beginning each survey. In addition to distance and bearing data, observers documented the species and sex of each bird seen and heard. Bird abundance was modeled as density and occupancy for abundant and rarer species, respectively.

Density modeling

Densities of the most abundant species (dickcissel, grasshopper sparrow, eastern meadowlark, and western meadowlark [*Sturnella neglecta*]) were modeled from distance sampling data using the Unmarked software package and gdistsamp function (Fiske and Chandler 2011) in R (R Core Team 2019). Species with ≥ 60 detections per region, across years, were included in density models. Eastern meadowlark met the criteria for both regions; however, due to model convergence issues, analysis was only done for the eastern region. As a preparatory step to density modeling, distances were binned to 10-m intervals up to a maximum of 125 m and shape functions of detections per distance were modeled per species using half-normal, hazard rate, exponential, and uniform distributions. The most supported function (lowest AIC_c) per species was tested for goodness of fit using χ^2 and used in subsequent modeling. Detection probability per species was then modeled as a function of wind speed, cloud cover (Sky), temperature, Julian date, observer, and the habitat treatments of grazing, CP, and burning (burning only in the eastern region). Continuous variables were standardized to a mean of 0 and SD of 1. Correlation between continuous predictor variables was tested using Pearson correlation and between categorical burning, grazing, and CP in eastern Kansas using χ^2 tests of association. Predictors that were associated ($r > 0.5$ for continuous or $P < 0.10$ for categorical variables) were not included in the same models to prevent multicolinearity. I used an information theoretic model selection procedure (Burnham and Anderson 2002) to determine the most informative set of treatment factors and covariates and ranked models using AIC_c values. Models were deemed competitive if their ΔAIC_c was ≤ 4. Models within the competitive model set that contained one to two additional predictors beyond the predictor(s) in the best model were deemed uninformative (Arnold 2010). Detection models that were informative were then used as my base models for subsequent density modeling, where each competitive detection model was used in modeling all combinations of density covariates (this accounted for uncertainty of detection predictors, rather than simply using the detection model with the lowest AIC_c value). I modeled density against predictors of grazing, CP, a grazing*CP interaction, burning, a burning*grazing interaction, (burning only in the eastern region), year, and the interaction between grazing and year to test for lag effects of grazing on habitat use. Year was treated as a categorical variable and included in all models to account for variable densities between years (Reiley et al. 2019). To account for uncertainty among multiple competitive detection models, each density model was run in tandem with each competitive detection model's covariates. I accounted for model uncertainty among competitive models ($\Delta\text{AIC}_c \leq 4$) by using model averaging of predictors among models in which the predictors appeared (Burnham and Anderson 2002, Mazerolle 2006), which also prevented correlated predictors from being included in model-averaged sets (Cade 2015). The strength of predictor effects (β) within competitive models was determined using 85% confidence intervals with respect to 0.

Group size was not accountable in Unmarked, thus each detection was assumed to be independent (an assumption of distance sampling for density estimation). While this is acceptable for most birds that are recorded as solitary individuals (e.g., for the most part males singing on breeding territories), brown-headed cowbirds (*Molothrus ater*) are often gregarious on breeding territories when at high densities in Kansas (Elliott 1980). Therefore, relative abundance (mean detections per year, per ha) of brown-headed cowbirds was modeled in relation to the covariates used in density models using generalized linear mixed models (GLMMs) from the package *lme4* in R (Douglas et al. 2015). Here individual fields were treated as random effects. I then ranked the models using their AIC_c scores as in the density analyses.

Vegetation structural variables at the field level were not included as covariates as preliminary analyses indicated correlation with categorical grazing treatment to be common (Table 1). Landscape composition covariates (e.g., % woodland in a defined buffer) were also not included as there were longitudinal landscape patterns (more woodland and fragmentation in the eastern portions of each study region) that might have been correlated with longitudinal patterns in bird distribution.

Occupancy Modeling

For less numerous species that were mostly detected as being present or absent from fields (little variation in counts beyond a single individual), I used multi-season occupancy modeling in program R (Fiske and Chandler 2011, R Core Team 2019), using the function colext in the package Unmarked. This included the ring-necked pheasant (*Phasianus colcicus*), where only single individuals were detected in 59.6 percent of surveys (maximum of 2 individuals), northern bobwhite (*Colinus virginianus*), where only single individuals were detected in 59.3 percent of surveys (maximum of 7 individuals), mourning dove (*Zenaida macroura*), where only single individuals were detected in 47.8 percent of surveys (maximum of 4 individuals), and Henslow's sparrow, where only single individuals were detected in 31.3 percent of surveys (maximum of 2 individuals). These species met my criterion of at least two fields with detections on each grazing*CP treatment across the three years. Ring-necked pheasants were not detected in the eastern study zone (Figure 3); for this reason, I combined the western and central study zones for the occupancy analysis of ring-necked pheasants. For simplicity and consistency, the region of ring-necked pheasant occupancy analysis will be noted as "west." For Henslow's sparrow occupancy, the eastern third of my study sites were used due to the species' breeding distribution being mostly restricted to this region (Thompson et al. 2011). Here, re-sighting histories per species among the three visits per site allowed modeling of detection (p), occupancy (Ψ), colonization (γ), and local extinction (ε) probabilities. In Unmarked, I used the function *colext* in order to model covariates that changed by year for detection colonization, extinction, and occupancy probabilities. The detection parameters were the same as with the parameters used for detection in the density analysis. I used the same criteria as in the density analysis for determining informative detection models. I then used all informative detection models when modeling for Ψ, γ, and ε. For Ψ, γ, and ε, I modeled all possible additive combinations of the covariates grazing, CP, burning (only in the east), and a grazing CP interaction. I ranked the models using the same AIC_c criteria and methods used in the density analyses.

Community Analyses

Species diversity and community similarity were compared between the grazing and CP treatments. Species diversity of adults per field was estimated using the Shannon-Weiner diversity index (*H*') and adjusted to the effective species number ($e^{H'}$; Jost 2006) (i.e., the estimated number of species assuming equal relative abundance). The effective species number presents a more linear representation of species diversity than commonly used metrics, such as *H*' (Jost 2006); although in preliminary analyses I found similar model rankings between *H*' and effective species number. I only included species that utilized grassland habitat (Appendix A). Meadowlarks (*Sturnella* spp.) that were unable to be identified as eastern or western (*S. neglecta*) meadowlark were omitted if they were detected on the same field and survey visit with birds identified eastern or western meadowlarks. The maximum number of individuals detected on a field per species, per year, was used for relative abundance in calculating *H*'. I used GLMs from the package *stats* in R to compare species diversity to the same set of candidate variables used in density analyses using the same information theoretic approach, but I also included an intercept-only model. Seven candidate models resulted for western Kansas and 11 for eastern Kansas (numbers of candidate models for density and occupancy analyses are provided in their respective table captions).

I used non-metric multidimensional scaling (NMDS) and permutational multivariate analysis of variance (PERMANOVA) to compare the similarity in rank-order abundances of particular bird species between the bird communities on fields under the different habitat treatments (grazed and CP). For the grazing treatment abundance matrices, I included the maximum number of individual birds detected per species between the three survey rounds in 2018 only, which was the second year of grazing where effects of this disturbance were predicted to be most noticeable. For the CP treatment abundance matrices, I included the maximum number of individual birds detected per species across all survey rounds and years per field. For both grazing and CP treatments I performed NMDS analysis separately by region. I used NMDS to graphically depict the difference of the bird communities between the treatments and used the Bray-Curtis dissimilarity matrix (Bray and Curtis 1957). I ran NMDS and PERMANOVA analyses in the program R, package *vegan* (Oksanen et al. 2019), using the functions metaMDS and adonis2, respectively. I used up to 500 permutations for NMDS and 999 for PERMANOVA. PERMANOVA included the predictors grazing (yes/no, 2018) and CP (2/25, 2017-2019) to determine if patterns of community dissimilarity between these treatments were statistically significant ($\alpha = 0.1$).

RESULTS

After three years (2017-2019) of line-transect surveys, I recorded 9,965 bird detections, excluding flyover detections, including 50 species, of which 24 utilize grassland habitat for nesting (Appendix A). Burning was not associated with grazing in eastern Kansas across years, but burning was more common in CP25 than CP2 ($P = 0.03$; Table 1);

therefore, burning and CP were not included together in any model for species density, relative abundance, occupancy, or species diversity in eastern Kansas.

Density

Distance models utilized halfnormal and hazard functions and were well fit (χ^2 *P*: 0.35 to 0.99). Generally, observer, grazing, CP, and wind speed were informative detection predictors; however, combinations of informative predictors varied by species between the two geographic regions (Tables 2 through 5). Densities of the majority of species analyzed were not affected by grazing, CP, or burning (latter in eastern Kansas).

The top (lowest AIC_c) four density models for dickcissels (combined AIC_c w_i = 0.401) in western Kansas contained only year as the top density predictor, varying only in detection predictors, though several density models contained competitive ($\Delta\mathrm{AIC}_c \leq 4$) habitat treatment predictors (Table 2). The 85% CI of β for the grazing*year interaction for 2017 versus 2019 did not overlap zero (Table 6) and indicated that dickcissels had higher densities in ungrazed versus grazed fields in 2017 but higher densities in grazed fields in 2019 (Figure 4). In general, dickcissel densities declined from 2017 to 2019 in western Kansas (Table 6, Figure 4) (I will not make inferences below on long-term population trends from these three years of data for any species). The top model for Dickcissel density in eastern Kansas included additive year and CP predictors, having over twice the support (w_i) of the next competing model (Table 2). Dickcissel density was higher in CP2 compared to CP25 fields (Table 6). No other habitat treatments had significant effects on dickcissel density across Kansas (85% CIs overlapped 0; Table 6).

For grasshopper sparrows in western Kansas, the top density model included the year predictor only, though several competitive models contained habitat treatment predictors (Table 3). However, there were no significant effects of any habitat treatment on grasshopper sparrow density in western Kansas (85% CIs overlapped 0; Table 6). Grasshopper sparrows in eastern Kansas also had a top model only containing the year predictor, having twice the model support of the next competing model (Table 3). No habitat treatment predictors had significant effects on grasshopper sparrow density in eastern Kansas (85% Cis overlapped 0; Table 6). Grasshopper sparrow densities generally increased over the study years in western Kansas and declined in eastern Kansas (Table 6).

The top two models for eastern meadowlark density in eastern Kansas consisted of the year-only predictor, though several competitive density models contained habitat treatment predictors (Table 4). The 85% CI for a grazing*CP and grazing*year interactions for 2017 versus 2019 did not overlap zero (Table 6). The grazing*CP interaction models showed that eastern meadowlarks had highest densities in grazed CP2 fields (Figure 5). The grazing*year interaction models depicted that density of eastern meadowlarks in 2017 was higher in grazed versus ungrazed fields, but in 2019, density was higher in ungrazed versus grazed fields (Figure 6). In general, eastern meadowlark densities declined from 2017 to 2019 (Figure 6; Table 6).

The top model for western meadowlark density in the west was a year-only model, though several competitive models contained habitat treatment predictors (Table 5). However, no habitat treatment predictors of western meadowlark density in western Kansas had significant effects (85% CIs overlapped 0; Table 6).

Relative Abundance of Cowbirds

Analysis of brown-headed cowbird relative abundance showed that for both western and eastern Kansas, top models contained only the year predictor (Table 7), having approximately twice the model support as competing models including habitat treatments. However, in western Kansas, the 85% CI for the grazing*year interaction for 2017 versus 2019 did not overlap zero (Table 8) and indicated that cowbird abundance was higher in ungrazed compared to grazed fields in 2017 and higher in grazed compared to ungrazed fields in 2019 (Figure 7). In eastern Kansas, the 85% CI for a grazing*CP interaction did not overlap zero (Table 8) and indicated that brown-headed cowbird abundance was highest in ungrazed CP2 fields (Figure 8); however, this model was ranked low in the competitive model set, having nearly 5 times less support than the year-only-model (Table 7).

Occupancy

Generally, intercept only, Julian date, and CP were informative detection (*p*) predictors among the species modeled for occupancy, but other predictors were also informative (specifically for mourning dove) (Tables 9 through 12). Results from multi-season occupancy modeling varied across species and region, with neither grazing, CP, nor burning (burning only in eastern Kansas) having strong or consistent effects on occupancy (Ψ), colonization (γ), or local extinction (ε) probabilities.

For ring-necked pheasants in western and central ("west") Kansas, the intercept-only model ranked as best for Ψ, γ, and ε (Table 9). All model w_i were low (< 0.04; cumulative $w_i = 0.558$ among all competitive models) and no predictors had significant effects (85% CIs overlapped 0) on these parameters (Table 10).

Northern bobwhites in western Kansas had a top model containing CP as the γ predictor and the intercept only predictor for Ψ and ε parameters, though model w_i were low (< 0.07; Table 11). However, the effect of CP on γ was not significant (85% CI overlapped 0 and was quite wide) and no other predictors had significant effects on northern bobwhite Ψ, γ, or ε in western Kansas (Table 10). For northern bobwhites in eastern Kansas, the top model contained intercept only for Ψ, γ, and ε, and again model w_i were quite low (< 0.07; Table 11). No predictor had significant effects on northern bobwhite Ψ, γ, or ε in eastern Kansas (85% CIs overlapped 0; Table 10).

The top model for Ψ, γ, and ε of mourning doves in western Kansas included only intercepts, having twice the w_i of the next best model (Table 12), and no predictors had significant effects on these parameters (85% CIs overlapped 0; Table 10). Mourning dove occupancy in eastern Kansas had top models containing CP predictors for Ψ and γ and the grazing treatment for ε (Table 12). However, model w_i were low (< 0.07) and none of these predictors had significant effects; indeed the 85% CIs for these effects not only overlapped 0 but were quite wide, indicating low model reliability (Table 10).

For Henslow's sparrows, on the eastern third of study sites, the intercept-only model ranked best for Ψ, γ, and ε (Table 13), though model w_i were low (< 0.09). No predictor had significant effects on any of these parameters for Henslow's sparrow (85% CIs overlapped 0; Table 10).

Community Analyses

Effects of grazing and CP on effective species number varied between the regions. In western Kansas, the top model was a grazing*year interaction, having five times the model support of the next competing model (Table 14), but the effect was not significant

(85% CI overlapped 0; Table 15). In eastern Kansas, the top model included the grazing and burning treatments (Table 14) and both predictors had significant effects (85% CI for β did not overlap 0) (Table 15). Effective species number was higher on grazed (2.07 ± 0.07 SE) versus ungrazed fields (1.88 ± 0.06 SE), but it was lower on burned (1.85 ± 0.07 SE) versus unburned fields (2.09 ± 0.06 SE).

Stress values from NMDS analysis ranged from 0.14 to 0.18 when using a 3-axis approach, which was required for convergence. The ordinations explained anywhere from 73.3% to 85.4% of the variation between the treatment types (linear fit r^2). There were no visually-distinct differences between the observed bird communities between the grazed and ungrazed treatments in 2018 (Figure 9) or between the two CP treatments across all years across both regions (Figure 10). Results from the PERMANOVA analyses similarly indicated no statistically significant ($P \geq 0.1$) patterns in bird community dissimilarity between the grazing or CP treatments (Table 16).

DISCUSSION

The results from three years (2017-2019) of line transect surveys on 108 sites across Kansas showed some, but subtle and inconsistent effects of cattle grazing in CRP grasslands on bird density, occupancy, and diversity. Furthermore, what effects were apparent varied between more arid western and more mesic eastern Kansas, perhaps due to long-term effects of climate on soils and plant communities (Borchert 1950), despite the relatively short ecological time that CRP fields have been established. My results suggest that grazing at conservative stocking rates (similar to those currently prescribed by USDA) for mid-CRP-contract management might not adversely impact the grassland bird communities in the central Great Plains, and it might temporarily increase species diversity in more mesic regions where CRP fields are dominated by certain bird species (e.g., dickcissels; Rahmig et al. 2009). However, there were patterns that are noteworthy to consider as they relate to grazing management in CRP and the two CPs of focus in my study.

Of the four species that were sufficiently numerous for density modeling, grazing effects were only discernable for two—dickcissel and eastern meadowlark—and these effects varied over time (dickcissel) or were contingent upon CP (eastern meadowlark). In western Kansas, dickcissel density was higher in ungrazed fields compared to grazed fields in 2017 but higher in grazed fields in 2019. Dickcissels generally prefer tall, thick vegetation (Zimmerman 1982), which might explain higher density in ungrazed CRP in 2017, but this was not seen in 2018, when vegetation structure was similarly reduced by cattle (Table 1). Dickcissel density was higher in CP2 fields versus CP25 in eastern Kansas, but there were no significant effects of grazing in that region. This may be due to CP2 fields having been, on average, planted earlier than CP25 fields, which might have allowed longer-term establishment of local dickcissel populations. Dickcissel males exhibit inter-annual site fidelity to their breeding territories (Zimmerman and Finck 1989, Small et al. 2012) and thus the legacy of dickcissel occupancy, and perhaps conspecific attraction (Ahlering et al. 2006), might be more pronounced in CP2 fields. Patterns of eastern meadowlark density also changed from 2017 to 2019 between the grazing treatments. In contrast to dickcissels, eastern meadowlark density was highest in grazed fields in 2017, but in 2019, density was higher in ungrazed fields. Again, it is unclear how such immediate responses to the introduction and cessation of grazing from 2017-2019 might have caused eastern meadowlarks to respond in this way, but this ground-nesting species has been found at higher abundances in cattle-grazed versus ungrazed tallgrass prairie (Powell 2008) and appears somewhat resilient to increasing grazing intensity during the breeding season (Rahmig et al. 2009). The positive response of eastern meadowlarks to grazing was also evident in grazed versus ungrazed CP2 fields, this pattern not being evident in CP25 fields. Higher meadowlark densities in grazed CP2, in particular, might resemble the aforementioned scenario regarding the longer establishment of this practice and its effect on bird populations.

Grasshopper sparrow density across Kansas was not affected by grazing treatment, CP, or burning (burning only in eastern Kansas) of CRP fields. One might have expected a positive response of this species to grazing in otherwise tall, grass-dominated habitats (Powell 2008, Rahmig et al. 2009). It is noteworthy that other studies in short-grass prairie regions have found negative effects on grazing on grasshopper sparrow densities (Dechant et al. 2002a). Western meadowlark density in western Kansas was similarly not affected by grazing treatment or CP; this species has been shown elsewhere to exhibit variable responses to grazing and grazing intensity across its range (Dechant et al. 2002b).

One species that might especially be affected by introduction of cattle into CRP fields is the brown-headed cowbird. This obligate brood parasite is a well-known associate of cattle, which apparently facilitate its communal forage flocks and local brood-parasitic activity (Morris and Thompson 1998, Goguen and Mathews 1999, Chace et al. 2005). However, I found that relative abundance of this species in western Kansas was highest in ungrazed fields in 2017, but in 2019 abundance was higher in grazed fields, when cattle were removed from the CRP fields. It would appear that brown-headed cowbird abundance increased in grazed fields over time, but it is unclear why abundance was higher in ungrazed CRP fields immediately after the onset of grazing. Did nest availability of the cowbird’s most common regional hosts (those discussed above; Elliott 1978, Rivers et al. 2010) affect cowbird habitat use (Chace et al. 2005)? The dickcissel, the most preferred regional host (Rivers et al. 2010), was—as with cowbirds—more abundant in ungrazed CRP in 2017 in western Kansas and perhaps this was related to the availability of dickcissel nests. However, effects of host abundance on cowbird distribution are equivocal (Chace et al 2005). It is also unclear why the relative abundance of cowbirds was higher in ungrazed CP2 fields in eastern Kansas. CP2 fields, as stated previously, have generally been established for longer periods of time, and perhaps contributed to a legacy of cowbird settlement. On a subset of study sites I used in central Kansas, cowbird parasitism levels were highest in grazed CP2 fields (Kraus 2019), perhaps also reflecting a legacy of cowbird establishment in that planting practice; though this pattern also exhibits a more intuitive response to grazing. Thus, there is a great deal of uncertainty that short-term, moderate-intensity grazing in CRP fields would affect cowbird abundance and parasitism across broad geographic and temporal scales.

Grazing, CP, or burning (burning in eastern Kansas) did not greatly affect the occupancy of upland game bird species (ring-necked pheasant, northern bobwhite, and mourning dove) or the Henslow’s sparrow. Others have suggested negative effects of intensive grazing on the abundance of the greater prairie-chicken (*Tympanuchus cupido*) (Robbins et al. 2002), though the regional stocking rates in that particular study were generally much greater than my study and implemented across the Flint Hills tallgrass prairie over several years. Other mid-contract management practices in CRP, such as disking and inter-seeding, might benefit pheasants and northern bobwhite (Greenfield et al. 2002, Matthews et al. 2012). Models for mourning dove occupancy showed no patterns among the management treatments, despite nests of this species being twice as abundant in CP25 versus CP2 fields on a subset of my study sites in central Kansas (Kraus 2019). This discrepancy could be due to lower detectability of adult mourning doves versus their nests. Despite Henslow's sparrow's apparent aversion to burned tallgrass prairie (Zimmerman 1988, Powell 2006), this was not reflected in a significant effect of burning of CRP in my study, though this might be due to low sample sizes of detections.

Despite the lack of density and occupancy responses to grazing in eastern Kansas, there were significant responses of species diversity to grazing and burning in that region. Effective species number was greater in both grazed and unburned fields, versus ungrazed and burned fields, respectively. Maximum abundances (used in calculation of H') of eastern meadowlark and brown-headed cowbirds were slightly higher on grazed (means ± SE, respectively: 3.5 ± 0.7 and 1.7 ± 0.3) versus ungrazed fields (2.7 ± 0.5 and 0.8 ± 0.1), and the common nighthawk (*Chordeiles minor*) and horned lark (*Eremphila alpestris*) were only detected on grazed fields in that region. It has been found elsewhere that increased habitat heterogeneity due to grazing (Adler et al. 2001), especially at multi-patch landscape scales, can increase grassland breeding bird diversity (Hovick et al. 2015). However, the effect of grazing and CP treatments on community dissimilarity, in terms of ranked abundance per particular species, was not apparent from NMDS and PERMANOVA analyses, perhaps due to the lack of covariation accounted for by year and burning in the multivariate models of effective species number.

MANAGEMENT IMPLICATIONS

Species-level abundances and communities of grassland birds might not be negatively affected by grazing in CRP grasslands. Variation in abundance and diversity patterns between arid western and mesic eastern Kansas also indicate the important context of climate in determining vegetative and wildlife responses to management of CRP. Another important context to consider in assessing the impacts of grazing in CRP on grassland birds is its effects on nest concealment and activity of nest predators, perhaps both being affected by changes in vegetation structure (Fondell and Ball 2004, Rahmig et al. 2009). Some effects of grazing on nest success were observable on a subset (third) of my study sites, though they were inconsistent across species, time, and CP treatments (Kraus 2019). Taken together, I suggest that grazing at a conservative stocking rate during nesting seasons, as a possible mid-contract management option for both CP2 and CP25 conservation practices, might not be detrimental to grassland birds and might increase bird diversity at least in the short term, especially in eastern Kansas and perhaps more broadly across the Midwest. However, except in extenuating circumstances of extreme drought, gazing is currently prohibited in the CP25 practice (USDA 2010a). Grazing is allowed in CP2 plantings but it can only occur outside of designated nesting seasons (mid-April to mid-July in Kansas; USDA 2011) and is accompanied by payment reductions to landowners. Perhaps disking, burning, and inter-seeding can appreciably alter the habitat structure and floristic diversity of CRP, and thus wildlife diversity, but the effects of large herbivores constitute distinct, natural disturbances which can also contribute economically to agricultural producers. My results can help inform any future changes to CRP management policy. However, even with the large geographic scope of the current study, continued research is warranted to fully assess any latent effects grazing—and perhaps variable grazing intensity—on restored grasslands and their associated grassland bird communities, especially among CRP conservation practices that differ in seed mixes and histories of establishment.

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Table 1. Habitat characteristics (“Var” means, SE in parentheses) in and around Conservation Reserve Program (CRP) fields across 108 study sites in Kansas, 2017-2019 (Yr). Fields were either grazed by cattle or ungrazed and were established under one of two CRP conservation practices (CP2 or CP25). See footnotes for variable definitions.

		West				**East**			
		Grazed		**Ungrazed**		**Grazed**		**Ungrazed**	
Var	**Yr**	**CP2**	**CP25**	**CP2**	**CP25**	**CP2**	**CP25**	**CP2**	**CP25**
pctb[a]	17	7.7	0	0	0	81.8	60	16.7	43.8
	18	0	0	7.1	0	18.2	20	8.3	25
	19	0	0	0	0	27.3	33.3	0	68.8
pctf[b]	17	7.6 (1.7)	8.9 (1.5)	16.9 (3.8)	11.2 (2.7)	18.3 (3.7)	25.8 (5.5)	16.7 (4.4)	26.2 (5.3)
	18	7.9 (1.3)	7.4 (1.6)	12.9 (2.4)	8.7 (2.7)	29.2 (5.5)	32.7 (6.2)	20.7 (6.3)	31.5 (5.5)
	19	16.5 (3.6)	11.5 (2.6)	13 (2.1)	10.5 (2.8)	39.3 (10.8)	43.8 (7.0)	23.6 (6.2)	45.2 (8.6)
pctg[c]	17	82.8 (6.4)	79.3 (4.3)	89.9 (5.6)	93.7 (8.5)	62.7 (6.6)	69.5 (4.8)	74.7 (6.5)	63.7 (3.3)
	18	72.9 (3.3	71.1 (3.5)	74.7 (4.1)	79.0 (4.5)	88.0 (10.5)	84.8 (7.3)	101.3 (8.0)	85.9 (4.7)
	19	79.6 (3.7)	77.7 (3.6)	84.8 (5.3)	80.4 (4.8)	130.3 (20.2)	142.9 (14.1)	144.6 (22.5)	105.3 (10.9)

pcts[d]	17	0.1 (0.1)	0.1 (0.1)	0.2 (0.1)	0.0 (0.0)	0.4 (0.2)	0.1 (0.1)	1.0 (0.5)	0.1 (0.1)
	18	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.8 (0.3)	0.1 (0.1)	1.2 (0.6)	0.3 (0.3)
	19	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.8 (0.3)	0.1 (0.0)	1.6 (0.9)	0.6 (0.5)
fh[e]	17	16.3 (2.3)	22.8 (3.5)	33.5 (3.7)	19.2 (2.1)	35.5 (4.9)	37.1 (3.8)	37.2 (5.7)	41.9 (4.3)
	18	16.3 (2.6)	20.8 (3.9)	30.8 (3.4)	21.4 (2.1)	38.7 (4.8)	42.0 (4.3)	44.3 (8.2)	48.0 (4.5)
	19	28.8 (3.1)	30.5 (3.5)	34.2 (3.2)	25.1 (2.7	42.6 (7.4)	49.3 (5.4)	44.0 (5.1)	44.9 (5.4)
gh[f]	17	32.2 (1.6)	31.1 (2.1)	40.8 (2.3)	31.3 (1.8)	39.9 (2.8)	41.8 (2.6)	48.0 (2.0)	44.5 (1.5)
	18	26.8 (2.1)	24.0 (1.9)	37.7 (2.6)	29.1 (2.1)	39.0 (2.5)	39.7 (2.0)	46.7 (2.2)	48.2 (2.2)
	19	31.8 (1.8)	28.3 (2.3)	43.1 (2.8)	31.1 (2.5)	43.9 (2.3)	43.2 (1.8)	47.4 (2.0)	43.5 (1.9)
sh[g]	17	1.0 (0.7)	0.8 (0.6)	2.6 (1.7)	0.0 (0.0)	3.5 (1.3)	2.5 (1.5)	7.9 (3.6)	1.9 (1.2)
	18	0.5 (0.4)	0.1 (0.1)	0.0 (0.0)	0.0 (0.0)	4.1 (1.7)	1.1 (1.1)	7.1 (3.2)	1.5 (1.1)
	19	0.6 (0.5)	0.2 (0.2)	0.0 (0.0)	0.0 (0.0)	3.5 (1.3)	1.6 (1.3)	8.5 (3.3)	2.4 (1.6)
pv[h]	17	0.2 (0.02)	0.19 (0.02)	0.34 (0.03)	0.26 (0.02)	0.28 (0.03)	0.34 (0.03)	0.38 (0.04)	0.43 (0.03)
	18	0.17 (0.02)	0.16 (0.02)	0.31 (0.03)	0.23 (0.02)	0.30 (0.03	0.32 (0.03)	0.45 (0.04)	0.46 (0.04)
	19	0.30 (0.02)	0.21 (0.03)	0.37 (0.03)	0.27 (0.03)	0.40 (0.03)	0.39 (0.03)	0.43 (0.03)	0.41 (0.03)

cvpv[i]	17	0.44 (0.05)	0.44 (0.04)	0.38 (0.03)	0.34 (0.05)	0.45 (0.04)	0.41 (0.03)	0.27 (0.03)	0.28 (0.02)
	18	0.50 (0.05)	0.50 (0.04	0.38 (0.03)	0.35 (0.04	0.42 (0.05)	0.48 (0.04)	0.23 (0.03)	0.27 (0.03)
	19	0.44 (0.04)	0.43 (0.06)	0.33 (0.03)	0.38 (0.02)	0.36 (0.04)	0.36 (0.04)	0.26 (0.03)	0.31 (0.04)
bgc[j]	17	2.6 (1.3)	5.1 (1.5)	0.9 (0.4)	1.9 (0.7)	4.0 (1.0)	2.3 (0.5)	0.5 (0.2)	1.5 (0.5)
	18	3.5 (0.9)	8.3 (2.2)	3.0 (1.3)	2.1 (0.8)	4.4 (1.9)	3.9 (1.3)	0.6 (0.4)	3.7 (1.6)
	19	6.8 (1.5)	12.9 (3.7)	2.1 (0.6)	3.5 (1.6)	15.0 (5.5)	16.7 (5.0)	0.5 (0.2)	24.3 (5.3)
ld[k]	17	2.7 (0.4)	2.8 (0.3)	3.8 (0.3)	2.9 (0.3)	0.8 (0.3)	1.6 (0.7)	4.2 (0.6)	2.6 (0.6)
	18	2.9 (0.4)	2.6 (0.4)	4.1 (0.5)	3.4 (0.4)	2.4 (0.4)	2.1 (0.3)	5.5 (0.8)	3.8 (0.7)
	19	2.5 (0.4)	2.4 (0.5)	4.5 (0.6)	2.8 (0.3)	1.8 (0.6)	1.6 (0.4)	4.1 (0.7)	2.2 (1.0)
bm[l]	17	117.2 (25.4)	150.6 (29.1)	184.6 (20.2)	153.9 (25.3)	175.5 (28.5)	163.1 (22.5)	179.8 (23.3)	215.1 (20.4)
	18	130.6 (32.0)	126.9 (27.9)	157.1 (24.8)	138.7 (26.8)	134.0 (31.6)	149.3 (22.9)	186.3 (28.0)	190.6 (23.2)
	19	130.4 (21.0)	133.5 (30.1)	243.7 (15.2)	171.8 (21.8)	146.4 (23.8)	135.9 (24.9)	172.7 (26.2)	190.8 (23.0)
cvbm[m]	17	195.0 (30.3)	149.8 (20.3)	163.0 (25.8)	111.9 (23.0)	143.4 (29.7)	215.6 (18.6)	130.3 (29.4)	158.4 (23.5)
	18	198.2 (25.4)	194.5 (22.2)	167.9 (30.7)	168.2 (25.6)	197.8 (22.4)	215.9 (23.9)	130.8 (27.6)	133.4 (27.0)
	19	130.7 (27.3)	146.8 (26.3)	139.4 (22.9)	146.8 (26.5)	188.8 (23.3)	148.2 (22.7)	168.7 (28.9)	154.9 (20.1)

lsbm[n]	18	134.2 (13.0)	148.0 (19.6)	217.3 (25.4)	165.4 (14.6)	192.3 (16.9)	200.1 (22.2)	224.5 (19.0)	269.6 (21.5)
cvlsb[o]	18	0.46 (0.06)	0.43 (0.05)	0.34 (0.04)	0.36 (0.06)	0.33 (0.06)	0.50 (0.05)	0.28 (0.03)	0.30 (0.03)
wd[p]	-	0.4 (0.3)	0.3 (0.2)	0.4 (0.2)	0.1 (0.0)	9.5 (3.0)	4.5 (1.3)	6.0 (2.3)	7.7 (1.9)
gr[q]	-	62.4 (5.4)	59.9 (6.4)	48.5 (3.8)	52.9 (3.8)	67.6 (5.6)	73.6 (4.3)	65.7 (5.4)	62.4 (5.3)

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[a] Percent of fields burned (F. Watson, unpubl. data, Wichita State University).

[b] Mean percent cover of forbs (adjusted for observer height; 0s included) (F. Watson, unpubl. data, Wichita State University).

[c] Mean percent cover of grasses (adjusted for observer height; 0s included) (F. Watson, unpubl. data, Wichita State University).

[d] Mean percent cover of shrubs (adjusted for observer height; 0s included) (F. Watson, unpubl. data, Wichita State University).

[e] Mean estimated height (cm) of forbs (0s included; values binned to nearest 5) (F. Watson, unpubl. data, Wichita State University).

[f] Mean estimated height (cm) of grasses (0s included; values binned to nearest 5) (F. Watson, unpubl. data, Wichita State University)..

[g] Mean estimated height (cm) of shrubs (0s included; values binned to nearest 5) (F. Watson, unpubl. data, Wichita State University).

[h] Mean proportion of space occupied by vegetation in two photos of a 1x0.5m^2 backstop to create an image of the vegetation of the nine 1m^2 sampling areas per field; Meand (F. Watson, unpubl. data, Wichita State University).

[i] Mean coefficient of variation of space occupied by vegetation in two photos of a 1x0.5m^2 backstop to create an image of the vegetation of the nine 1m^2 sampling areas per field (F. Watson, unpubl. data, Wichita State University).

[j] Mean percent cover of bare ground (adjusted for observer height) (F. Watson, unpubl. data, Wichita State University).

[k] Mean depth of vegetation litter (cm) (F. Watson, unpubl. data, Wichita State University).

[l] Mean total biomass (live and dead) collected (g) from five 1×0.5m^2 quadrats in each field (F. Watson, unpubl. data, Wichita State University).

[m] Mean coefficient of variance of total biomass (live and dead) collected (g) from five 1×0.5m^2 quadrats in each field (F. Watson, unpubl. data, Wichita State University).

[n] Mean total late season (collected in August and September 2018) biomass (live and dead) collected (g) from five 1×0.5m^2 quadrats in each field (F. Watson, unpubl. data, Wichita State University).

[o] Mean coefficient of variance of total late season (collected in August and September 2018) biomass (live and dead) collected (g) from five 1×0.5m^2 quadrats in each field (F. Watson, unpubl. data, Wichita State University).

[p] Mean percent woodland within 1 km of the survey plot border. Measured from remote sensing imagery and quantified using ArcGIS 10.6 (ESRI, Redlands, CA).

[q] Mean percent grassland within 1 km of the survey plot border. Measured from remote sensing imagery and quantified using ArcGIS 10.6 (ESRI, Redlands, CA).

Table 2. Model selection results for dickcissel density (individuals / ha), among competitive models ($\Delta AIC_c \leq 4$), in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are predictors for density models (D) and detection probability (*p*), ΔAIC_c, and the model weights (w_i). Detection predictors include observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B) in eastern Kansas. Density predictors include Year (Y), Gr, CP, Gr*CP, Gr*Y interactions, and B and Gr*B in eastern Kansas only (field burning was rare in western Kansas; Table 1). In all there were 32 models in the candidate set in western Kansas and 36 in eastern Kansas.

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
D(Y) *p*(Ob+Gr+W)	0.00	0.127	D(Y+CP) *p*(Ob+Gr+CP)	0.00	0.379
D(Y) *p*(Ob+Gr+CP+W)	0.21	0.114	D(Y+Gr+CP) *p*(Ob+Gr+CP)	1.58	0.172
D(Y) *p*(Ob+W)	0.86	0.082	D(Y+Gr*CP) *p*(Ob+Gr+CP)	3.05	0.083
D(Y) *p*(Ob+CP+W)	0.98	0.078	D(Y+CP) *p*(Gr+CP)	3.18	0.077
D(Y+CP) *p*(Ob+Gr+CP+W)	1.62	0.056	D(Y+Gr*Y) *p*(Ob+Gr+CP)	3.52	0.065
D(Y+CP) *p*(Ob+Gr+W)	1.91	0.049			
D(Y+Gr) *p*(Ob+Gr+W)	1.96	0.048			

D(Y+Gr) *p*(Ob+Gr+CP+W)	2.16	0.043
D(Y+Gr) *p*(Ob+W)	2.33	0.040
D(Y+CP) *p*(Ob+CP+W)	2.35	0.039
D(Y+Gr) *p*(Ob+CP+W)	2.43	0.038
D(Y+CP) *p*(Ob+W)	2.76	0.032
D(Y+Gr*Y) *p*(Ob+Gr+W)	2.43	0.023
D(Y+Gr+CP) *p*(Ob+Gr+CP+W)	2.57	0.021
D(Y+Gr*Y) *p*(Ob+Gr+CP+W)	3.68	0.020
D(Y+Gr+CP) *p*(Ob+CP+W)	3.83	0.019
D(Y+Gr*Y) *p*(Ob+W)	3.85	0.018
D(Y+Gr+CP) *p*(Ob+Gr+W)	3.86	0.018
D(Y+Gr*Y) *p*(Ob+CP+W)	4.00	0.017

Table 3. Model selection results for grasshopper sparrow density (individuals / ha), among competitive models ($\Delta AIC_c \leq 4$), in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are predictors for density models (D) and detection (*p*), ΔAIC_c, and the model weights (w_i). Detection predictors include observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B) in eastern Kansas. Density predictors include Year (Y), Gr, CP, Gr*CP, Gr*Y interactions, and B and Gr*B in eastern Kansas only (field burning was rare in western Kansas; Table 1). In all there were 32 models in the candidate set in western Kansas and 48 in eastern Kansas.

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
D(Y) *p*(Ob)	0.00	0.235	D(Y) *p*(Gr+B)	0.00	0.174
D(Y+Gr) *p*(Ob)	0.98	0.144	D(Y+Gr) *p*(Gr+B)	1.42	0.085
D(Y+CP) *p*(Ob)	1.91	0.090	D(Y+CP) *p*(Gr+B)	1.68	0.075
D(Y+Gr+CP) *p*(Ob)	2.92	0.055	D(Y+B) *p*(Gr+B)	1.75	0.073
D(Y+Gr*Y) *p*(Ob)	3.21	0.047	D(Y) *p*(Gr)	2.29	0.055
D(Y+Gr*CP) *p*(Ob)	3.39	0.043	D(Y) *p*(B)	2.84	0.042
D(Y+Gr) *p*(T+W+Gr+Ob)	3.62	0.038	D(Y) *p*(I.O)	2.86	0.042

D(Y) *p*(T+W+Gr+Ob)	3.68	0.037	D(Y+Gr+CP) *p*(Gr+B)	3.14	0.036
			D(Y+Gr+B) *p*(Gr+B)	3.26	0.034
			D(Y+B) *p*(Gr)	3.36	0.032
			D(Y+Gr) *p*(Gr)	3.85	0.025
			D(Y+Gr*CP) *p*(Gr+B)	3.99	0.024

Table 4. Model selection results for eastern meadowlark density (individuals / ha), among competitive models ($\Delta AIC_c \leq 4$), in Conservation Reserve Program fields across eastern Kansas, 2017-2019. Shown are predictors for density models (D) and detection (*p*), ΔAIC_c, and the model weights (w_i). Detection predictors include observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B). Density predictors include Year (Y), Gr, CP, B, Gr*CP, Gr*Y, and Gr*B interactions. In all there were 96 models in the candidate set.

Predictor	**ΔAIC_c**	**w_i**
D(Y) *p*(W+S)	0.00	0.076
D(Y) *p*(S)	0.39	0.063
D(Y+B) *p*(W+S)	0.98	0.047
D(Y+Gr*Y) *p*(W+S)	1.07	0.045
D(Y+Gr) *p*(W+S)	1.20	0.042
D(Y+B) *p*(S)	1.28	0.040
D(Y+Gr*Y) *p*(S)	1.43	0.037
D(Y+Gr) *p*(S)	1.58	0.035
D(Y+Gr*B+Gr*Y) *p*(W+S)	1.70	0.033
D(Y+Gr+B) *p*(W+S)	1.75	0.032
D(Y+Gr*B+Gr*Y) *p*(S)	1.91	0.029
D(Y+CP) *p*(W+S)	2.00	0.028
D(Y+Gr+B) *p*(S)	2.02	0.028
D(Y) *p*(W)	2.19	0.025

D(Y+CP) *p*(S)	2.38	0.023
D(Y+Gr*B) *p*(W+S)	2.63	0.020
D(Y+Gr*CP+Gr*Y) *p*(W+S)	2.71	0.020
D(Y+Gr*B) *p*(S)	2.88	0.018
D(Y+Gr*CP) *p*(W+S)	2.90	0.018
D(Y+Gr*CP) *p*(S)	3.05	0.017
D(Y+Gr*Y) *p*(W+S)	3.06	0.016
D(Y+Gr+CP) *p*(W+S)	3.19	0.015
D(Y+B) *p*(W)	3.20	0.015
D(Y+Gr*CP) *p*(S)	3.26	0.015
D(Y+Gr) *p*(W)	3.34	0.014
D(Y+CP+Gr*Y) *p*(S)	3.43	0.014
D(Y+B) *p*(I.O)	3.47	0.013
D(Y+Gr*Y) *p*(W)	3.52	0.013
D(Y+Gr+CP) *p*(S)	3.58	0.013
D(Y+Gr) *p*(I.O)	3.68	0.012
D(Y+Gr*Y) *p*(I.O)	3.84	0.011
D(Y+Gr+B) *p*(W)	3.91	0.011

Table 5. Model selection results for western meadowlark density (individuals / ha), among competitive models ($\Delta AIC_c \leq 4$), in Conservation Reserve Program fields across western Kansas, 2017-2019. Shown are predictors for density models (D) and detection (*p*), ΔAIC_c, and the model weights (w_i). Detection predictors include observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), and sky (S). Density predictors include Year (Y), Gr, CP, Gr*CP, and Gr*Y interactions. In all there were 24 models in the candidate set.

Predictor	ΔAIC_c	w_i
D(Y) *p*(Jd)	0	0.268
D(Y+Gr) *p*(Jd)	0.77	0.183
D(Y+CP) *p*(Jd)	0.95	0.167
D(Y+Gr+CP) *p*(Jd)	1.79	0.110
D(Y+Gr*Y) *p*(Jd)	3.56	0.045
D(Y+Gr*CP) *p*(Jd)	3.72	0.042
D(Y) *p*(Jd+Ob)	3.94	0.038

Table 6. Density (individuals / ha) predictors in the competitive model set ($\Delta AIC_c \leq 4$) and their model-averaged parameter estimates (β), unconditional standard errors (SE), and 85% confidence intervals (85% CI) for songbird densities in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. See Table 2 for predictor codes and footnotes for reference treatments.

	West				**East**			
Species	**Predictor**	**β**	**SE**	**85% CI**	**Predictor**	**β**	**SE**	**85% CI**
Dickcissel	Gr[a]	0.05	0.11	-0.11, 0.20	Gr[a]	-0.04	0.07	-0.14, 0.05
	CP[b]	0.06	0.11	-0.10, 0.21	CP [b]	-0.19	0.07	-0.29, -0.09
	Gr*Y(2018[c])	0.13	0.24	-0.21, 0.47	Gr*CP	-0.09	0.13	-0.28, 0.09
	Gr*Y(2019[c])	0.39	0.25	0.03, 0.75	Gr*Y(2018[a])	-0.11	0.15	-0.34, 0.11
	Y(2018[c])	-0.85	0.13	-1.03, -0.67	Gr*Y(2019[a])	-0.22	0.15	-0.44, 0.00
	Y(2019[c])	-1.36	0.14	-1.56, -1.15	Y(2018[a])	0.02	0.09	-0.10, 0.14
					Y(2019[a])	0.16	0.09	0.04, 0.29
Grasshopper Sparrow	Gr[a]	-0.09	0.09	-0.22, 0.03	Gr[a]	0.21	0.29	-0.20, 0.63
	CP [b]	-0.02	0.09	-0.15, 0.10	CP[b]	-0.16	0.28	-0.56, 0.25

	Gr*CP	0.21	0.17	-0.03, 0.45	B^{d}	0.19	0.32	-0.27, 0.64
	Gr*Y(2018^{c})	-0.22	0.22	-0.53, 0.09	Gr*CP	-0.61	0.57	-1.44, 0.21
	Gr*Y(2019^{c})	0.02	0.21	-0.29, 0.33	Y(2018^{a})	-0.38	0.32	-0.84, 0.07
	Y(2018^{c})	0.72	0.12	0.55, 0.89	Y(2019^{a})	-1.88	0.38	-2.42, -1.33
	Y(2019^{c})	0.68	0.12	0.51, 0.85				
Eastern Meadowlark					Gr^{a}	0.12	0.13	-0.06, 0.31
					CP^{b}	0.00	0.13	-0.18, 0.19
					B^{d}	-0.15	0.14	-0.35, 0.05
					Gr*CP	-0.39	0.25	-0.75, -0.02
					Gr*B	0.30	0.28	-0.11, 0.70
					Gr*Y(2018^{a})	0.07	0.30	-0.36, 0.50
					Gr*Y(2019^{a})	-0.58	0.32	-1.04, -0.12
					Y(2018^{a})	-0.73	0.17	-0.97, -0.49
					Y(2019^{a})	-0.93	0.20	-1.22, -0.64

Western Meadowlark	Gr[a]	-0.10	0.09	-0.24, 0.03
	CP[b]	-0.09	0.09	-0.23, 0.04
	Gr*CP	-0.05	0.18	-0.31, 0.22
	Gr*Y(2018[a])	0.26	0.25	-0.10, 0.63
	Gr*Y(2019[c])	0.25	0.26	-0.25, 0.75
	Y(2018[c])	0.72	0.13	0.53, 0.91
	Y(2019[c])	0.67	0.13	0.48, 0.86

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[a] Reference values for β are grazed versus ungrazed fields.

[b] Reference values for β are CP25 versus CP2 fields.

[c] Versus reference year of 2017.

[d] Reference values for β are burned versus unburned fields.

Table 7. Models of brown-headed cowbird relative abundance (individuals / ha), among competitive models ($\Delta\text{AIC}_c \leq 4$), from surveys in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Model predictors, their ΔAIC_c, and model weight (w_i). Relative abundance predictors include year (Y), grazing treatment (Gr), conservation practice (CP), Gr*CP, Gr*Y interactions, and burning (B) and Gr*B interaction (in eastern Kansas) are shown. In all there were 6 models in the candidate set in western Kansas and 9 in eastern Kansas.

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
Y	0.00	0.4	Y	0	0.37
Y+Gr*Y	1.01	0.24	Y+Gr	1.73	0.16
Y+CP	1.88	0.16	Y+B	2.02	0.14
Y+Gr	2.13	0.14	Y+CP	2.12	0.13
			Y+Gr*CP	3.2	0.08
			Y+Gr+CP	3.88	0.05

Table 8. Relative abundance (individuals / ha) predictors for brown-headed cowbirds in the competitive model set ($\Delta AIC_c \leq 4$) and their model-averaged parameter estimates (β), unconditional standard errors (SE), and 85% confidence intervals (85% CI) in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019.

West				**East**			
Predictor	**β**	**SE**	**85% CI**	**Predictor**	**β**	**SE**	**85% CI**
Gr[a]	-0.02	0.4	-0.61, 0.56	Gr[a]	-0.29	0.45	-0.94, 0.37
CP[b]	0.2	0.4	-0.38, 0.78	CP[b]	-0.04	0.46	-0.7, 0.62
Gr*Y(2018[c])	0.52	0.42	-0.09, 1.13	B[d]	-0.1	0.3	-0.52, 0.33
Gr*Y(2019[c])	1.01	0.44	0.38, 1.65	Gr*CP	1.54	0.91	0.23, 2.85
Y(2018[c])	0.18	0.25	-0.19, 0.54	Y(2018[c])	0.07	0.27	-0.32,0.46
Y(2019[c])	0	0.33	-0.48, 0.48	Y(2019[c])	0.1	0.27	-0.28, 0.49

[a] Reference values for β are grazed versus ungrazed fields.

[b] Reference values for β are CP25 versus CP2 fields.

[c] Versus reference year of 2017.

[d] Reference values for β are burned versus unburned fields.

Table 9. Model selection results for multi-season occupancy, among competitive models ($\Delta AIC_c \leq 4$), for ring-necked pheasants in Conservation Reserve Program fields across western Kansas, 2017-2019. Shown are the predictors for occupancy (Ψ), colonization (γ), local extinction (ε), and detection probability (*p*) parameters that occurred in the competitive model set. Detection predictors include intercept-only (I.O), observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), and sky (S). Occupancy predictors include I.O, Gr, CP, and Gr*CP interaction. Colonization and extinction predictors include I.O, Gr, CP, and Gr*CP. In all there were 744 models in the candidate set.

Predictor	**ΔAIC**	**W_i**
Ψ(I.O) γ(I.O) ε(I.O) *p*(CP+W+Jd)	0.00	0.032
Ψ(I.O) γ(I.O) ε(I.O) *p*(CP+Jd)	0.33	0.027
Ψ(I.O) γ(I.O) ε(I.O) *p*(W+Jd)	0.52	0.025
Ψ(I.O) γ(I.O) ε(CP) *p*(W+Jd)	0.80	0.022
Ψ(CP) γ(I.O) ε(I.O) *p*(CP+W+Jd)	0.97	0.020
Ψ(I.O) γ(I.O) ε(I.O) *p*(Jd)	1.01	0.019
Ψ(I.O) γ(I.O) ε(CP) *p*(Jd)	1.17	0.018
Ψ(CP) γ(I.O) ε(I.O) *p*(CP+Jd)	1.19	0.018
Ψ(I.O) γ(I.O) ε(CP) *p*(CP+W+Jd)	1.86	0.013
Ψ(I.O) γ(CP) ε(CP) *p*(W+Jd)	1.95	0.012
Ψ(I.O) γ(I.O) ε(Gr) *p*(CP+W+Jd)	1.99	0.012
Ψ(I.O) γ(I.O) ε(CP) *p*(CP+Jd)	2.12	0.011

Ψ(I.O) γ(I.O) ε(Gr) *p*(CP+Jd)	2.18	0.011
Ψ(I.O) γ(CP) ε(CP) *p*(Jd)	2.22	0.011
Ψ(I.O) γ(Gr) ε(I.O) *p*(CP+W+Jd)	2.24	0.010
Ψ(I.O) γ(CP) ε(I.O) *p*(CP+W+Jd)	2.40	0.010
Ψ(I.O) γ(Gr) ε(I.O) *p*(CP+Jd)	2.53	0.009
Ψ(Gr) γ(I.O) ε(I.O) *p*(CP+W+Jd)	2.53	0.009
Ψ(I.O) γ(Gr) ε(I.O) *p*(W+Jd)	2.60	0.009
Ψ(I.O) γ(CP) ε(I.O) *p*(CP+Jd)	2.63	0.009
Ψ(I.O) γ(I.O) ε(Gr*CP) *p*(W+Jd)	2.67	0.008
Ψ(I.O) γ(CP) ε(Gr*CP) *p*(W+Jd)	2.68	0.008
Ψ(CP) γ(I.O) ε(CP) *p*(CP+W+Jd)	2.72	0.008
Ψ(I.O) γ(I.O) ε(Gr) *p*(W+Jd)	2.75	0.008
Ψ(Gr) γ(I.O) ε(I.O) *p*(CP+Jd)	2.77	0.008
Ψ(I.O) γ(CP) ε(Gr*CP) *p*(Jd)	2.79	0.008
Ψ(I.O) γ(CP) ε(I.O) *p*(W+Jd)	2.80	0.008
Ψ(CP) γ(I.O) ε(I.O) *p*(W+Jd)	2.81	0.008
Ψ(I.O) γ(I.O) ε(Gr*CP) *p*(Jd)	2.82	0.008
Ψ(CP) γ(I.O) ε(CP) *p*(W+Jd)	2.87	0.008
Ψ(CP) γ(I.O) ε(CP) *p*(CP+Jd)	2.89	0.008
Ψ(I.O) γ(Gr) ε(CP) *p*(W+Jd)	2.91	0.007
Ψ(Gr) γ(I.O) ε(I.O) *p*(W+Jd)	2.98	0.007
Ψ(CP) γ(I.O) ε(Gr) *p*(CP+W+Jd)	2.98	0.007

Ψ(I.O) γ(Gr) ε(I.O) *p*(Jd)	3.01	0.007
Ψ(CP) γ(I.O) ε(Gr) *p*(CP+Jd)	3.04	0.007
Ψ(I.O) γ(I.O) ε(Gr) *p*(Jd)	3.14	0.007
Ψ(I.O) γ(I.O) ε(CP) *p*(Jd)	3.20	0.006
Ψ(I.O) γ(CP) ε(I.O) *p*(Jd)	3.21	0.006
Ψ(I.O) γ(Gr) ε(CP) *p*(Jd)	3.22	0.006
Ψ(CP) γ(I.O) ε(I.O) *p*(Jd)	3.25	0.006
Ψ(I.O) γ(I.O) ε(Gr+CP) *p*(W+Jd)	3.33	0.006
Ψ(Gr) γ(I.O) ε(CP) *p*(W+Jd)	3.33	0.006
Ψ(Gr) γ(I.O) ε(I.O) *p*(Jd)	3.39	0.006
Ψ(I.O) γ(Gr+CP) ε(Gr*CP) *p*(Jd)	3.42	0.006
Ψ(CP) γ(CP) ε(I.O) *p*(CP+W+Jd)	3.44	0.006
Ψ(CP) γ(Gr) ε(I.O) *p*(CP+W+Jd)	3.48	0.006
Ψ(I.O) γ(Gr+CP) ε(Gr*CP) *p*(W+Jd)	3.51	0.006
Ψ(CP) γ(CP) ε(I.O) *p*(CP+Jd)	3.58	0.005
Ψ(Gr+CP) γ(I.O) ε(I.O) *p*(CP+W+Jd)	3.58	0.005
Ψ(I.O) γ(CP) ε(CP) *p*(CP+W+Jd)	3.61	0.005
Ψ(Gr) γ(I.O) ε(CP) *p*(Jd)	3.63	0.005
Ψ(I.O) γ(I.O) ε(Gr+CP) *p*(Jd)	3.63	0.005
Ψ(CP) γ(CP) ε(I.O) *p*(CP+Jd)	3.67	0.005
Ψ(Gr+CP) γ(I.O) ε(I.O) *p*(CP+Jd)	3.72	0.005
Ψ(I.O) γ(I.O) ε(I.O) *p*(CP+W)	3.72	0.005

Ψ(I.O) γ(CP) ε(CP) *p*(CP+Jd)	3.76	0.005
Ψ(I.O) γ(I.O) ε(I.O) *p*(CP)	3.76	0.005
Ψ(I.O) γ(Gr+CP) ε(CP) *p*(W+Jd)	3.99	0.004

Table 10. Occupancy (Ψ), colonization (γ), and local extinction (ε) parameters (Parm) in the competitive model set and their model-averaged parameter estimates (β), unconditional standard errors (SE), and 85% confidence intervals (85% CI) for gamebirds and Henslow's sparrows in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. See Table 9 for predictor codes.

	West					**East**				
Species	**Parm**	**Predictor**	**β**	**SE**	**85% CI**	**Parm**	**Predictor**	**β**	**SE**	**85% CI**
Ring-necked Pheasant	Ψ	Gr[a]	-0.05	0.67	-1.01, 0.92					
		CP[b]	-0.91	0.99	-2.34, 0.52					
	γ	Gr[a]	-1.35	3.10	-5.8, 3.11					
		CP[b]	-1.75	9.73	-15.75, 12.25					
	ε	Gr[a]	0.55	1.06	-0.97, 2.07					
		CP[b]	-1.25	1.04	-2.74, 0.24					
		Gr*CP	6.43	25.36	-30.07, 42.94					

Northern Bobwhite	Ψ	Gr[a]	-0.84	1.74	-3.35, 1.67	Ψ	Gr[a]	0.54	0.76	-0.55, 1.63
		CP[b]	-1.27	1.06	-2.80, 0.26		CP[b]	0.09	0.79	-1.04, 1.22
	γ	Gr[a]	-4.13	16.70	-28.17, 19.91	γ	Gr[a]	-1.01	3.04	-5.39, 3.38
		CP[b]	7.97	27.59	-31.75, 47.69		CP[b]	-0.29	0.94	-1.65, 1.07
		Gr*CP	4.44	21.01	-25.81, 34.69		B[c]	1.68	7.15	-8.62, 11.97
	ε	Gr[a]	1.59	12.32	-16.15, 19.32	ε	Gr[a]	-1.13	1.30	-3.01, 0.74
		CP[b]	-4.20	41.25	-63.58, 55.18		CP[b]	1.30	1.01	-0.14, 2.75
		Gr*CP	10.26	36.91	-42.88, 63.39		B[c]	1.45	1.19	-0.27, 3.16
							Gr*CP	-7.76	20.13	-36.73, 21.21
Mourning Dove	Ψ	Gr[a]	0.16	0.89	-1.13, 1.44	Ψ	Gr[a]	-1.65	17.02	-26.15, 22.86
		CP[b]	-0.83	0.96	-2.21, 0.56		CP[b]	-11.71	89.00	-139.83, 116.41
	γ	Gr[a]	-1.34	1.61	-3.66, 0.98	γ	Gr[a]	-1.10	1.09	-2.68, 0.47

		CP^{b}	-0.51	1.26	-2.32, 1.30		CP^{b}	8.26	46.05	-58.03, 74.54
	ε	Gr^{a}	0.94	1.00	-0.50, 2.38		B^{c}	0.43	1.02	-1.03, 1.90
		CP^{b}	-0.07	0.95	-1.44, 1.29	ε	Gr^{a}	-13.93	53.20	-30.51, 62.64
							CP^{b}	-14.06	67.34	-111.00, 82.88
							B^{c}	13.81	119.63	-186.02, 158.41
							Gr*CP	-1.53	162.70	-235.75, 232.69
Henslow's Sparrow						Ψ	Gr^{a}	-0.77	1.28	-2.61, 1.07
							CP^{b}	0.28	1.28	-1.56, 2.13
						γ	Gr^{a}	-0.90	0.67	-1.86, 0.07
							CP^{b}	-0.34	0.65	-1.28, 0.60
							B^{c}	0.00	0.65	-0.94, 0.94
						ε	Gr^{a}	-5.26	14.66	-26.37, 15.85
							CP^{b}	4.15	11.49	-12.39, 20.69
							B^{c}	-0.54	1.59	-2.84, 1.75

	Gr*CP	-16.73	41.00	-75.75, 42.3

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[a] Reference values for β are grazed versus ungrazed fields.

[b] Reference values for β are CP25 versus CP2 fields.

[c] Reference values for β are burned versus unburned fields.

Table 11. Model selection results for multi-season occupancy, among competitive models ($\Delta\text{AIC}_c \leq 4$), for northern bobwhites in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are the predictors for occupancy (Ψ), colonization (γ), local extinction (ε), and detection probability (*p*) parameters that occurred in the competitive model set. Detection predictors include intercept-only (I.O), observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B) in eastern Kansas. Occupancy predictors include I.O, Gr, CP, and Gr*CP interaction. Colonization and extinction predictors include I.O, Gr, CP, Gr*CP and B and Gr*B in eastern Kansas only (field burning was rare in western Kansas; Table 1). In all there were 124 models in the candidate set in western Kansas and 319 in eastern Kansas.

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
Ψ(I.O) γ(CP) ε(I.O) *p*(I.O)	0.00	0.067	Ψ(I.O) γ(I.O) ε(I.O) *p*(I.O)	0.00	0.063
Ψ(I.O) γ(CP) ε(Gr) *p*(I.O)	0.23	0.060	Ψ(I.O) γ(I.O) ε(CP) *p*(I.O)	0.71	0.044
Ψ(I.O) γ(Gr+CP) ε(I.O) *p*(I.O)	0.39	0.055	Ψ(I.O) γ(I.O) ε(B) *p*(I.O)	0.97	0.039
Ψ(CP) γ(CP) ε(I.O) *p*(I.O)	0.83	0.044	Ψ(I.O) γ(B) ε(I.O) *p*(I.O)	1.89	0.024
Ψ(I.O) γ(Gr) ε(CP) *p*(I.O)	1.16	0.038	Ψ(Gr) γ(I.O) ε(I.O) *p*(I.O)	1.89	0.024
Ψ(CP) γ(Gr+CP) ε(I.O) *p*(I.O)	1.32	0.035	Ψ(I.O) γ(I.O) ε(Gr+B) *p*(I.O)	2.08	0.022

Ψ(CP) γ(CP) ε(Gr) *p*(I.O)	1.63	0.030	Ψ(I.O) γ(I.O) ε(Gr) *p*(I.O)	2.14	0.022
Ψ(I.O) γ(Gr+CP) ε(Gr) p(I.O)	1.83	0.027	Ψ(I.O) γ(CP) ε(I.O) *p*(I.O)	2.15	0.021
Ψ(I.O) γ(Gr) ε(I.O) p(I.O)	1.90	0.026	Ψ(I.O) γ(I.O) ε(Gr*CP) *p*(I.O)	2.19	0.021
Ψ(I.O) γ(Gr) ε(Gr+CP) p(I.O)	1.95	0.025	Ψ(I.O) γ(Gr) ε(I.O) *p*(I.O)	2.28	0.020
Ψ(Gr) γ(CP) ε(I.O) p(I.O)	2.03	0.024	Ψ(I.O) γ(CP) ε(I.O) *p*(I.O)	2.41	0.019
Ψ(I.O) γ(I.O) ε(CP) p(I.O)	2.28	0.022	Ψ(I.O) γ(I.O) ε(Gr+CP) *p*(I.O)	2.42	0.019
Ψ(Gr) γ(I.O) ε(CP) p(I.O)	2.40	0.020	Ψ(I.O) γ(B) ε(B) *p*(I.O)	2.43	0.019
Ψ(I.O) γ(CP) ε(Gr+CP) p(I.O)	2.49	0.190	Ψ(I.O) γ(B) ε(CP) *p*(I.O)	2.63	0.017
Ψ(I.O) γ(CP) ε(CP) p(I.O)	2.52	0.019	Ψ(Gr) γ(I.O) ε(CP) *p*(I.O)	2.76	0.016
Ψ(Gr) γ(GR+CP) ε(I.O) p(I.O)	2.67	0.018	Ψ(Gr) γ(I.O) ε(B) *p*(I.O)	2.95	0.014
Ψ(I.O) γ(Gr+CP) ε(CP) p(I.O)	2.74	0.017	Ψ(I.O) γ(Gr) ε(CP) *p*(I.O)	3.06	0.014
Ψ(I.O) γ(I.O) ε(I.O) p(I.O)	2.76	0.017	Ψ(CP) γ(I.O) ε(CP) *p*(I.O)	3.21	0.013
Ψ(I.O) γ(Gr*CP) ε(I.O) p(I.O)	2.82	0.016	Ψ(I.O) γ(CP) ε(CP) *p*(I.O)	3.24	0.012
Ψ(Gr) γ(CP) ε(Gr) p(I.O)	2.82	0.016	Ψ(I.O) γ(Gr+B) ε(I.O) *p*(I.O)	3.30	0.012
Ψ(CP) γ(Gr+CP) ε(Gr) p(I.O)	2.84	0.016	Ψ(I.O) γ(Gr) ε(B) *p*(I.O)	3.38	0.012

Ψ(CP) γ(Gr) ε(I.O) p(I.O)	2.93	0.016	Ψ(I.O) γ(CP) ε(B) *p*(I.O)	3.40	0.011
Ψ(Gr+CP) γ(CP) ε(I.O) p(I.O)	3.00	0.015	Ψ(I.O) γ(B) ε(Gr+B) *p*(I.O)	3.50	0.011
Ψ(CP) γ(Gr) ε(CP) p(I.O)	3.02	0.015	Ψ(CP) γ(I.O) ε(B) *p*(I.O)	3.50	0.011
Ψ(I.O) γ(I.O) ε(Gr) p(I.O)	3.33	0.013	Ψ(I.O) γ(Gr) ε(Gr+B) *p*(I.O)	3.91	0.009
Ψ(CP) γ(CP) ε(CP) p(I.O)	3.40	0.012	Ψ(Gr) γ(B) ε(I.O) *p*(I.O)	3.95	0.009
Ψ(Gr+CP) γ(Gr+CP) ε(I.O) p(I.O)	3.62	0.011	Ψ(I.O) γ(B) ε(Gr*CP) *p*(I.O)	3.96	0.009
Ψ(CP) γ(I.O) ε(I.O) p(I.O)	3.68	0.011			
Ψ(CP) γ(Gr+CP) ε(CP) p(I.O)	3.79	0.010			
Ψ(Gr) γ(Gr) ε(CP) p(I.O)	3.81	0.010			
Ψ(I.O) γ(CP) ε(Gr*CP) p(I.O)	3.84	0.010			
Ψ(CP) γ(Gr*CP) ε(I.O) p(I.O)	3.99	0.009			

Table 12. Model selection results for multi-season occupancy, among competitive models ($\Delta\text{AIC}_c \leq 4$), for mourning doves in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are the predictors for occupancy (Ψ), colonization (γ), local extinction (ε), and detection probability (*p*) parameters that occurred in the competitive model set. Detection predictors include intercept-only (I.O), observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B) in eastern Kansas. Occupancy predictors include I.O, Gr, CP, and Gr*CP interaction. Colonization and extinction predictors include I.O, Gr, CP, Gr*CP and B and Gr*B in eastern Kansas only (field burning was rare in western Kansas; Table 1). In all there were 250 models in the candidate set in western Kansas and 957 in eastern Kansas.

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
Ψ(I.O) γ(I.O) ε(I.O) *p*(Ob)	0	0.166	Ψ(CP) γ(CP) ε(Gr) *p*(I.O)	0	0.069
Ψ(I.O) γ(I.O) ε(Gr) *p*(Ob)	1.76	0.069	Ψ(CP) γ(CP) ε(Gr+CP) *p*(I.O.)	0.3	0.06
Ψ(I.O) γ(Gr) ε(I.O) *p*(Ob)	1.89	0.065	Ψ(CP) γ(I.O) ε(Gr+CP) *p*(I.O.)	0.33	0.059
Ψ(CP) γ(I.O) ε(I.O) *p*(Ob)	1.98	0.062	Ψ(CP) γ(I.O) ε(Gr) *p*(I.O.)	0.45	0.055
Ψ(I.O) γ(CP) ε(I.O) *p*(Ob)	2.6	0.045	Ψ(CP) γ(Gr+CP) ε(Gr) *p*(I.O.)	1.15	0.039

Ψ(Gr) γ(I.O) ε(I.O) *p*(Ob)	2.73	0.042	Ψ(CP) γ(CP) ε(Gr+B) *p*(I.O.)	1.92	0.027
Ψ(I.O) γ(I.O) ε(CP) *p*(Ob)	2.76	0.042	Ψ(CP) γ(I.O) ε(Gr+B) *p*(I.O.)	1.95	0.026
Ψ(I.O) γ(I.O) ε(I.O) *p*(Ob+CP+T)	3.81	0.025	Ψ(CP) γ(Gr+CP) ε(Gr+CP) *p*(I.O.)	1.97	0.026
Ψ(CP) γ(Gr) ε(I.O) *p*(Ob)	3.81	0.025	Ψ(CP) γ(Gr) ε(Gr) *p*(I.O.)	2.4	0.021
			Ψ(CP) γ(Gr) ε(Gr+CP) *p*(I.O.)	2.54	0.02
			Ψ(Gr+CP) γ(I.O) ε(Gr+CP) *p*(I.O.)	2.6	0.019
			Ψ(Gr+CP) γ(I.O) ε(Gr) *p*(I.O.)	2.7	0.018
			Ψ(CP) γ(B) ε(Gr+CP) *p*(I.O.)	2.71	0.018
			Ψ(Gr+CP) γ(CP) ε(Gr) *p*(I.O.)	2.74	0.018
			Ψ(CP) γ(I.O) ε(I.O) *p*(I.O.)	2.75	0.018
			Ψ(CP) γ(B) ε(Gr) *p*(I.O.)	3.06	0.015
			Ψ(CP) γ(I.O) ε(Gr*CP) *p*(I.O.)	3.09	0.015
			Ψ(CP) γ(Gr+CP) ε(Gr+B) *p*(I.O.)	3.11	0.015
			Ψ(Gr+CP) γ(CP) ε(Gr+CP) *p*(I.O.)	3.12	0.015
			Ψ(CP) γ(CP) ε(Gr*CP) *p*(I.O.)	3.19	0.014

	Ψ(CP) γ(I.O) ε(CP) p(I.O.)	3.43	0.012
	Ψ(CP) γ(Gr*CP) ε(CP) p(I.O.)	3.78	0.01
	Ψ(CP) γ(Gr) ε(Gr+B) p(I.O.)	3.89	0.01
	Ψ(CP) γ(Gr*CP) ε(Gr) p(I.O.)	3.99	0.009

Table 13. Model selection results for multi-season occupancy among competitive models ($\Delta AIC_c \leq 4$) for Henslow's sparrow in Conservation Reserve Program fields across the eastern third sites in Kansas, 2017-2019. Shown are the predictors for occupancy (Ψ), colonization (γ), local extinction (ε), and detection probability (*p*) parameters that occurred in the competitive model set. Detection predictors include intercept-only (I.O), observer (Ob), grazing treatment (Gr), conservation practice (CP), wind speed (W), Julian date (Jd), temperature (T), sky (S), and burning (B. Occupancy predictors include I.O, Gr, CP, and Gr*CP interaction. Colonization and extinction predictors include I.O, Gr, CP, B, Gr*CP and Gr*B interactions. In all there were 638 models in the candidate set.

Predictor	**ΔAIC_c**	**w_i**
Ψ(I.O) γ(I.O) ε(I.O) *p*(W+Jd)	0.00	0.081
Ψ(I.O) γ(I.O) ε(Gr*CP) *p*(W+Jd)	0.88	0.052
Ψ(I.O) γ(Gr) ε(I.O) *p*(W+Jd)	1.29	0.042
Ψ(I.O) γ(I.O) ε(CP) *p*(W+Jd)	1.32	0.042
Ψ(I.O) γ(I.O) ε(Gr+CP) *p*(W+Jd)	1.56	0.037
Ψ(I.O) γ(I.O) ε(Gr*CP) *p*(Jd)	2.55	0.023
Ψ(I.O) γ(I.O) ε(I.O) *p*(Jd)	2.69	0.021
Ψ(I.O) γ(I.O) ε(Gr) *p*(W+Jd)	2.70	0.021

Ψ(Gr) γ(I.O) ε(I.O) *p*(W+Jd)	2.72	0.021
Ψ(I.O) γ(Gr) ε(CP) *p*(W+Jd)	2.82	0.02
Ψ(I.O) γ(CP) ε(I.O) *p*(W+Jd)	2.83	0.02
Ψ(I.O) γ(Gr) ε(Gr*CP) *p*(W+Jd)	2.90	0.019
Ψ(I.O) γ(I.O) ε(B) *p*(W+Jd)	2.99	0.018
Ψ(CP) γ(I.O) ε(I.O) *p*(W+Jd)	3.05	0.018
Ψ(I.O) γ(B) ε(I.O) *p*(W+Jd)	3.10	0.017
Ψ(I.O) γ(Gr) ε(Gr+CP) *p*(W+Jd)	3.11	0.017
Ψ(I.O) γ(Gr) ε(I.O) *p*(Jd)	3.73	0.013
Ψ(I.O) γ(I.O) ε(CP) *p*(Jd)	3.98	0.011

Table 14. Model selection results for effective species numbers in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are models competitive models ($\Delta AIC_c \leq 4$), their predictors (grazing treatment [Gr], conservation practice [CP], year [Y], intercept-only [I.O], Gr*CP and Gr*Y interactions, burning [B], and Gr*B in eastern Kansas only), ΔAIC_c, and model weight (w_i).

West			**East**		
Predictor	**ΔAIC_c**	**w_i**	**Predictor**	**ΔAIC_c**	**w_i**
Gr*Y	0.00	0.65	Gr+B	0	0.42
Gr*CP+Gr*Y	3.26	0.13	Gr*B+Gr*Y	1.57	0.19
I.O	3.76	0.1	Gr*B	1.78	0.18
			Gr*Y	3.84	0.06

Table 15. Predictors in competitive model sets of effective species numbers in Conservation Reserve Program fields across western and eastern Kansas, 2017-2019. Shown are the predictors and their model-averaged parameter estimates (β), unconditional standard errors (SE), and 85% confidence intervals (85% CI).

West				**East**			
Predictor	**β**	**SE**	**85% CI**	**Predictor**	**β**	**SE**	**85% CI**
Gr*CP	0.03	0.14	-0.17, 0.23	Gr[b]	0.19	0.08	0.08, 0.30
Gr*Y(2018[a])	0.02	0.17	-0.23, 0.26	B[c]	-0.24	0.08	-0.36, -0.13
Gr*Y(2019[a])	-0.07	0.17	-0.31, 0.18	Gr*B	-0.04	0.17	-0.29, 0.20
				Gr*Y(2018[a])	0.13	0.19	-0.15, 0.41
				Gr*Y(2019[a])	0.23	0.19	-0.05, 0.51

[a] Versus reference year of 2017.

[b] Grazed versus ungrazed.

[c] Burned versus unburned.

Table 16. PERMANOVA results of grazing treatment (grazed versus ungrazed) and conservation practice (CP2 versus CP25) in Conservation Reserve Program fields across western and eastern Kansas from 2017-2019.

		West				**East**			
Predictor	**Year**	***df***	**Residual *df***	**Pseudo-*F***	***P*-value**	***df***	**Residual *df***	**Pseudo-*F***	***P*-value**
Grazing	2018	1	52	1.830	0.111	1	52	1.677	0.140
CP	2017-2019	1	52	0.701	0.687	1	52	1.418	0.228

Figure 1. Distribution of 108 study sites spanning precipitation isoclines across Kansas. Isoclines depict average annual precipitation (cm), 1980-2010 (EPA 2015). Treatments are illustrated as follows: CP2 (CRP conservation practice) grazed (red triangle), CP2 ungrazed (red circles), CP25 grazed (yellow triangles), and CP25 ungrazed (yellow circles).

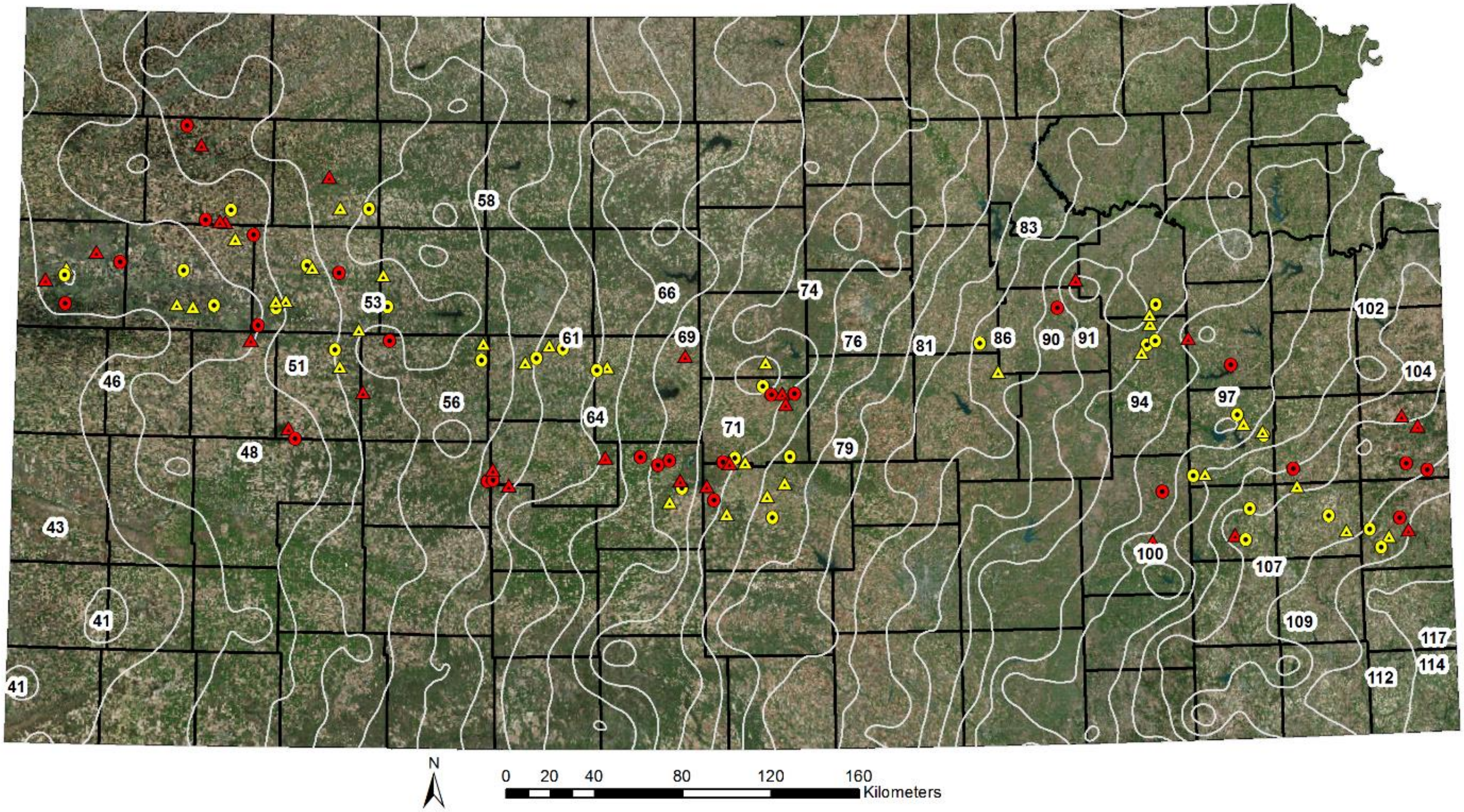

58
83
74
66
53
61
69
76
81
86
90
91
102
104
51
46
56
64
71
97
94
79
48
43
100
107
41
109
117
114
112
41
N
0
20
40
80
120
160
Kilometers

Figure 2. Example of transect establishment within plots along the longest axis (red line) in the largest block of habitat per Conservation Reserve Program field.

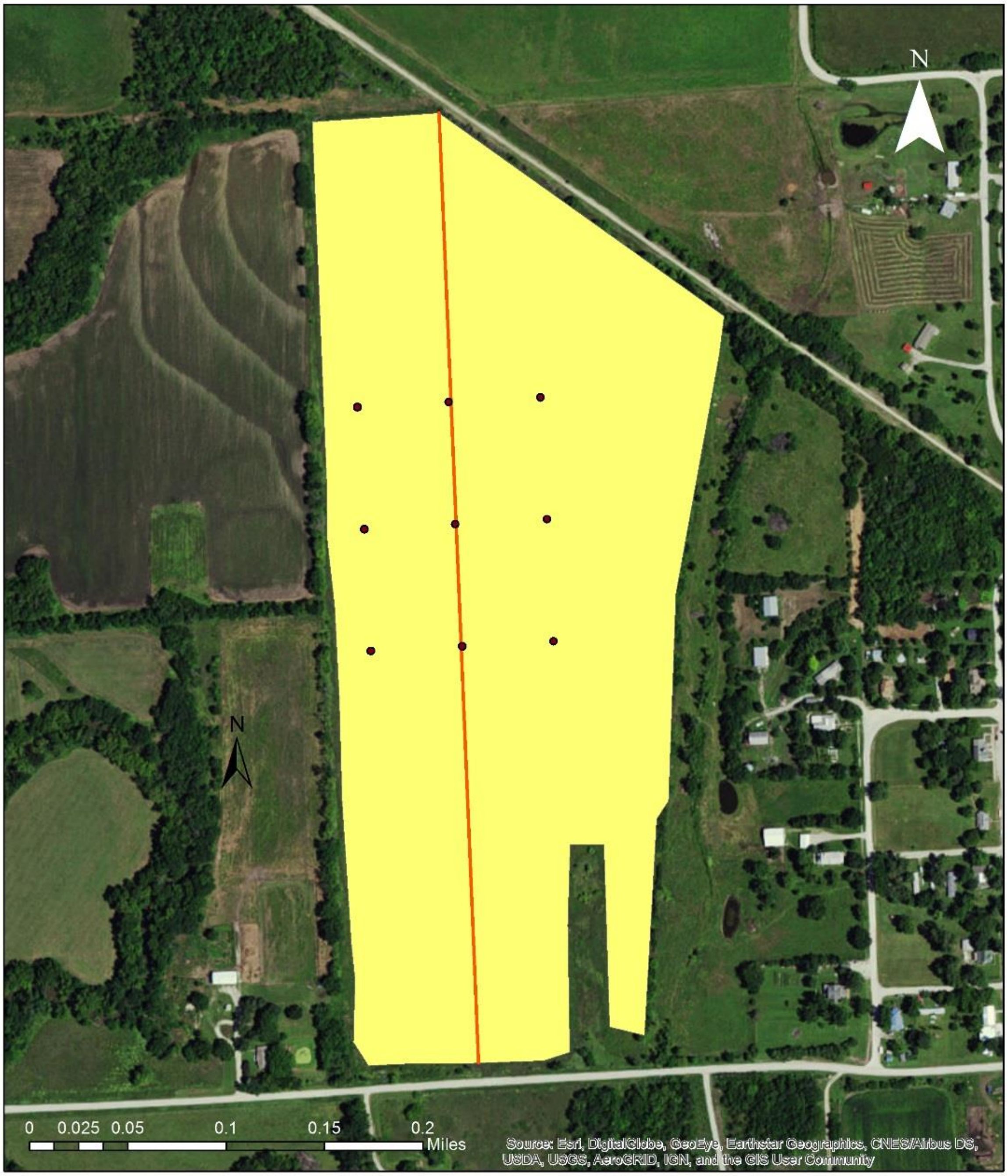

N
N
0
0.025
0.05
0.1
0.15
0.2
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3. Detection frequency (total numbers of detections) of ring-necked pheasants across the isocline gradient of average annual precipitation (cm), 1980-2010 (EPA 2015), across Kansas, 2017-2019. The western study zone ranges from 46−56 cm, the central study zone ranges from 56−76 cm, and the eastern study zone ranges form 86−109 cm.

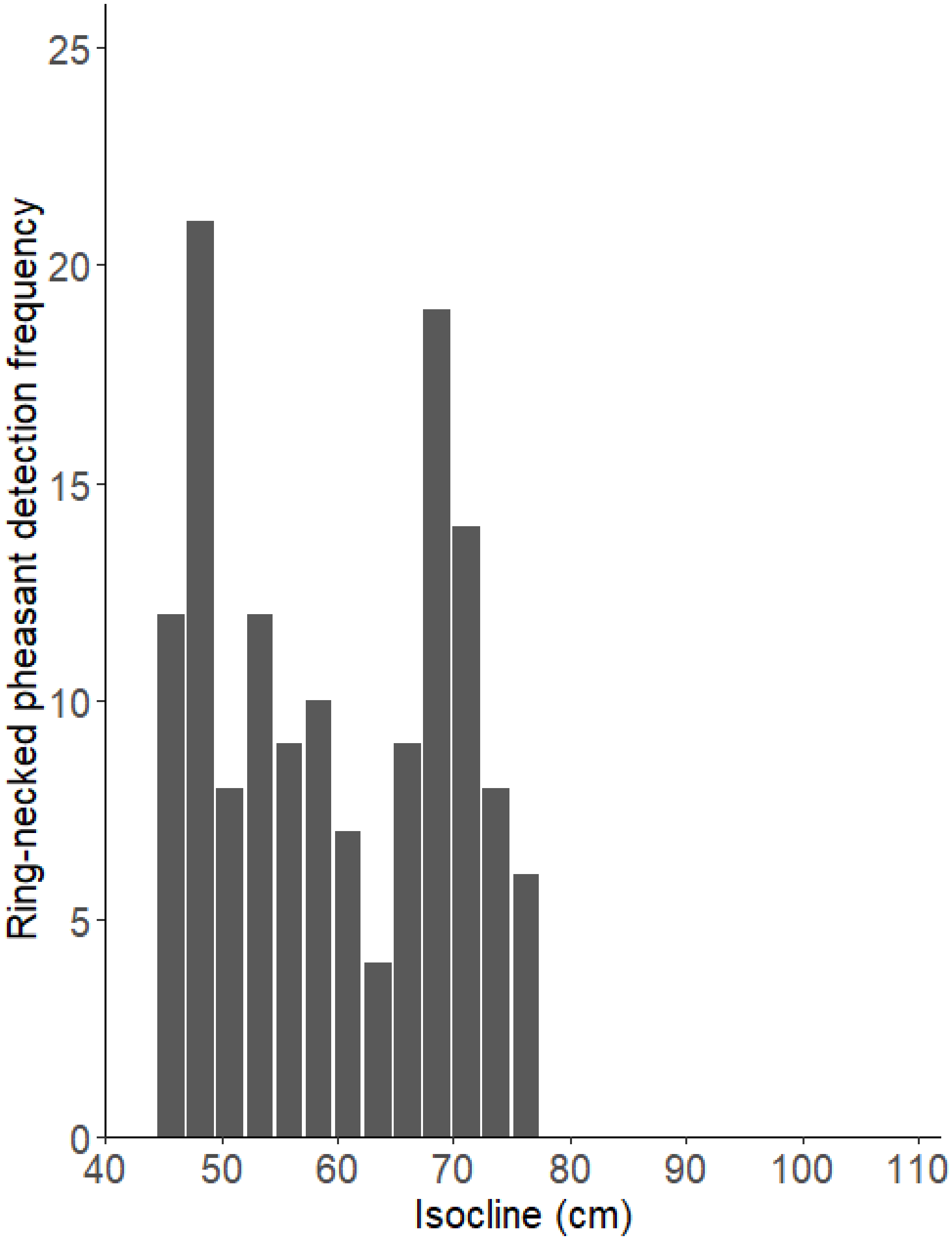

Ring-necked pheasant detection frequency
0
5
10
15
20
25
40
50
60
70
80
90
100
110
Isocline (cm)

Figure 4. Predicted dickcissel density (individuals / ha; ±SE) in cattle-grazed (solid) and ungrazed (open) fields in Conservation Reserve Program fields across western Kansas, 2017-2019, from model-averaged grazing*year interaction parameter estimates (β) in the competitive set.

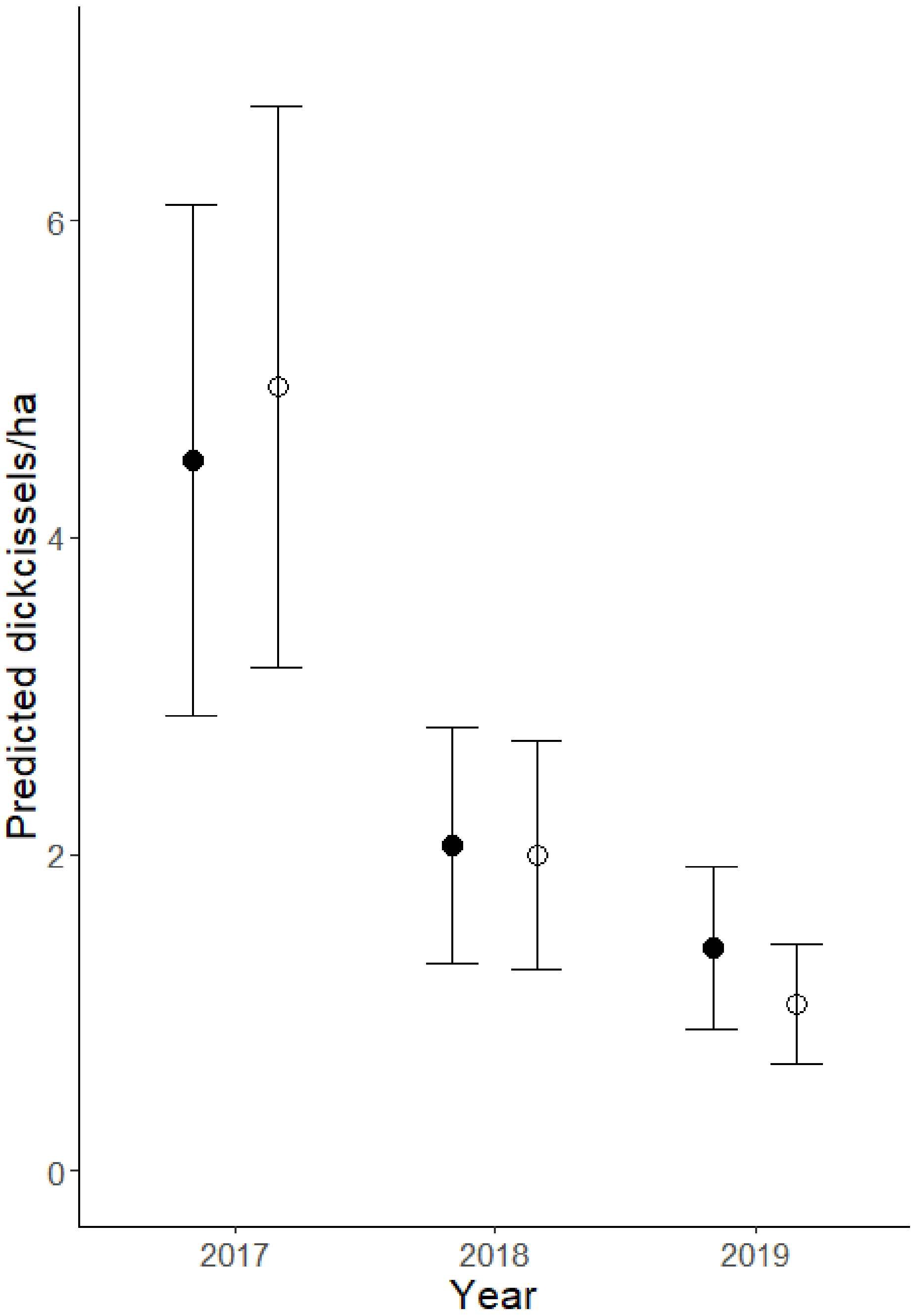

Predicted dickcissels/ha
0
2
4
6
2017
2018
2019
Year

Figure 5. Predicted eastern meadowlark density (individuals / ha; ±SE) in cattle-grazed (solid) and ungrazed (open) fields in Conservation Reserve Program fields across eastern Kansas, 2017-2019, from model-averaged grazing*CP (CRP conservation practices C2 versus CP25) interaction parameter estimates (β) in the competitive set.

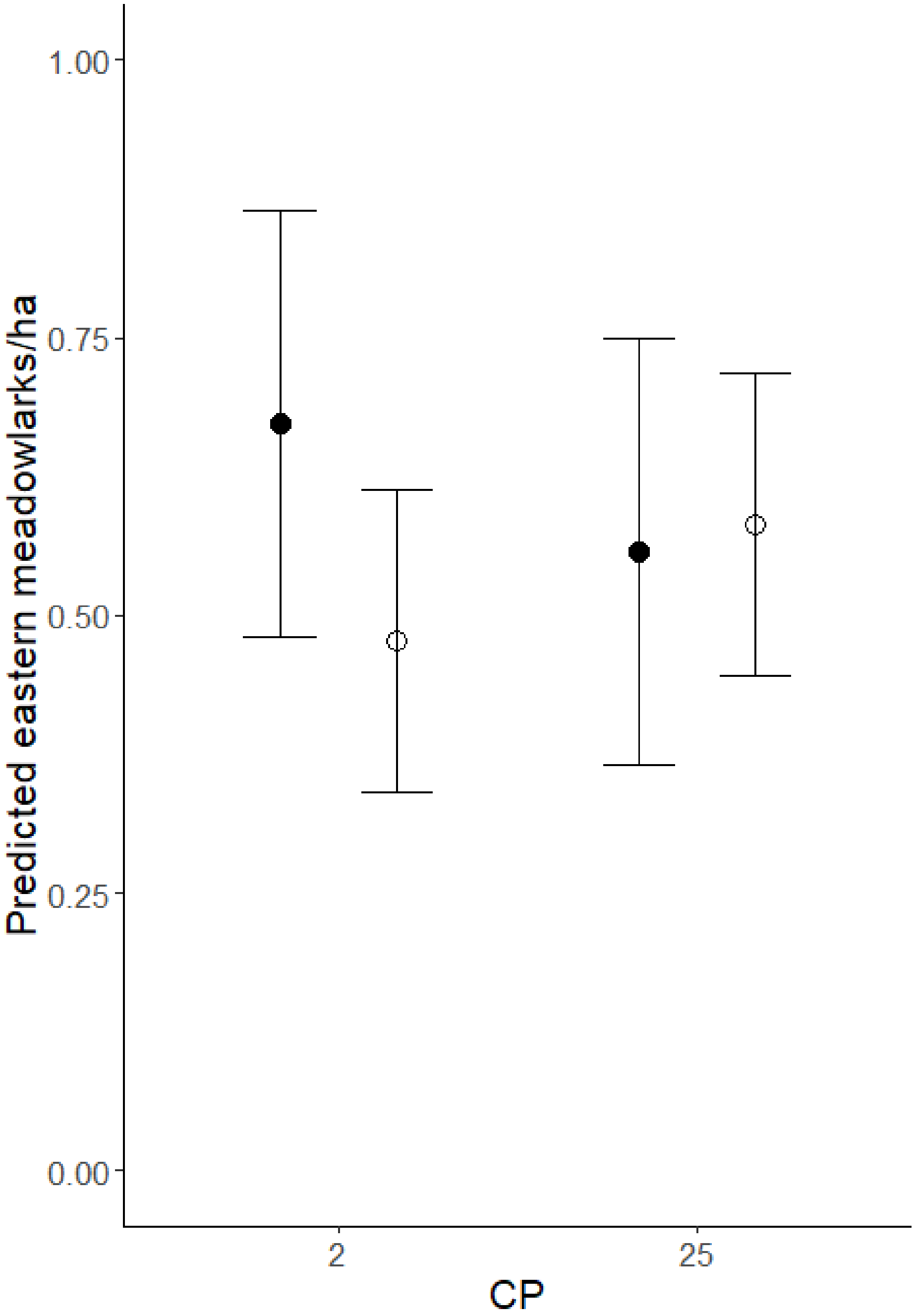

Predicted eastern meadowlarks/ha
1.00
0.75
0.50
0.25
0.00
2
25
CP

Figure 6. Predicted eastern meadowlark density (individuals / ha; ±SE) in cattle-grazed (solid) and ungrazed (open) fields in Conservation Reserve Program fields across eastern Kansas, 2017-2019, from model-averaged grazing*year interaction parameter estimates (β) in the competitive set.

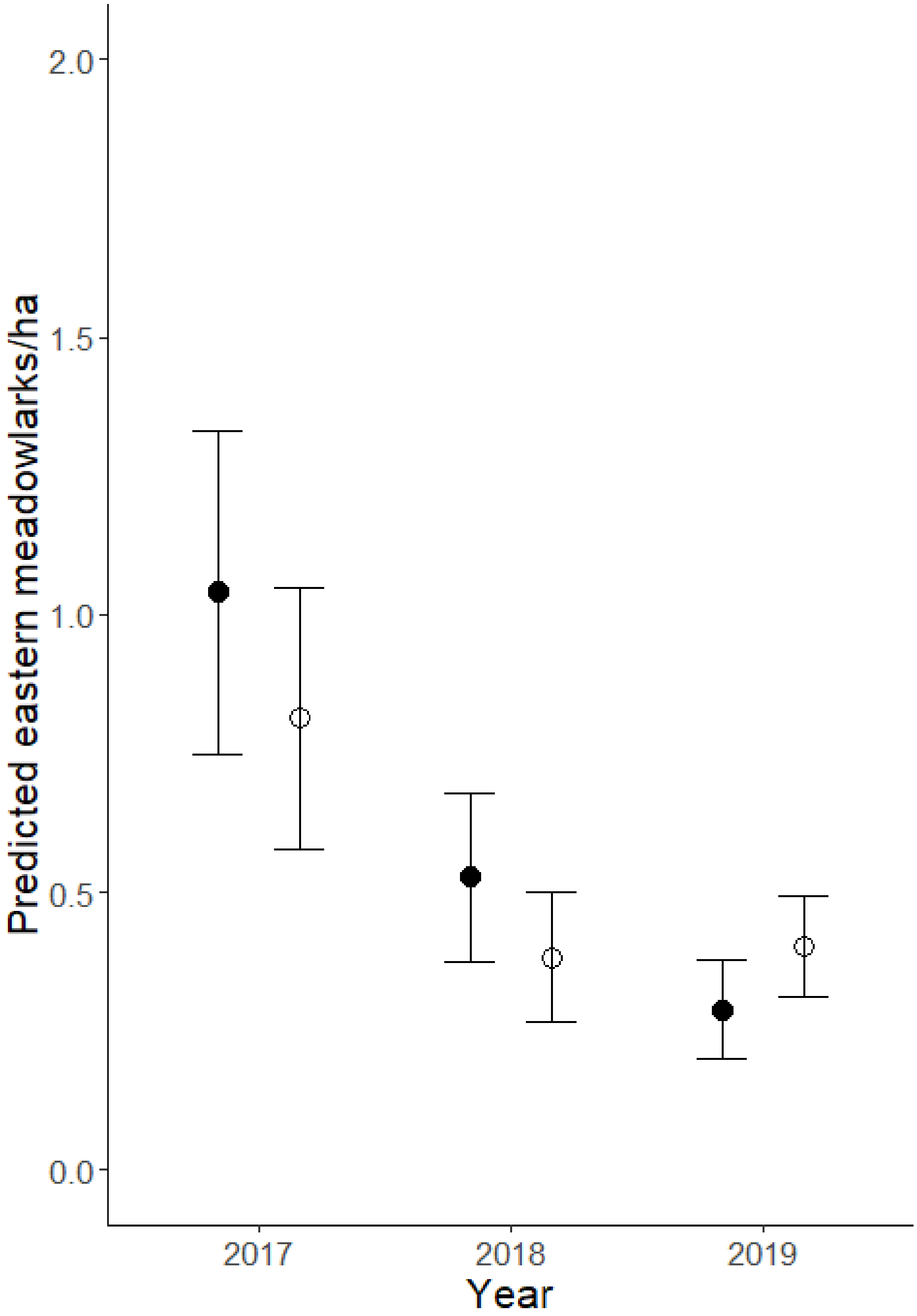

Predicted eastern meadowlarks/ha
2.0
1.5
1.0
0.5
0.0
2017
2018
2019
Year

Figure 7. Predicted brown-headed cowbird relative abundance (individuals / ha; ±SE) in cattle-grazed (solid) and ungrazed (open) fields in Conservation Reserve Program fields across western Kansas, 2017-2019, from model-averaged grazing*year interaction parameter estimates (β) in the competitive set.

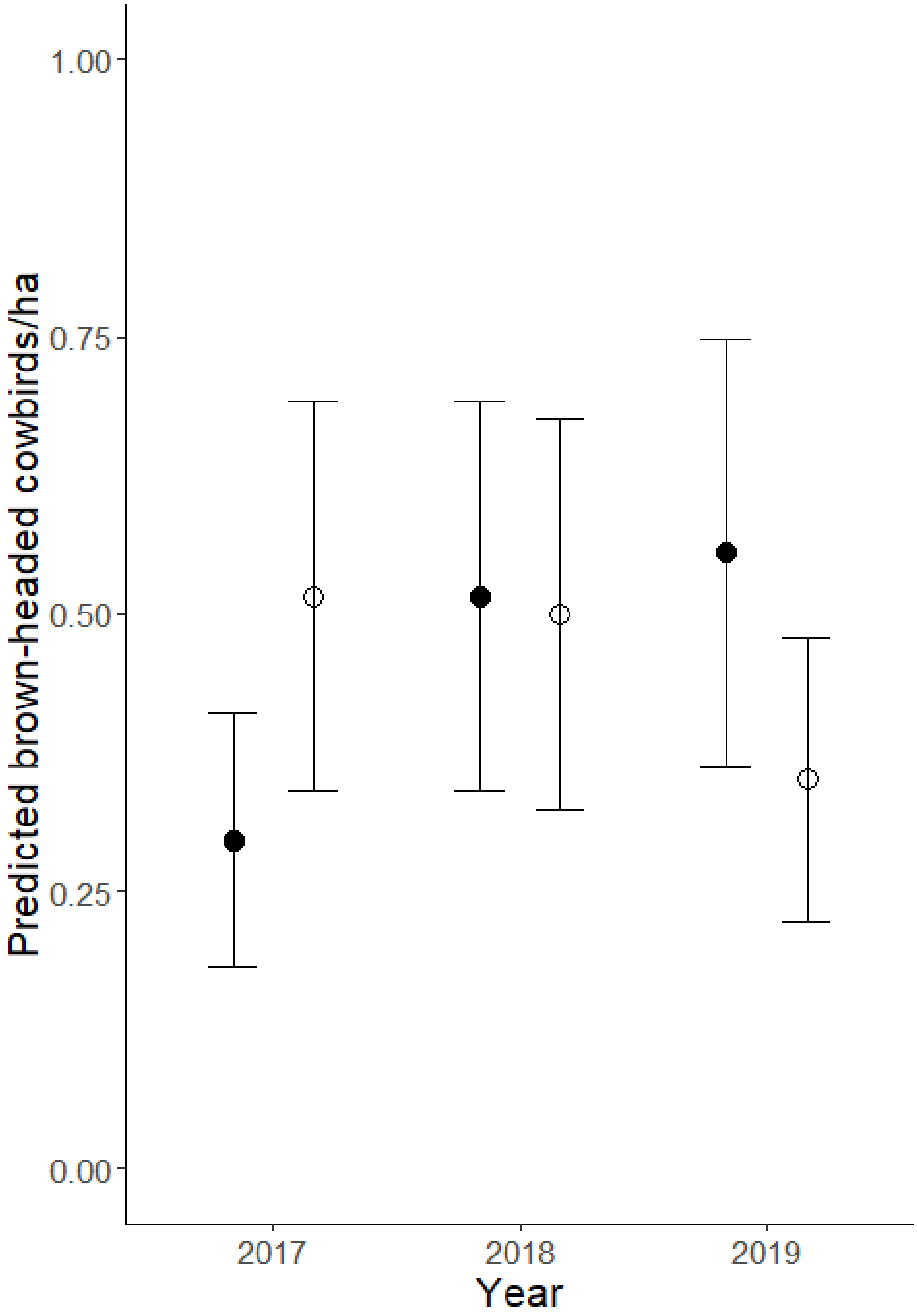

Predicted brown-headed cowbirds/ha
1.00
0.75
0.50
0.25
0.00
2017
2018
2019
Year

Figure 8. Predicted brown-headed cowbird relative abundance (individuals / ha; ±SE) in cattle-grazed (solid) and ungrazed (open) fields in Conservation Reserve Program fields across eastern Kansas, 2017-2019, from model-averaged grazing*CP (CRP conservation practices C2 versus CP25) interaction parameter estimates (β) in the competitive set.

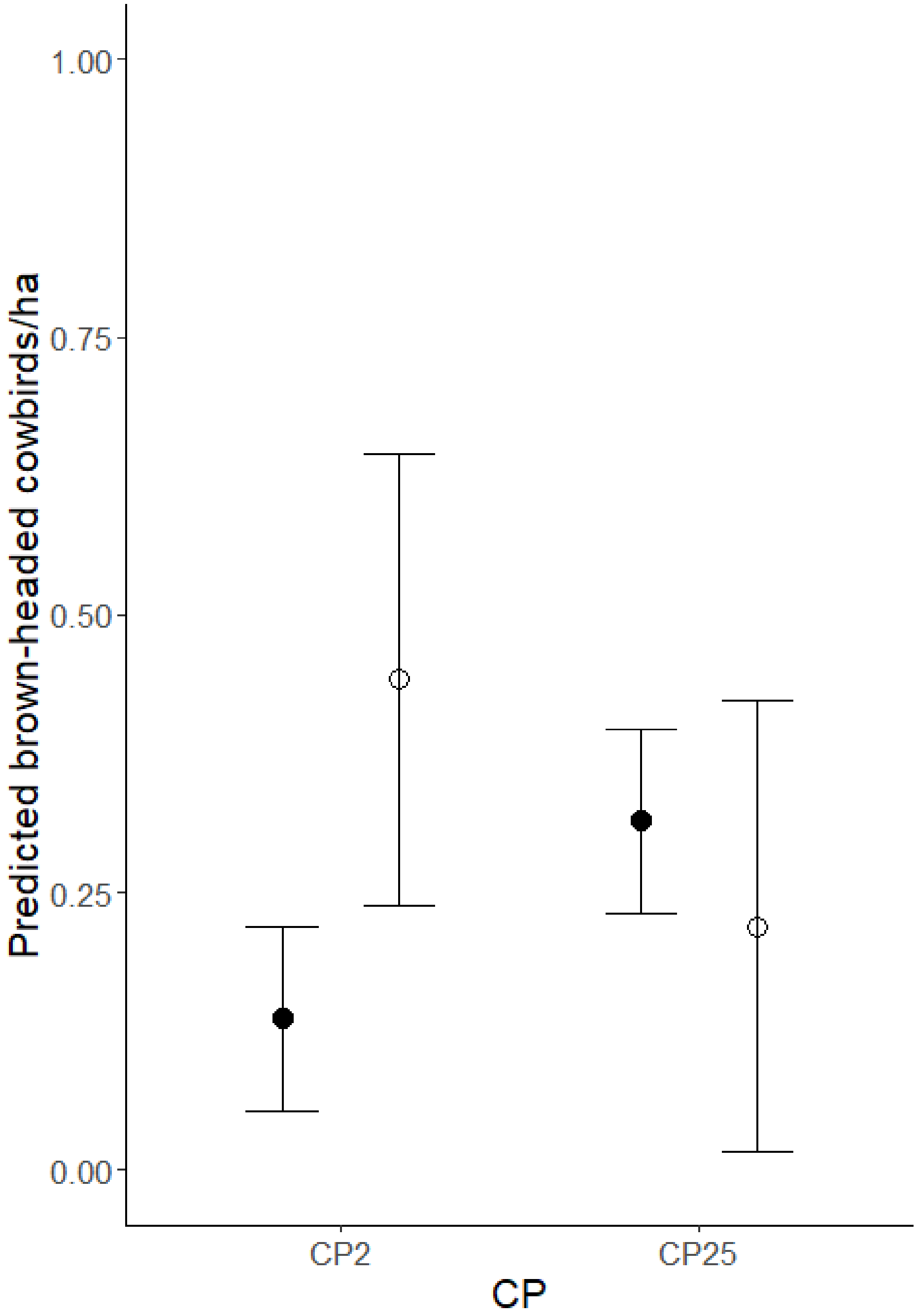
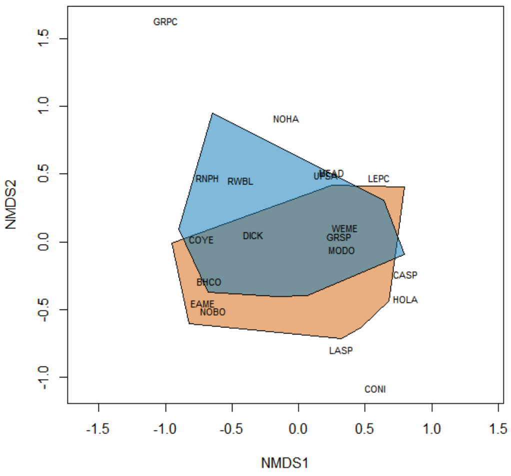
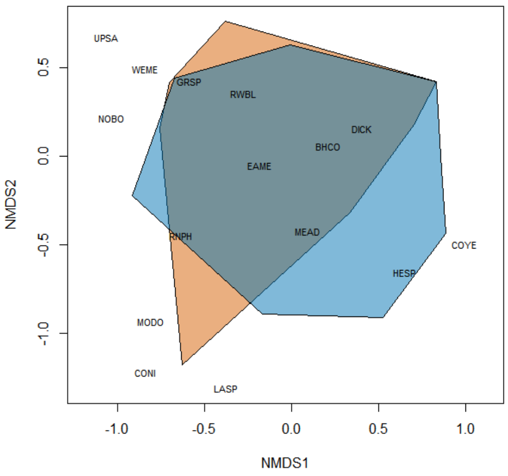

Predicted brown-headed cowbirds/ha
1.00
0.75
0.50
0.25
0.00
CP2
CP25
CP

Figure 9. Non-metric multidimensional scaling (NMDS) graphs depicting bird community similarity between cattle-grazed (orange) and ungrazed (blue) Conservation Reserve Program fields in western and eastern Kansas in 2018 (during the second growing season of grazing on grazed fields) among three dimensions. Each pairwise combination among three NMDS axes are shown, with graphs A-C from western Kansas and D-F from eastern Kansas. See Appendix A for corresponding 4-letter species codes.

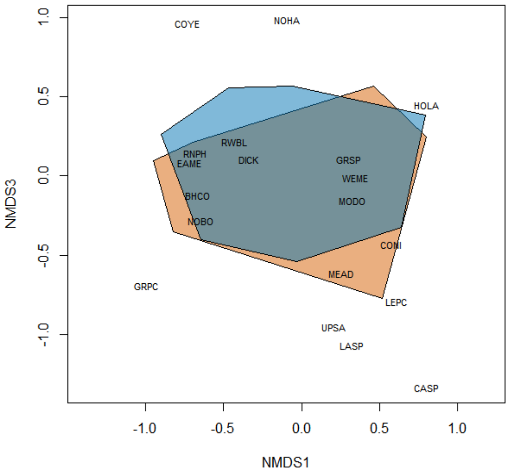
A


GRPC
NOHA
RNPH
RWBL
UPSA
MEAD
LEPC
COYE
DICK
WEME
GRSP
MODO
CASP
BHCO
HOLA
EAME
NOBO
LASP
CONI
1.5
1.0
0.5
0.0
-0.5
-1.0
NMDS2
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
NMDS1

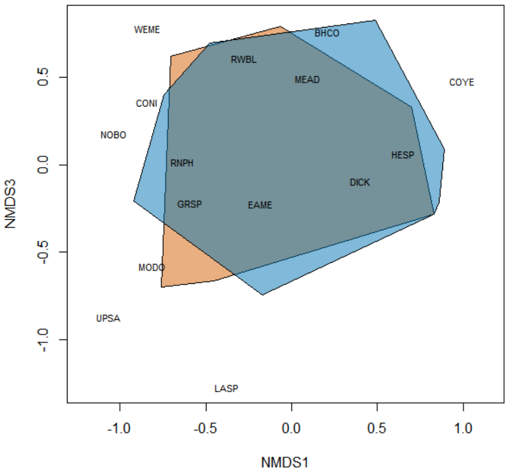
D


UPSA
WEME
GRSP
RWBL
NOBO
DICK
BHCO
EAME
RNPH
MEAD
COYE
HESP
MODO
CONI
LASP
0.5
0.0
-0.5
-1.0
NMDS2
-1.0
-0.5
0.0
0.5
1.0
NMDS1

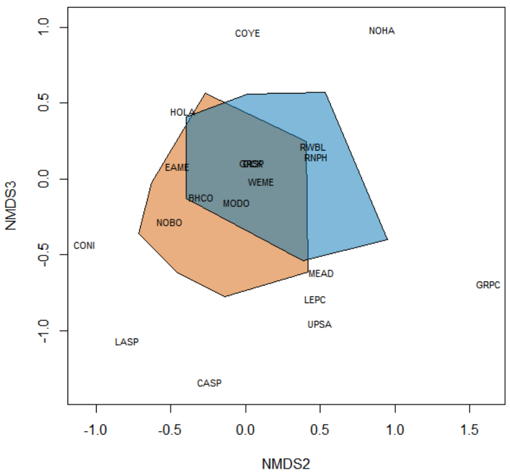
B


COYE
NOHA
HOLA
RWBL
RNPH
EAME
DICK
GRSP
WEME
BHCO
MODO
NOBO
CONI
MEAD
GRPC
LEPC
UPSA
LASP
CASP
1.0
0.5
0.0
-0.5
-1.0
NMDS3
-1.0
-0.5
0.0
0.5
1.0
NMDS1

E


WEME
BHCO
RWBL
MEAD
COYE
CONI
NOBO
HESP
RNPH
DICK
GRSP
EAME
MODO
UPSA
LASP
0.5
0.0
-0.5
-1.0
NMDS3
-1.0
-0.5
0.0
0.5
1.0
NMDS1

C


COYE
NOHA
HOLA
RWBL
RNPH
EAME
GRSP
DICK
WEME
BHCO
MODO
NOBO
CONI
MEAD
GRPC
LEPC
UPSA
LASP
CASP
1.0
0.5
0.0
-0.5
-1.0
NMDS3
-1.0
-0.5
0.0
0.5
1.0
1.5
NMDS2

F

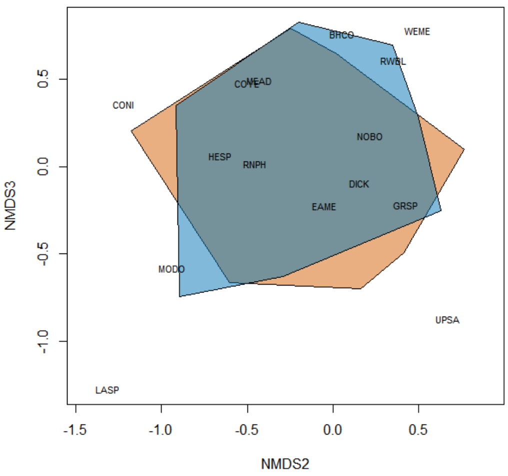
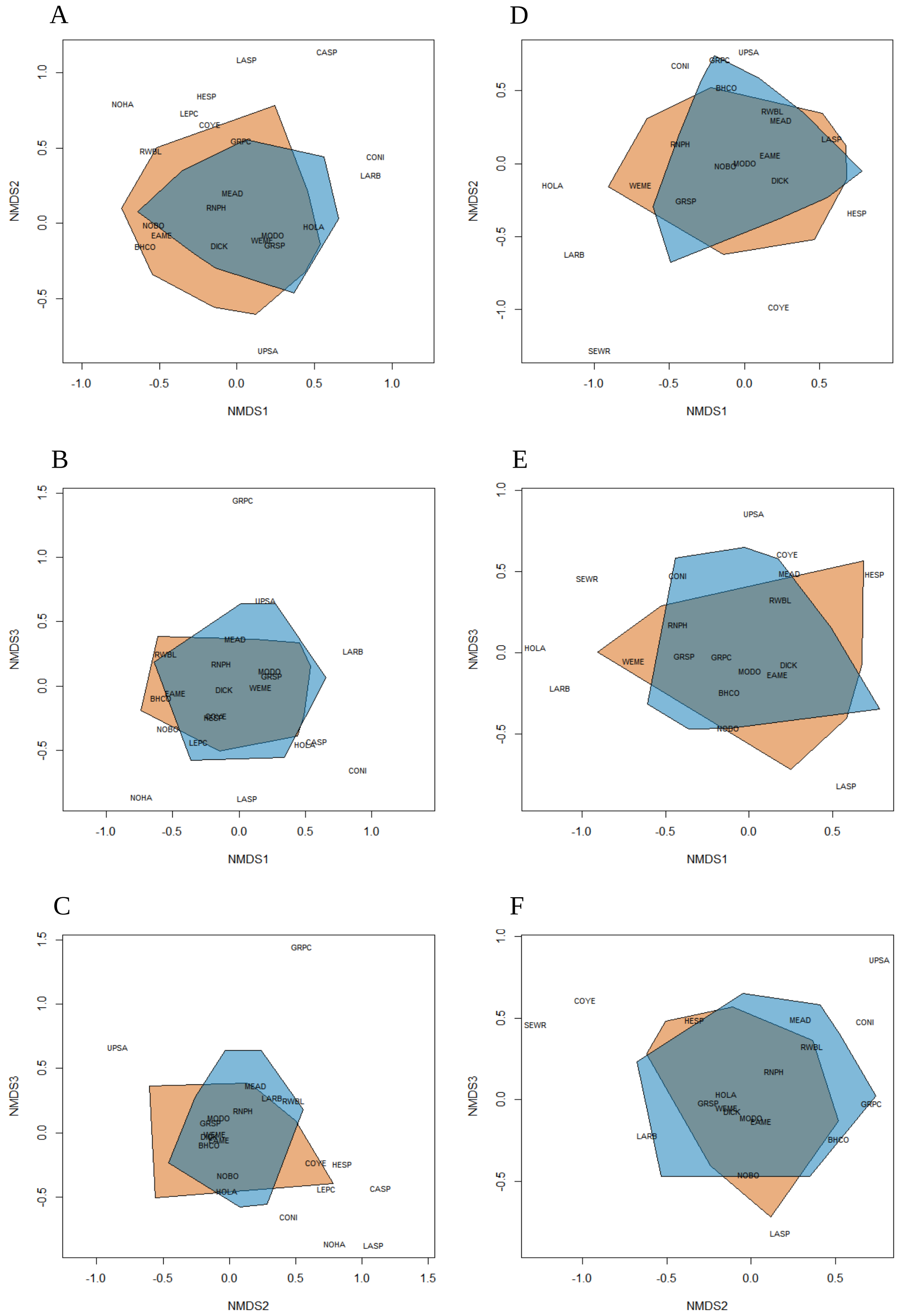

BHCO
WEME
RWBL
COYE
MEAD
CONI
NOBO
HESP
RNPH
DICK
EAME
GRSP
MODO
UPSA
LASP
0.5
0.0
-0.5
-1.0
NMDS3
-1.5
-1.0
-0.5
0.0
0.5
NMDS2

Figure 10. Non-metric multidimensional scaling graphs depicting bird community similarity between CP2 (orange) and CP25 (blue) Conservation Reserve Program fields in western and eastern Kansas between 2017 and 2019 among three dimensions. Each pairwise combination among three NMDS axes are shown, with graphs A-C from western Kansas and D-F from eastern Kansas. See Appendix A for corresponding 4-letter species codes.


A
NMDS1
NMDS2
CASP
LASP
HESP
NOHA
LEPC
COYE
GRPC
RWBL
CONI
LARB
MEAD
RNPH
NOBO
EAME
BHCO
DICK
WEME
MODO
GRSP
HOLA
UPSA
D
NMDS1
NMDS2
UPSA
GRPC
CONI
BHCO
RWBL
MEAD
LASP
RNPH
EAME
NOBO
MODO
DICK
HOLA
WEME
GRSP
HESP
LARB
COYE
SEWR
B
NMDS1
NMDS3
GRPC
UPSA
MEAD
LARB
RWBL
RNPH
MODO
GRSP
WEME
DICK
EAME
BHCO
COYE
HESP
NOBO
LEPC
HOLA
CASP
CONI
NOHA
LASP
E
NMDS1
NMDS3
UPSA
COYE
SEWR
CONI
MEAD
HESP
RWBL
RNPH
HOLA
WEME
GRSP
GRPC
DICK
MODO
EAME
LARB
BHCO
NOBO
LASP
C
NMDS2
NMDS3
GRPC
UPSA
MEAD
LARB
RWBL
RNPH
MODO
GRSP
WEME
DICK
EAME
BHCO
COYE
HESP
NOBO
HOLA
LEPC
CASP
CONI
NOHA
LASP
F
NMDS2
NMDS3
UPSA
COYE
SEWR
HESP
MEAD
CONI
RWBL
RNPH
HOLA
GRSP
WEME
DICK
MODO
EAME
GRPC
LARB
BHCO
NOBO
LASP

Appendix A. List of birds detected during line-transect surveys, corresponding alpha code (Pyle and Desante 2003), and the total number of detections per species by region (excluding flyovers) in western and eastern Kansas, 2017-2019.

Common name	**Species name**	**Alpha code**	**West**	**East**
Blue-winged teal	*Spatula discors*	BWTE	-	2
Mallard	*Anas platyrhynchos*	MALL	4	-
Northern bobwhite[a]	*Colinus virginianus*	NOBO	37	72
Ring-necked pheasant[a]	*Phasianus colchicus*	RWBL	156	-
Prairie Chicken spp. [a]	*Tympanuchus spp.*	PRCH	1	-
Greater prairie-chicken[a]	*Tympanuchus cupido*	GRPC	2	4
Lesser prairie-chicken[a]	*Tympanuchus pallidicinctus*	LEPC	2	-
Wild turkey	*Meleagris gallopavo*	WITU	-	1
Mourning dove[a]	*Zenaida macroura*	MODO	137	24
Common nighthawk[a]	*Chordeiles minor*	CONI	7	6
Sora	*Porzana carolina*	SORA	1	-
Killdeer	*Charadrius vociferus*	KILL	1	1
Upland sandpiper[a]	*Bartramia longicauda*	UPSA	2	12
Northern harrier[a]	*Circus hudsonius*	NOHA	1	-
Northern flicker	*Colaptes auratus*	NOFL	2	2
Western kingbird	*Tyrannus verticalis*	WEKI	9	3
Eastern kingbird	*Tyrannus tyrannus*	EAKI	6	14
Scissor-tailed flycatcher	*Tyrannus forficatus*	STFL	-	4

Eastern phoebe	*Sayornis phoebe*	EAPH	-	1
Bell's vireo	*Vireo bellii*	BEVI	-	10
Horned lark[a]	*Eremophila alpestris*	HOLA	61	1
Cliff swallow	*Petrochelidon pyrrhonota*	CLSW	1	-
Sedge wren[a]	*Cistothorus platensis*	SEWR	-	3
Eastern bluebird	*Sialia sialis*	EABL	-	1
American robin	*Turdus migratorius*	AMRO	-	1
Grey catbird	*Dumetella carolinensis*	GRCA	-	1
Brown thrasher	*Toxostoma rufum*	BRTH	-	2
Northern mockingbird	*Mimus polyglottos*	NOMO	-	1
European starling	*Sturnus vulgaris*	EUST	1	-
House finch	*Haemorhous mexicanus*	HOFI	1	-
American goldfinch	*Spinus tristis*	AMGO	-	2
Cassin's sparrow[a]	*Peucaea cassinii*	CASP	7	-
Grasshopper sparrow[a]	*Ammodramus savannarum*	GRSP	1716	314
Lark sparrow[a]	*Chondestes grammacus*	LASP	1	9
Lark bunting[a]	*Calamospiza melanocorys*	LARB	25	-
Field sparrow	*Spizella pusilla*	FISP	-	7
Henslow's sparrow[a]	*Centronyx henslowii*	HESP	-	64
Meadowlark spp. [a]	*Sturnella spp.*	MEAD	185	106
Eastern meadowlark[a]	*Sturnella magna*	EAME	242	546
Western meadowlark[a]	*Strnella neglecta*	WEME	795	24
Orchard oriole	*Icterus spurius*	OROR	1	3

Baltimore oriole	*Icterus galbula*	BAOR	-	3
Red-winged blackbird[a]	*Agelaius phoeniceus*	RNPH	147	93
Brown-headed cowbird[a]	*Molothrus ater*	BHCO	121	59
Common grackle	*Quiscalus quiscula*	COGR	1	3
Great-tailed grackle	*Quiscalus mexicanus*	GTGR	-	1
Common yellowthroat[a]	*Geothlypis trichas*	COYE	2	16
Yellow warbler	*Setophaga petechia*	YEWA	-	1
Indigo bunting	*Passerina cyanea*	INBU	-	1
Dickcissel[a]	*Spiza americana*	DICK	1763	3109

[a] Species that utilize grassland habitat for nesting.

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Effects of cattle grazing on bird abundance and diversity in
Conservation Reserve Program grasslands

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