Regional Assessment of the Effects of Conservation Practices on Priority Birds in the Shortgrass Prairie Bird Conservation Region (BCR 18)

March 2012

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ROCKY MOUNTAIN BIRD OBSERVATORY

***Mission**: To conserve birds and their habitats*

***Vision**: Native bird populations are sustained in healthy ecosystems*

***Core Values**:*

1. ***Science** provides the foundation for effective bird conservation.*
2. ***Education** is critical to the success of bird conservation.*
3. ***Stewardship** of birds and their habitats is a shared responsibility.*

RMBO accomplishes its mission by:

- ***Monitoring** long-term bird population trends to provide a scientific foundation for conservation action.*
- ***Researching** bird ecology and population response to anthropogenic and natural processes to evaluate and adjust management and conservation strategies using the best available science.*
- ***Educating** people of all ages through active, experiential programs that create an awareness and appreciation for birds.*
- ***Fostering** good stewardship on private and public lands through voluntary, cooperative partnerships that create win-win situations for wildlife and people.*
- ***Partnering** with state and federal natural resource agencies, private citizens, schools, universities, and other non-governmental organizations to build synergy and consensus for bird conservation.*
- ***Sharing** the latest information on bird populations, land management and conservation practices to create informed publics.*
- ***Delivering** bird conservation at biologically relevant scales by working across political and jurisdictional boundaries in western North America.*

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EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory (RMBO) piloted a monitoring and assessment effort for agricultural conservation projects implemented by producers under the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Conservation Stewardship Program (CSP). The objectives of this pilot study are to 1) evaluate the effects of grazing deferment on grassland bird species and assess the overall feasibility of monitoring conservation activities implemented under CSP, and 2) compare avian distribution and abundance in lands enrolled in CSP to bird distribution and abundance within the Shortgrass Prairie Bird Conservation Region (BCR 18).

We used the principles of distance analysis and occupancy estimation to assess differences between grazed and deferred pastures enrolled in CSP, and comparisons between these lands and those throughout BCR 18 north of the Arkansas River in Colorado. We also determined habitat relationships for selected bird species in lands enrolled in CSP program using a multi-scale occupancy model.

We surveyed 52 pastures, with 23 treatment pastures and 29 control pastures on 14 participant's properties between May 15th and July 1st, 2011. We counted birds at 176 points within the 23 treatments and 221 points within the 29 controls, with an average of 8 points per pasture. We recorded 4,779 birds of 62 species. Among CSP lands, Cassin's Sparrow occurred in higher densities in deferred pastures, while Horned Lark occurred in higher densities in grazed pastures. Grasshopper Sparrows were more abundant on lands enrolled in CSP than those on randomly located lands within the northern region of BCR 18 within Colorado. Horned Lark, Lark Bunting and Western Meadowlark were more abundant on BCR 18 lands compared to those enrolled in CSP. Sixteen species had detections sufficient enough to generate occupancy estimates; and all occupied a similar proportion of parcels across grazed and deferred pastures. Barn Swallow, Killdeer, Lark Bunting, Mourning dove and Red-winged Blackbird had higher proportions of occupancy in BCR 18 lands within Colorado than those on lands enrolled in CSP. Brown-headed Cowbird and Northern Mockingbird had higher proportions of occupancy on CSP lands than the BCR 18 lands. Among CSP lands, Horned Lark and Vesper Sparrow occupied a higher proportion of points in grazed pastures than points in deferred pastures. Brown-headed Cowbird, Lark Bunting, Mourning Dove, Northern Mockingbird and Western Meadowlark occupied a higher proportion of points within BCR 18 than points within CSP lands. Cassin's Sparrow, Grasshopper Sparrow and Killdeer occupied a higher proportion of points within CSP lands than those within BCR 18 lands. Grazing intensity and the cover of Sand Dropseed (*Sporobolus cryptandrus),* an increaser species, which shows up with heavier grazing pressure, had the largest influence on bird occurrence in grazed and deferred pastures enrolled in the CSP program.

This pilot work yielded interesting results revealing which common species benefit most from grazing deferment and how these species respond to habitat characteristics on CSP lands. This information should help inform management of CSP lands and future conservation practices.

ACKNOWLEDGEMENTS

Rocky Mountain Bird Observatory (RMBO) thanks the Natural Resource Conservation Service (NRCS) and Charlie Rewa for funding this project. We gratefully acknowledge all of the private producers who allowed us access to their land and provided us with valuable information regarding their participation in the Conservation Stewardship Program. Lauren Throop conducted the majority of field work for this project and contacted producers for permission. Private Lands Biologist, Noe Marymor, obtained missing participant contact information. Seth Gallagher provided vegetation training and assisted with developing the study design. Rob Sparks provided spatial expertise and assisted with developing the sampling design. Michael Getzy managed and updated the RMBO database which holds the data for this project. This report was reviewed by RMBO staff who served as CEAP committee participants.

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INTRODUCTION

Rocky Mountain Bird Observatory (RMBO) piloted a monitoring and assessment effort for agricultural conservation projects implemented by producers under the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Conservation Stewardship Program (CSP). The CSP is a voluntary program that encourages private producers to implement conservation activities on their lands which address regional or local natural resource needs (Natural Resources Conservation Service 2010). Cooperating with local NRCS offices, RMBO chose to investigate the CSP Enhancement Activity – "Grazing Management to Improve Wildlife Habitat" (ANM09) – throughout Northeastern Colorado because of our knowledge and history working in the area and the adequate number of program participants available within the proposed study area.

Native grass prairies of the Great Plains are one of the most endangered ecosystems in North America (Samson et al. 1998) and are heavily relied upon by cattle producers. In both grazed and un-grazed prairies, birds which rely on the grassland for successful breeding are experiencing dramatic declines (Samson and Knopf 1994, Peterjohn and Sauer. 1999, Ribic et al. 2009). To track populations of grassland birds and identify specific causes of declines, long-term and large-scale monitoring is required. Despite the widespread use of monitoring to address these declines on other lands, historically there has been very little monitoring to determine the effectiveness of conservation practices implemented by producers as part of incentive-based programs such as CSP.

The objectives of this pilot study are to 1) evaluate the effects of grazing deferment on grassland bird species and assess the overall feasibility of monitoring conservation activities implemented under CSP, and 2) compare avian distribution and abundance in lands enrolled in CSP to bird distribution and abundance within lands the Shortgrass Prairie Bird Conservation Region (BCR 18). We narrowed the area of inference to BCR 18 in Colorado north of the Arkansas River (hereafter referred to as "BCR 18 lands"). We selected transects from four predetermined strata which include public and private land. These transects were selected using generalized random-tessellation stratification (GRTS), a spatially balanced algorithm (Stevens and Olsen 2004). We chose to compare CSP lands to these locations because the sample units were previously selected and sampled as part of another RMBO monitoring project, "Integrated Monitoring in Bird Conservation Regions", during the spring of 2011 The CSP lands surveyed and those used for comparison are both areas characterized by unique shortgrass prairie fragmented by agriculture and various grazing regimes. The area covers 2/3 of eastern Colorado totaling 79,845 km².

As outlined in the agreement between NRCS and RMBO, we also conducted one supplemental survey in South Dakota. We worked with the Ecosystem Management Research Institute (EMRI), a non-profit implementing a collaborative grassland restoration program in South Dakota and Nebraska across NRCS ecological sites on private lands. The program aims to restore 4-8,000 acres of native grasslands to demonstrate how grassland restoration can be achieved using incentive-based federal programs. EMRI will develop a 10-year grazing plan where restoration is maintained while maximizing producer output. RMBO conducted 16 point

counts at one of nine active project areas in South Dakota. The surveyed site is located in Sanborn County and after deferring grazing for one season, is scheduled to be burned in the spring of 2012 to decrease invasive grasses and increase native vegetation. We surveyed this site on June 16, 2011 and recorded 171 birds of 32 species (Appendix B). RMBO will conduct a 2012 survey after prescribed burning takes place.

METHODS

Study Area

We used NRCS data from all "Grazing Management to Improve Wildlife Habitat" participates within Colorado, stratified by county, and removed all counties west of Interstate-25 (BCR 18 western boundary). We eliminated extreme southern counties to reduce variation in bird species and travel-related expenses. The study area covered nine counties in northeastern Colorado; Cheyenne, Elbert, El Paso, Kit Carson, Larimer, Lincoln, Sedgwick, Washington and Weld (Figure 1). These counties are all part of BCR 18 and have high percentages of private land, with large areas of grasslands grazed by cattle. From the list of potential locations provided by NRCS, producers were contacted in order of priority based onsite rank and acreage. Once a producer gave permission to survey, the pasture(s) was then added to the sampling list. Before surveying, the technician asked whether each pasture enrolled in the program had any cattle present during May or June (controls), or whether they are free of cattle until July or later (treatments).

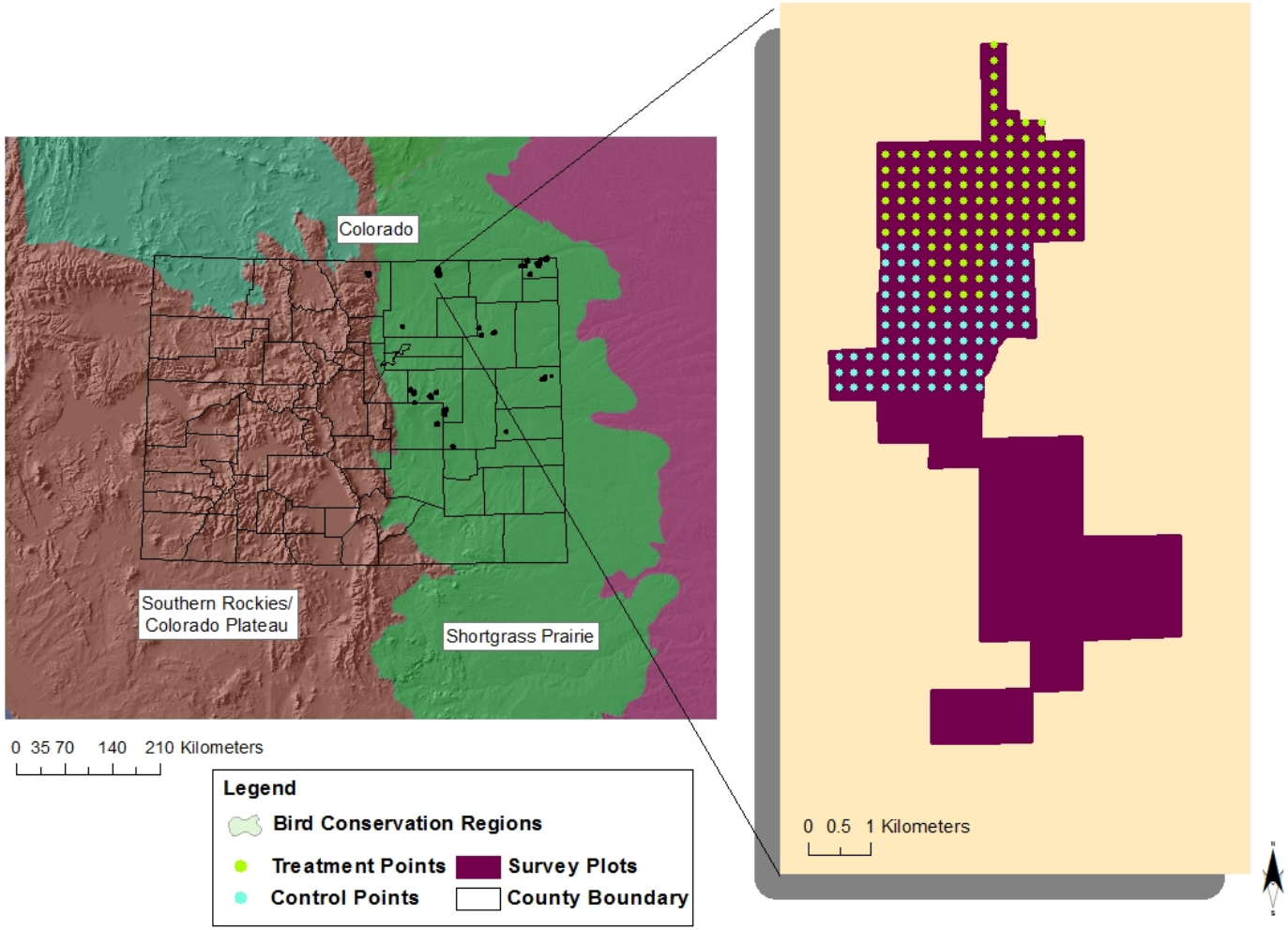

Figure 1. Study area and survey locations.

Sampling Design

We populated each pasture enrolled in the program with randomly numbered points spaced 250 meters apart. Since individual pastures deferred from grazing varied widely among producers, treatment and control status was assigned after confirming deferment with the landowner. We surveyed birds at up to nine points within each pasture (the sample unit) beginning at the point randomly designated as point one. The technician formed a nine-point grid (3 x 3) around point one with point one ideally in the center. If the first point fell at the edge of a pasture, the grid was formed as symmetrically as possible within that same pasture with point one on the edge of the grid. If any points fell into any habitat other than shortgrass-prairie or shrub-grassland (e.g. riparian, wetland, pine woodland, etc.), the point was skipped and the technician moved to the next-closest point in appropriate habitat.

A trained RMBO biological technician conducted point counts (Buckland et al. 2001) between May 15th and July 1st, 2011 following protocol established by RMBO (Hanni et al. 2011). Sites were surveyed in the morning, beginning ½-hour before sunrise and concluding no later than 10 AM. The complete sampling interval at each point was six minutes. For every bird detected during each of the six minute counts, we recorded species, sex, horizontal distance from the observer, minute we detected the bird, and type of detection (e.g., call, song, visual). Unless prevented by weather or other factors, two sites (generally a treatment and control) were visited each morning.

At the start and end of each survey, the technician recorded time, temperature in degrees Fahrenheit, percent cloud cover, precipitation type, and wind speed using the Beaufort scale. To navigate between points and pastures, the technician used a hand-held Global Positioning System (GPS) unit with Universal Transverse Mercator (UTM) North American Datum 1983 (NAD 83). At each point, we recorded distance from a road (if within 100 meters), detailed site data (within a 50 m radius), including whether there was excessive noise, the presence of structures or fences, whether there was a cliff, rock feature or cut bank, the presence of prairie dogs, and whether the point was a wetland. We also recorded vegetation data, including the intensity of grazing from none (0) to heavy (3) grazing. For shrub and ground components, we recorded species, relative abundance, percent coverage, and mean height. We differentiated exotic and native cover types and recorded their relative abundance. We recorded these data prior to beginning each point count.

For more detailed information about survey methods, refer to RMBO's Field Protocol for Spatially Balanced Sampling of Landbird Populations on our website: http://rmbo.org/v3/ourwork/science/birdpopulationmonitoring/specializedprograms/OurWork/Science/Protocols.aspx.

Distance Analysis

We used the analysis software Distance 6.0 (Thomas et al. 2010) to estimate detection probabilities using the point count data. Analysis of distance data is accomplished by fitting a detection function to the distribution of recorded distances. We estimated densities of species for which we obtained at least 60 independent detections. We excluded birds flying over but not using the immediate surrounding landscape and birds detected between points from analyses.

We fit the following functions to the distribution of distances for each species: Half normal key function with cosine series expansion, Uniform function with cosine series expansion, Hazard rate key function with cosine series expansion, and Hazard rate key function with simple polynomial series expansion (Buckland et al. 2001). We used Akaike's Information Criterion (AIC) corrected for small sample size (AICc) and model selection theory to select the most parsimonious detection function for each species (Burnham and Anderson 2002). We estimated variance in program Distance using bootstrapping of transects within strata rather than using empirical estimates. Empirical methods tend to underestimate variance from small sample sizes. We compared density estimates from treatment and control pastures and to the same geographic area density estimates collected under RMBO's IMBCR design (White et al. 2011).

Occupancy Analysis

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., grid cells) occupied by an organism (MacKenzie et al. 2002). The application of occupancy models requires multiple surveys of the sample unit in space or time to estimate a detection probability (MacKenzie et al. 2006). The detection probability adjusts the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). The assumptions of the occupancy model are 1) the probabilities of detection and occupancy are constant across the sample units, 2) each point is closed to changes in occupancy over the sampling season, 3) the detection of species at each point are independent and 4) the target species are never falsely identified (MacKenzie et al. 2006).

We used a multi-scale occupancy model (Nichols et al. 2008, Pavlacky et al. 2012) to estimate 1) the probability of detecting a species given presence (*p*), 2) the proportion of points occupied by a species given presence within the sampled grid cells (Theta) and 3) the proportion of grid cells occupied by a species (Psi). For the CSP design, Psi represented the proportion of parcels occupied by the species, and Theta represented of proportion of points occupied by a species when the parcel was occupied. We used a removal design (MacKenzie et al. 2006) to estimate a detection probability for each species by partitioning the six-minute count into three sequential two-minute sampling intervals. After the target species was detected at a point, we set all subsequent sampling intervals at that point to missing data (MacKenzie et al. 2006). The nine grid points in the CSP design and 16 grid points in the IMBCR design served as spatial replicates for estimating the proportion of points occupied within the sampled grid cells. We truncated the data, using only detections within 125 m of the sample points. Truncating the data at 125 m allowed us to use bird detections over a consistent plot size and ensured that the points were independent (points were spread 250 m apart), which in turn allowed us to estimate Theta (the proportion of points occupied within each grid cell or parcel) (Pavlacky et al. 2012).

For the IMBCR design, we expected that regional differences in the behavior, habitat use and local abundance of bird species would correspond to regional variation in detection and the proportion of occupied points. Therefore, we estimated the proportion of grid cells occupied (Psi) for each stratum by evaluating four models with different structure for detection (*p*) and the proportion of points occupied (Theta). Within these models, the estimates of *p* and Theta were held constant across the BCRs and/or allowed to vary by BCR. The first model constrained *p*

and Theta by holding these parameters constant. The second model held *p* constant, but allowed Theta to vary across BCRs. The third model allowed *p* to vary across BCRs, but held Theta constant. The fourth model allowed both *p* and Theta to vary across BCRs. We ran model 1 for species with less than 10 detections in all BCRs or less than 10 detections in all but one BCR. We ran models 1 through 4 for species with greater than 10 detections in more than 1 BCR. For the purpose of estimating regional variation in detection (*p*) and availability (Theta), we pooled data for BCRs with fewer than 10 detections into adjacent BCRs with sufficient numbers of detections.

For the CSP design, we ran multiple occupancy models to determine the effects of grazing deferment on bird occurrence. The models allowed the proportion of parcels occupied (Psi) and the proportion of points occupied (Theta) to be constant (no treatment effect) and to vary by grazing treatment (treatment effect). The detection probabilities (p) were allowed to be constant (no treatment effect), and to vary by grazing treatment (treatment effect), survey date, and time of day.

We determine habitat relationships for selected bird species in lands enrolled in CSP ANM09 Enhancement Activity, specifically, Grazing Management for Wildlife, using the multi-scale occupancy model (Nichols et al. 2008, Pavlacky et al. 2012). We modeled the proportion of points occupied for each bird species as a function of the grazing treatment variable and nine habitat variables which included grass height, grass cover, shrub cover, and the cover of five common native and introduced species: Cheatgrass (*Bromus tectorum)*, Crested Wheatgrass (*Agropyron cristatum)*, Blue Grama (*Bouteloua gracilis)*, Sand Dropseed (*Sporobolus cryptandrus)*, and Western Wheatgrass (*Pascopyrum smithii*) (Table 2). We constructed multiple models containing all subsets of the grazing treatment and habitat variables. Effect sizes for the difference between the percentage (proportion) of shrub and grass cover in the grazed and deferred pastures were estimated using a generalized linear mixed model (Bolker et al. 2009) with a random effect of pasture, and an over-dispersed binomial distribution and logit link function (PROC GILIMMIX, SAS Institute 2008). The model for differences between the grass height index in grazed and deferred pastures used a normal distribution and identity link function. We used odds ratios to evaluate the effect sizes for the grass and shrub cover variables.

We used program MARK (White and Burnham 1999) to fit the multi-scale occupancy models and estimate the model parameters. We combined stratum-level estimates of Psi for the IMBCR design using a weighted mean indexed by stratum area. The sampling variance and standard error for the combined estimates of Psi was estimated using the delta method (Powell 2007) in program R (R Development Core Team 2011). We used our data to estimate the proportion of grid cells occupied for all species that were detected on a minimum of 10 points after truncating the 2011 data to observations within 125 m of each point. Occupancy estimates for species occurring on fewer than 10 points are not reported here because of unreliable model convergence.

As with the Distance analyses, we used Akaike's Information Criterion (AIC) corrected for small sample size (AICc) and model selection theory to evaluate models from which estimates of p,

Theta and Psi were derived for each species (Burnham and Anderson 2002). We model averaged the estimates of Psi from the candidate models and calculated unconditional standard errors for the estimates (Burnham and Anderson 2002). We evaluated the importance of the habitat variables by summing AICc weights for models containing each habitat variable (Burnham and Anderson 2002).

RESULTS

We surveyed 52 pastures, with 23 treatment pastures and 29 control pastures on 14 participant's properties between May 15th and July 1st, 2011. Twenty-two producers had pastures which met the previously described criteria for the study. Many producers had multiple areas enrolled in the program available for surveys. Four pastures had producers who were unreachable, six had producers who denied permission for surveys, four were in unsuitable habitat or had unsuitable acreage size, two fell on public land and three were on property's in which we were unable to obtain contact information for the producer. We counted birds at 176 treatment points and 221 control points, with an average of 8 points per pasture. We recorded 4,779 birds of 62 species (Appendix A). Unless otherwise specified, all bird species names listed in this report are from the American Ornithologists'' Union (A.O.U.) Check-list of North American Birds, Seventh Edition (2007).

Density Results

Five species had sufficient detections to estimate densities in order to compare treatments and controls; Cassin's Sparrow (*Aimophila cassinii*), Grasshopper Sparrow (*Ammodramus savannarum*), Horned Lark (*Eremophila alpestris*), Lark Bunting (*Calamospiza melanocorys*), and Western Meadowlark (*Sturnella neglecta*) (Table 1). Among CSP lands, Cassin's Sparrow occurred in higher densities in deferred pastures, while Horned Lark occurred in higher densities in grazed pastures. Grasshopper Sparrows were more abundant on lands enrolled in CSP than those on lands within the northern region of BCR 18 within Colorado. Conversely, Horned Lark, Lark Bunting and Western Meadowlark are more abundant throughout BCR 18 lands compared to lands enrolled in CSP lands.

Table 1. Estimated densities per km2 (D), standard errors (SE) and number of independent detections (n) for breeding bird species in deferred and grazed pastures enrolled in the Conservation Stewardship Program, and Bird Conservation Region 18 in Colorado north north of the Arkansas River, 2011 (IMBCR). The symbol S indicates the number of transects used in analyses.

	Deferred pastures (S=23)			Grazed pastures (S=29)			IMBCR (S=44)		
Species	D	SE	n	D	SE	n	D	SE	n
Cassin's Sparrow	27.63	9.39	269	12.98	4.15	139	7.44	1.79	134
Grasshopper Sparrow	47.22	18.42	122	50.73	21.81	145	16.41	3.72	105
Horned Lark	58.26	9.32	365	82.18	10.68	472	122.53	9.37	1078
Lark Bunting	15.04	7.82	97	16.47	5.27	230	97.85	15.64	946
Western Meadowlark	16.2	2.43	773	14.4	2.88	876	29.47	2.53	774

Occupancy Results

Sixteen species had detections sufficient enough to generate occupancy estimates; Barn Swallow (*Hirundo rustica)*, Brown-headed Cowbird (*Molothrus ater)*, Common Grackle (*Quiscalus quiscula)*, Cassin's Sparrow, Dickcissel (*Spiza americana*), Grasshopper Sparrow, Horned Lark, Killdeer (*Charadrius vociferus*), Lark Bunting, Lark Sparrow (*Chondestes grammacus)*, Mourning Dove (*Zenaida macroura)*, Northern Mockingbird (*Mimus polyglottos)*, Red-winged Blackbird (*Agelaius phoeniceus)*, Vesper Sparrow (*Pooecetes gramineus*), Western Kingbird (*Tyrannus verticalis)* and Western Meadowlark (Tables 2 and 3). All 16 species occupied a similar proportion of pastures (Psi) across grazed and deferred pastures. Barn Swallow, Killdeer, Lark Bunting, Mourning Dove and Red-winged Blackbird had higher proportions of occupancy on northern region BCR 18 lands within Colorado than those on lands enrolled in CSP (Table 3). Brown-headed Cowbird and Northern Mockingbird had higher proportions of occupancy on CSP lands than the BCR 18 lands (Table 3).

Of pastures occupied among CSP lands, Horned Lark and Vesper Sparrow occupied a higher proportion of points in grazed pastures than points in deferred pastures (Table 4). Brown-headed Cowbird, Lark Bunting, Mourning Dove, Northern Mockingbird and Western Meadowlark occupied a higher proportion of points within the BCR 18 lands than points within CSP lands (Table 4). Conversely, Cassin's Sparrow, Grasshopper Sparrow and Killdeer occupied a higher proportion of points within CSP lands than those within the BCR 18 lands (Table 4).

Table 2. Estimated proportion of sample units occupied (Psi), standard errors (SE) and number of parcels with one or more detections (nParc) for breeding bird species in deferred and grazed pastures enrolled in the Conservation Stewardship Program, and Bird Con servation Region 18 in Colorado north of the Arkansas River, 2011 (IMBCR). The symbol S indicates the number of transects used in analyses.

	Deferred pastures (S=23)			Grazed pastures (S=29)			IMBCR (S=44)		
Species	Psi	SE	nParc	Psi	SE	nParc	Psi	SE	nParc
Barn Swallow	0.183	0.070	4	0.173	0.064	4	0.588	0.106	20
Brown-headed Cowbird	0.754	0.235	8	0.791	0.238	13	0.418	0.086	17
Cassin's Sparrow	0.612	0.085	15	0.580	0.084	15	0.454	0.089	17
Common Grackle	0.214	0.090	3	0.222	0.090	5	0.234	0.070	10
Dickcissel	0.081	0.044	2	0.076	0.041	2	0.027	0.017	2
Grasshopper Sparrow	0.508	0.085	12	0.482	0.079	13	0.361	0.081	19
Horned Lark	1.000	-	23	0.932	0.047	27	0.947	0.040	42
Killdeer	0.184	0.070	4	0.205	0.069	5	0.419	0.114	12
Lark Bunting	0.586	0.095	11	0.623	0.086	18	0.884	0.054	39
Lark Sparrow	0.455	0.112	12	0.385	0.102	8	0.447	0.093	16
Mourning Dove	0.218	0.088	5	0.216	0.107	4	0.518	0.092	21
Northern Mockingbird	0.665	0.374	8	0.374	0.262	3	0.054	0.041	2
Red-winged Blackbird	0.096	0.063	2	0.133	0.066	4	0.532	0.092	17
Vesper Sparrow	0.338	0.173	6	0.210	0.077	5	0.455	0.131	10
Western Kingbird	0.819	0.135	15	0.766	0.116	16	0.575	0.098	25

Species	Deferred pastures (S=23)			Grazed pastures (S=29)			IMBCR (S=44)		
	Psi	SE	nParc	Psi	SE	nParc	Psi	SE	nParc
Western Meadowlark	0.951	0.045	21	0.952	0.041	27	0.954	0.035	42

Table 3. Estimated proportion of point count locations occupied when the sample unit is occupied (Theta), standard errors (SE) and number of points with one or more detections (nPt) for breeding bird species in deferred and grazed pastures enrolled in the Conservation Stewardship Program, and Bird Conservation Region 18 in Colorado north of the Arkansas River, 2011 (IMBCR). The symbol S indicates the number of transects used in analyses.

Species	Deferred pastures (S=23)			Grazed pastures (S=29)			IMBCR (S=44)		
	Theta	SE	nPt	Theta	SE	nPt	Theta	SE	nPt
Barn Swallow	0.350	0.187	7	0.354	0.187	9	0.253	0.074	33
Brown-headed Cowbird	0.120	0.054	12	0.116	0.045	16	0.294	0.025	25
Cassin's Sparrow	0.556	0.047	63	0.548	0.055	61	0.459	0.020	85
Common Grackle	0.146	0.098	3	0.218	0.122	8	0.261	0.078	32
Dickcissel	0.448	0.107	7	0.472	0.113	7	0.366	0.054	7
Grasshopper Sparrow	0.573	0.041	55	0.567	0.040	57	0.410	0.020	87
Horned Lark	0.782	0.036	131	0.856	0.028	183	0.750	0.013	441
Killdeer	0.269	0.073	7	0.290	0.062	16	0.106	0.038	21
Lark Bunting	0.326	0.061	26	0.386	0.051	58	0.546	0.012	305
Lark Sparrow	0.350	0.062	26	0.337	0.067	16	0.328	0.021	38
Mourning Dove	0.223	0.096	8	0.158	0.084	5	0.348	0.020	61
Northern Mockingbird	0.069	0.037	8	0.064	0.037	5	0.308	0.025	2
Red-winged Blackbird	0.205	0.108	2	0.241	0.085	8	0.259	0.018	30
Vesper Sparrow	0.184	0.078	9	0.868	0.141	17	0.112	0.052	17
Western Kingbird	0.214	0.051	23	0.230	0.065	32	0.278	0.028	45
Western Meadowlark	0.476	0.032	79	0.471	0.030	98	0.606	0.013	337

Habitat Results

We conducted habitat relationship analyses for nine bird species: Brown-headed Cowbird, Cassin's Sparrow, Grasshopper Sparrow, Horned Lark, Lark Bunting, Lark Sparrow, Vesper Sparrow, Western Kingbird and Western Meadowlark (Table 5). The occurrence of Brown-headed Cowbirds was greater at point count locations with low grazing intensity than at locations with moderate grazing intensity and occupancy was greater at moderate grazing intensity than at high grazing intensity (Figure 2). Brown-headed Cowbirds also declined at point count locations with increasing grass height (Table 5). Cassin's Sparrow occupancy increased at points with increasing shrub cover, declined with increasing cover of Blue Grama (*Bouteloua gracilis*), declined with increasing grass cover, declined with increasing cover of Crested Wheatgrass (*Agropyron cristatum*) and declined with increasing grass height (Table 5). Grasshopper Sparrow occupancy was greater at points with low and moderate grazing intensity than at points with high grazing intensity (Figure 2). The occurrence of Grasshopper Sparrow also increased with increasing grass cover, declined with increasing cover of Western

Wheatgrass (*Pascopyrum smithii*) and increased with increasing cover of Sand Dropseed (*Sporobolus cryptandrus*). The occurrence of Horned Lark declined at points with increasing Cheatgrass (*Bromus tectorum*), declined with increasing shrub cover, increased with increasing Blue Grama cover and declined with increasing Western Wheatgrass cover (Table 5). Lark Bunting occupancy declined at points with increasing Sand Dropseed cover, and after accounting for this effect, Lark Buntings occurred less frequently at deferred pastures than at grazed pastures (Table 5). The occupancy of Lark Sparrow was greater at points with moderate grazing intensity than at points with high and low grazing intensity (Figure 2), and occupancy increased with increasing Crested Wheatgrass (Table 5). The occurrence of Vesper Sparrow was lower at deferred pastures than at grazed pastures, and this species did not show large responses to the habitat variables (Table 5). Western Kingbird occupancy increased at points with increased grass height, decreased with increasing Sand Dropseed cover and increased with increasing Crested Wheatgrass cover (Table 5). The occurrence of Western Meadowlark declined at points with increasing Blue Grama and declined with increasing Sand Dropseed (Table 5). Western Meadowlark occurred more frequently at points with low grazing intensity than at points with moderate and high grazing intensity (Figure 2).

There was very little evidence for differences between grass height, shrub cover, grass cover and grass cover by species in the grazed and deferred pastures (Table 1). The 95% confidence intervals (CI) for the odds ratios between grass and shrub cover in grazed and deferred pastures all covered one (not shown), indicating small effect sizes for the grazed and deferred pastures. In addition, the difference between the grass height index in the deferred and grazed pastures was small and the 95% confidence interval for the effect size covered zero (Table 1; effect size = -0.22; CI = -0.59, 0.15).

Table 4. The mean values and standard errors (SE) for habitat variables measured in grazed and deferred pastures enrolled in the CSP program.

	Deferred		Grazed	
Habitat variables	Mean	SE	Mean	SE
Grass height (Index)	2.24	0.14	2.02	0.12
Grass cover (%)	69.26	3.03	74.41	2.42
Shrub cover (%)	2.88	0.74	1.83	0.44
Cheatgrass cover (%)	1.23	0.65	1.57	0.72
Crested wheatgrass cover (%)	0.69	0.34	1.07	0.44
Blue grama cover (%)	42.33	12.70	53.50	11.54
Sand dropseed cover (%)	7.25	2.38	3.80	1.17
Western wheatgrass cover (%)	3.70	1.23	2.83	0.87

Table 5. The importance of habitat variables for explaining the occurrence of bird species at the point count locations (Theta).Table 6. The values are cumulative AICc weights for models including the variables and the signs represent the direction of the habitat relationships. The values greater than 0.5 (shown in bold) represent the habitat relationships that are more likely than are expected by chance. The bird species are Brown-headed Cowbird (BHCO), Cassin's Sparrow (CASP), Grasshopper Sparrow (GRSP), Horned Lark (HOLA), Lark Bunting (LARB),

Lark Sparrow (LASP), Vesper Sparrow (VESP), Western Kingbird (WEKI) and Western Meadowlark (WEME).

Habitat variables	BHCO	CASP	GRSP	HOLA	LARB	LASP	VESP	WEKI	WEME
Deferred pasture	-0.250	+0.172	-0.392	-0.319	-0.720	+0.194	-0.996	-0.409	-0.250
Grass cover	-0.372	-0.888	+1.000	+0.238	+0.217	-0.238	+0.293	-0.222	-0.209
Grass height	-0.961	-0.563	+0.265	-0.255	+0.194	+0.194	+0.197	+0.866	+0.266
Shrub cover	-0.287	+1.000	+0.264	-0.768	-0.212	+0.301	+0.400	-0.249	-0.480
Grazing intensity	0.984	0.462	0.996	0.286	0.198	0.821	0.193	0.085	0.548
Cheatgrass	-0.203	+0.186	+0.389	-0.933	-0.246	+0.244	-0.389	+0.470	-0.207
Crested wheatgrass	+0.276	-0.601	-0.197	+0.196	-0.213	+0.549	+0.220	+0.725	+0.236
Blue grama	-0.308	-0.966	-0.478	+0.757	+0.320	+0.454	-0.198	+0.493	-0.947
Sand dropseed	-0.400	+0.426	+0.829	-0.493	-0.886	-0.203	-0.233	-0.739	-0.810
Western wheatgrass	+0.340	-0.387	-0.913	-0.672	-0.249	-0.403	-0.456	+0.345	+0.262

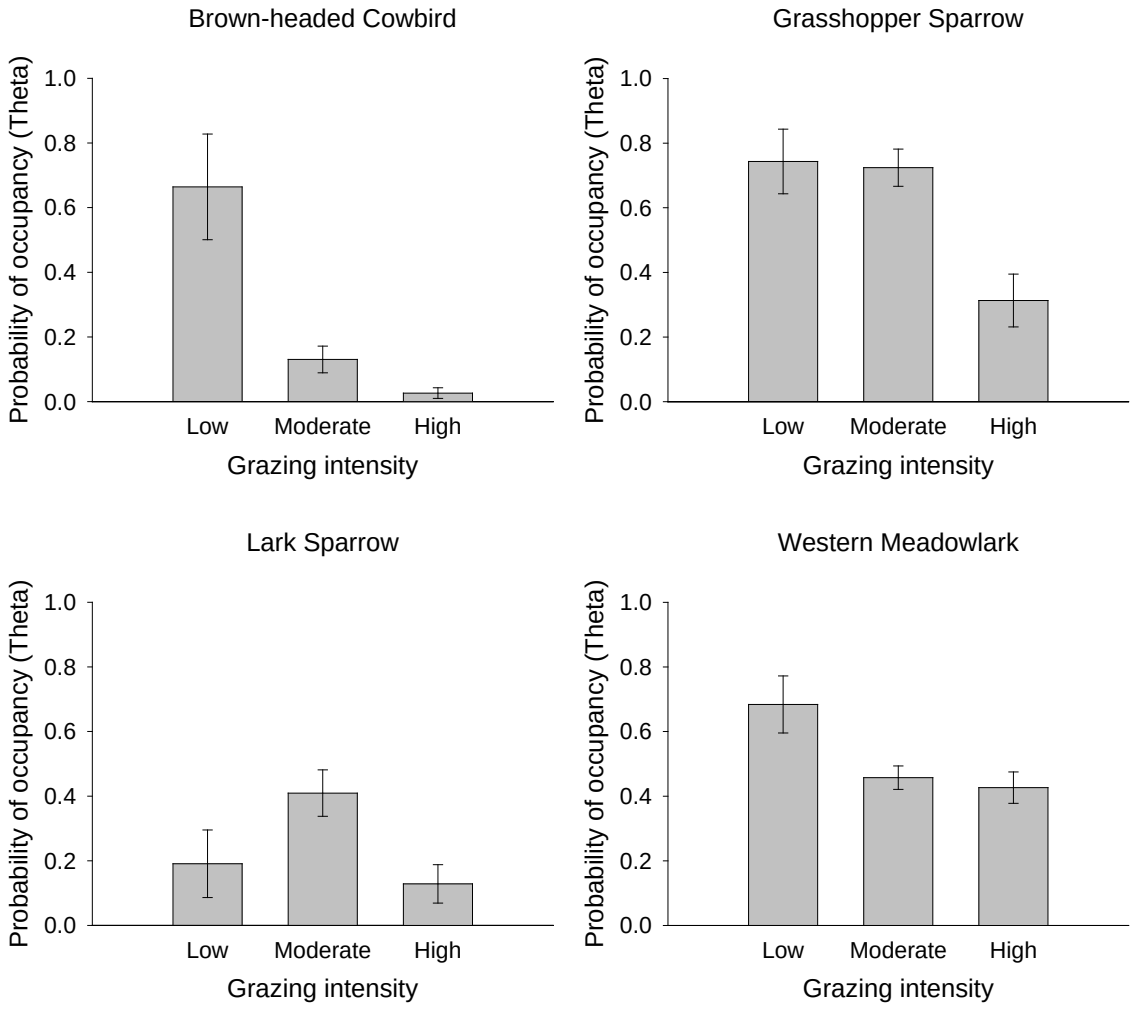

Figure 2. The proportion of point count locations occupied (Theta) as a function grazing intensity from the best habitat models for the Brown-headed Cowbird, Grasshopper Sparrow, Lark Sparrow, and Western Meadowlark.

DISCUSSION

Among the five species that had sufficient detections to estimate densities, we expected Cassin's Sparrow to benefit from deferred grazing during the breeding season as these areas may have sections of denser and taller grass, ideal for singing perches. According to our results, Cassin's Sparrow reached its highest density in deferred pastures. We also expected to see Horned Lark in higher densities in grazed pastures, since this species prefers areas with bare ground, or lower vegetative cover (Beason 1995). If we assume lands outside of CSP enrollment are grazed more heavily, grasshopper sparrows may also be benefiting from deferment practices as they were more abundant on lands enrolled in CSP than those on lands within the northern region of BCR 18 within Colorado. Conversely, Horned Lark, Lark Bunting and Western Meadowlark are more abundant on these sampled BCR 18 lands compared to those enrolled in CSP. These are three species for which we get very high density estimates throughout sampled BCR18 lands.

Of the 16 species available for occupancy estimation, there were no significant differences in occupancy across grazed and deferred pastures on CSP lands. We did see differences for seven species when we compared CSP lands to BCR 18 lands. Barn Swallow, Killdeer, Lark Bunting, Mourning Dove and Red-winged Blackbird had higher proportions of occupancy on BCR 18 lands than those on lands enrolled in CSP (Table 2). Barn Swallow, Killdeer and Red-winged Blackbirds are more generalist species which may prefer disturbed lands with some structure unlike species such as Cassin's and Grasshopper Sparrows which have particular grassland structural needs for breeding. Brown-headed Cowbirds having higher proportions of occupancy on CSP lands may be attributed to the presence of cattle at or near the survey site. Cowbirds also follow nesting species, and their occupancy may indicate birds of other species nesting in CSP lands. Northern Mockingbirds also had higher proportions of occupancy on CSP lands than the BCR 18 lands, but this may be attributed to this species being locally common and many CSP sites clustered together geographically because of ownership.

Of pastures occupied among CSP lands, Horned Lark and Vesper Sparrow occupied a higher proportion of points in grazed pastures than points in deferred pastures (Table 3). Brown-headed cowbird, lark bunting, mourning dove, northern mockingbird and western meadowlark occupied a higher proportion of points within the BCR 18 lands than points within CSP lands (Table 3). Conversely, Cassin's sparrow, grasshopper sparrow and killdeer occupied a higher proportion of points within CSP lands than those within the BCR 18 lands (Table 3).

In order to determine our ability to detect differences in the occupancy rates of the treatment and control plots, during the sampling design phase of this project, we ran a simulation using the multi-scale occupancy model, which estimated the fraction of deferred and grazed pastures occupied (Psi), as well as the fraction of points occupied in the deferred and grazed pastures (Theta). We used a detection probability of 0.3, which is typical of many songbirds. We investigated four scenarios with a 25% or 50% change in Psi and Theta using a sample design that assumed an average of six point counts per pasture and 50 deferred and 50 grazed pastures. We were able to detect a 50% change in occupancy at the pasture and point level, but not a 25% change. The results of this power analysis suggested that with a sample size 50

deferred and 50 grazed pastures, we would be able to detect differences in occupancy somewhat greater than 25%. The current study design allocated nine points per pasture and an average of eight point count surveys were conducted per pasture, which should result in greater power to detect changes in occupancy. Nevertheless, we were constrained by limited time to prepare for field work and limited producer participation in the defined study area, to complete all 100 pasture visits and this may have reduced the power to detect changes in occupancy.

Grazing intensity and the cover of Sand Dropseed had the largest influence on bird occurrence in grazed and deferred pastures enrolled in the CSP program. Each of these variables influenced the distribution of four species (Figure 2). Sand Dropseed is a warm season grass which shows up with increased grazing pressure. It is palatable for cattle early in the summer, but not preferred like Blue Grama. Grass height, Crested Wheatgrass cover and Blue Grama cover were the next most important variables, each influencing the distribution of three species (Table 5). Our results suggest that range management activities that influence grazing intensity, grass height and the cover of native and non-native grass species can influence the territory occupancy of grassland bird species. Each point count location encompassed an area of 4.9 ha, which is approximately the territory size for small songbirds (Pavlacky et al. 2012). When the sample units are approximately the size of a territory, occupancy can be interpreted as abundance or the number of territories (MacKenzie et al. 2006). The habitat results of Brown-headed Cowbird are curious, as lower grazing intensity should be correlated with increased grass height. Cowbirds increased with lower grazing intensity but declined with increasing grass height. There may be other variables accounting for these results that were not measured in this analysis.

It is important to emphasize the overall approach to grazing many CSP participants undertake. Sustainable grazing regimes previously or currently practiced by participants make qualifying the differences between grazed and deferred pastures sometimes difficult. This may be one reason we saw more differences when we compared all CSP enrolled parcels to BCR 18 lands, than when we compared only grazed and deferred parcels within CSP. The spring of 2011 had above average precipitation, which emphasizes the need to conduct multi-year analyses of density and occupancy data, perhaps with rainfall and other weather data as co-variants.

Twenty-two producers had site locations which met the previously described criteria for the study however only 14 producers had surveys conducted on their properties. If additional producers had granted permission or missing contact information obtained, additional sites could have been completed prior to July 1. Future improvements can be made to the process of obtaining sites to survey. Sites that we did not visit could have been obtained with better communication between NRCS local offices and RMBO. One producer wanted to hear from NRCS directly about our participation on this pilot project. Producers who were unreachable by RMBO staff may have been reachable through NRCS staff means. Collaboration between partner organizations is sometimes difficult on small, short term projects such as this, but often proves effective at increasing the efficiency of field and sampling logistics where one partner holds the expertise.

We recommend improving monitoring efforts on local project sites either through local NRCS offices or through a partnership approach such as this pilot study. Agency and partner collaboration with an emphasis on communication that also engages the producer will help increase future sample sizes and may expand similar CSP practices in the region. One avenue to achieve this may be to build and specify monitoring objectives into contracts with participants at the time they enroll. Participants could then choose their level of participation in monitoring efforts. Site information useful for monitoring could then be collected from participants when the practice is implemented (locations and dates of deferral, etc.). Regardless of the typical pilot study challenges with site and field logistics, this pilot work yielded interesting results revealing which common species benefit most from grazing deferment, and how these species respond to habitat characteristics on CSP lands. This information may help inform management of CSP lands and future conservation practices.

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APPENDIX A

All species and number of individuals detected in grazed and deferred pastures.

Common Name	Grazed	Deferred	Total
American Crow	3		3
American Goldfinch		1	1
American Kestrel	7	2	9
American Robin	5	7	12
American White Pelican		1	1
Barn Swallow	13	12	25
Black-billed Magpie	7	13	20
Blue Grosbeak	1		1
Blue-gray Gnatcatcher		1	1
Brewer's Blackbird	3		3
Brown-headed Cowbird	48	39	87
Bullock's Oriole		1	1
Canada Goose	1		1
Cassin's Sparrow	149	279	428
Chimney Swift	2		2
Chipping Sparrow		4	4
Cliff Swallow	1	1	2
Common Grackle	25	11	36
Common Nighthawk	9	20	29
Common Raven	2	5	7
Cooper's Hawk		1	1
Dark-eyed Junco		3	3
Dickcissel	14	27	41
Eastern Kingbird	3	4	7
Eurasian Collared-Dove	37	40	77
European Starling	9	1	10
Golden Eagle	5	2	7
Grasshopper Sparrow	150	127	277
Great Blue Heron	3		3
Great Horned Owl	1		1
Horned Lark	545	384	929
Killdeer	16	19	35
Lark Bunting	260	111	371
Lark Sparrow	42	60	102
Loggerhead Shrike	8	6	14
Mallard	7		7
McCown's Longspur	11		11
Mountain Bluebird	1	4	5

Common Name	Grazed	Deferred	Total
Mourning Dove	31	40	71
Northern Flicker	3	2	5
Northern Harrier	7	1	8
Northern Mockingbird	30	46	76
Northern Rough-winged Swallow	5	3	8
Pied-billed Grebe	1		1
Prairie Falcon	4	2	6
Red-headed Woodpecker	1	1	2
Red-tailed Hawk	11	12	23
Red-winged Blackbird	26	16	42
Ring-necked Pheasant	18	27	45
Savannah Sparrow		1	1
Say's Phoebe	9	8	17
Spotted Towhee		1	1
Swainson's Hawk	1	3	4
Turkey Vulture		1	1
Upland Sandpiper	1		1
Vesper Sparrow	50	46	96
Violet-green Swallow	2		2
Western Kingbird	61	55	116
Western Meadowlark	886	782	1668
Western Tanager	3	6	9
Wilson's Warbler	1		1
Yellow Warbler		1	1
Grand Total	2869	2508	4779

APPENDIX B

Appendix B. Species and number of individuals at EMRI restoration site, Sanborn, South Dakota.

Species	# of individuals
American Coot	4
American Goldfinch	2
American Robin	1
Barn Swallow	4
Blue Grosbeak	1
Blue-winged Teal	9
Bobolink	10
Brown-headed Cowbird	14
Common Grackle	4
Common Yellowthroat	1
Dickcissel	16
Eastern Kingbird	4
European Starling	1
Gadwall	5
Grasshopper Sparrow	16
Green-winged Teal	1
Horned Lark	1

Species	# of individuals
Killdeer	5
Mallard	11
Mourning Dove	3
Northern Harrier	1
Orchard Oriole	2
Pied-billed Grebe	3
Red-winged Blackbird	21
Ring-necked Pheasant	2
Savannah Sparrow	2
Song Sparrow	3
Western Meadowlark	13
Wilson's Phalarope	1
Wilson's Snipe	1
Wood Duck	2
Yellow-headed Blackbird	7
Total	**171**