Avian Monitoring Report for Range Monitoring Group

Bird Conservancy of the Rockies (BCR)

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Bird Conservancy of the Rockies

Connecting people, birds and land

Mission: Conserving birds and their habitats through science, education and land stewardship

Vision: Native bird populations are sustained in healthy ecosystems

Bird Conservancy of the Rockies conserves birds and their habitats through an integrated approach of science, education, and land stewardship. Our work radiates from the Rockies to the Great Plains, Mexico and beyond. Our mission is advanced through sound science, achieved through empowering people, realized through stewardship, and sustained through partnerships. Together, we are improving native bird populations, the land, and the lives of people.

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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.

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1. Guide conservation action where it is needed most by conducting scientifically rigorous monitoring and research on birds and their habitats within the context of their full annual cycle.

2. Inspire conservation action in people by developing relationships through community outreach and science-based, experiential education programs.

3. Contribute to bird population viability and help sustain working lands by partnering with landowners and managers to enhance wildlife habitat.

4. Promote conservation and inform land management decisions by disseminating scientific knowledge and developing tools and recommendations.

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Abstract

Monitoring within Bird Conservation Regions (BCRs), or regions with similar bird communities, can provide valuable information and comparisons regarding population trends by species, including "priority species" as identified by Partners in Flight, a collaborative group from multiple sectors in bird conservation that provides tools and assessments for current bird populations. This report presents Integrated Monitoring in Bird Conservation Regions (IMBCR) program findings for ranches in central eastern Montana, specifically those participating in the Range Monitoring Group (RMG). As the study area is part of BCR17 (Badlands and Prairies), the results from the RMG ranches were compared with regional results for the Montana portion of BCR17. Specifically, ranchers can compare density and occupancy estimates for species on their ranches relative to the "big picture" to evaluate how they are managing their land for wildlife, such as birds. Although the RMG ranches represent a small fraction of the total area in BCR17 in Montana (<1%), the ranches still serve as important habitat for many bird species, several of which are priority species. For example, densities of six priority species were higher within the RMG ranches than in the Montana portion of BCR17, such as Brewer's and grasshopper sparrows. Occupancy rates were also higher on RMG ranches for these two sparrows compared to the larger region. Further monitoring is needed in order to determine long-term trends, especially for priority species and species that may move around annually in response to precipitation. IMBCR offers unique opportunities including the comparison of local bird populations to broader regional estimates and the examination of specific factors associated with changes, such as range expansion or contraction. IMBCR may also facilitate future development of the monitoring project, including expanding the study area and incorporating additional indicators.

Introduction

The Northern Great Plains (NGP) region of the U.S encompasses vast intact grasslands of Montana, North Dakota, South Dakota, Wyoming and northern Nebraska. Stretching from the foothills of the Rockies into the badlands of the Dakotas and Nebraska, the NGP covers over 180 million acres. Characterized by expansive grasslands, it supports a unique assemblage of wildlife adapted to this landscape. These species require large open spaces as habitat to sustain their populations (National Fish and Wildlife Foundation, NGP Business Plan 2016). Much of the region remains in grasslands that are in perennial grass cover, which may include native range, non-native pastures, and hay meadows. Ninety-nine percent of non-urban land in the NGP is used for farming and ranching purposes (Forrest et al., 2004). Comparatively, America's grasslands have received much less conservation attention than other ecosystems. Grasslands are associated with uneventful landscapes, experience harsh climate conditions and are located far from population centers. The NGP is no different, but this intact grassland system also represents an incredible conservation opportunity. The vast majority of the landscape is in cattle grazing which, when managed, is compatible as to the needs of wildlife, and allows conservation efforts and rural communities to co-exist. Effective grassland management requires a unique set of skills, and the potential loss of the ranching way of life is a major threat to this region. Young ranchers are finding it difficult to afford the costs associated with a profitable ranching business and many are migrating to urban centers where they take on other livelihoods. Many grassland birds depend on livestock and ungulate grazing for suitable grassland habitat, and working with ranchers to ensure sustainable livelihoods will ensure longevity of grassland birds.

Bird Conservation Regions (BCRs) provide a spatially consistent framework for bird conservation in North America (Figure 1; US North American Bird Conservation Initiative [NABCI 2007]). BCRs represent distinct ecological regions with similar bird communities, vegetation types and resource management interests (NABCI 2000). Population monitoring within BCRs can be implemented using robust survey methods, so the data can be analyzed at multiple scales. Information on the status of bird populations can be partitioned for small-scale conservation planning (e.g., ranch scale), or aggregated to support large-scale conservation efforts throughout a species' geographic range (e.g., BCR) (White et al. 2016). Bird Conservancy of the Rockies, along with various partners, has conducted land bird monitoring for the past decade as part of the Integrated Monitoring in Bird Conservation Regions (IMBCR) program. The IMBCR design provides a spatially consistent and flexible framework for understanding the status and annual changes of bird populations. Birds are often seen as indicators of environmental status and change. We can measure bird species densities (number of individuals/km^2) and occupancies (proportion of sites occupied) and potentially provide recommendations for management by species. Together, we work collaboratively with ranchers on private lands for conservation of grasslands and bird habitat.

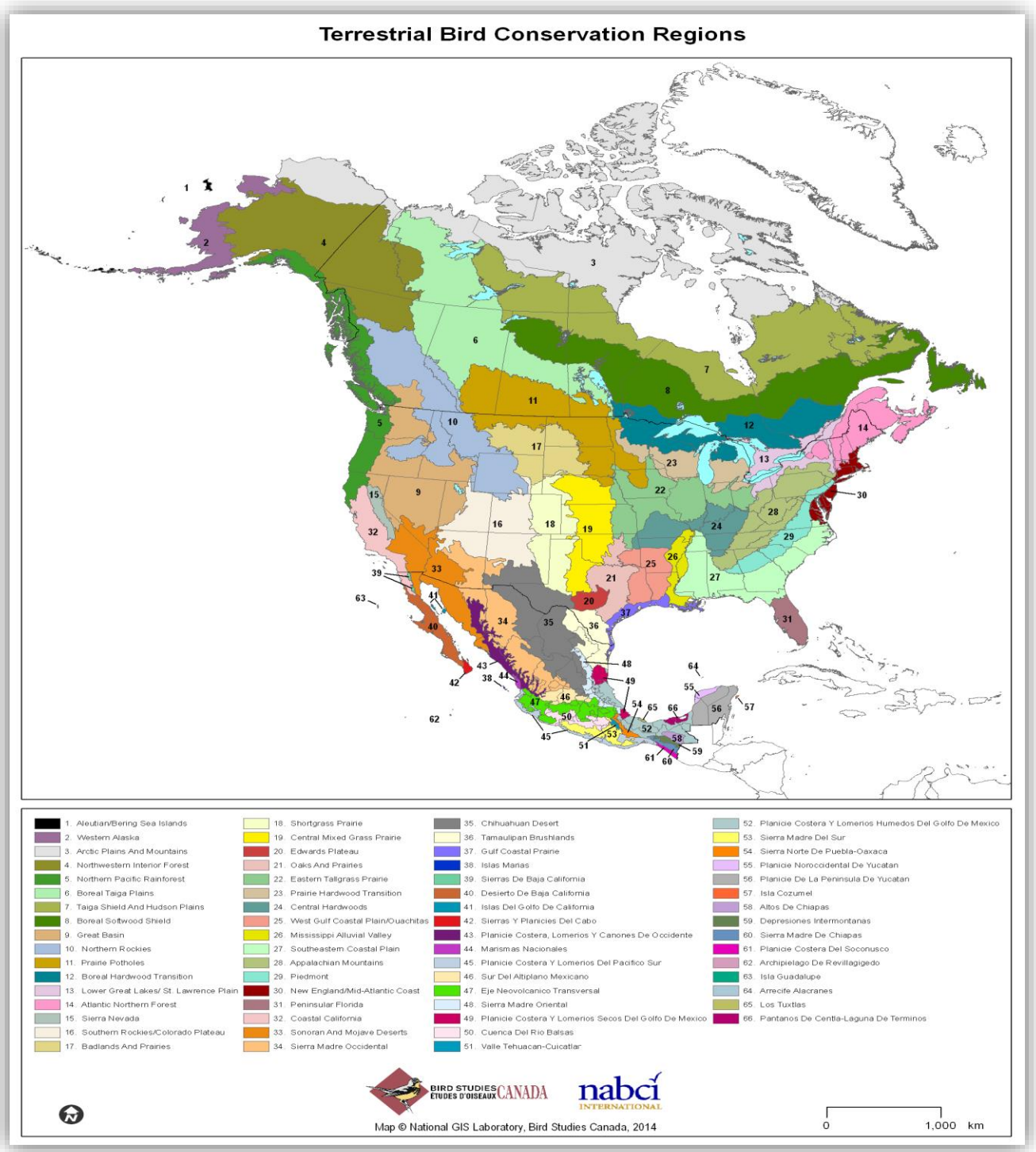

Figure 1. Bird Conservation Regions throughout North America, excluding Hawaii and Mexico

(Source: http://www.birdscanada.org/research/gislab/index.jsp?targetpg=bcr).

Methods

Study Area

The study area was defined as the area containing ranches participating in the Range Monitoring Group's (RMG) avian monitoring. This area is located in the Musselshell Plains of central eastern Montana and comprises 216 km^2. Since the participating RMG ranches are within the larger BCR17 (Badlands and Prairie), results from the RMG ranches are compared with results from the Montana portion of BCR17 (139,918 km^2) produced through the IMBCR program in 2017 for use as a regional comparison.

Sampling Design

Sampling Units

The IMBCR design defined sampling units as 1-km^2 grids, each containing 16 points, spaced 250 meters apart (Figure 2). Potential sampling units were defined by superimposing a uniform grid of 1 km^2 grids over each RMG ranch in the study area, and then grids were randomly selected with a spatially balanced approach (Stevens and Olsen 2004) using ArcGIS version 10.X and higher (Environmental Systems Research Institute 2006). Surveyed grids in the surrounding Montana portion of BCR17 were also selected using the same spatially balanced method.

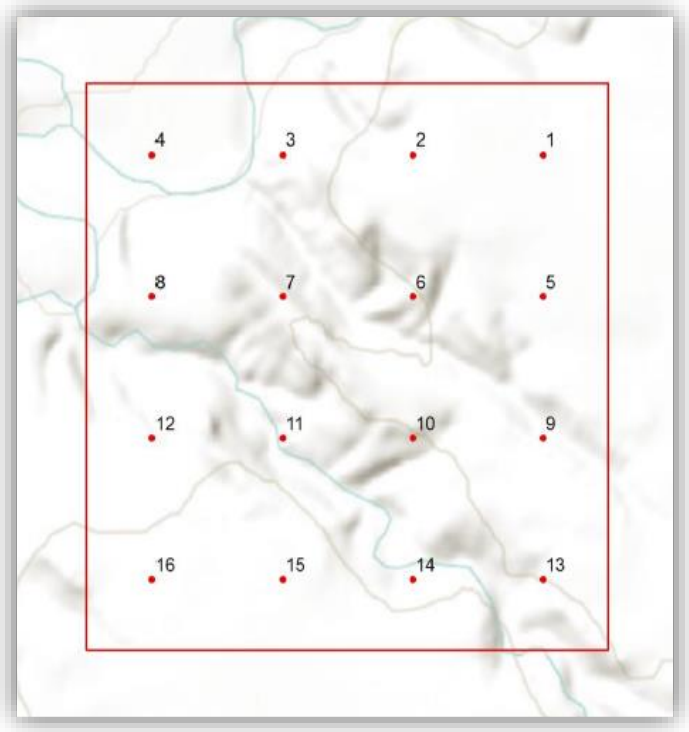

Figure 2. Example 1 km^2 sampling grid using IMBCR design.

Sampling methods

Prior to conducting surveys, the surveyor completed an intensive seven-day training program to ensure complete understanding of field protocols and sufficient knowledge of bird identification. Data collection was attempted at all points within a grid; however, due to safety concerns, inclement weather and other restrictions, not all 16 points were surveyed within every grid.

Avian point counts were conducted using a distance sampling framework (Buckland et al. 2001) following protocol established by IMBCR partners (Hanni et al. 2014; Hanni et al. 2016). The surveyor conducted avian counts in the morning, beginning ½-hour before sunrise and concluding no later than 10:30 AM. For every bird detected during the six-minute period, the surveyor recorded the species, sex (if possible), horizontal distance from the observer, minute, and type of detection (e.g., call, song, visual). Distances to each bird were measured using laser rangefinders. When it was not possible to measure the distance to a bird, distance was estimated by measuring to some nearby object. The surveyor recorded birds flying over but not using the immediate surrounding landscape. While traveling between points within a grid, the surveyor recorded the presence of any species that had not been previously detected during one of the six-minute counts that morning.

All non-independent detections of birds (i.e., flocks or pairs of conspecific birds together in close proximity) were considered as part of a "cluster" rather than as independent observations. The surveyor recorded the number of birds detected within each cluster along with a letter code to distinguish between multiple clusters.

At the start and end of each survey, time, ambient temperature, cloud cover, precipitation and wind speed were recorded. The surveyor navigated to each point using hand-held Global Positioning System (GPS) units. Before beginning each six-minute count, vegetation data were recorded within a 50 meter radius. Vegetation data included the dominant habitat type, structural stage and the relative abundance, percent cover and mean height of trees and shrubs by species, as well as grass height and ground cover types. The surveyor recorded vegetation data quietly to allow birds the time to return to normal habits prior to beginning each avian point count.

Data Analysis

Population density (number of individuals/km^2) was estimated using point count distance sampling, and site occupancy (proportion of sites occupied) was estimated using a multi-scale occupancy model (White et al. 2016) within a modified version of the RIMBCR package in Program R (R Core Team 2017; Paul Lukacs, University of Montana, Missoula). Density and occupancy estimates are presented for detected species on the RMG ranches and for the Montana portion of BCR17 as a regional comparison (obtained from the Rocky Mountain Avian Data Center: http://rmbo.org/v3/avian/ExploretheData.aspx).

Distance Analysis

Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that five critical assumptions be met: 1) all birds at

and near the sampling location (distance = 0) are detected; 2) distances to birds are measured accurately; 3) birds do not move in response to the observer's presence (Buckland et al. 2001, Thomas et al. 2010); 4) cluster sizes are recorded without error; and 5) the sampling units are representative of the entire survey region (Buckland et al. 2008).

Analysis of distance data included fitting a detection function to the distribution of recorded distances (Buckland et al. 2001). The distribution of distances can be a function of characteristics of the object (e.g., for birds, size and color, movement, volume of song or call and frequency of call), the surrounding environment (e.g., density of vegetation) and observer ability. Because detectability varies among species, data were analyzed separately for each species. The development of robust density estimates typically requires 80 or more independent detections ($n \geq 80$) within the entire sampling area. Birds flying over, but not using the immediate surrounding landscape, and birds detected between points were excluded from analyses. We estimated density for each species using a sequential framework where 1) year specific detection functions were applied to species with ≥80 detections, 2) global detection functions were applied to species with <80 detections per year and ≥80 detections over the life of the project, and 3) remedial measures were used for species with moderate departures from the assumptions of distance sampling (Buckland et al. 2001). We truncated the largest 10% of distances for all species following Buckland et al. (2001) recommendations.

We estimated population size ($\hat{N}$) for the RMG ranches as $\hat{N} = \hat{D} * A$, where $\hat{D}$ was the estimated population density and A was the number of 1 km² sampling units in the RMG stratum. We calculated Satterthwaite 90% Confidence Intervals (CI) for the estimates of density and population size (Buckland et al. 2001). To calculate the regional estimates for the Montana portion of BCR 17, we combined the stratum-level density estimates for all strata in this region using an area-weighted mean. For the combined density estimates, we estimated the variance for detection and cluster size using the delta method (Powell 2007, Thomas et al. 2010) and the variance for the encounter rate using the design-based estimator of Fewster et al. (2009).

Occupancy Analysis

Occupancy estimation is most commonly used to quantify the proportion of sampling units (i.e., 1 km² cells) occupied by an organism (MacKenzie et al. 2002). The application of occupancy modeling 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). We used a removal design (MacKenzie et al. 2006) to estimate a detection probability for each species, in which we binned minutes one and two, minutes three and four, and minutes five and six. 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 16 points in each sampling unit served as spatial replicates for estimating the proportion of points occupied within the sampled sampling units. A multi-scale occupancy model was used to estimate 1) the probability of detecting a species given presence (p), 2) the proportion of points occupied by a species given presence within sampled sampling units (θ, Theta) and 3) the proportion of sampling units occupied by a species (ψ, Psi).

For occupancy estimation, data are truncated to detections <125 m from the sample point, thereby resulting in fewer estimates for occupancy as compared to density. Truncating the data at <125 m allows for consistency of plot size and ensures that points are truly independent (spread 250 m apart) (Pavlacky et al. 2012). To determine regional occupancy of the Montana portion of BCR 17, we combined stratum-level estimates of Psi using an area-weighted mean.

Results

Density estimates

Due to logistical constraints, the surveyor only conducted point counts at 5 of the 12 selected grids on the RMG ranches during the 2017 field season. Staff from Intermountain Bird Observatory (an IMBCR partner) conducted point counts at 595 grids in the Montana portion of BCR17 during the same 2017 field season. Surveys on the RMG ranches were completed between June 2nd and June 10th, 2017. During 55 point count surveys on the 5 grids, 631 individual birds were detected (11.47 individuals/point count) on RMG ranches and 5,721 birds were detected during 467 point count surveys on 40 grids (12.25 individuals/point count) conducted within the larger Montana portion of BCR17. One or more individuals of 31 avian species were detected on RMG ranches compared to 135 species which were detected within the larger region of BCR17 in Montana. For comparison, the area of land on the RMG ranches represents <1% of the area for the Montana portion of BCR 17 (216 km2 out of 139,918 km2).

Densities were estimated for 29 of the species that were detected on the RMG ranches and for 111 species detected in the Montana portion of BCR17. Of the 29 RMG-detected species for which density estimates were produced, 9 species are considered priority species by Partners in Flight for BCR17 (PIF 2017). Compared to the larger region of BCR17 in Montana, the RMG ranches exhibited higher densities of 15 of the RMG-detected species, while the Montana portion of BCR17 exhibited higher densities of 14 species (Table 1). Densities of six PIF priority species were higher within the RMG ranches than in the Montana portion of BCR17 while the reverse was true for three PIF priority species.

Table 1. Estimated densities of detected bird species on RMG ranches and in the Montana portion of BCR17 in 2017. S = the number of sample units used in analyses; D = estimated densities per km^2; % CV = percent coefficient of variation of estimates; n = the number of independent detections. BCR17 priority species, as designated by Partners in Flight, are in bold.

Species	RMG Ranches (S=5)			Montana - BCR17 (S=595)		
	D	**% CV**	**n**	**D**	**% CV**	**n**
American Robin	0.58	90	1	6.98	30	125
Black-headed Grosbeak	0.39	112.57	1	0.19	62	5
Brewer's Blackbird	3.88	78.12	2	14.54	47	51
Brewer's Sparrow	20.66	51.23	23	10.31	30	114

Brown-headed Cowbird	6.45	55.56	7	26.26	16	218
Bullock's Oriole	0.72	95.92	1	0.73	42	10
Canada Goose	0.05	97.62	1	0.09	43	9
Common Grackle	7.38	41.73	5	9.62	89	27
Common Raven	0.06	97.26	1	0.05	57	4
Eastern Kingbird	1.95	53.71	3	1.21	47	18
Eurasian Collared-Dove	10.41	90.99	4	0.01	96	1
European Starling	12.9	90.35	1	1.3	62	7
Field Sparrow	2.26	112.46	12	1.56	52	54
Grasshopper Sparrow	45.86	63.49	35	11.64	34	73
Horned Lark	3.75	112.42	5	7.12	44	68
Killdeer	1.43	46.71	3	2.05	47	33
Lark Bunting	11.8	78.9	36	12.66	36	241
Lark Sparrow	5.435	86.87	6	13.94	25	115
Long-billed Curlew	0.41	90.13	5	0.17	74	10
Mourning Dove	5.58	45.5	21	4.64	40	118
Red-winged Blackbird	22.33	78.94	43	10.48	32	120
Savannah Sparrow	0.99	94.97	1	5.88	52	30
Say's Phoebe	0.25	90.14	1	0.71	47	15
Upland Sandpiper	1.03	23.6	6	0.41	39	20
Vesper Sparrow	18.61	23.88	54	9.64	20	208
Western Kingbird	1.34	95.09	2	3.68	68	26
Western Meadowlark	34.07	8.31	184	24.85	9	1071
Western Wood-Pewee	0.42	112.46	1	3.38	41	53
Wilson's Snipe	0.21	96.83	1	0.02	100	1

Occupancy comparison

Occupancies were estimated for 24 of the species that were detected on the RMG ranches (Table 2) and for 102 species detected in the Montana portion of BCR17. Of the 24 RMG-detected species for which occupancy estimates were produced, 9 species are considered priority species by Partners in Flight for BCR17 (PIF 2017). Compared to the larger region of BCR17 in Montana, the RMG ranches exhibited higher occupancy rates for 16 of the RMG-detected species while the Montana portion of the BCR17 exhibited higher occupancy rates for 8 species (Table 2). Occupancy rates of four PIF BCR17 priority species were higher within the RMG ranches than in the larger Montana portion of BCR17 while the reverse was true for five species.

Table 2. Estimated occupancies of detected bird species on RMG ranches and in the Montana portion of BCR17, 2017. S = the number of sample units used in analyses; Psi = probability a grid cell is occupied (i.e. occupancy rate). SE = standard errors. BCR17 priority species, as designated by Partners in Flight, are in bold.

Species	RMG Ranches (S=5)		Montana – BCR17 (S=595)	
	Psi	**SE**	**Psi**	**SE**
American Robin	0.21	0.19	0.38	0.10
Brewer's Blackbird	0.47	0.26	0.43	0.11
Brewer's Sparrow	0.80	0.18	0.47	0.09
Brown-headed Cowbird	0.41	0.23	0.90	0.06
Common Grackle	0.87	0.19	0.19	0.08
Eastern Kingbird	0.25	0.22	0.22	0.09
Eurasian Collared-Dove	0.29	0.26	0.01	0.01
European Starling	0.26	0.23	0.08	0.05
Field Sparrow	0.20	0.18	0.22	0.08
Grasshopper Sparrow	0.61	0.22	0.54	0.09
Horned Lark	0.20	0.18	0.29	0.09
Killdeer	0.92	0.32	0.367	0.12
Lark Bunting	0.40	0.22	0.49	0.10
Lark Sparrow	0.40	0.22	0.62	0.10
Long-billed Curlew	0.31	0.28	0.06	0.06
Mourning Dove	0.68	0.25	0.42	0.10
Red-winged Blackbird	1.00	0.00	0.54	0.10
Savannah Sparrow	0.22	0.20	0.26	0.09
Say's Phoebe	0.29	0.26	0.26	0.11
Upland Sandpiper	0.23	0.20	0.07	0.05
Vesper Sparrow	0.67	0.25	0.78	0.08
Western Kingbird	0.27	0.24	0.25	0.1
Western Meadowlark	1.00	0.00	0.94	0.05
Wilson's Snipe	0.25	0.22	0.02	0.02

Discussion

The results presented in this report highlight some important findings for the Range Monitoring Group (RMG). In terms of area, the RMG ranches represent < 1% of the entire BCR17 Montana region, yet the ranches contained 23% of the species detected in the larger region in 2017. In addition, densities and occupancy rates were higher for several priority species on the RMG ranches compared to the larger region.

Of the RMG-detected species, RMG ranches had higher densities of more priority species (PIF 2017), such as Brewer's and grasshopper sparrows compared to the larger BCR 17 region in Montana.

However, the same was not true regarding occupancy rates. Specifically, there were higher densities but lower occupancy rates for vesper sparrows and field sparrows on RMG ranches compared to the Montana portion of the BCR17 region. These findings suggest that while these two species may be locally abundant, they are not as common across the RMG ranches. The other priority species with higher densities on RMG ranches in 2017, specifically Brewer's sparrows, eastern kingbirds, grasshopper sparrows and western meadowlarks, also had higher occupancy rates, suggesting that these species are not only locally abundant, but also common across the RMG landscape. It will be important to continue monitoring in order to better understand long-term trends on these ranches and to improve precision of the density and occupancy estimates.

RMG ranches had higher densities and occupancy rates of invasive species such as the Eurasian-collared dove and the European starling compared to the larger Montana portion of BCR17. However, RMG ranches also had a lower density and occupancy rate of the brown-headed cowbird, a common nest parasite.

The Integrated Monitoring in Bird Conservation Regions Program (IMBCR) annually collects breeding bird information in all or portions of 15 states, covering an area of 1.9 million km^2. Each year, occupancy and density estimates are calculated for 263 species at a variety of spatial scales, such as national forests or grasslands, individual states, and entire Bird Conservation Regions. In BCR17 alone, 162 – 315 sample units are surveyed each year. The hierarchical framework that comprises IMBCR allows for inferences at multiple spatial scales. Information obtained from IMBCR can be used in some of the following ways:

1) **Bird population estimates can be compared in space and time**. For example, estimates for RMG ranches can be compared to state and regional estimates to determine whether local populations are above or below estimates for the region;
2) **Annual estimates of density and occupancy can be compared over time to determine if population changes are a result of population growth or decline and/or range expansion or contraction.** For example, if population densities of a species declined over time, but the occupancy rates remained constant, then the population change was due to declines in local abundance. In contrast, if both density and occupancy rates of a species declined, then population change was due to range contraction;
3) **Occupancy rates can be multiplied by the land area in a region of interest to estimate the area occupied by a species.** For example, the Montana portion of BCR17 is 139,918 km^2 in size and the occupancy estimate for grasshopper sparrows is 0.54, so managers can estimate that 75,556 km^2 (139,918 km^2 * 0.54) of area within the stratum is occupied by grasshopper sparrows; and
4) **Conservation practices can be evaluated in terms of impact on bird populations.** For example, RMG ranches can evaluate how their ranch management practices influence chestnut-collared longspurs by comparing longspur abundance on the ranches to longspur abundance in the surrounding landscape.

Future considerations associated with IMBCR include:

1) **The large scale effort of IMBCR makes future expansion possible.** For example, if the RMG is wanting to expand its reach, baseline IMBCR efforts can be used at other sites to inform density and occupancy estimates, as well as species distributions.
2) **Additional indicators can be added to the relatively simple vegetation data that are currently collected with IMBCR**. Habitat indicators are currently collected at each IMBCR point count; however, other indicators, such as soil properties could potentially be collected and entered into the database using a Protocol Editor.
3) **Longer term monitoring, especially for priority species, will provide insight into population trends.** In addition, if we can expand the effort on RMG ranches and survey a few additional grid cells, we may be able to increase detections for more species and obtain density and occupancy estimates for them.

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