Avian Monitoring on Colorado State Land Board's Lowry Range: 2012 Final Report

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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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Lowry Range; photo provided by the Colorado State Land Board

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EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory (RMBO), in conjunction with the Colorado State Land Board, conducted landbird monitoring throughout the 26,000-acre Lowry Range parcel located near Denver, CO in 2012. This project used a spatially balanced sampling design and a survey protocol implemented in portions of 12 states as part of a program entitled "Integrated Monitoring in Bird Conservation Regions" (IMBCR). The IMBCR design allows inferences to avian species occurrence and population sizes from local to regional scales, including states and Bird Conservation Regions (BCR). By using a design compatible with the IMBCR program, estimates for the Lowry Range can be compared to nearby regional estimates to determine whether avian populations within the Lowry Range are similar to regional populations. We used regional population estimates for the Colorado portion of BCR 18 (shortgrass prairie) as the region for comparison in this report.

In 2012, RMBO completed 16 surveys, resulting in 243 point counts conducted. Surveys on the Lowry Range were conducted between 23 May and 2 June. Field technicians observed 2,623 individuals of 54 bird species during the surveys. Using the RIMBCR package for Program R designed by Paul Lukacs, we estimated densities of 91 species occurring in the Colorado portion of BCR18 and/or on the Lowry Range, including 19 species with special designation for BCR 18 as designated by Partners In Flight.

Occupancy rates were higher on the Lowry Range than within the Colorado portion of BCR 18 for 40 of the 44 species (91%) for which we estimated Lowry Range occupancy rates. Similarly, 32 of the 40 species (80%) for which we estimated Lowry Range densities exhibited higher densities on the Lowry Range than throughout the Colorado portion of BCR 18. Results of our species richness analyses indicate that species richness is nearly twice as high on the Lowry Range compared to adjacent lands. Together, these results suggest that the Lowry Range currently represents important breeding bird habitat. We recommend that anthropogenic disturbances should be limited to maintain quality habitat on the Lowry Range. Additionally, we recommend riparian areas should be fenced to exclude cattle and improve riparian habitat conditions on the property.

ACKNOWLEDGEMENTS

We thank the Colorado State Land Board (COSLB) for providing the funding for this project. Additionally, funding from Colorado Parks and Wildlife and US Forest Service-Region 2 allowed for the production of population estimates across the Colorado portion of Bird Conservation Region 18 which served as the regional comparison in this report. We also thank Mindy Gottsegen of the COSLB for her comments on the first draft of this document and for her assistance providing property information and access to the Lowry Range. We thank Paul Lukacs of the University of Montana who created the RIMBCR statistical package for Program R which was used to produce the multi-scale occupancy and density estimates.

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INTRODUCTION

The Colorado State Land Board (COSLB) is interested in preserving and improving the ecological health and functioning of its 26,000-acre Lowry Range property. The goal of this pilot bird monitoring effort therefore was to provide information to COSLB managers on how bird monitoring data could be used to inform land management decisions on its properties. Additionally, oil and gas development is anticipated to begin on the Lowry Range in the near future. Because birds act as excellent sentinels of environmental health, the COSLB believed that obtaining information on bird species' diversity and abundance would help its land managers make more informed decisions on the impacts of such development. It is anticipated that the 2012 field season monitoring will serve as a baseline against which future years of bird monitoring can be compared.

Monitoring is an essential component of wildlife management and conservation science [1, 2]. Common goals of population monitoring are to estimate the population status of target species and to detect changes in populations over time [3, 4]. Effective monitoring programs can identify species that are at-risk due to small or declining populations [5], provide an understanding of how management actions affect populations [6, 7], evaluate population responses to landscape alteration and climate change [8, 9] and provide basic information on species distributions. The apparent large-scale declines of avian populations and the loss, fragmentation and degradation of native habitats highlight the need for extensive and rigorous landbird monitoring programs [10, 11]. As natural areas are developed, it is imperative for land managers to better understand the impacts subsequent landscape changes have on wildlife communities.

Before monitoring can be used by land managers to guide conservation efforts, sound program designs and analytic methods are necessary to produce unbiased population estimates [4]. At the most fundamental level, reliable knowledge about the status of avian populations requires accounting for spatial variation and incomplete detection of the target species [12, 13, 14]. Addressing spatial variation entails the use of probabilistic sampling designs that allow population estimates to be extended over the entire area of interest [3]. Adjusting for incomplete detection involves the use of appropriate sampling and analytic methods to address the fact that few, if any, species are so conspicuous that they are detected with certainty during surveys, even when present [12, 14]. Accounting for these two sources of variation ensures observed trends reflect true population changes rather than artifacts of sampling and observation processes [12, 14].

In order to provide local land managers with unbiased and reliable information on avian communities within the Colorado State Land Board's Lowry Range, Rocky Mountain Bird Observatory (RMBO) utilized a probabilistic sampling design based on the "Integrated Monitoring in Bird Conservation Regions (IMBCR)" [15] design for this study. Important properties of the IMBCR design that relate to this study are:

- All vegetation types are available for sampling.
- Strata are based on fixed attributes; this will allow us to relate changes in bird populations to changes on the landscape through time.
- Local population estimates and trends can be directly compared to estimates and trends at regional scales.
- Coordination among partners can reduce the costs of monitoring per partner.

Using the IMBCR design, RMBO'S monitoring objectives are to:

1. Provide a design framework to spatially integrate existing bird monitoring efforts in the region to provide better information on distribution and abundance of breeding landbirds, especially for high priority species;
2. Provide basic habitat association data for bird species to address habitat management issues;
3. Provide robust occupancy estimates that account for incomplete detection and are comparable at different geographic extents;
4. Maintain a high-quality database that is accessible to all of our collaborators as well as to the public over the internet, in the form of raw and summarized data.

By using the IMBCR design for avian monitoring on the Lowry Range, RMBO was able to use detections from approximately 1,200 samples throughout the inter-mountain west. These surveys provided additional detections for avian species thereby improving the statistical power of our estimates and increasing the number of species for which we were able to estimate occupancy and density. Additionally, by utilizing the IMBCR design while conducting monitoring on the Lowry Range, results of this report are comparable to regional estimates produced under the IMBCR monitoring program. In this report we have selected the Colorado portion of Bird Conservation Region 18 (BCR 18, Shortgrass Prairie) as a geographically appropriate region to which the Lowry Range estimates can be compared.

METHODS

Study Area

The study area was defined as the area contained by the State Land Board's Lowry Range boundary. The Lowry Range is located about 20 miles southeast of Metro Denver. It spans approximately 26,000 acres (105 km^2) and is composed of a mixture of native shortgrass prairie, Piedmont tallgrass prairie, and riparian habitats. The study area is leased for grazing with the exception of the property south of East Quincy Avenue which has not been grazed since June 2007. Because the Lowry Range lies within BCR 18 (Figure 1), and BCR 18 habitats are representative of those found on the Lowry Range, we have presented results for the Colorado portion of BCR 18 produced through the IMBCR program in 2012 for use as a regional comparison.

Sampling Design

Sampling Units

We defined sampling units as 1-km^2 cells, each containing 16 evenly-spaced sample points, 250 meters apart (Figure 2). The grid used to define the 1-km^2 cells was established for the IMBCR program by superimposing a uniform grid of cells over the entire state of Colorado.

Sample Selection

Following the IMBCR design, we used generalized random-tessellation stratification (GRTS), a spatially balanced sampling algorithm, to select sample units [16] within the study area. Spatial data and sample cells were compiled and selected using ARCGIS 9.2 [17].

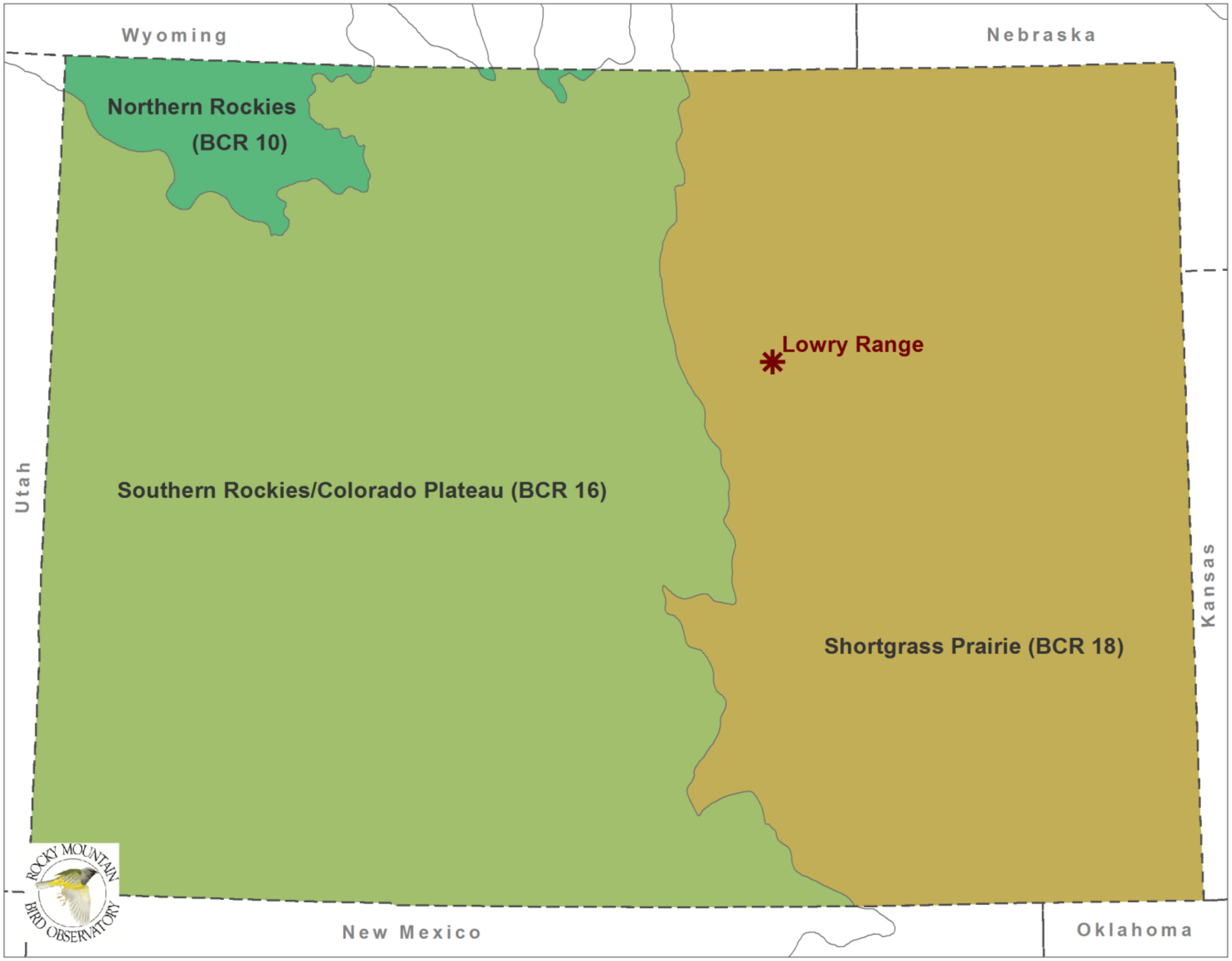

Figure 1. Bird Conservation Regions in Colorado

Figure 2. Image of an IMBCR 1-km^2 sample cell containing 16 survey points arranged in a 4 X 4 matrix.

The GRTS design has several appealing properties with respect to long-term monitoring of birds at large spatial scales:

- Spatially-balanced sampling is generally more efficient than simple random sampling of natural resources [18].
- Incorporating information about spatial autocorrelation in the data can increase precision of density estimates.

All sample cells in the sampling frame are ordered such that any set of consecutively numbered units is a spatially-balanced sample [18]. In the case of fluctuating budgets, we can adjust the sampling effort among years within each stratum while still preserving a random, spatially-balanced sampling design.

Based on available funding, RMBO conducted point counts at 16 and 81 individually selected sample cells on the Lowry Range and the Colorado portion of BCR18; respectively. This resulted in a total of 243 and 961 point counts on the Lowry Range and within the Colorado portion of BCR18. Figure 3 illustrates the location of the sample cells and point count stations visited within the Lowry Range during the 2012 field season.

Sampling Methods
Surveyors with excellent aural and visual bird-identification skills conducted field work between May 23rd and June 2nd 2012. Prior to conducting surveys, surveyors completed an intensive

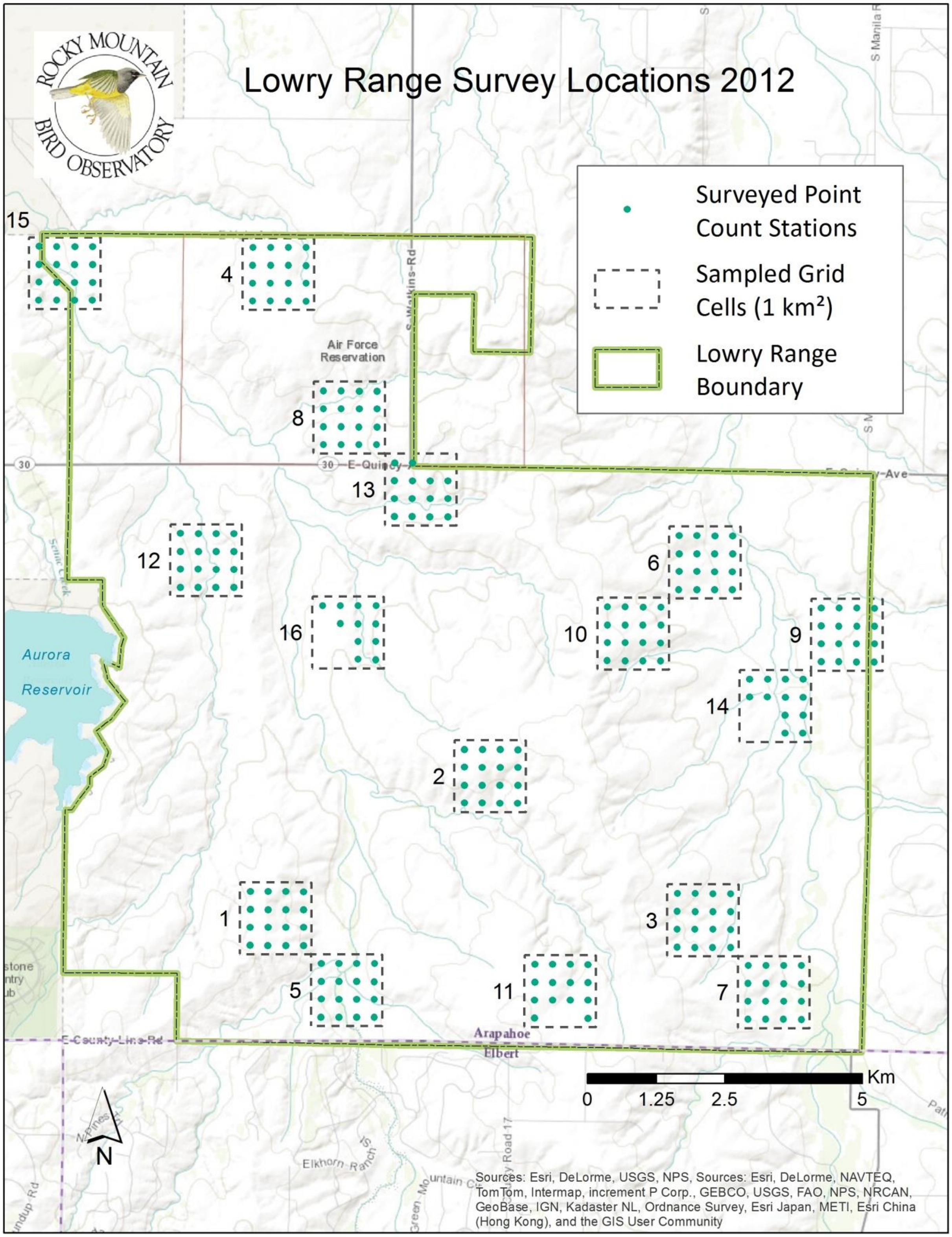

Figure 3. Sample cells and individual point count stations surveyed within the Lowry Range during the 2012 field season.

seven-day training program to ensure they had a complete understanding of field protocols and sufficient knowledge of bird and plant identification. Surveyors also attended unexploded ordinance (UXO) training provided through the US Army Corps of Engineers' contractor because the Lowry Range property was formerly part of the Lowry Bombing and Gunnery Range. Surveyors attempted to collect data at all points within a sample cell each morning; however, not all 16 points were surveyed within every sample cell. Inclement weather, safety concerns because points were near a mining site, and decreased bird activity later in the morning were the most common reasons for all 16 points not being surveyed within a grid cell.

We conducted point counts using a Distance sampling framework [19] following protocol established by IMBCR partners [15]. Surveyors conducted avian counts in the morning, beginning ½-hour before sunrise and concluding no later than five hours after sunrise. For every bird detected during the six-minute period, observers recorded the species, sex; horizontal distance from the observer; minute and type of detection (e.g., call, song, visual). Surveyors measured distances to each bird using laser rangefinders. When it was not possible to measure the distance to a bird, observers estimated the distance by measuring to some nearby object. In addition to recording all bird species detected in the area during point counts, surveyors also recorded birds flying over but not using the immediate surrounding landscape. While observers traveled between points within a sampling unit they recorded the presence of any species not recorded during a point count that morning. The opportunistic detections of these species can later be used for the development of a species inventory and for the purpose of creating additional distribution maps for species on the Lowry Range.

Surveyors considered all non-independent detections of birds (i.e., flocks or pairs of conspecific birds in close proximity) as part of a "cluster" rather than as independent observations. Surveyors 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, surveyors recorded time, ambient temperature, cloud cover, occurrence and type of precipitation and wind speed. Surveyors navigated to each point using hand-held Global Positioning System (GPS) units. Before beginning each six-minute count, surveyors recorded vegetation data (within a 50 meter radius). Vegetation data included the dominant habitat type; percent cover and mean height of any overstory and understory layers; the relative abundance of trees and shrubs by species; grass height and ground cover types. Surveyors recorded vegetation data quietly to allow birds the time to return to normal habits prior to beginning each avian point count.

For more detailed information about survey methods, refer to RMBO's Field Protocol for Spatially Balanced Sampling of Landbird Populations on our Avian Data Center website: http://rmbo.org/v3/Portals/5/Protocols/2012%20Field_protocol_for_spacially_balanced_sampling_final.pdf.

Data Analysis

Estimating Occupancy

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., 1-km^2 cells) occupied by an organism [20]. The application of occupancy modeling requires multiple surveys of the sample unit in space or time to estimate a detection probability [21]. The detection probability adjusts the proportion of sites occupied to account for species that were present but undetected [20]. We used a removal design [21], 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 to meet the assumption of a monotonic decline in the detection rates through time.

After the target species was detected at a point, we set all subsequent sampling intervals at that point to "missing data" [21].

The 16 points in each sampling unit served as spatial replicates for estimating the proportion of points occupied within the sampled sampling units. We used a multi-scale occupancy model 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 (Theta) and 3) the proportion of sampling units occupied by a species (Psi).

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 sampling unit) [22].

We expected that regional differences in the behavior, habitat use and local abundance of species would correspond to regional variation in detection and the fraction of occupied points. Therefore, we estimated the proportion of sampling units 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. Models are defined as follows:

Model 1: Constrained *p* and Theta by holding these parameters constant;
Model 2: Held *p* constant, but allowed Theta to vary across BCRs;
Model 3: Allowed *p* to vary across BCRs, but held Theta constant;
Model 4: 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 1 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. We used AIC corrected for small sample size (AIC_c) and model selection theory to evaluate models from which estimates of Psi were derived for each species [23]. We model averaged the estimates of Psi from models 1 through 4 and calculated unconditional standard errors [23].

Our application of the multi-scale model was analogous to a within-season robust design [24] where the two-minute intervals at each point were the secondary samples for estimating *p* and the points were the primary samples for estimating Theta [25, 22]. We considered both *p* and Theta to be nuisance variables that were important for generating unbiased estimates of Psi. Theta can be considered an availability parameter or the probability a species was present and available for sampling at the points [25, 22].

The new RIMBCR package streamlined occupancy analyses by calling the raw data from the IMBCR SQL server database and incorporating the R code we created in previous years. We allowed the input of all data collected in a manner consistent with the IMBCR design to increase the number of detections available for estimating *p* and Theta. The RIMBCR program utilized program MARK [26] and package RMark to fit the multi-scale occupancy models and to estimate model parameters. We combined stratum-level estimates of Psi using an area-weighted mean to produce the estimates of the Colorado portion of BCR 18. Sampling variances and standard errors for the combined estimates of Psi were estimated in RIMBCR using the delta method [27]. The proportion of sampling units occupied (Psi) was estimated for all species that were detected on a minimum of 5 points after removing detections beyond 125 m of each point. Occupancy estimates for species occurring on fewer than five points are not reported because of unreliable model convergence.

Estimating Density

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 [19]. 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 three critical assumptions be met: 1) all birds at and near the sampling location (distance = 0) are detected; 2) distances of birds are measured accurately; and 3) birds do not move in response to the observer's presence [19, 28]. Removal modeling is based on mark-recapture theory; detection probability is estimated based on the number of birds detected during consecutive sampling intervals [29]. In this design, sampling intervals consist of one minute segments of the six minute sampling period. Removal modeling can also incorporate distance data.

Analysis of distance data includes fitting a detection function to the distribution of recorded distances [19]. 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, we analyzed the data separately for each species. We attempted to estimate densities of all species detected within the Lowry Range and any of the strata comprising the Colorado portion of BCR18. The development of robust density estimates typically requires 80 or more independent detections ($n \geq 80$) within the entire sampling area. We excluded birds flying over, but not using the immediate surrounding landscape, and birds detected between points from analyses.

We estimated bird densities using the new RIMBCR package in Program R [30] developed by Paul Lukacs of the University of Montana. RIMBCR streamlined data analysis procedures we had previously completed in multiple steps. RIMBCR calls the raw data from the IMBCR SQL server database maintained by RMBO and outputs final estimates in tabular format. For each species, RIMBCR fit one of three detection functions: global detection functions across years (2008 – 2012), detection functions modeling year as a covariate, and year-specific detection functions. RIMBCR used Akaike's Information Criterion (AIC) corrected for small sample size (AIC_c) and model selection theory to select the most parsimonious detection function for each species [23]. RIMBCR incorporated the SPSURVEY package [31] in Program R to estimate density, population size and confidence intervals for each species. The SPSURVEY package uses spatial information from the survey locations to improve estimates of the variance of density.   We computed density estimates for each stratum as well as for the aggregation of strata within the Colorado portion of BCR18. The Colorado portion of BCR18 estimates were calculated using an area-weighted mean.

Estimating Species Richness

We estimated species richness using the individual species occupancy estimates for the two areas of interest. Since Psi represents both the proportion of 1 km^2 grid cells occupied by a species and the probability that any 1 km^2 grid cell will be occupied, we were able to estimate the number of species occupying any 1 km^2 grid cell within the areas of interest by summing the respective Psi values for the Lowry Range and the Colorado portion of BCR 18 for all species. We calculated the variance of the species richness estimate using the delta method [27] on the standard errors of the Psi estimates. 95% confidence intervals around the species richness estimates were calculated by adding and subtracting the product of 1.96 and the standard error for the respective richness estimates.

Modeling Habitat

We extended a generalized multinomial mixture model developed by Royle [32] and Chandler et al. [33] to estimate population density, availability and probabilities of detection using spatial replication [34]. We developed a hierarchical model for McCown's Longspur and Loggerhead Shrike using four years of data (2010-2013) from the IMBCR program. We conducted habitat modeling for these species because they were observed on the Lowry Range, they represent priority species as designated by PIF and these two species are associated with two disparate habitat types (McCown's Longspur are grassland specialists and Loggerhead Shrikes are generalists typically found in environments with some shrub component).

The generalized multinomial mixture model used is a three level hierarchical model. The first level models the number of individuals at a sampling location, the second level models availability, the probability that an individual in the sample is available at the point, and the third level models detection probability. We used an Information Theoretic Approach to select the best model. Covariates considered on abundance were percent cover (within the 1km^2 sampling grid, derived from the LandFire GIS layer) of shortgrass prairie and shrubland, Latitude; Longitude and year. The Covariates considered on availability were percent grass, herbaceous, shrub and woody cover and grass height (within a 50 meter radius around the point, collected by the field technician). Covariates considered on detection were Julian date and year. The distribution maps were created by using the coefficient estimates and corresponding covariates throughout the Colorado portion of BCR 18 using the United States National Grid (USNG). To map the average distribution across the four years we excluded the top model if it contained the year covariate. We anticipated the density results produced through this analysis to differ from the density estimates presented through our Distance analysis because of the inclusion of vegetation and land cover covariates which were not incorporated in the primary Distance analysis.

RESULTS

We detected 2,623 individual birds during 243 point count surveys (10.79 individuals/point count) within the Lowry Range compared to 10,503 individual birds detected during 961 point count surveys (10.93 individuals/point count) conducted within the Colorado portion of BCR18. While conducting the 16 surveys on the Lowry Range, RMBO surveyors detected 54 avian species; 50 of which were observed during point counts. In contrast, RMBO detected 108 species within the Colorado portion of BCR18 during 81 surveys.

Occupancy and Density Estimates

Using the RIMBCR package we were able to estimate occupancy rates of 44 of the 50 species detected on the Lowry Range during point counts (Table 1). We calculated the coefficient of variance (%CV) for all estimates to provide a unit of measurement for the precision of the results. The % CV demonstrates the relationship between the standard deviation of the estimate and the mean. Generally, a % CV less than 50% reflects a very precise estimate, a % CV of 50% to 100% is considered moderately precise and estimates with a % CV greater than 100% have a high degree of uncertainty and are not precise. We calculated estimates with a % CV less than 50% for 19 of these species. Additionally, we calculated occupancy rates (the proportion of 1km^2 grid cells expected to be occupied by one or more individuals) for 91 species within the Colorado portion of BCR18; all of which have a % CV less than 50. In total, we estimated occupancy rates for 94 species that occur within the Lowry Range and/or the Colorado portion of BCR18. Eighteen of the species we estimated occupancy rates for have received special designation within BCR 18 by Partners in Flight. 40 of the 44 species (91%) for which we estimated Lowry Range occupancy rates exhibited higher occupancy rates (psi) on the Lowry Range than throughout the Colorado portion of BCR18.

Using the RIMBCR analysis program, we estimated the densities of 40 species found on the Lowry Range for which there were a sufficient number of detections for analyses, 17 of which have a % CV of less than 50. Additionally, we estimated densities of 89 species within the Colorado portion of BCR18; 26 of which had robust estimates with a % CV of less than 50. In total, we estimated densities of 91 species that occur within the Lowry Range and/or the Colorado portion of BCR18 (Table 2). Nineteen of the species we estimated densities of have received special designation within BCR 18 by Partners in Flight. Thirty-two of the 40 species (80%) for which we estimated Lowry Range densities exhibited higher densities on the Lowry Range than throughout the Colorado portion of BCR 18.

Additional occupancy and density results for other geographic regions that may be of interest to Lowry Range managers can be viewed at the Rocky Mountain Avian Data Center (http://rmbo.org/v3/avian/ExploretheData.aspx). Other regional estimates that may act as appropriate comparisons include:

Colorado statewide estimates:
(http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgrgDgpgTmALnAhoiBbEAuEBhAeRAF8gAA)

All other lands within the Colorado portion of BCR 18 (representing lands that are not managed by the US Forest Service or Bureau of Land Management) in Colorado:
(http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgrgDgpgTmALnAhoiBbEAuEBhAeQFoAhPAJQEYAOIgQQBsGACAxAC3hAF8gA)

Non-river lands within Colorado BCR 18
(http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgrgDgpgTmALnAhoiBbEAuEBhAeQFoAhPAJQEYAOIgOQHsA7OASwDd4wQBfIAAA).

To view the results for these geographic regions click on the hyperlink above and then click the "Run Query" button near the top of the "Explore the Data" screen on the Rocky Mountain Avian Data Center. Detailed directions on how to run customized queries on the Rocky Mountain Avian Data Center can be found in Appendix A or at:
http://rmbo.org/v3/avian/ExploretheData/UsageTips.aspx

Table 1. Estimated proportion of 1km^2 sample units occupied (Psi), percent coefficient of variation of Psi (% CV) and number of sample cells with one or more detections (n Tran) of breeding bird species on the Lowry Range and the Colorado portion of BCR18. Psi values can be interpreted as the percent of the landscape occupied by each species and/or the probability that a 1km^2 grid cell will have one or more individuals of that species. The % CV indicates the precision of the estimate with values below 50% representing very precise estimates, values between 50% and 100% representing fairly robust estimates and values greater than 100% representing estimates with a low level of precision. S indicates the number of sample cells used in analyses. BCR18 priority species, as designated by Partners In Flight, are bolded.

	Lowry Range (S = 16)			CO-BCR18 (S = 81)		
Common Name	Psi	% CV	n Tran	Psi	% CV	n Tran
American Avocet	0.00	-	0	0.02	3	2
American Crow	0.00	-	0	0.02	15	5
American Goldfinch	0.06	97	1	0.01	4	9
American Kestrel	0.42	56	3	0.01	5	5

	Lowry Range (S = 16)			CO-BCR18 (S = 81)		
Common Name	Psi	% CV	n Tran	Psi	% CV	n Tran
American Robin	0.38	32	6	0.17	7	24
Ash-throated Flycatcher	0.00	-	0	0.03	16	4
Bank Swallow	0.16	67	2	0.00	20	1
Barn Swallow	0.22	52	3	0.45	4	27
Bewick's Wren	0.00	-	0	0.00	20	1
Black-billed Magpie	0.07	97	1	0.00	9	4
Black-capped Chickadee	0.00	-	0	0.02	13	7
Black-chinned Hummingbird	0.00	-	0	0.00	14	2
Black-headed Grosbeak	0.00	-	0	0.02	8	9
Blue Grosbeak	0.20	52	3	0.02	4	7
Blue Jay	0.07	97	1	0.02	7	9
Blue-gray Gnatcatcher	0.00	-	0	0.01	16	2
Blue-winged Teal	0.00	-	0	0.00	20	1
Bobolink	0.00	-	0	0.00	20	1
Brewer's Blackbird	0.22	53	3	0.18	7	7
Brewer's Sparrow	0.00	-	0	0.10	10	9
Broad-tailed Hummingbird	0.06	97	1	0.00	-	0
Brown Thrasher	0.00	-	0	0.00	11	3
Brown-headed Cowbird	0.47	28	7	0.29	5	29
Bullock's Oriole	0.52	29	7	0.13	9	13
Canada Goose	0.00	-	0	0.01	4	7
Canyon Towhee	0.00	-	0	0.00	13	2
Cassin's Sparrow	0.13	66	2	0.28	4	20
Cedar Waxwing	0.00	-	0	0.00	13	2
Chipping Sparrow	0.07	97	1	0.00	13	2
Cliff Swallow	0.21	52	3	0.17	6	23
Common Grackle	0.00	-	0	0.18	6	22
Common Nighthawk	0.81	45	5	0.07	7	7
Common Raven	0.00	-	0	0.00	14	2
Common Yellowthroat	0.00	-	0	0.01	8	8
Cooper's Hawk	0.00	-	0	0.01	22	1
Cordilleran Flycatcher	0.00	-	0	0.00	20	1
Dark-eyed Junco	0.00	-	0	0.01	20	1
Downy Woodpecker	0.00	-	0	0.01	6	7
Eastern Kingbird	0.42	33	6	0.05	11	11
Eurasian Collared-Dove	0.00	-	0	0.05	11	14
European Starling	0.51	25	8	0.15	7	24
Grasshopper Sparrow	0.88	9	14	0.35	4	20
Gray Catbird	0.09	99	1	0.00	-	0
Great Blue Heron	0.00	-	0	0.00	17	2
Great-tailed Grackle	0.00	-	0	0.02	18	3

	Lowry Range (S = 16)			CO-BCR18 (S = 81)		
Common Name	Psi	% CV	n Tran	Psi	% CV	n Tran
Green-tailed Towhee	0.00	-	0	0.00	13	2
Hairy Woodpecker	0.00	-	0	0.02	17	3
Horned Lark	1.00	-	16	0.93	1	59
House Finch	0.00	-	0	0.06	10	15
House Sparrow	0.00	-	0	0.10	8	16
House Wren	0.44	28	7	0.06	12	16
Indigo Bunting	0.06	97	1	0.01	13	2
Juniper Titmouse	0.00	-	0	0.01	16	2
Killdeer	0.28	44	4	0.25	6	20
Ladder-backed Woodpecker	0.00	-	0	0.00	20	1
Lark Bunting	0.81	12	13	0.69	2	39
Lark Sparrow	0.38	32	6	0.36	4	29
Lazuli Bunting	0.00	-	0	0.01	8	5
Loggerhead Shrike	0.17	108	1	0.08	22	1
Mallard	0.24	54	3	0.01	6	8
Marsh Wren	0.00	-	0	0.00	13	2
McCown's Longspur	0.00	-	0	0.02	10	5
Mourning Dove	0.82	12	13	0.56	3	48
N. Rough-winged Swallow	0.00	-	0	0.05	18	5
Northern Flicker	0.37	37	5	0.05	7	14
Northern Mockingbird	0.06	97	1	0.16	7	13
Orchard Oriole	0.30	73	2	0.00	-	0
Pine Siskin	0.00	-	0	0.00	13	2
Red-tailed Hawk	0.15	100	1	0.02	12	4
Red-winged Blackbird	0.69	17	11	0.21	6	25
Ring-necked Pheasant	0.00	-	0	0.08	11	7
Rock Pigeon	0.07	97	1	0.07	14	8
Rock Wren	0.13	66	2	0.01	14	3
Rufous-crowned Sparrow	0.00	-	0	0.00	20	1
Savannah Sparrow	0.00	-	0	0.00	20	1
Say's Phoebe	0.00	-	0	0.27	11	9
Scaled Quail	0.00	-	0	0.04	15	2
Song Sparrow	0.00	-	0	0.01	-	10
Spotted Sandpiper	0.00	-	0	0.00	15	2
Spotted Towhee	0.00	-	0	0.02	13	4
Swainson's Hawk	0.13	104	1	0.14	14	5
Tree Swallow	0.08	98	1	0.01	9	4
Turkey Vulture	0.00	-	0	0.00	22	1
Vesper Sparrow	0.89	9	14	0.09	10	5
Violet-green Swallow	0.00	-	0	0.01	9	4
Warbling Vireo	0.00	-	0	0.00	20	1

	Lowry Range (S = 16)			CO-BCR18 (S = 81)		
Common Name	Psi	% CV	n Tran	Psi	% CV	n Tran
Western Kingbird	0.72	17	11	0.44	4	31
Western Meadowlark	1.00	-	16	0.95	1	70
Western Wood-Pewee	0.00	-	0	0.00	11	3
White-breasted Nuthatch	0.07	97	1	0.00	10	3
Wild Turkey	0.00	-	0	0.00	20	1
Wilson's Snipe	0.10	99	1	0.00	20	1
Yellow Warbler	0.32	37	5	0.11	9	20
Yellow-breasted Chat	0.00	-	0	0.01	9	6

Table 2. Estimated densities of breeding bird species on the Lowry Range and the Colorado portion of BCR18, 2012. The estimated densities per km^2 (D), the total estimated population size of the study area (N), the number of independent detections (n), percent coefficient of variation of estimates (% CV) and the number of sample cells used in analyses (S) are shown. The % CV indicates the precision of the estimate with values below 50% representing very precise estimates, values between 50% and 100% representing fairly robust estimates and values greater than 100% representing estimates with a low level of precision. BCR18 priority species, as designated by Partners In Flight, are bolded.

	Lowry Range (S = 16)				**CO-BCR18 (S = 81)**			
Common Name	D	N	n	% CV	D	N	n	% CV
American Avocet	0	0	0	-	0.13	16,023	4	72
American Crow	0	0	0	-	0.10	11,079	15	73
American Goldfinch	0.28	29	1	102	0.14	34,633	36	42
American Kestrel	0.52	54	10	35	0.03	3,206	7	77
American Robin	0.86	89	14	42	1.85	331,521	179	37
Ash-throated Flycatcher	0	0	0	-	0.05	6,566	8	64
Bank Swallow	4.16	429	2	85	0.13	13,221	2	108
Barn Swallow	4.20	432	7	64	8.73	1,372,388	48	56
Bewick's Wren	0	0	0	-	0.08	8,999	5	106
Black-billed Magpie	0.12	12	3	831	0.02	3,295	31	64
Black-capped Chickadee	0	0	0	-	0.27	37,567	25	66
Black-chinned Hummingbird	0	0	0	-	0.42	58,861	4	81
Black-headed Grosbeak	0	0	0	-	0.14	14,634	20	76
Blue Grosbeak	0.13	14	4	374	0.04	6,374	16	45
Blue Jay	0.62	64	2	103	0.11	14,690	23	63
Blue-gray Gnatcatcher	0	0	0	-	0.06	6,154	3	80
Bobolink	0	0	0	-	0	342	2	101
Brewer's Blackbird	1.60	165	6	40	1.28	225,096	8	59
Brewer's Sparrow	0	0	0	-	0.75	98,219	22	61
Brown Thrasher	0	0	0	-	0.01	1,875	8	71
Brown-headed Cowbird	2.23	230	11	40	0.81	187,660	78	24
Bullock's Oriole	1.63	168	18	25	0.59	80,790	23	52
Canada Goose	0	0	0	-	0.16	29,291	54	47
Canyon Towhee	0	0	0	-	0.01	1,371	5	66

	Lowry Range (S = 16)				CO-BCR18 (S = 81)			
Common Name	D	N	n	% CV	D	N	n	% CV
Canyon Wren	0	0	0	-	0	267	2	100
Cassin's Sparrow	0.28	29	4	78	2.60	482,220	317	31
Cedar Waxwing	0	0	0	-	0.10	11,853	4	92
Chihuahuan Raven	0	0	0	-	0.04	3,785	1	115
Chipping Sparrow	0.32	33	1	310	0.02	3,076	3	81
Cliff Swallow	13.31	1371	5	92	5.45	825,540	53	41
Common Grackle	0	0	0	-	2.86	541,783	134	34
Common Nighthawk	0.32	33	9	132	0.03	6,441	10	37
Common Raven	0	0	0	-	0.01	1,222	8	54
Common Yellowthroat	0	0	0	-	0.34	34,094	46	100
Dark-eyed Junco	0	0	0	-	0.13	14,207	1	103
Downy Woodpecker	0	0	0	-	0.03	8,654	10	33
Eastern Kingbird	2.09	215	7	42	0.47	49,877	28	64
Eurasian Collared-Dove	0	0	0	-	0.24	42,370	65	37
European Starling	28.42	2928	40	58	2.79	436,299	146	39
Grasshopper Sparrow	18.88	1944	64	22	4.55	1,271,459	97	31
Gray Catbird	0.88	90	2	116	0	0	0	-
Great Blue Heron	0	0	0	-	0	390	7	52
Greater Roadrunner	0	0	0	-	0.01	550	1	110
Great-tailed Grackle	0	0	0	-	0.05	4,988	5	95
Green-tailed Towhee	0	0	0	-	0.01	764	2	99
Hairy Woodpecker	0	0	0	-	0.01	1,377	2	63
Horned Lark	72.00	7416	340	17	20.82	11,247,263	1272	11
House Finch	0	0	0	-	2.07	269,621	101	68
House Sparrow	0	0	0	-	9.55	1,160,038	107	74
House Wren	1.50	154	11	32	1.13	155,906	83	56
Juniper Titmouse	0	0	0	-	0.02	2,710	3	79
Killdeer	0.65	67	7	87	1.50	213,425	58	53
Lark Bunting	15.89	1637	518	2	25.79	8,063,275	1374	20
Lark Sparrow	0.77	79	11	48	1.94	396,486	110	25
Lazuli Bunting	0	0	0	-	0.01	1,846	3	54
Loggerhead Shrike	0.15	15	1	100	0.07	8,379	1	98
Long-billed Curlew	0	0	0	-	0.10	9,914	2	110
Mallard	0.60	61	7	59	0.19	30,656	24	52
McCown's Longspur	0	0	0	-	0.34	53,172	42	58
Mourning Dove	6.05	623	107	23	1.59	595,263	398	15
N. Rough-winged Swallow	0	0	0	-	2.04	235,336	10	83
Northern Flicker	0.79	82	8	45	0.17	23,308	33	41
Northern Mockingbird	0.10	10	2	1046	0.33	75,752	95	28
Orchard Oriole	0.76	78	2	73	0	0	0	-
Pine Siskin	0	0	0	-	0.02	3,417	2	79
Red-tailed Hawk	0.23	24	3	69	0.06	7,347	12	70

	Lowry Range (S = 16)				CO-BCR18 (S = 81)			
Common Name	D	N	n	% CV	D	N	n	% CV
Red-winged Blackbird	11.43	1177	54	38	4.60	782,046	386	36
Ring-necked Pheasant	0	0	0	-	0.23	39,227	85	48
Rock Pigeon	0.39	40	1	262	0.37	47,417	26	51
Rock Wren	0.14	15	3	510	0.02	2,657	11	66
Rufous-crowned Sparrow	0	0	0	-	0.01	1,548	1	100
Savannah Sparrow	0	0	0	-	0.01	1,505	3	104
Say's Phoebe	0	0	0	-	0.14	18,142	17	49
Scaled Quail	0	0	0	-	0.02	2,415	2	82
Song Sparrow	0	0	0	-	0.07	17,590	40	43
Spotted Sandpiper	0	0	0	-	0.01	2,102	3	75
Spotted Towhee	0	0	0	-	0.15	16,257	13	65
Swainson's Hawk	0.16	17	3	59	0.08	8,649	8	79
Tree Swallow	0	0	0	-	0.05	8,296	4	62
Turkey Vulture	0	0	0	-	0	341	2	78
Upland Sandpiper	0	0	0	-	0.02	2,478	2	74
Vesper Sparrow	1.37	141	70	15	0.69	105,519	24	57
Violet-green Swallow	0	0	0	-	0.06	8,587	2	74
Warbling Vireo	0	0	0	-	0	522	1	93
Western Kingbird	19.78	2037	65	36	4.78	868,495	97	40
Western Meadowlark	1.81	187	533	3	4.78	2,694,512	1473	10
Western Wood-Pewee	0	0	0	-	0.02	2,766	11	66
White-breasted Nuthatch	0.16	16	1	102	0.01	1,480	4	49
Wild Turkey	0	0	0	-	0.04	4,096	2	100
Wilson's Snipe	0.14	14	4	72	0	164	2	104
Yellow-breasted Chat	0	0	0	-	0.06	7,443	16	75

Species Richness

The species richness values indicate the Lowry Range (estimate of 15.24 species per 1km^2 grid cell; 95% confidence interval of 13.61, 16.87) hosts nearly twice the number of species on average per 1 km^2 grid cell than the Colorado portion of BCR 18 (estimate of 8.80 ; 95% confidence interval of 8.65, 8.95).

Distribution Models

The best distribution model for McCown's Longspur predicting density included the quadratic of shortgrass prairie, Latitude, Longitude, shrub cover (negative effect) and year, the top model on availability included grass height (negative effect) and shrub cover (negative effect), the top model on detection included Julian date. Using mean covariate values within Lowry from the best model, density was 2.53 birds/km^2 (95% Confidence Interval (CI) = 0, 6.62); availability was 0.004 (95% CI = 0.001, 0.007); detection was 0.49 (95% CI = 0.39, 0.59). The predicted distributions of McCown's Longspur in the Colorado portion of BCR18 and on the Lowry Range are shown in Figure 4.

The best distribution model for Loggerhead Shrike predicting density included shortgrass prairie (positive effect), the top model on availability included herbaceous cover (negative effect) and shrub cover (positive effect), the top model on detection included year. Using mean covariate values within Lowry from the best model, density was 2.92 birds/km2 (95% CI = 0, 9.7); availability was 0.001 (95% CI = 0, 0.004); detection in 2012 was 0.14 (95% CI = 0, 0.42), detection in 2011 was 0.03 (95% CI = 0, 0.1), detection in 2010 was 0.87 (95% CI = 0.63, 1). The predicted distributions of Loggerhead Shrike in the Colorado portion of BCR18 and on the Lowry Range are shown in Figure 5.

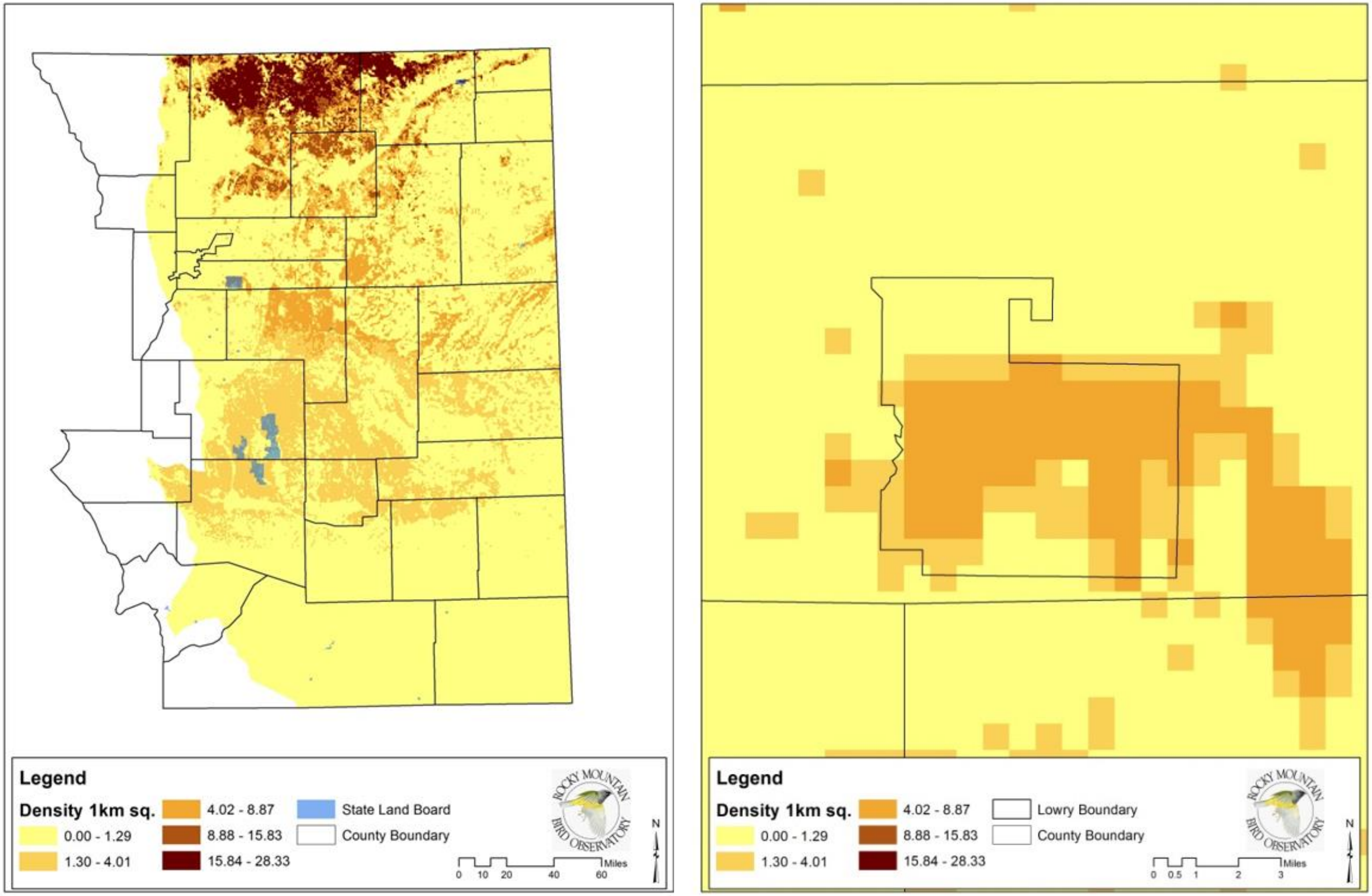

Figure 4. Predicted densities of McCown's Longspur throughout the Colorado portion of BCR 18 (left) and the Lowry Range (right).

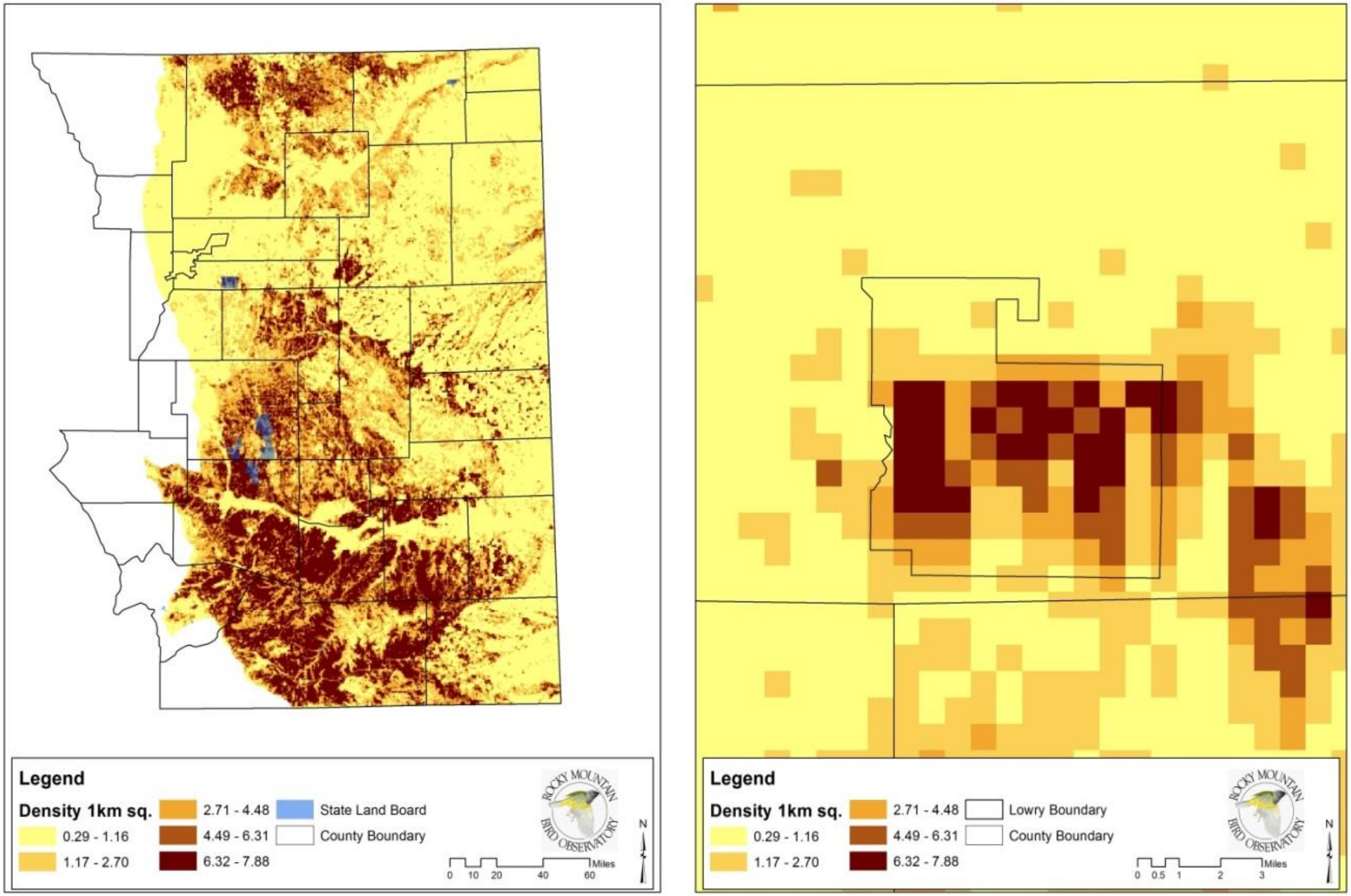

Figure 5. Predicted densities of Loggerhead Shrike throughout the Colorado portion of BCR 18 (left) and the Lowry Range (right).

DISCUSSION

Temporal and Spatial Comparisons

The IMBCR program's ability to make comparisons between small-scale locations, large regions, and across years can provide managers with important information about the lands they manage. Data collected and results produced for the Lowry Range can be used in the following ways to inform avian conservation:

1) Population estimates can be compared in space and time. For example, estimates for the Lowry Range can be compared to state and regional estimates to determine whether local populations are above or below estimates for the region;
2) Population estimates can be used to make informed management decisions about where to focus conservation efforts. For example, strata with large populations can be targeted for protection and strata with low populations can be prioritized for conservation action; a threshold could be set to trigger a management action when populations reach a predetermined level;
3) 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;
4) Occupancy rates can be multiplied by the land area in a region of interest to estimate the area occupied by a species. For example, if a stratum comprises 120,000 km^2 and the occupancy estimate for Western Meadowlark is 0.57, managers can estimate that 68,400 km^2 (120,000 km^2 * 0.57) of habitat within that stratum is occupied by Western Meadowlarks.

Management Implications

Occupancy rates and density estimates were generally larger on the Lowry Range than in the Colorado portion of BCR 18 indicating that the Lowry Range likely provides good habitat for breeding bird species along the Front Range of Colorado. In particular, grassland-affiliated species occupied a larger proportion of sites and were found in higher densities on the Lowry Range than within the other lands constituting the Colorado portion of BCR 18. Additionally, species richness was found to be nearly twice as high on the Lowry Range compared to the Colorado portion of BCR 18; indicating that the Lowry Range hosts a complex avian community compared to the surrounding landscape. Therefore, managers should be aware that the Lowry Range represents important avian habitat which should be protected from substantial anthropogenic disturbance.

A lower sampling intensity (S = 16 versus S = 81) on the Lowry Range than within the Colorado portion of BCR18 likely contributed to the absence of 54 species on the Lowry Range which were detected within the Colorado portion of BCR18. Additionally, 8 species absent from the Lowry Range do not regularly occur in the area (Black-chinned Hummingbird, Bobolink, Canyon Towhee, Chihuahuan Raven, Greater Roadrunner, Juniper Titmouse, Rufous-crowned Sparrow, and Scaled Quail), 15 species inhabit forest, sagebrush or shrubland environments which do not represent a significant portion of the habitat on the Lowry Range (Ash-throated Flycatcher, Bewick's Wren, Black-capped Chickadee, Black-headed Grosbeak, Blue-gray Gnatcatcher, Brewer's Sparrow, Brown Thrasher, Dark-eyed Junco, Downy Woodpecker, Green-tailed Towhee, Hairy Woodpecker, House Sparrow, Pine Siskin, Spotted Towhee and Wild Turkey), 10 species inhabit wetlands or are affiliated with open water which is not present on the Lowry Range (American Avocet, Canada Goose, Common Grackle, Great Blue Heron, Great-tailed

Grackle, Long-billed Curlew, Northern Rough-winged Swallow, Spotted Sandpiper, Tree Swallow and Violet-green Swallow) and 3 species are non-native (Eurasian Collared-Dove, House Sparrow and Ring-necked Pheasant). The absence of these species should not concern Lowry Range land managers.

One suite of species that were largely undetected on the Lowry Range are riparian-associated species. Eight riparian-associated species (Cedar Waxwing, Common Yellowthroat, Lazuli Bunting, Savannah Sparrow, Song Sparrow, Warbling Vireo, Western Wood-Pewee and Yellow-breasted Chat) had higher occupancy and/or density rates throughout Colorado BCR18 than on the Lowry Range. One reason for this is that randomly selected survey locations on the Lowry Range largely fell outside of riparian habitat (only 8 of 243 surveyed points were characterized as riparian habitat). Another reason could be that understory vegetation within the riparian areas is being impacted by cattle grazing. To encourage the growth of riparian vegetation and improve overall habitat quality along Coal and Box Elder Creeks RMBO recommends constructing fencing around these riparian corridors to reduce livestock-associated browsing (Noe Marymor pers. comm.). Lowry Range land managers should also ensure that recruitment of overstory species is occurring. This will ensure that mature riparian corridors will persist in the future.

The absence of two grassland affiliated species, Say's Phoebe and McCown's Longspur, from the Lowry Range is of note. The habitat at Lowry Range would seem to represent suitable open-country habitat for Say's Phoebe. Their absence may therefore result from limited available nest sites. Say's Phoebe readily use anthropogenic structures as nesting platforms or seek banks, cliffs and rocky outcroppings for natural nest sites [35]. The relative paucity of these structures would seem to be the most likely cause for their absence on the Lowry Range. We do not recommend the creation of nesting structures to improve Say's Phoebe occupancy; however, Lowry Range managers should attempt to limit disturbance around existing suitable nesting structures.

Although the McCown's Longspur core area occurs to the north of the Lowry Range, there have been a number of McCown's Longspur detections near, and even south of, the Lowry Range. Results of our habitat modeling efforts for McCown's Longspur indicate that suitable habitat does exist within the Lowry Range; however, we do not expect this species to occur there in high densities. The distribution modeling effort for Loggerhead Shrike indicates the Lowry Range represents better habitat for that species. Unfortunately, these two species will likely be difficult to manage concurrently because Loggerhead Shrike is positively associated with shrub cover while the opposite is true for McCown's Longspur. Regular disturbance through grazing and/or prescribed fires throughout the Lowry Range to prevent succession from grassland to shrubland will likely be necessary to maintain habitat that is potentially suitable for McCown's Longspur. Conversely, if Lowry Range managers desire increased Loggerhead Shrike population densities then succession from grassland to shrubland should be encouraged and disturbance reduced or eliminated while additional shrub cover accumulates. We believe these modeling efforts provide valuable information to land managers seeking specific information on habitat needs of declining species or those of conservation concern. Unfortunately, due to the time-intensive nature of the modeling efforts and funding limitations our efforts were limited to these two species. Additional modeling efforts for other priority species may be of value to managers in the future.

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APPENDIX A: AVIAN DATA CENTER USAGE TIPS

The Avian Data Center has been designed to provide information for specific questions and therefore works best when users select multiple filters for a query. To run a query, click the arrow for the drop down "Filter" menu (located in the extreme upper left corner of the screen) and select one of the following filter types: Study Design, Species, Stratum, Super Stratum, BCR, State, County, Habitat, Year, Priority Species List, or Management Entity. After selecting the filter type, click the "Add" button immediately to the right of the drop down menu. A box will appear with options for the filter that you may select. Use the drop down menu in the box to select the specific filter and then click "Add filter". The selected filter will appear near the top of the screen. Users may add multiple filter types to view results for a very specific inquiry (e.g., to view IMBCR results for BRSP in CO you would apply the following filters: Study Design = IMBCR, Species = Brewer's Sparrow, and State = CO) or to view multiple outputs at once (e.g., to view data and results for Brewer's Sparrow and Vesper Sparrow at the same time select Species = Brewer's Sparrow and Species =Vesper Sparrow). Below is an explanation of the different filter types you may choose from.

Study Design: This filter will allow users to select data and results for IMBCR, GRTS, NEON, Migration Phenology or NPS study designs.

Species: This filter allows users to select data and results for a particular species.

Stratum: This filter allows users to select data and results for a particular stratum.

Super Stratum: This filter allows users to select data and results for multiple stratum that were analyzed jointly (e.g., the entire Bridger-Teton National Forest which is broken up into 2 strata or the entire state of Colorado which is broken up into 29 strata).

BCR: This filter will allow users to select data and results for a particular BCR.

State: This filter will allow users to select data and results for a particular state.

County: This filter will allow users to select data and results for a particular county. Please note that only raw count data and survey locations are available at the county level.

Year: This filter will allow users to select data and results for a particular year.

Priority Species List: This filter will allow users to select data and results for multiple species at once. The query will display data and results for all species included on the selected management indicator list, species of conservation concern list, etc.

Management Entity: This filter will allow users to select data and results for All Other Lands, US Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), Department of Defense (DOD), or US Fish and Wildlife Service (USFWS). Once a management entity is chosen, users may notice that additional filter types are available in the filters drop down list. These additional filter types, listed from most general to most specific, are management regions (e.g., USFS Region 1), management units (e.g., Dakota Prairie Grasslands), management forests (e.g., Shoshone National Forest), or management districts (e.g., North Kaibab district within Kaibab National Forest). Below is the filter hierarchy for the different management entities.

USFS:
Tier One – Management Entity – US Forest Service
Tier Two – Management Region – USFS Regions (correct!)
Tier Three – Management Unit – NF or NG management units
Tier Four – National Forest or Grassland – NF or NG
Tier Five – Management District – NF or NG Ranger Districts

NPS:
Tier One – Management Entity – National Park Service
Tier Two – Management Region – Inventory and Monitoring Network
Tier Three – Management Unit – Individual Park Units
Tier Four – Mgmt Forest – Not applicable
Tier Five – Management District – Not applicable

BLM:
Tier One – Management Entity – Bureau of Land Management
Tier Two – Management Region – BLM Field Office
Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

DOD:
Tier One – Management Entity – US Department of Defense
Tier Two – Management Region – Installation Unit
Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

Tribal Lands:
Tier One – Management Entity – US Bureau of Indian Affairs
Tier Two – Management Region – Reservation Region
Tier Three – Management Unit – Reservation
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

All Other Lands:
Tier One – Management Entity – All Other Lands
Tier Two – Management Region – Not applicable
Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

USFWS:
Tier One – Management Entity – US Fish and Wildlife Service
Tier Two – Management Region – USFWS Region
Tier Three – Management Unit – USFWS Unit
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

The Nature Conservancy:
Tier One – Management Entity – The Nature Conservancy
Tier Two – Management Region – Cherry Creek

Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

Clearing Filters
Filters can be cleared in one of two ways. You may click on the circled "X" to the left of an individual filter at the top of the screen to remove it or you may click the "clear all filters" button at the top of the screen to start building a new query.

Running Queries
Once you have selected your desired filters, please click on the "Run Query" button located at the top of the screen. The amount of time it takes for the desired data and results to be displayed will depend on how specific your query is.

Comparing Multiple Queries
Users may view results of more than one query at once. To do this, run the first query as described above and then click the button "New Query Window" (located at the top of the screen). A new window will appear where a new query can be run and the two windows can then be viewed side by side.

Viewing Maps (Map Tab)
What is displayed?
By default, the map tab is the initial start-up page. After clicking the "Run Query" button, the ADC will display a map of all survey locations corresponding to your set of filters (surveyed grid cells are represented by blue semi-transparent circles) in Google Earth. If you have filtered by species, survey locations where that species was not detected will be represented by the blue circle. Locations where that species was detected will have a pink dot in the center of the blue circle. To see the specific name of a survey location, move the mouse arrow over the blue circle. After a moment the name of the surveyed grid cell should appear. You may view the bird detection info for a grid cell and the survey dates by left clicking your mouse on the blue circle.

By default, the zoom capability of the maps page is restricted to protect the privacy of private landowners. Partners wishing for more precise location information to be displayed should request a password from RMBO via email (it@rmbo.org). Once a user has a password, click on the "View Options" button at the top of the screen, enter the password in the "Password for RMBO staff and partners" field, and click "Save". If you have run a query prior to entering the password, you will need to click the "Run Query" button again in order to utilize the enhanced zooming features now available to you.

Adding boundary layers
You may add the following layers to the map: Bird Conservation Region boundaries, BIA boundaries, DOD boundaries, NPS boundaries, and USFS boundaries. To do this, left click on the drop down menu at the top left corner of the map, select the desired layer, and click the "add layer" button. It is possible to add multiple layers to the map by repeating this process. If you left click your mouse inside of any of these boundaries a text box will appear that contains the name of the region encompassed by the boundary.

Viewing Occupancy/Density Results (Occupancy and Density Tabs)
Viewing Tables
You may view a table of occupancy or density results and a chart for all appropriate strata

(based on the set of filters) for which we have results by clicking on the tabs labeled "Occupancy" or "Density". These tabs are located just below the drop down filter menu in the upper left corner of the screen. The occupancy tables will display the species for which the estimate was produced, the stratum the estimate pertains to, the year, Psi (proportion of grid cells expected to be occupied), the number of grid cells the species was detected on, the standard error (SE) of the estimate, and the percent coefficient of variance (% CV). The density tables will display the species for which the estimate was produced, the stratum or habitat type that the estimate pertains to, the year, the number of birds expected per km2 (D), the total number of individuals expected to reside within the stratum (N), the percent coefficient of variance (% CV), and the number of individuals detected (n). You may view a description of the column headings by moving the mouse arrow over the column heading. You may also sort the table by clicking on any of the column headings.

Viewing the Charts

When viewing the occupancy and density charts, the point estimate of Psi or D is indicated with a dot. Additionally, short horizontal dashes above and below the point estimate represent values one standard error away from the point estimate. To view the species, stratum, and year that correspond to an estimate on the chart, simply move your mouse arrow over the point estimate or standard error bar. A message will pop up with the appropriate information. If you have queried out multiple years of data the point estimates for each year will be connected with a solid line. You may remove an individual estimate from the chart by clicking on the corresponding row of the table on the left side of the screen. Estimates that are not displayed on the chart will turn a peach color in the table. You may add the estimate back onto the chart simply by clicking on the peach colored row in the table.

Knowing which species have estimates

To restrict the species filter to display only those species for which occupancy or density estimates have been produced, click on the "View Options" button on the very top of the screen and then check the box next to "Only show species for which occupancy/density results are available". This will prevent you from querying out numerous species for which occupancy or density estimates are not available.

Saving results of your query

You may easily save the results of your query by clicking the "Copy to clipboard" button and pasting the results into another program such as excel or by clicking the "Save to CSV" button. To save images, the best option is to take a screenshot. Use the Print Screen key on Windows or Command-Shift-3 on a Mac.

Functionality

Please keep in mind that queries with very generic filters will result in long wait times and may not function optimally (your browser may end up crashing). For instance, if a user selects only the IMBCR filter, occupancy results will be displayed for every species and strata/super strata combination for which there are occupancy and/or density results. If your query is not specific enough, the chart on the right side of the screen will not be displayed or a pop-up box will appear asking if you'd like to continue. This pop-up box is designed to prevent your web browser from crashing while the ADC attempts to create a chart that would be extremely difficult to interpret. We recommend that you cancel the proposed query and add additional filters to make your query less generic.

What is available?

Currently, occupancy results are available for 2010 to 2012 via the ADC as well as density results for 2009 thru 2012.

Viewing Raw Count Statistics (Species Counts Tab)

You may view the raw count of detections for each species (left table) and the effort (expressed as the number of points surveyed) (right table) for your query by clicking on the "Species Counts" tab located next to the "Density Tab" in the upper left corner of your screen. Both the counts and effort tables may be sorted by clicking on the row header. Additionally, you may view the counts and effort by BCR, State, County, Stratum, or Management Entity by clicking on the "Count by" drop down menu located above the counts table. If you have filtered using "Super Strata", viewing counts by Stratum is an excellent way of getting a list of all the strata that comprise a Super Strata. If you would prefer to view effort expressed as the number of grid cells surveyed, click on the "View Options" button located at the top of the screen and check the box labeled "Show effort by number of grid cells instead of by point".