

Avian Monitoring on Colorado State Land Board's Lowry Range: 2013 Final Report



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Rocky Mountain Bird Observatory

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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), in conjunction with the Colorado State Land Board, conducted landbird monitoring throughout the 26,000-acre Lowry Range parcel located near Denver, CO for the second year in 2013. 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 2013, RMBO completed 16 surveys, resulting in 235 point counts conducted. Surveys on the Lowry Range were conducted between 22 May and 6 June. Field technicians observed 2,810 individuals of 49 bird species during the surveys. Using the RIMBCR package for Program R designed by Paul Lukacs, we estimated occupancy rates of 103 species occurring in the Colorado portion of BCR18 and/or on the Lowry Range, including 23 species with special designation for BCR 18 as designated by Partners In Flight. We estimated densities of 100 species occurring in the Colorado portion of BCR18 and/or on the Lowry Range, including 24 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 30 of the 40 species (75%) for which we estimated Lowry Range occupancy rates. Similarly, 27 of the 40 species (68%) 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 higher 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.

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. This was the second year of monitoring on the Lowry Range using the IMBCR monitoring design. The goal of this bird monitoring effort is to provide a framework for understanding the status and annual changes of bird populations on the Lowry Range property by providing occupancy, density and species richness estimates. These estimates can be used to inform land management decisions. 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. Additionally, oil and gas development is taking place on the Lowry Range. Because birds act as excellent indicators 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.

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, and 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 1,363 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 km²) 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-km² cells, each containing 16 evenly-spaced sample points, 250 meters apart (Figure 2). The grid used to define the 1-km² 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].

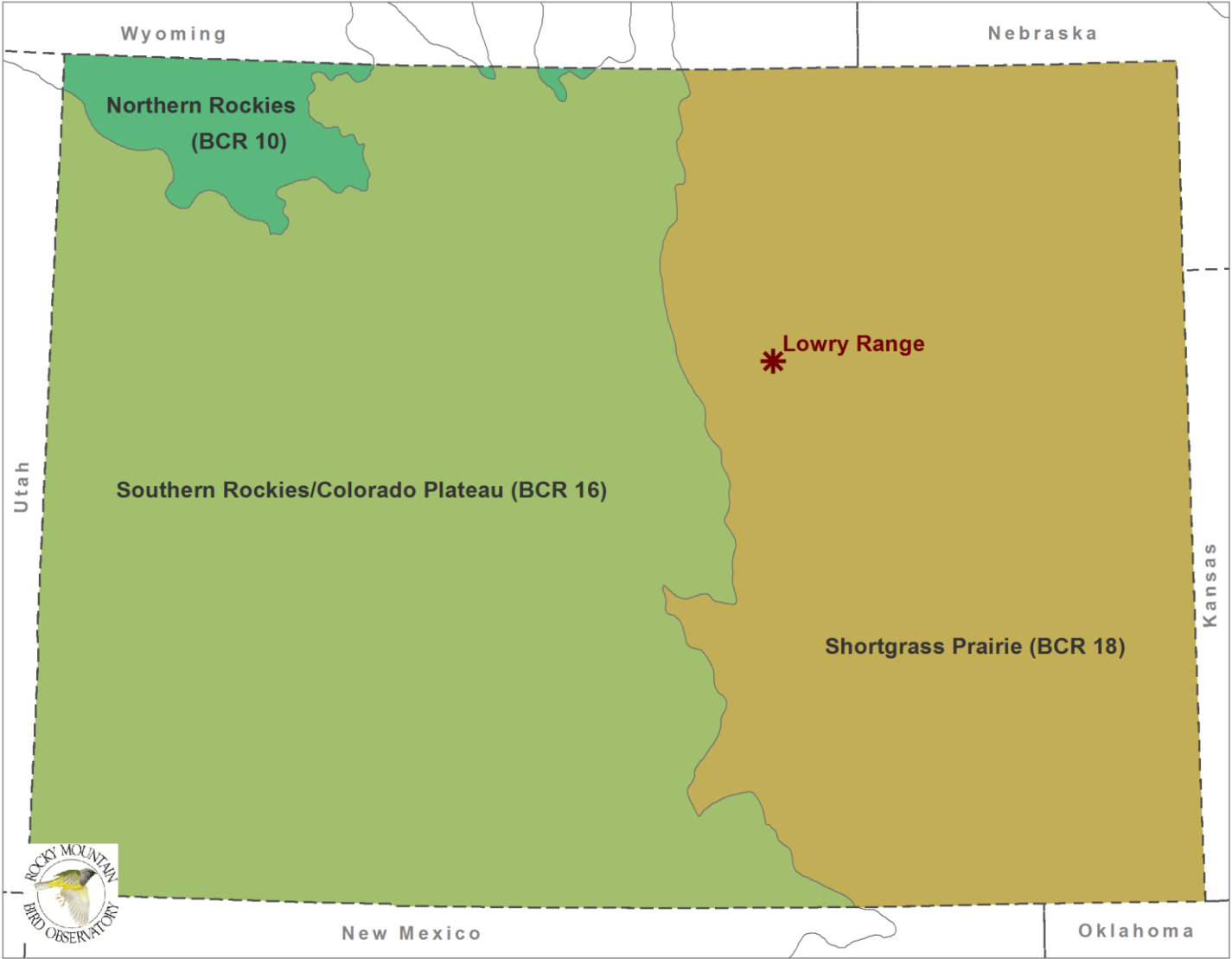


Figure 1. Bird Conservation Regions in Colorado



Figure 2. Image of an IMBCR 1-km² 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.

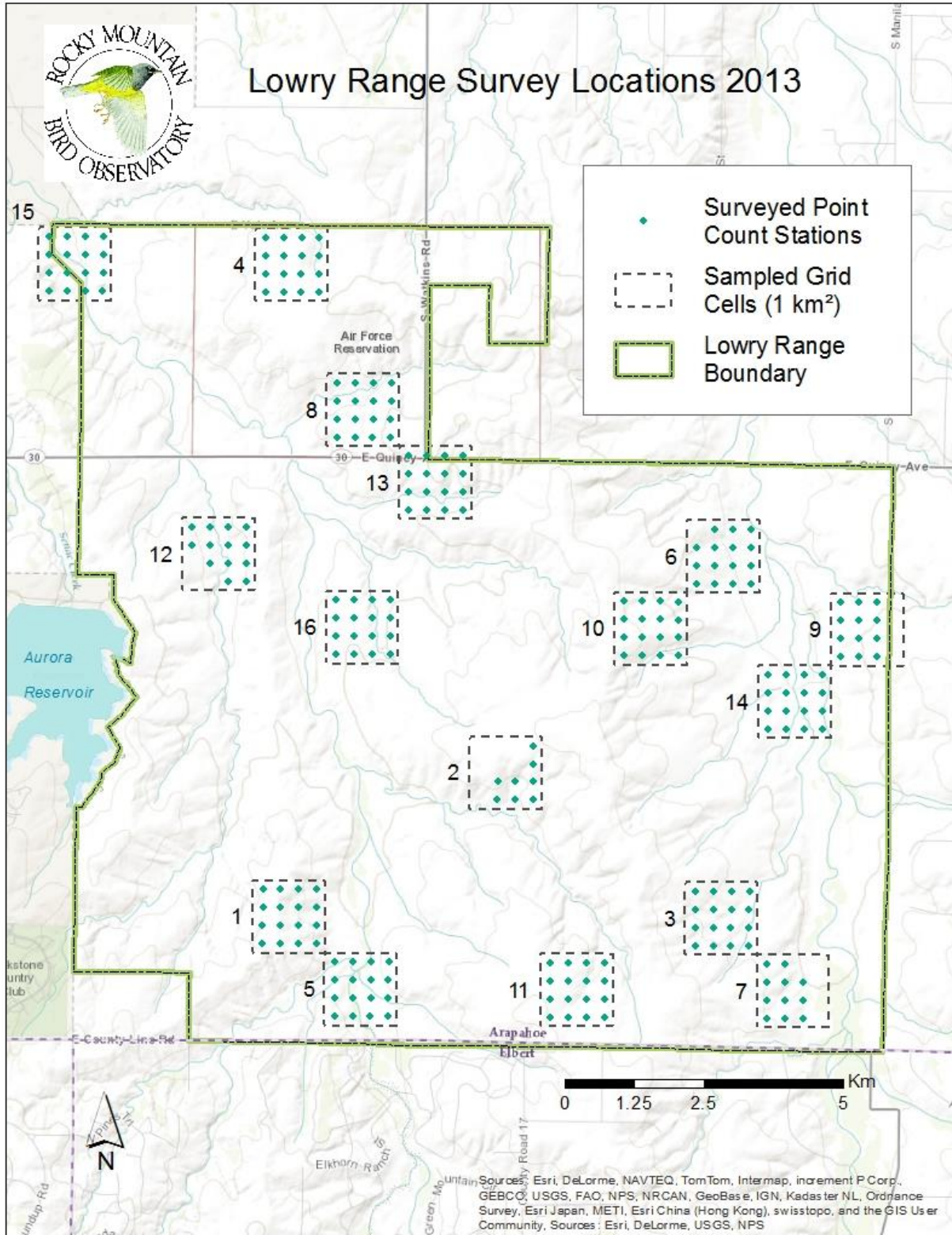
All sample cells in the sampling frame are ordered such that any set of consecutively numbered units is a spatially-balanced sample [18]. In the case of fluctuating budgets, we can adjust the sampling effort among years within each stratum while still preserving a random, spatially-balanced sampling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

Based on available funding, RMBO conducted point counts at 16 and 82 individually selected sample cells on the Lowry Range and the Colorado portion of BCR18; respectively. This resulted in a total of 235 and 971 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 2013 field season.

Sampling Methods

Surveyors with excellent aural and visual bird-identification skills conducted field work between May 22nd and June 6nd 2013. Prior to conducting surveys, surveyors completed an intensive

Figure 3. Sample cells and individual point count stations surveyed within the Lowry Range during the 2013 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 and private property without permission to survey 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_spatially_balanced_sampling_final.pdf.

Data Analysis

Estimating Occupancy

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., 1-km² 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 km² grid cells occupied by a species and the probability that any 1 km² grid cell will be occupied, we were able to estimate the number of species occupying any 1 km² 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.

RESULTS

We detected 2,810 individual birds during 235 point count surveys (11.96 individuals/point count) within the Lowry Range compared to 11,359 individual birds detected during 961 point count surveys (11.82 individuals/point count) conducted within the Colorado portion of BCR18. While conducting the 16 surveys on the Lowry Range, RMBO surveyors detected 49 avian species. In contrast, RMBO detected 148 species within the Colorado portion of BCR18 during 82 surveys.

Occupancy and Density Estimates

Using the RIMBCR package we were able to estimate occupancy rates of 40 of the 49 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 14 of these species. Additionally, we calculated occupancy rates (the proportion of 1km² grid cells expected to be occupied by one or more individuals) for 103 species within the Colorado portion of BCR18; 102 of which have a % CV less than 50. In total, we estimated occupancy rates for 103 species that occur within the Lowry Range and/or the Colorado portion of BCR18. Twenty three of the species we estimated occupancy rates for have received special designation within BCR 18 by Partners in Flight. Thirty of the 40 species (75%) 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, 12 of which have a % CV of less than 50. Additionally, we estimated densities of 99 species within the Colorado portion of BCR18; 31 of which had robust estimates with a % CV of less than 50. In total, we estimated densities of 100 species that occur within the Lowry Range and/or the Colorado portion of BCR18 (Table 2). Twenty four of the species we estimated densities of have received special designation within BCR 18 by Partners in Flight. Twenty seven of the 40 species (68%) 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#N4lqzrgDqpgTmALnAhoiBbEAuEBhAeRAF8gAA)

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#N4lqzrgDqpgTmALnAhoiBbEAuEBhAeQFoAhPAJQEYAOlqQQBsGACAxAC3hAF8gA)

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Non-river lands within Colorado BCR 18

(http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4lqzrgDqpgTmALnAhoiBbEAuEBhAeQFoAhPAJQEYAOlqOQHsA7OASwDd4wQBfIAAA).

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 1km² 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, 2013. Psi values can be interpreted as the percent of the landscape occupied by each species and/or the probability that a 1km² 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.

Species	Lowry Range (S = 16)			CO-BCR18 (S = 82)		
	Psi	% CV	n Tran	Psi	% CV	n Tran
American Crow	0.00	-	0	0.02	14	6
American Goldfinch	0.07	97	1	0.06	13	8
American Kestrel	0.16	98	1	0.03	5	4
American Robin	0.38	32	6	0.14	7	22
Ash-throated Flycatcher	0.00	-	0	0.01	10	5
Baltimore Oriole	0.00	-	0	0.00	20	1
Bank Swallow	0.19	52	3	0.02	14	6
Barn Swallow	0.36	44	4	0.42	5	24
Belted Kingfisher	0.00	-	0	0.01	16	1
Bewick's Wren	0.00	-	0	0.00	19	1
Black-billed Magpie	0.00	-	0	0.02	14	6
Black-capped Chickadee	0.00	-	0	0.00	8	4
Black-headed Grosbeak	0.00	-	0	0.03	9	6
Blue Grosbeak	0.00	-	0	0.07	11	9
Blue Jay	0.07	97	1	0.02	7	9
Blue-gray Gnatcatcher	0.00	-	0	0.01	16	2
Bobolink	0.00	-	0	0.00	19	1
Brewer's Blackbird	0.08	97	1	0.09	10	12
Brewer's Sparrow	0.00	-	0	0.04	11	7
Broad-tailed Hummingbird	0.14	66	2	0.00	19	1
Brown Thrasher	0.00	-	0	0.00	14	2
Brown-headed Cowbird	0.13	66	2	0.40	4	33
Bullock's Oriole	0.41	32	6	0.22	6	20
Canada Goose	0.09	98	1	0.01	-	7
Canyon Towhee	0.00	-	0	0.01	11	4
Canyon Wren	0.00	-	0	0.01	14	2

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Species	Lowry Range (S = 16)			CO-BCR18 (S = 82)		
	Psi	% CV	n Tran	Psi	% CV	n Tran
Cassin's Kingbird	0.00	-	0	0.04	15	5
Cassin's Sparrow	0.13	66	2	0.23	6	15
Cedar Waxwing	0.00	-	0	0.00	14	2
Chipping Sparrow	0.00	-	0	0.00	19	1
Cliff Swallow	0.07	97	1	0.31	5	26
Common Grackle	0.32	37	5	0.31	5	32
Common Nighthawk	0.40	56	3	0.35	8	8
Common Raven	0.00	-	0	0.05	11	9
Common Yellowthroat	0.00	-	0	0.02	8	8
Curve-billed Thrasher	0.00	-	0	0.05	11	5
Downy Woodpecker	0.00	-	0	0.01	9	4
Eastern Kingbird	0.56	29	7	0.12	9	13
Eurasian Collared-Dove	0.07	97	1	0.13	7	18
European Starling	0.39	32	6	0.20	6	22
Grasshopper Sparrow	0.69	17	11	0.17	6	9
Gray Catbird	0.00	-	0	0.00	13	2
Great Blue Heron	0.00	-	0	0.01	11	4
Greater Roadrunner	0.00	-	0	0.01	20	1
Green-tailed Towhee	0.00	-	0	0.00	19	1
Hairy Woodpecker	0.00	-	0	0.00	10	3
Horned Lark	1.00	-	16	0.94	1	62
House Finch	0.06	97	1	0.15	7	15
House Sparrow	0.06	97	1	0.07	9	14
House Wren	0.19	52	3	0.06	11	16
Indigo Bunting	0.00	-	0	0.00	20	1
Juniper Titmouse	0.00	-	0	0.01	14	3
Killdeer	0.32	44	4	0.31	6	21
Ladder-backed Woodpecker	0.00	-	0	0.00	22	1
Lark Bunting	0.88	9	14	0.64	2	40
Lark Sparrow	0.70	17	11	0.45	3	33
Lazuli Bunting	0.00	-	0	0.00	19	1
Lesser Goldfinch	0.00	-	0	0.03	18	2
Lewis's Woodpecker	0.00	-	0	0.02	18	2
Loggerhead Shrike	0.13	99	1	0.10	14	4
Mallard	0.00	-	0	0.33	10	10
Marsh Wren	0.00	-	0	0.00	19	1
McCown's Longspur	0.00	-	0	0.06	10	6
Mountain Plover	0.00	-	0	0.17	8	5
Mourning Dove	0.52	25	8	0.53	3	47
Northern Flicker	0.17	68	2	0.09	11	11
Northern Harrier	0.00	-	0	0.01	15	2
Northern Mockingbird	0.07	97	1	0.13	8	11
Northern Rough-winged Swallow	0.00	-	0	0.15	11	6

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Species	Lowry Range (S = 16)			CO-BCR18 (S = 82)		
	Psi	% CV	n Tran	Psi	% CV	n Tran
Orchard Oriole	0.00	-	0	0.00	20	1
Pinyon Jay	0.00	-	0	0.00	21	1
Plumbeous Vireo	0.00	-	0	0.00	19	1
Red-headed Woodpecker	0.07	97	1	0.02	11	3
Red-tailed Hawk	0.00	-	0	0.08	14	5
Red-winged Blackbird	0.32	37	5	0.18	7	22
Ring-necked Pheasant	0.00	-	0	0.01	15	1
Rock Pigeon	0.00	-	0	0.05	14	6
Rock Wren	0.00	-	0	0.01	10	5
Rufous-crowned Sparrow	0.00	-	0	0.01	16	2
Say's Phoebe	0.26	53	3	0.17	9	9
Scaled Quail	0.00	-	0	0.04	16	2
Song Sparrow	0.00	-	0	0.01	5	10
Spotted Sandpiper	0.00	-	0	0.02	4	4
Spotted Towhee	0.00	-	0	0.01	10	6
Swainson's Hawk	0.63	62	3	0.42	6	4
Tree Swallow	0.00	-	0	0.00	19	1
Turkey Vulture	0.00	-	0	0.01	11	3
Vesper Sparrow	0.19	52	3	0.05	12	4
Violet-green Swallow	0.00	-	0	0.00	20	1
Warbling Vireo	0.00	-	0	0.01	12	3
Western Kingbird	0.83	12	13	0.54	3	43
Western Meadowlark	1.00	-	16	0.82	1	60
Western Scrub-Jay	0.00	-	0	0.01	16	2
Western Tanager	0.00	-	0	0.03	19	2
Western Wood-Pewee	0.13	66	2	0.01	8	5
Wild Turkey	0.00	-	0	0.00	21	1
Willow Flycatcher	0.00	-	0	0.00	19	1
Wilson's Snipe	0.08	97	1	0.00	19	1
Wood Duck	0.00	-	0	0.00	21	1
Yellow Warbler	0.26	43	4	0.12	8	18
Yellow-breasted Chat	0.00	-	0	0.01	9	6
Yellow-headed Blackbird	0.00	-	0	0.00	14	2
Yellow-rumped Warbler	0.00	-	0	0.04	19	1

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Table 2. Estimated densities of breeding bird species on the Lowry Range and the Colorado portion of BCR18, 2013. The estimated densities per km² (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.

Species	Lowry Range (S = 16)				CO-BCR18 (S = 82)			
	D	N	n	% CV	D	N	n	% CV
American Avocet	0.00	0	0	-	0.02	1,757	2	75
American Crow	0.00	0	0	-	0.12	13,892	22	93
American Goldfinch	0.38	39	2	100	0.21	24,061	12	63
American Kestrel	0.34	34	2	90	0.13	14,448	8	85
American Robin	2.76	285	13	55	2.57	291,443	166	46
Ash-throated Flycatcher	0.00	0	0	-	0.06	6,782	12	64
Bank Swallow	5.12	527	8	69	0.87	98,423	34	59
Barn Swallow	1.56	161	2	74	7.47	847,453	38	60
Bewick's Wren	0.00	0	0	-	0.04	4,685	7	100
Black-billed Magpie	0.00	0	0	-	0.10	11,566	27	63
Black-capped Chickadee	0.00	0	0	-	0.09	10,473	25	46
Black-headed Grosbeak	0.00	0	0	-	0.11	12,858	8	68
Blue Grosbeak	0.00	0	0	-	0.24	26,603	23	52
Blue Jay	0.22	22	3	72	0.07	8,281	38	44
Blue-gray Gnatcatcher	0.00	0	0	-	0.07	8,006	2	78
Blue-winged Teal	0.00	0	0	-	0.04	4,757	1	75
Bobolink	0.00	0	0	-	0.00	150	1	99
Brewer's Blackbird	0.40	41	1	101	0.68	77,322	17	60
Brewer's Sparrow	0.00	0	0	-	0.69	78,568	56	52
Brown Thrasher	0.00	0	0	-	0.02	1,739	7	72
Broad-tailed Hummingbird	1.16	120	1	100	0.00	0	0	-
Brown-headed Cowbird	1.04	108	5	63	3.15	356,633	96	30
Bullock's Oriole	5.62	579	25	39	1.76	199,146	46	37
Burrowing Owl	0.00	0	0	-	0.06	6,603	4	51
Canada Goose	0.09	9	3	72	0.04	4,254	60	28
Canyon Towhee	0.00	0	0	-	0.05	5,251	4	60
Canyon Wren	0.00	0	0	-	0.01	852	7	74
Cassin's Kingbird	0.00	0	0	-	0.46	52,297	26	83
Cassin's Sparrow	0.63	64	5	71	6.39	724,663	230	36
Cedar Waxwing	0.00	0	0	-	0.08	8,732	3	83
Chihuahuan Raven	0.00	0	0	-	0.01	1,140	7	49
Chipping Sparrow	0.00	0	0	-	0.23	26,107	2	97
Cliff Swallow	0.51	52	1	100	6.35	719,951	58	32
Common Grackle	3.77	388	4	62	10.42	1,181,255	124	48

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Species	Lowry Range (S = 16)				CO-BCR18 (S = 82)			
	D	N	n	% CV	D	N	n	% CV
Common Nighthawk	0.49	50	4	44	0.48	54,732	13	37
Common Raven	0.00	0	0	-	0.28	31,340	41	43
Common Yellowthroat	0.00	0	0	-	0.19	20,965	25	93
Curve-billed Thrasher	0.00	0	0	-	0.12	13,179	6	58
Downy Woodpecker	0.00	0	0	-	0.02	2,135	3	52
Eastern Kingbird	5.65	582	18	54	0.55	62,205	27	47
Eurasian Collared-Dove	1.05	108	1	133	2.16	244,536	49	101
European Starling	28.84	2,970	52	54	2.45	277,998	88	36
Grasshopper Sparrow	8.21	845	32	33	3.08	348,716	29	52
Gray Catbird	0.00	0	0	-	0.03	3,733	3	103
Great Blue Heron	0.00	0	0	-	0.05	5,435	14	58
Greater Roadrunner	0.00	0	0	-	0.01	672	1	108
Green-tailed Towhee	0.00	0	0	-	0.02	1,707	1	106
Hairy Woodpecker	0.00	0	0	-	0.02	2,247	3	51
Horned Lark	53.28	5,488	299	15	92.73	10,516,484	1,454	8
House Finch	0.24	24	1	100	1.75	198,380	83	32
House Sparrow	0.00	0	0	-	3.40	385,410	118	61
House Wren	2.82	291	13	63	0.94	106,947	68	49
Juniper Titmouse	0.00	0	0	-	0.14	15,761	10	72
Killdeer	1.46	150	8	44	1.89	214,746	72	34
Ladder-backed Woodpecker	0.00	0	0	-	0.00	382	1	101
Lark Bunting	28.27	2,912	227	33	35.88	4,069,612	1,052	17
Lark Sparrow	11.09	1,142	53	36	5.55	629,670	147	19
Lazuli Bunting	0.00	0	0	-	0.01	621	1	105
Lesser Goldfinch	0.00	0	0	-	0.25	28,332	2	109
Lewis's Woodpecker	0.00	0	0	-	0.04	4,605	3	85
Loggerhead Shrike	0.15	15	1	100	0.12	13,870	6	73
Long-billed Curlew	0.00	0	0	-	0.11	11,973	2	101
Mallard	0.00	0	0	-	0.32	36,024	20	49
Marsh Wren	0.00	0	0	-	0.01	556	1	105
McCown's Longspur	0.00	0	0	-	0.92	104,119	50	78
Mountain Plover	0.00	0	0	-	0.66	74,672	14	64
Mourning Dove	4.54	468	51	39	4.45	504,427	250	16
Northern Flicker	0.52	53	6	59	0.16	17,754	20	47
Northern Harrier	0.03	3	1	104	0.00	249	3	69
Northern Mockingbird	0.25	26	6	83	0.64	72,468	79	29
Northern Rough-winged Swallow	0.00	0	0	-	0.53	59,692	5	72
Northern Shoveler	0.00	0	0	-	0.01	1,219	2	102
Pinyon Jay	0.00	0	0	-	0.00	275	1	100
Plumbeous Vireo	0.00	0	0	-	0.00	401	1	101
Red-headed Woodpecker	0.55	57	5	66	0.05	5,533	7	86
Red-tailed Hawk	0.00	0	0	-	0.13	14,694	12	74
Red-winged Blackbird	5.39	555	44	49	2.76	313,034	406	26

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Species	Lowry Range (S = 16)				CO-BCR18 (S = 82)			
	D	N	n	% CV	D	N	n	% CV
Ring-necked Pheasant	0.00	0	0	-	0.12	13,951	28	72
Rock Pigeon	0.00	0	0	-	0.48	54,577	22	53
Rock Wren	0.00	0	0	-	0.09	10,021	29	57
Rufous-crowned Sparrow	0.00	0	0	-	0.03	3,040	3	77
Say's Phoebe	0.68	70	11	40	0.35	39,698	21	46
Scaled Quail	0.00	0	0	-	0.07	7,357	4	65
Song Sparrow	0.00	0	0	-	0.12	13,314	16	38
Spotted Sandpiper	0.00	0	0	-	0.15	16,947	3	67
Spotted Towhee	0.00	0	0	-	0.08	8,743	12	61
Swainson's Hawk	0.31	32	5	61	0.71	80,523	23	46
Vesper Sparrow	2.62	270	32	68	0.50	57,126	24	60
Warbling Vireo	0.00	0	0	-	0.04	4,787	4	58
Western Kingbird	14.92	1,537	70	22	10.03	1,137,666	198	36
Western Meadowlark	33.82	3,484	875	8	15.94	1,807,369	1,240	7
Western Scrub-Jay	0.00	0	0	-	0.04	4,637	3	106
Western Tanager	0.00	0	0	-	0.07	7,720	1	97
Western Wood-Pewee	0.32	33	3	72	0.05	5,287	19	52
Wild Turkey	0.00	0	0	-	0.00	213	4	77
Willow Flycatcher	0.00	0	0	-	0.04	4,426	2	104
Wilson's Snipe	0.08	8	2	100	0.00	79	1	102
Yellow Warbler	2.60	268	11	52	0.99	112,654	73	35
Yellow-breasted Chat	0.00	0	0	-	0.10	11,463	16	97
Yellow-headed Blackbird	0.00	0	0	-	0.02	2,509	9	74

Species Richness

The species richness values indicate the Lowry Range (estimate of 12.55 species per 1km² grid cell; 95% confidence interval of 11.02, 14.08) hosts more species on average per 1 km² grid cell than the Colorado portion of BCR 18 (estimate of 10.56; 95% confidence interval of 10.74, 10.39).

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 km² and the occupancy estimate for Western Meadowlark is 0.57, managers can estimate that 68,400 km² (120,000 km² * 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 higher 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.

In 2013, 99 species were recorded in the Colorado portion of BCR 18 that were not recorded on the Lowry Range property. Fifteen of these species do not regularly occur in the area (Ash-throated Flycatcher, Bewick's Wren, Canyon Towhee, Curve-billed Thrasher, Eastern Phoebe, Greater Prairie-Chicken, Greater Roadrunner, Juniper Titmouse, Ladder-backed Woodpecker, Rufous-crowned Sparrow, Scaled Quail, Upland Sandpiper, Cassin's Kingbird, Chihuahuan Raven, and Long-billed Curlew). Additionally, 21 species inhabit forest, sagebrush, or foothills shrubland environments which do not represent a significant portion of the habitat on the Lowry Range (American Crow, Black-capped Chickadee, Brewer's Sparrow, Brown Thrasher, Bushtit, Canyon Wren, Common Poorwill, Common Raven, Downy Woodpecker, Green-tailed Towhee, Hairy Woodpecker, Lazuli Bunting, Lesser Goldfinch, Pine Siskin, Plumbeous Vireo, Spotted Towhee, Warbling Vireo, Western Scrub-jay, Western Tanager, White-throated Swift, and Wild Turkey), 21 species inhabit wetlands or are affiliated with open water which is not present on the Lowry Range (American Avocet, American Coot, American White Pelican, American Wigeon, Belted Kingfisher, Black-crowned Night-Heron, Blue-winged Teal, Cinnamon Teal, Double-crested Cormorant, Gadwall, Great Blue Heron, Great Egret, Marsh Wren, Northern Shoveler, Pied-billed Grebe, Redhead, Snowy Egret, Spotted Sandpiper, Western Grebe, Wood Duck, and Yellow-headed Blackbird), 9 species are very rare in the Colorado portion of BCR 18 (American Redstart, Baltimore Oriole, Blackpoll Warbler, Bobolink, Green Heron, Indigo Bunting, Least Flycatcher, Rose-breasted Grosebeak, White-faced Ibis, and Yellow-billed Cuckoo), 9 species breed in the mountains of Colorado and are most likely migrants in the Colorado portion of BCR 18 (Evening Grosebeak, Lewis's Woodpecker, Olive-sided Flycatcher, Orange-crowned Warbler, Violet-green Swallow, White-crowned Sparrow, Willow Flycatcher, Wilson's Warbler, and Yellow-rumped Warbler) and one species is closely associated with urban development which is not present on the Lowry Range (Chimney Swift). The absence of these species should not concern Lowry Range land managers.

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The absence of 6 species associated with Riparian habitats within the Colorado portion of BCR18 is of note (Common Yellowthroat, Savannah Sparrow, Song Sparrow, Black-headed Grosbeak, Cedar waxwing, and Great-tailed Grackle). We noted a similar pattern in 2012 for Riparian associated species. One reason for this is that randomly selected survey locations on the Lowry Range largely fell outside of 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.). If Lowry range managers are concerned about Riparian associated species they may want to consider increasing sampling effort or re-stratifying to target Riparian habitats. Increasing the sampling effort or re-stratifying would add additional costs and the Colorado State Land Board may not want to spend the additional money given that Riparian habitats are not a large habitat type on the Lowry range property.

Three grassland species were either absent or had lower density and occupancy estimates on the Lowry range compared to the BCR18 portion of Colorado. These species are of particular interest since the Lowry range should contain suitable habitat for these species. Cassin's Sparrow was detected on the Lowry Range in 2013, but had lower density and occupancy estimates when compared to the rest of BCR18 in Colorado. The core area for this species is to the Southeast of the Lowry range and we do not expect this species to occur there in high densities. Lowry Range managers should not be concerned by the lower occurrence and abundance of this species on the property. For the second year we had no detections of McCown's Longspur. Results of our habitat modeling efforts for McCown's Longspur indicate that suitable habitat does exist within the Lowry Range; however the core breeding area for this species is to the North and East of the Lowry range. Additional years of data will help clarify the status of McCown's Longspur on the Lowry Range. Ferruginous Hawk was also absent from the Lowry range for the second straight year. RMBO would expect to find Ferruginous Hawk on this property; however they are a very low density species in the Colorado portion of BCR18 (1 detection in BCR18 in 2013). With more years of sampling we would expect to detect this species on the Lowry range in low numbers. Say's Phoebe was notably absent in 2012, but was recorded in 2013 with a total of 16 individuals recorded. Additional years of sampling will provide a more complete list of species occurring on the Lowry Range and will reduce the effects of yearly variation in species abundance and occurrence.

RMBO recommends that Lowry range managers continue monitoring breeding birds using the IMBCR study design. With more years of data we will be able to provide more precise occupancy and density estimates and will be able to provide these estimates for additional species. The IMBCR design reduces costs through cooperation with multiple partners and population estimates can be used to support local management efforts and inform management decisions. Monitoring at regional and BCR scales provides land managers with dependable knowledge about the status and change of bird populations at ecologically relevant scales (36). In addition, the population estimates for the Lowry Range can be compared to those at the BCR scale to place the population estimates in a regional context. The first two years of monitoring conducted by RMBO indicate that the Lowry Range represents important avian habitat for many grassland species. As oil and gas development continues on the Lowry range it is important to monitor the avian community. This monitoring effort can serve as an early warning for any possible impacts of oil and gas development on the Lowry range. Currently, IMBCR data are being used to model bird-habitat relationships and map species distributions with applications to habitat management, conservation planning and the development of decision support tools. Additionally, with more years of data RMBO will be able to conduct trend analyses for the Lowry

Range. These analyses would provide information about population changes and managers would be able to identify species to target for conservation efforts and further research. With additional years of monitoring managers will be able to use these tools and estimates to help guide and inform management decisions for the Lowry Range.

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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

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(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".