Monitoring the Birds of the Colorado and Dolores Rivers National Conservation Lands: 2013 Field Season Report

September 2014

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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) conducted bird monitoring on Bureau of Land Management (BLM) lands along the Colorado and Dolores Rivers in eastern Utah for the first time in 2013. These areas are part of the BLM's National Conservation Lands and host migratory and breeding bird species. This monitoring program was designed to 1) estimate density and occupancy rates for riparian birds, 2) determine temporal trends in bird populations and 3) evaluate the effectiveness of management actions for increasing populations of riparian birds.

In 2013, RMBO completed 36 of 36 (100%) planned surveys across the control and treatment strata. Technicians conducted 167 point counts within the 36 surveyed sampling units between 14 May and 10 June 2013. They recorded 2,015 individual birds of 82 species.

Sampling was conducted using a spatially-balanced sampling design which allows inferences to avian species occurrence and population sizes. The sampling design allows for the estimation of density, population size and occupancy and can be used for comparison with estimates in other regions. Collaboration across organizations increased the number of species for which estimates could be generated, and improved the accuracy and precision of the population estimates. Analyzing these data collectively with data collected under the Integrated Monitoring in Bird Conservation Regions program allowed the estimation of detection probabilities for species that would have otherwise had insufficient numbers of detections in the BLM strata.

We estimated densities for 56 species including 19 priority species in the treatment stratum and 49 species including 12 priority species in the control stratum. In the treatment stratum we produced 17 robust density estimates (CV% < 50). In the control stratum we produced 21 robust density estimates (CV% < 50). Only one species, Lark Sparrow, showed substantially higher density in the treatment stratum than the control stratum. The data allowed for occupancy estimation of 52 species including 16 priority species in the treatment stratum and 51 species including 14 priority species in the control stratum. In the treatment stratum we produced 16 robust occupancy estimates (CV% < 50). In the control stratum we produced 18 robust occupancy estimates (CV% < 50). Only two species showed large differences in their occupancy estimates where the point estimates of the treatment and control were outside the respective 90% confidence intervals. The occupancy estimate for Spotted Towhee was considerably higher in the control stratum than the treatment stratum, and the occupancy estimate for Western Tanager was lower in the control stratum than in the treatment stratum.

We also evaluated species richness for the two strata using our occupancy estimates. We calculated 90% confidence intervals for the species richness in the two strata and determined that there was no meaningful difference between the species richness among the treated and control strata.

RMBO monitoring programs are well positioned to address conservation and management needs for a wide range of stakeholders, landowners and government entities at various spatial scales. By focusing on multiple scales from local management units to entire regions, the study design can easily be integrated within an interdisciplinary approach to bird conservation that combines monitoring, research and management. To view interactive maps illustrating survey and detection locations, species counts, and density, population and occupancy results, please visit RMBO's Avian Data Center at http://rmbo.org/v3/avian/ExploretheData.aspx. Instructions for using the Avian Data Center are included in Appendix A of this report and are available on the Avian Data Center.

ACKNOWLEDGEMENTS

Many individuals helped complete the 2013 Colorado and Dolores River bird monitoring project. Stratification and allocation of survey efforts were determined in collaboration with the Utah Division of Wildlife Resources and the BLM, each of which provided funding or in-kind assistance. RMBO's landowner liaison, Jenny Berven, contacted county assessors to determine land ownership of survey locations. We thank Gary White, professor emeritus of Colorado State University, who wrote the initial SAS code and implemented the multi-scale occupancy model in program MARK and Paul Lukacs of the University of Montana who wrote code in program R to automate data analysis for density and occupancy estimates. We thank Jeff Laake for implementing the multi-scale occupancy model in the RMark package which aided in the automation of the analyses. We also thank the field technicians who collected avian and vegetation point count data and contacted private landowners to obtain access to survey locations and establish working relationships for the future. Without the efforts of these technicians and the cooperation of private landowners partners would have been unable to access many of the survey sites. Finally, this report benefited greatly from review by partners.

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ACRONYMS

BCR	Bird Conservation Region
BCR 16	Southern Rockies and Colorado Plateau Bird Conservation Region
BCR 17	Badlands and Prairies Bird Conservation Region
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
DOD	Department of Defense
GRTS	Generalized Random-Tessellation Stratification
IMBCR	Integrated Monitoring in Bird Conservation Regions
NF	National Forest
NG	National Grassland
NPS	National Park Service
RMBO	Rocky Mountain Bird Observatory
UDWR	Utah Division of Wildlife Resources
USFS	US Forest Service
USFWS	US Fish and Wildlife Service

INTRODUCTION

Monitoring is an essential component of wildlife management and conservation science (Witmer 2005, Marsh and Trenham 2008). Common goals of population monitoring are to estimate the population status of target species and to detect changes in populations over time (Thompson et al. 1998, Sauer and Knutson 2008). Effective monitoring programs can identify species that are at-risk due to small or declining populations (Dreitz et al. 2006); provide an understanding of how management actions affect populations (Alexander et al. 2008, Lyons et al. 2008); evaluate population responses to landscape alteration and climate change (Baron et al. 2008, Lindenmayer and Likens 2009); as well as 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 (Rich et al. 2004, US North American Bird Conservation Initiative 2007). Population monitoring helps to achieve the intent of legislation such as the Migratory Bird Treaty Act (1918), National Environmental Policy Act (1969), Endangered Species Act (1973), the National Forest Management Act (1976) and various state laws (Manley et al. 1993, Sauer 1993). Population monitoring of eco-regional landscapes provides an important context for evaluating population change at local and regional scales, with the potential to identify causal factors and management actions for species recovery (Manley et al. 2005, Sauer and Knutson 2008).

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 (Sauer and Knutson 2008). 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 (Pollock et al. 2002, Rosenstock et al. 2002, Thompson 2002). Addressing spatial variation entails the use of probabilistic sampling designs that allow population estimates to be extended over the entire area of interest (Thompson et al. 1998). 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, even when present during a survey (Pollock et al. 2002, Thompson 2002). Accounting for these two sources of variation ensures observed trends reflect true population changes rather than artifacts of the sampling and observation processes (Pollock et al. 2002, Thompson 2002).

This monitoring program was designed to address avian monitoring objectives for 1) estimating density and occupancy rates for riparian birds, 2) determining temporal trends in bird populations and 3) evaluating the effectiveness of management actions for increasing populations of riparian birds.

Tamarisk (*Tamarix spp.*) are one of the most established invasive plants in the western United States. Public agencies have tried many eradication methods to remove or limit this species along riparian areas. Removal of tamarisk can also have unintended negative effects on wildlife and habitat (Hultine et. al. 2010). The BLM is applying several methods to remove tamarisk on their lands and want to evaluate the impact of these management actions on avian populations.

METHODS

Study Area

The area of inference encompasses riparian grids along the Colorado River and its tributary, the Dolores River, from the Colorado border downstream continuing from their confluence to Canyonlands National Park (Figure 2). Survey locations were located between 1,200 m and 1,500 m (3,937 ft – 4,921 ft) in elevation. Riparian shrubs and trees, including Tamarisk (*Tamarix spp.*), Fremont Cottonwood (*Populus fremontii*), Willow (*Salix spp.*), Skunkbrush (*Rhus trilobata*), and Ash (*Fraxinus spp.*) were prevalent at sampling sites. Greasewood (*Sarcobatus spp.*), Cliffrose (*Purshia spp.*), Skunkbrush (*Rhus trilobata*), Pinyon Pine (*Pinus edulis*) and Aspen (*Populus tremuloides*) were also found with some regularity in the study area.

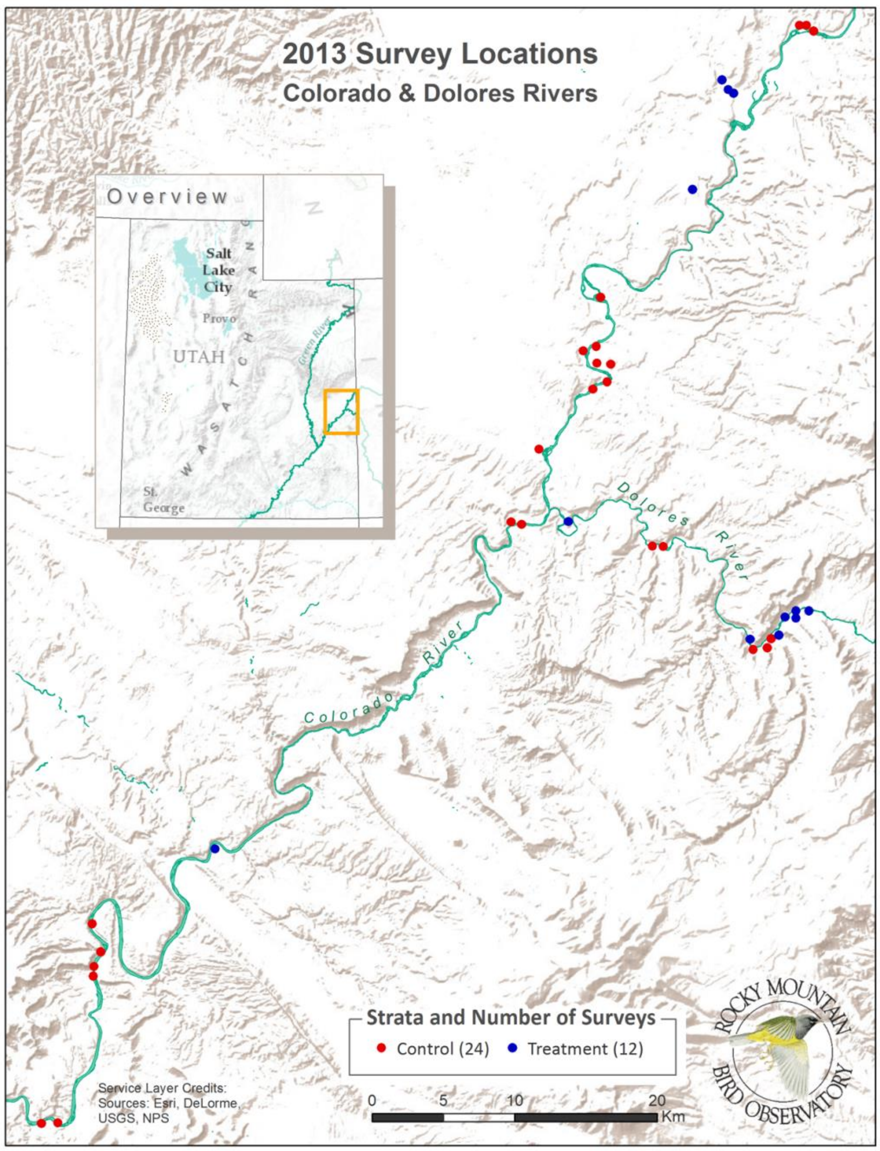

Figure 1. The location of surveyed grids along the Colorado and Dolores Rivers.

Sampling Design

This monitoring program was designed to address avian monitoring objectives for 1) estimating density and occupancy rates for riparian birds, 2) determining temporal trends in bird populations and 3) evaluating the effectiveness of management actions for increasing populations of riparian birds. The sampling design is similar to that used for the Integrated Monitoring in Bird Conservation Regions program

We used the United States National Grid (FGDC 2001, Cavell 2005) and layers provided by the BLM to define the sampling frame. Sampling units were 1 km^2 grid cells. We determined the population of grid cells for sampling by intersecting the grid cells with riparian vegetation for lands managed by the BLM along the Colorado and Dolores Rivers in Utah. We used the Utah Division of Wildlife Resources digital riparian vegetation data for the Colorado River and the Southwest Regional Gap Analysis riparian data (Prior-Magee et al. 2007) for the Dolores River. To define the population of grid cells, we partitioned the 1 km^2 grid cells into four 0.25 km^2 quadrants and selected all grid cells that contained a minimum of two points within riparian vegetation in at least one quadrant. We considered points to be within riparian vegetation when the points were less than 25 m from a patch of riparian vegetation. The grid cells were allocated to the treatment and control strata using the BLM Canyon Country treatment polygons using ARCGIS versions 10.0 (Environmental Systems Research Institute 2006). Within the treatment cells, the BLM is conducting chemical, hand piling, burning, mastication, mowing, planting, seeding and thinning (Table 1). The grid cells were allocated to the treatment stratum when the treatment polygons intersected two riparian points within at least one quadrant and to the control stratum where grids did not meet this criterion. We selected a spatially balanced sample of 12 grids within the treatment stratum and 24 grids within the untreated, or control, riparian stratum using Generalized Random-Tessellation Stratification (Stevens and Olsen 2004).

This design is well suited for estimating avian density and population size using distance sampling (Thomas et al. 2010), as well as avian occupancy of sample grids and point count locations (Pavlacky et al. 2012). The design is useful for determining temporal trends in bird populations, and the comparison of the treated and control strata allows an evaluation of bird responses to riparian treatments. The spatially-balanced design ensures a representative sample of bird communities and riparian conditions along the Colorado and Dolores Rivers in Utah. The criterion for surveying grid quadrants that contain a minimum of two points in riparian vegetation ensures that the survey effort is focused on riparian vegetation. In addition, limiting the spatial extent of the study to the two rivers increases the proximity of the sample grids and the likelihood of completing two grids in a single morning.

Table 1: Treatment Types Applied 2002-2012 by Transect-Point

Transect*	Point	Chemical	Hand Pile	Hand Pile Burn	Masti-cation/ Mowing	Planting	Seeding	Thinning
UT-BCR16-BR3	14	X	X	X				X
UT-BCR16-BT1	4						X	
UT-BCR16-BT1	7						X	
UT-BCR16-BT1	8						X	
UT-BCR16-BT2	4						X	
UT-BCR16-BT2	8						X	
UT-BCR16-BT2	12						X	
UT-BCR16-BT3	15				X	X		
UT-BCR16-BT4	5		X	X				X
UT-BCR16-BT5	1						X	
UT-BCR16-BT5	2						X	
UT-BCR16-BT5	5						X	
UT-BCR16-BT6	1	X	X	X				X
UT-BCR16-BT6	6	X	X	X		X	X	X
UT-BCR16-BT9	11						X	
UT-BCR16-BT9	15						X	
UT-BCR16-BT10	12		X	X				X
UT-BCR16-BT12	8	X	X	X	X		X	X
UT-BCR16-BT12	12	X	X	X	X		X	X

*Transects beginning with UT-BCR16-BT are treatment stratum, UT-BCR16-BR3 is in the control stratum.

Sampling Methods

RMBO surveyors with excellent aural and visual bird-identification skills conducted field work in 2013. Prior to conducting surveys, technicians completed an intensive training program to ensure full understanding of the field protocol, to review bird and plant identification, and to practice distance estimation.

Data collection within the grids was limited to four point count stations in quadrants that contained at least two points within riparian vegetation. The field technicians sampled adjacent quadrants if other quadrants of the grid also contained sufficient riparian vegetation. The field technicians surveyed quadrants within two grids in a morning when multiple grid cells were in close proximity to each other.

Field technicians conducted point counts (Buckland et al. 2001) following the protocol established by IMBCR partners (Hanni et al. 2013). Observers conducted surveys in the morning, beginning ½-hour before sunrise and concluding no later than 5 hours after sunrise. Technicians recorded the start time for every point count conducted. For every bird detected during the six-minute count period, observers recorded species, sex; horizontal distance from the observer; minute interval (i.e., 1-6), type of detection (e.g., call, song, visual), whether the bird was thought to be a migrant, and whether or not the observer used visual cues to identify the bird to species.

Observers measured distances to each bird using laser rangefinders when possible. 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 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 are used for distribution mapping purposes only.

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

For more detailed information about survey methods and vegetation data collection protocols, refer to RMBO's Field Protocol for Spatially Balanced Sampling of Landbird Populations on our Avian Data Center website at http://rmbo.org/v3/avian/DataCollection.aspx. There you will find links to past and current protocols and data sheets.

Data Analysis

Data collected during the monitoring effort along the Colorado and Dolores Rivers were analyzed in concert with data collected under the IMBCR monitoring program. This increased the total number of detections which could be used to estimate the detectability of various species observed during this monitoring effort.

Distance Analysis

Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that three critical assumptions be met: 1) all birds at and near the sampling location (distance = 0) are detected; 2) distances to birds are measured accurately; and 3) birds do not move in response to the observer's presence (Buckland et al. 2001, Thomas et al. 2010). Removal modeling is based on mark-recapture theory where detection probability is estimated based on the number of birds detected during consecutive sampling intervals (Farnsworth et al. 2002). 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 (Buckland et al. 2001). The distribution of distances can be a function of characteristics of the object (e.g., 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 these data separately for each species. We attempted to estimate densities of all species detected during the point counts. The development of robust density estimates typically requires 80 or more independent detections within the entire sampling area. We excluded birds flying over, but not using the immediate surrounding landscape, birds detected while migrating (not breeding), juvenile birds, and birds detected between points from analyses.

We estimated bird densities using the new RIMBCR package in Program R (R Core Team 2012) 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, 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 (Burnham and Anderson 2002). RIMBCR incorporated the SPSURVEY package (Kincaid 2008) 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, standard errors (SE), coefficients of variation (CV) and 90% confidence intervals (CI) for both strata included in this study.

Occupancy Analysis

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., 1-km^2 cells) occupied by an organism (MacKenzie et al. 2002). The application of occupancy modeling requires multiple surveys of the sample unit in space or time to estimate a detection probability (MacKenzie et al. 2006). The detection probability adjusts the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). We used a removal design (MacKenzie et al. 2006), to estimate a detection probability for each species. We divided the six-minute sampling interval into three two-minute visits by binning minutes one and two, minutes three and four and minutes five and six. Separating the count period into three visits allowed for repeat sampling intervals while meeting 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" (MacKenzie et al. 2006).

The four points in each sampled quadrat served as spatial replicates for estimating the proportion of points occupied within the sampled area. 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 bird detection data, using only detections within 125 m from the point count station. Truncating the data 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) (Pavlacky et al. 2012).

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 (Burnham and Anderson 2002). We mode- averaged the estimates of Psi from models 1 through 4 and calculated unconditional standard errors (Burnham and Anderson 2002).

Our application of the multi-scale model was analogous to a within-season robust design (Pollock 1982) 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 (Nichols et al. 2008, Pavlacky et al. 2012). 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 (Nichols et al. 2008, Pavlacky et al. 2012).

The new RIMBCR package streamlined occupancy analyses by calling the raw data from the IMBCR SQL server database and incorporating the R code 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 package utilized program MARK (White and Burnham 1999) and package RMark (Laake 2013) to fit the multi-scale occupancy models and to estimate model parameters. We estimated the proportion of sampling units occupied (Psi) for all species that were detected on a minimum of 10 points within 125 m of each point, except in cases where model convergence failed. We did not report occupancy estimates for species occurring on fewer than 10 points because of unreliable model convergence. We computed occupancy estimates, standard errors (SE), coefficients of variation (CV) and 90% confidence intervals (CI) for both strata included in this study.

Species Richness Analysis

We summed the occupancy estimates for each of the species (1) to estimate species richness (SpR) for the control and treatment strata (MacKenzie et al. 2006). Since occupancy estimates (ψ_i) take incomplete detection into account, this method is able to address uncertainty that other, more basic summaries of the raw data cannot. We used the delta method (Powell 2007) to estimate (2) the standard error (SE), (3) variance (VAR), and (4) upper (U) and lower (L) 90% confidence limits (CL) for the species richness estimates.

(1) $\text{SpR} = \sum \psi_i$

(2) $\text{SE}(\psi_i)^2 = \text{VAR}(\psi_i)$

(3) $\text{SE(SpR)} = \sqrt{\sum \psi_i}$

(4) $\text{CL} = \text{SpR} \pm [\text{SE(SpR)} * 1.645]$

RESULTS

In 2013, field technicians completed all 36 planned surveys throughout the Colorado and Dolores Rivers National Conservation Lands (Table 1). Technicians conducted 167 point counts within the 36 surveyed sampling units between 14 May and 10 June 2013. Technicians conducted 98 point counts on 24 sampling units in the control stratum (UT-BCR16-BR) and 69 point counts on 12 sampling units in the treatment stratum (UT-BCR16-BT).

Field technicians detected 2,015 birds of 82 species including 22 priority species in 2013 (Table 2). Technicians detected 1,253 birds of 70 species in the control stratum and 769 birds of 65 species in the treatment stratum. We detected 12 species in the treatment stratum that were not detected in the control stratum: Belted Kingfisher (*Megaceryle alcyon*); Black-chinned Hummingbird (*Archilochus alexandri*); Black-throated Gray Warbler (*Setophaga nigrescens*); Chukar (*Alectoris chukar*); Common Merganser (*Mergus merganser*); Eurasian Collared-Dove (*Streptopelia decaocto*); European Starling (*Sturnus vulgaris*); Golden Eagle (*Aguila chrysaetos*); Juniper Titmouse (*Baeolophus ridgwayi*); Northern Flicker (*Colaptes auratus*); Sagebrush Sparrow (*Artemisiospiza belli*); and White-crowned Sparrow (*Zonotrichia leucophrys*). We detected 17 species in the control stratum that were not detected in the treatment stratum: Bald Eagle (*Haliaeetus leucocephalus*); Barn Swallow (*Hirundo rustica*); Black Phoebe (*Sayornis nigricans*); Brewer's Sparrow (*Spizella breweri*); Calliope Hummingbird (*Stellula calliope*); Cedar Waxwing (*Bombycilla cedrorum*); Cliff Swallow (*Petrochelidon pyrrhonota*); House Sparrow (*Passer domesticus*); Indigo Bunting (*Passerina cyanea*); Killdeer (*Charadrius vociferus*); Lucy's Warbler (*Oreothlypis luciae*); Peregrine Falcon (*Falco peregrinus*); Red-tailed Hawk (*Buteo jamaicensis*); Scott's Oriole (*Icterus parisorum*); Song Sparrow (*Melospiza melodia*); Vesper Sparrow (*Pooecetes gramineus*); and Wilson's Warbler (*Cardellina pusilla).*

We estimated densities for 56 species including 19 priority species in the treatment stratum and 49 species including 12 priority species in the control stratum (Table 3). In the treatment stratum we produced 17 robust density estimates (CV% < 50). In the control stratum we produced 21 robust density estimates (CV% < 50). Only one species, Lark Sparrow, showed substantially higher density in the treatment stratum than the control stratum.

The data allowed for occupancy estimation of 52 species including 16 priority species in the treatment stratum and 51 species including 14 priority species in the control stratum (Table 4). In the treatment stratum we produced 16 robust occupancy estimates (CV% < 50). In the control stratum we produced 18 robust occupancy estimates (CV% < 50). Only two species showed large differences in their occupancy estimates where the point estimates of the treatment and control were outside the respective 90% confidence intervals. The occupancy estimate for Spotted Towhee was considerably higher in the control stratum than the treatment stratum, and the occupancy estimate for Western Tanager was lower in the control stratum than in the treatment stratum. We observed a trend for lower occupancy in the control stratum than in the treatment strata, where the estimates for species were greater in the treatment stratum but were contained within the bounds of the 90% confidence interval for the control stratum: Ash-throated Flycatcher; Broad-tailed Hummingbird; Lark Sparrow; Rock Wren; and Western Kingbird. Occupancy estimates for two species were lower in the treatment stratum but were contained within the bounds of the 90% confidence interval for the control stratum: Common Yellowthroat; and Violet-green Swallow.

We also evaluated species richness for the two strata using our occupancy estimates. The treatment stratum had a species richness of 22.74 (SE = 1.42; CI = 20.41, 25.07). The control stratum had a slightly higher species richness of 23.89 (SE = 1.39; CI = 21.61, 26.17). We calculated 90% confidence intervals for the species richness in the two strata and determined that there was no meaningful difference between the species richness among the treated and control strata.

All results, including parameter estimates, distribution maps, raw count data, and effort are available online and included in this report. To view interactive maps showing survey and detection locations, species counts, and density, population and occupancy results please visit the Rocky Mountain Avian Data Center at http://rmbo.org/v3/avian/ExploretheData.aspx. Instructions for using the Avian Data Center are included in Appendix A of this report and are available on the Avian Data Center itself.

Results for the control stratum can be found by visiting the link below and then clicking the “Run Query” button at the top of the screen:

http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgLgTghhCuBbEAuEBVAKgWgEIGEAlARgDY9CUACXeKAUxnioHsAzKgGRgDsATKgFleMAOb1E9HhCrYqhAJYAHGFAW8qACRgAjBRDggAvkAAA

Results for the treatment stratum can be found by visiting the link below and then clicking the “Run Query” button at the top of the screen:

http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgLgTghhCuBbEAuEBVAKgWgEIGEAlARgDY9MUACXeKAUxnioHsAzKgGRgDsATKgFleMAOaJ69HhCrYqmBnHoDCASwAOMKKt4gAvkAAA

Unless otherwise specified, all bird species names listed in this report are from the American Ornithologists’ Union Check-list of North and Middle American Birds, seventh edition (2007).

Table 2. Survey Effort by Grid

Grid ID	Survey Date	# of Points Sampled
UT-BCR16-BR1	5/27/2013	4
UT-BCR16-BR2	6/6/2013	4
UT-BCR16-BR3	5/14/2013	4
UT-BCR16-BR5	5/27/2013	2
UT-BCR16-BR6	5/22/2013	6
UT-BCR16-BR8	5/31/2013	2
UT-BCR16-BR9	5/20/2013	1
UT-BCR16-BR10	6/4/2013	8
UT-BCR16-BR12	5/31/2013	4
UT-BCR16-BR17	6/6/2013	4
UT-BCR16-BR18	5/14/2013	4
UT-BCR16-BR20	5/23/2013	3
UT-BCR16-BR26	6/3/2013	3
UT-BCR16-BR27	6/8/2013	7
UT-BCR16-BR28	5/27/2013	4
UT-BCR16-BR30	6/6/2013	4
UT-BCR16-BR31	6/4/2013	4
UT-BCR16-BR32	5/28/2013	12
UT-BCR16-BR33	6/1/2013	2
UT-BCR16-BR38	5/26/2013	4
UT-BCR16-BR39	6/10/2013	3
UT-BCR16-BR43	6/1/2013	3
UT-BCR16-BR46	6/8/2013	3
UT-BCR16-BR47	6/10/2013	3
UT-BCR16-BT1	5/26/2013	4
UT-BCR16-BT2	5/25/2013	4
UT-BCR16-BT3	5/27/2013	6
UT-BCR16-BT4	6/3/2013	4
UT-BCR16-BT5	5/25/2013	4
UT-BCR16-BT6	5/25/2013	8
UT-BCR16-BT7	5/21/2013	10
UT-BCR16-BT8	5/26/2013	6
UT-BCR16-BT9	5/25/2013	4
UT-BCR16-BT10	5/16/2013	6
UT-BCR16-BT11	6/4/2013	3
UT-BCR16-BT12	6/5/2013	10
UT-BCR16-BR Total	**--**	***98***
UT-BCR16-BT Total	**--**	***69***
Total	**--**	***167***

Table 3. Species counts for the treatment (UT-BCR16-BT) and control (UT-BCR16-BR) strata

Species*	UT-BCR16-BR	UT-BCR16-BT	Total
American Crow	10	2	12
American Goldfinch	1	1	2
American Kestrel	4	1	5
American Robin	15	7	22
Ash-throated Flycatcher	31	15	46
Bald Eagle	**1**	**0**	**1**
Barn Swallow	2	0	2
Belted Kingfisher	**0**	**1**	**1**
Black Phoebe	2	0	2
Black-billed Magpie	29	7	36
Black-chinned Hummingbird	**0**	**2**	**2**
Black-headed Grosbeak	29	9	38
Black-throated Gray Warbler	**0**	**5**	**5**
Black-throated Sparrow	25	17	42
Blue Grosbeak	37	12	49
Blue-gray Gnatcatcher	50	32	82
Brewer's Sparrow	6	0	6
Broad-tailed Hummingbird	3	5	8
Brown-headed Cowbird	37	9	46
Bullock's Oriole	**22**	**9**	**31**
Calliope Hummingbird	1	0	1
Canada Goose	9	16	25
Canyon Wren	2	1	3
Cedar Waxwing	2	0	2
Chipping Sparrow	1	2	3
Chukar	0	2	2
Cliff Swallow	36	0	36
Common Merganser	**0**	**1**	**1**
Common Raven	38	24	62
Common Yellowthroat	6	1	7
Dusky Flycatcher	**1**	**1**	**2**
Eurasian Collared-Dove	0	2	2
European Starling	0	12	12
Golden Eagle	0	1	1

Species*	UT-BCR16-BR	UT-BCR16-BT	Total
Gray Flycatcher	2	2	4
Gray Vireo	**1**	**5**	**6**
Great Blue Heron	13	3	16
Green-tailed Towhee	1	1	2
House Finch	40	51	91
House Sparrow	10	0	10
Indigo Bunting	**1**	**0**	**1**
Juniper Titmouse	**0**	**5**	**5**
Killdeer	1	0	1
Lark Sparrow	13	37	50
Lazuli Bunting	65	39	104
Lesser Goldfinch	13	1	14
Lucy's Warbler	1	0	1
MacGillivray's Warbler	4	2	6
Mallard	3	1	4
Mountain Bluebird	1	2	3
Mourning Dove	123	70	193
Northern Flicker	0	1	1
Northern Mockingbird	11	15	26
Peregrine Falcon	2	0	2
Pine Siskin	**1**	**4**	**5**
Plumbeous Vireo	**15**	**9**	**24**
Red-tailed Hawk	1	0	1
Red-winged Blackbird	5	2	7
Rock Wren	**18**	**18**	**36**
Sagebrush Sparrow	**0**	**1**	**1**
Say's Phoebe	**15**	**13**	**28**
Scott's Oriole	1	0	1
Song Sparrow	2	0	2
Spotted Sandpiper	15	5	20
Spotted Towhee	49	16	65
Turkey Vulture	12	1	13
Vesper Sparrow	**1**	**0**	**1**
Violet-green Swallow	**21**	**17**	**38**
Virginia's Warbler	**5**	**8**	**13**

Species*	UT-BCR16-BR	UT-BCR16-BT	Total
Warbling Vireo	**2**	**3**	**5**
Western Kingbird	25	18	43
Western Meadowlark	4	27	31
Western Scrub-Jay	2	5	7
Western Tanager	6	11	17
Western Wood-Pewee	3	3	6
White-crowned Sparrow	0	1	1
White-throated Swift	**11**	**26**	**37**
Wild Turkey	23	5	28
Willow Flycatcher	**11**	**1**	**12**
Wilson's Warbler	4	0	4
Yellow Warbler	71	27	98
Yellow-breasted Chat	**177**	**69**	**246**
Total	***1253***	***762***	***2015***

* Species in bold are Priority Species for Partners in Flight, US Fish and Wildlife Service and/or Utah Division of Wildlife Resources. See Appendix A for Priority designations.

Table 4. Estimated densities of breeding bird species within the treatment (UT-BCR16-BT) and control (UT-BCR16-BR) strata in 2013. The estimated densities per km^2 (D), percent coefficient of variation of estimates (% CV) and the number of independent detections used in analyses (n) are shown.

Species*	UT-BCR16-BR			UT-BCR16-BT		
	D	% CV	n	D	% CV	n
American Crow	0.13	102	2	0.16	100	1
American Kestrel	1.9	76	3	0.57	116	1
American Robin	4.17	45	8	1.88	47	3
Ash-throated Flycatcher	4.04	29	14	4.86	17	14
Barn Swallow	2.95	102	1	--	--	0
Black-billed Magpie	2.09	34	17	0.56	42	4
Black-chinned Hummingbird	**--**	**--**	**0**	**23.9**	**108**	**1**
Black-headed Grosbeak	6.48	27	13	4.2	34	7
Black-throated Gray Warbler	**--**	**--**	**0**	**3.68**	**72**	**3**
Black-throated Sparrow	11.82	38	15	13.33	20	13
Blue Grosbeak	8.15	18	30	2.84	44	9
Blue-gray Gnatcatcher	59.55	19	32	55.96	30	24

Species*	UT-BCR16-BR			UT-BCR16-BT		
	D	% CV	n	D	% CV	n
Brewer's Sparrow	0.53	101	1	--	--	0
Broad-tailed Hummingbird	6.59	71	2	11.89	56	3
Brown-headed Cowbird	12.42	28	15	4.27	56	5
Bullock's Oriole	**8.25**	**40**	**13**	**2.13**	**67**	**3**
Canada Goose	0.04	101	1	0.13	101	2
Canyon Wren	0.25	74	2	0.15	95	1
Cedar Waxwing	4.7	107	1	--	--	0
Chipping Sparrow	--	--	0	2.71	104	2
Common Raven	1.55	40	11	1.36	59	8
Common Yellowthroat	2.07	52	5	0.5	95	1
Dusky Flycatcher	**0.88**	**96**	**1**	**1.06**	**97**	**1**
Eurasian Collared-Dove	--	--	0	1.79	131	1
European Starling	--	--	0	9.99	105	4
Golden Eagle	--	--	0	0.09	107	1
Gray Flycatcher	--	--	0	2.1	104	2
Gray Vireo	**--**	**--**	**0**	**2.24**	**69**	**5**
Great Blue Heron	1.14	54	6	0.69	61	3
Green-tailed Towhee	--	--	0	0.62	103	1
House Finch	14.09	29	19	28.24	19	34
House Sparrow	3.16	103	4	--	--	0
Juniper Titmouse	**--**	**--**	**0**	**2.25**	**94**	**2**
Lark Sparrow	4.14	43	7	18.52	26	24
Lazuli Bunting	23.96	22	38	17.45	35	23
Lesser Goldfinch	11.29	76	6	1.94	111	1
MacGillivray's Warbler	1.31	101	1	1.57	94	1
Mallard	0.46	74	2	--	--	0
Mountain Bluebird	--	--	0	1.49	100	2
Mourning Dove	15.23	40	67	9.99	38	42
Northern Mockingbird	0.59	63	5	1.43	58	10
Pine Siskin	**--**	**--**	**0**	**5.02**	**100**	**1**
Plumbeous Vireo	**2.44**	**36**	**6**	**2.94**	**54**	**6**
Red-winged Blackbird	1.36	102	4	0.33	97	1
Rock Wren	**1.7**	**35**	**9**	**3.07**	**40**	**15**
Sagebrush Sparrow	**--**	**--**	**0**	**0.26**	**104**	**1**

Species*	UT-BCR16-BR			UT-BCR16-BT		
	D	% CV	n	D	% CV	n
Say's Phoebe	**1.75**	**46**	**10**	**1.9**	**38**	**9**
Scott's Oriole	0.25	103	1	--	--	0
Song Sparrow	2.2	106	2	--	--	0
Spotted Sandpiper	7.95	54	7	4.1	74	3
Spotted Towhee	13.44	27	28	6.93	50	12
Violet-green Swallow	**7.62**	**61**	**3**	**45.81**	**98**	**3**
Virginia's Warbler	**2.62**	**75**	**3**	**8.4**	**53**	**8**
Warbling Vireo	**--**	**--**	**0**	**1.44**	**63**	**2**
Western Kingbird	5.33	57	12	6.41	41	11
Western Meadowlark	--	--	0	2.19	53	17
Western Scrub-Jay	0.93	104	1	2.24	97	4
Western Tanager	1.4	59	3	3.36	44	6
Western Wood-Pewee	0.91	74	3	1.09	94	3
White-throated Swift	**9.57**	**126**	**1**	**92.06**	**106**	**3**
Wild Turkey	0.84	36	12	0.34	50	4
Willow Flycatcher	**17.98**	**54**	**8**	**--**	**--**	**0**
Yellow Warbler	32.1	19	48	18.5	26	22
Yellow-breasted Chat	**30.81**	**15**	**109**	**17.34**	**33**	**51**

*Species in bold are Species of Concern for Partners in Flight, US Fish and Wildlife Service and/or Utah Division of Wildlife Resources. See Appendix A for Priority designations.

Table 5. 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 (nTran) of breeding bird species in the control (UT-BCR16-BR) and treatment (UT-BCR16-BT) strata along the Colorado and Dolores Rivers. 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.

Species*	UT-BCR16-BR			UT-BCR16-BT		
	Psi	% CV	n Tran	Psi	% CV	n Tran
American Crow	--	--	0	0.163	96	1
American Kestrel	0.566	75	1	--	--	0
American Robin	0.268	45	4	0.406	41	4
Ash-throated Flycatcher	0.496	34	6	0.902	19	8
Barn Swallow	0.186	102	1	--	--	0
Belted Kingfisher	**--**	**--**	**0**	**0.36**	**102**	**1**

Species*	UT-BCR16-BR			UT-BCR16-BT		
	Psi	% CV	n Tran	Psi	% CV	n Tran
Black-billed Magpie	0.32	55	3	0.27	65	2
Black-chinned Hummingbird	**--**	**--**	**0**	**0.128**	**96**	**1**
Black-headed Grosbeak	0.802	24	9	0.57	41	4
Black-throated Gray Warbler	**--**	**--**	**0**	**0.189**	**65**	**2**
Black-throated Sparrow	0.618	35	6	1	0	10
Blue Grosbeak	1	0	13	0.51	42	4
Blue-gray Gnatcatcher	1	0	16	1	0	10
Brewer's Sparrow	0.07	97	1	--	--	0
Broad-tailed Hummingbird	0.167	67	2	0.454	40	4
Brown-headed Cowbird	1	0	11	0.555	40	4
Bullock's Oriole	**0.736**	**37**	**6**	**0.96**	**24**	**5**
Calliope Hummingbird	0.216	107	1	--	--	0
Canyon Wren	0.155	107	1	--	--	0
Cedar Waxwing	0.128	98	1	--	--	0
Chipping Sparrow	--	--	0	0.105	96	1
Common Raven	0.477	53	3	0.448	64	2
Common Yellowthroat	0.519	39	5	0.146	96	1
Dusky Flycatcher	**0.086**	**97**	**1**	**0.118**	**96**	**1**
Eurasian Collared-Dove	--	--	0	0.403	112	1
European Starling	--	--	0	0.13	99	1
Gray Flycatcher	--	--	0	0.097	96	1
Gray Vireo	**--**	**--**	**0**	**0.226**	**65**	**2**
Great Blue Heron	0.938	40	4	0.667	77	2
House Finch	0.77	22	10	1	0	10
House Sparrow	0.155	103	1	--	--	0
Indigo Bunting	**0.172**	**106**	**1**	**--**	**--**	**0**
Juniper Titmouse	**--**	**--**	**0**	**0.239**	**65**	**2**
Lark Sparrow	0.352	45	4	0.956	19	8
Lazuli Bunting	0.971	15	13	0.982	21	8
Lesser Goldfinch	0.585	49	4	0.201	98	1
Lucy's Warbler	0.066	97	1	--	--	0
MacGillivray's Warbler	0.193	67	2	0.275	64	2
Mountain Bluebird	--	--	0	0.146	96	1
Mourning Dove	1	0	13	0.846	20	8

Species*	UT-BCR16-BR			UT-BCR16-BT		
	Psi	% CV	n Tran	Psi	% CV	n Tran
Northern Mockingbird	0.38	61	3	0.301	69	2
Pine Siskin	**--**	**--**	**0**	**0.099**	**96**	**1**
Plumbeous Vireo	**0.485**	**34**	**6**	**0.333**	**50**	**3**
Red-winged Blackbird	0.108	99	1	0.147	97	1
Rock Wren	**0.349**	**44**	**4**	**0.716**	**29**	**6**
Sagebrush Sparrow	**--**	**--**	**0**	**0.1**	**96**	**1**
Say's Phoebe	**0.96**	**16**	**4**	**0.972**	**17**	**3**
Song Sparrow	0.175	99	1	--	--	0
Spotted Sandpiper	0.994	28	5	0.821	53	3
Spotted Towhee	0.788	16	13	0.374	41	4
Turkey Vulture	0.466	112	1	--	--	0
Violet-green Swallow	**0.366**	**44**	**4**	**0.13**	**96**	**1**
Virginia's Warbler	**0.148**	**67**	**2**	**0.318**	**50**	**3**
Warbling Vireo	**0.065**	**97**	**1**	**0.192**	**64**	**2**
Western Kingbird	0.453	40	5	0.763	24	7
Western Meadowlark	--	--	0	0.181	65	2
Western Scrub-Jay	0.104	98	1	0.144	96	1
Western Tanager	0.204	53	3	0.513	34	5
Western Wood-Pewee	0.147	67	2	0.106	96	1
White-crowned Sparrow	--	--	0	0.108	96	1
White-throated Swift	**0.121**	**98**	**1**	**0.319**	**65**	**2**
Wild Turkey	0.564	81	2	--	--	0
Willow Flycatcher	**1**	**0**	**7**	**--**	**--**	**0**
Wilson's Warbler	0.436	54	3	--	--	0
Yellow Warbler	1	0	17	1	0	7
Yellow-breasted Chat	**1**	**0**	**19**	**0.648**	**25**	**7**

*Species in bold are Species of Concern for Partners in Flight, US Fish and Wildlife Service and/or Utah Division of Wildlife Resources. See Appendix A for Priority designations.

DISCUSSION

RMBO conducted bird monitoring along the Colorado and Dolores Rivers National Conservation Lands in eastern Utah for the first time in 2013. These areas are part of the BLM's National Conservation Lands and host migratory and breeding bird species.

Auxiliary, or "overlay", projects, such as the Colorado and Dolores River Natural Conservation Lands, are a growing component of the IMBCR program that improve efficiency and can be tailored to address specific management questions. Auxiliary projects utilize the IMBCR sampling design and field methods but are not integrated into the nested stratification of the IMBCR program. These projects benefit from the IMBCR program by incorporating detection data from relevant IMBCR surveys in analyses. In this way, the collaborative efficiency of the IMBCR program is extended to auxiliary projects by improving the accuracy and precision of population estimates, and allowing population estimates for infrequently detected species. In a similar fashion, data collected as part of auxiliary projects contributes to the efficiency of the IMBCR program.

Monitoring is integral to the management and conservation of wildlife populations (Marsh and Trenham 2008, Sauer and Knutson 2008). In particular, monitoring is necessary for the adaptive management of wildlife populations (Nichols and Williams 2006, Lyons et al. 2008). Monitoring in adaptive management is used to 1) make state-dependent management decisions, 2) evaluate the effectiveness of management, and 3) improve understanding of the system (Lyons et al. 2008). For example, management decisions may depend on the state of a bird population and a threshold can be set to trigger a management action when the population reaches a predetermined level. Bird population monitoring is also necessary to determine if management actions implemented in previous management cycle(s) are achieving conservation objectives. The population estimates within management units can be compared over time and space, and to average conditions in the region to evaluate effectiveness of management actions. Monitoring data are also useful for evaluating competing hypotheses about how bird populations respond to system dynamics. A better understanding of regional bird population dynamics will help land managers predict species responses to landscape change and large-scale conservation efforts (Jones 2011, Noon et al. 2012)

For both the control and treatment strata, RMBO estimated the Blue-gray Gnatcatcher (*Polioptila caerulea*) to have the highest densities. Blue-gray Gnatcatchers prefer brushy habitats of oak, pinyon and juniper that is common along the riparian study area. Yellow Warbler (*Setophaga petechia*), Yellow-breasted Chat (*Icteria virens*), and Lazuli Bunting (*Passerina amoena*) were the next most common species in the control stratum. These species are almost exclusively birds of brushy riparian habitats in the arid west. House Finch (*Haemorhous mexicanus*) and Lark Sparrow (*Chondestes grammacus*) both had high density estimates in the treatment stratum. House Finches are habitat generalists and occur in a wide variety of brushy habitats. Only Lark Sparrows had a density estimate that was considerably higher in the treatment stratum than the control stratam. Lark Sparrows breed in open habitats with scattered shrubs and trees (Cornell Lab of Ornithology 2014). There is likely more open habitat in the treatment stratum than the control stratum. As we see native shrub cover increase in the treatment stratum, we should see Lark Sparrow populations equalize among the strata.

We found no meaningful difference in species richness between the control and treatment strata. The only species that was found to have a substantially lower occupancy estimate in the treatment stratum was the Spotted Towhee. Spotted Towhee is a shrub-loving species. Treatment methods have likely temporarily reduced shrub cover on the treatment stratum. As shrub growth increases over time in the treatment stratum, we are likely going to see an increase in Spotted Towhee occupancy estimates. Western Tanager is the only species that was found to have a considerably higher occupancy estimate in the treatment stratum. Western Tanagers prefer open coniferous woodlands including pinyon-juniper and ponderosa pine forests. The occupancy rate of the Western Tanager was greater in the treatment than in the control, which suggested that the treatment stratum may have more open understory due to treatment methods than the control stratum. As native shrub cover increases in the treatment stratum, we should see Western Tanager occupancy estimates approach those of the control stratum.

Several species were detected in the control stratum that were not detected in the treatment stratum. As shrub cover increases in the treatment stratum, we should see more species return to those areas. The species that we detected in the treatment stratum, but not the control stratum, may be benefitting from decreased Tamarisk shrub cover and increased herbaceous growth. Shrub cover also can have an effect on detectability of certain species. Reduced shrub cover on the treatment stratum may have slightly increased detectability of certain species that could have been present in similar numbers on the control stratum.

Land managers and conservation organizations can use IMBCR population estimates to better understand annual trends in landbird populations (US North American Bird Conservation Initiative 2009). Simulations using 10 years of data from a similar avian monitoring program (J. Blakesley, RMBO, unpublished) indicated this monitoring program would have 80% power to detect an average annual decline of 3% in a population within 25 years when % CVs of the estimates are ≤ 40%. A similar trend could be detected within 30 years with a % CV of ≤ 50%. The ability to detect population trends for any species is a function of the sampling effort, abundance and annual variation of abundance for individual species. Currently, we are investigating Bayesian trend estimation, which should have greater power to detect a trend, and also will provide estimates of the probability that a species is declining. The IMBCR data can also be used to investigate population, metapopulation and community dynamics over time. Annually surveyed sampling units provide the information on dynamic processes that give rise to the patterns of abundance, occupancy and species richness over time.

With continued monitoring on the Colorado and Dolores Rivers, detection data could be combined across additional years to allow for the estimation of density and occupancy for infrequently detected species. Additional years of data collection would increase the statistical power to detect impacts of the treatments on bird populations and determine how bird populations respond to treatment practices as the vegetation rebounds from treatment. Impacts of the tamarisk removal on BLM priority species could also be modeled by utilizing IMBCR bird occurrence and vegetation data. These models could then be applied to create predictive distribution maps highlighting areas with high densities and/or occupancy rates. The modeling effort can also better inform managers on vegetation characteristics (i.e., amount of shrub cover, shrub height, etc.) that lead to improved bird occupancy rates and densities. Additionally, population trends over time could be estimated with long-term monitoring within the study area.

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APPENDIX A: PRIORITY SPECIES DESIGNATIONS BY AGENCY

Species	USFWS*		PIF†	UDWR‡
	BCR 16	Region 6	BCR 16	
Abert's Towhee				Tier III
American Avocet				Tier III
American Bittern	BCC	BCC		
American Three-toed Woodpecker				Tier II
American White Pelican				Tier II
Baird's Sparrow		BCC		
Bald Eagle	BCC	BCC		Tier I
Band-tailed Pigeon			CC	Tier III
Bell's Vireo		BCC	CC,RC	Tier III
Bendire's Thrasher	BCC		CC,RC,RS	Tier III
Bewick's Wren		BCC		
Black Rail		BCC		
Black Rosy-Finch	BCC	BCC	CC	Tier III
Black Swift				Tier II
Black-billed Cuckoo		BCC		
Black-billed Magpie			RS	
Black-chinned Sparrow			CC	
Black-necked Stilt				Tier III
Black-throated Gray Warbler			RC	Tier III
Black-throated Sparrow			RC	
Bobolink				Tier II
Boreal Owl				Tier III
Brewer's Sparrow	BCC		CC,RC	Tier III
Broad-tailed Hummingbird			RS	Tier III
Brown-capped Rosy-Finch	BCC	BCC	CC,CS,RS	
Buff-breasted Sandpiper		BCC		
Burrowing Owl	BCC	BCC		Tier II
California Condor			CC,RC,CS,RS	Tier I
Calliope Hummingbird			CC	
Canyon Wren			RC	
Caspian Tern				Tier III
Cassin's Finch	BCC	BCC	RC	
Chestnut-collared Longspur	BCC	BCC		
Clark's Nutcracker			CS,RS	
Common Nighthawk			RC	
Cordilleran Flycatcher			RS	
Crissal Thrasher				Tier III
Dusky Grouse			CC	
Ferruginous Hawk	BCC	BCC	RC	Tier II
Flammulated Owl	BCC	BCC	CC,RS	
Gambel's Quail				Tier III
Golden Eagle	BCC	BCC	RC	
Grace's Warbler	BCC		CC,RC	
Grasshopper Sparrow	BCC	BCC		Tier II
Gray Vireo	BCC	BCC	CC,RC,RS	Tier III
Greater Sage-Grouse			CC,RC	Tier II
Green-tailed Towhee			CS,RS	

Species	USFWS*		PIF[†]	UDWR[‡]
	BCR 16	Region 6	BCR 16	
Gunnison Sage-Grouse	BCC	BCC	CC,RC,CS,RS	Tier I
Henslow's Sparrow		BCC		
Horned Grebe		BCC		
Hudsonian Godwit		BCC		
Juniper Titmouse	BCC		RC,RS	
Least Bittern		BCC		
Lesser Prairie-Chicken		BCC		
Lewis's Woodpecker	BCC	BCC	CC,RC,CS,RS	Tier II
Loggerhead Shrike		BCC	RC	
Long-billed Curlew	BCC	BCC		Tier II
Lucy's Warbler				Tier III
Marbled Godwit		BCC		
McCown's Longspur		BCC		
Mountain Bluebird			RC,CS,RS	
Mountain Plover	BCC	BCC		Tier III
Nelson's Sparrow		BCC		
Northern Goshawk				Tier I
Olive-sided Flycatcher			CC	
Osprey				Tier III
Peregrine Falcon	BCC	BCC		Tier III
Pine Siskin			RC,RS	
Pinyon Jay	BCC	BCC	CC,RC,CS,RS	
Plumbeous Vireo			RS	
Prairie Falcon	BCC	BCC	RC	
Pygmy Nuthatch			RC	
Red-headed Woodpecker		BCC		
Rock Wren			RS	
Sage Sparrow		BCC	RC	Tier III
Sage Thrasher		BCC		Tier III
Say's Phoebe			RS	
Scaled Quail			CC,RC	
Sharp-tailed Grouse				Tier II
Short-billed Dowitcher		BCC		
Short-eared Owl		BCC		Tier II
Smith's Longspur		BCC		
Snowy Plover	BCC	BCC		Tier III
Spotted Owl			CC,RC	Tier I
Sprague's Pipit		BCC		
Swainson's Hawk			CC,RC	
Upland Sandpiper		BCC		
Veery	BCC			
Violet-green Swallow			RS	
Virginia's Warbler			CC,RC,RS	Tier III
Warbling Vireo			RS	
Western Bluebird			RS	
White-throated Swift			CC,RS	
Whooping Crane				Tier I
Williamson's Sapsucker			CS,RS	Tier III
Willow Flycatcher	BCC	BCC	CC,RC	Tier I
Yellow Rail		BCC		

Species	**USFWS***		**PIF†**	**UDWR‡**
	BCR 16	**Region 6**	**BCR 16**	
Yellow-billed Cuckoo	BCC			Tier I

* USFWS = United States Fish and Wildlife Service; BCC = Birds of Conservation Concern (USFWS 2008)
† PIF = Partners in Flight; BCR 16=Bird Conservation Region 16 (Southern Rockies/Colorado Plateau); CC = Continental Concern Species; RC = Regional Concern Species; CS = Continental Stewardship Species; RS = Regional Stewardship Species (PIF Science Committee 2012).
‡ UDWR=Utah Division of Wildlife Resources; Tier I= Federally listed species and species for which a Conservation Agreement has been completed and implemented; Tier II=Species listed on the Utah species of Concern List; Tier III=Species of conservation concern because they linked to an at-risk habitat, have suffered marked population declines, or there is little information available regarding the ecology or status of the species (UDWR 2005).

APPENDIX B: AVIAN DATA CENTER USAGE TIPS

Overview

All results, including parameter estimates, distribution maps, raw count data, and effort are available online and are not presented in this report. To view interactive maps showing survey and detection locations, species counts, and density, population and occupancy results using the IMBCR study design please visit the Rocky Mountain Avian Data Center at http://rmbo.org/v3/avian/ExploretheData.aspx. Click on the "Explore the Data" tab to view IMBCR results.

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, BCR, State, County, Management Entity, Priority Species List, Species, Year, Super Stratum, or Individual Stratum. 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, Migration phenology, NEON, or NPS study designs.

- Selecting the GRTS filter will display data and results for monitoring efforts which used the IMBCR design but do NOT contribute to state-wide and regional estimates (these have been called "overlays" at some of the IMBCR meetings).
- The IMBCR filter will select data and results collected under the IMBCR protocol that contribute to state and BCR-wide estimates.
- The Migration Phenology filter will select data and results for the Migration Phenology project.
- The NEON study design is a specific study design developed by NEON and RMBO for surveys conducted at NEON research locations.
- The NPS study designs are a mixture of study designs specifically designed for individual national parks. Please note that we are still working on adding some of the historic data to the Avian Data Center so not all study designs are currently available.

BCR: This filter will allow users to select IMBCR data and results for a particular Bird Conservation Region. Selecting this filter will provide you with results for all strata and super strata within a particular BCR.

State: This filter will allow users to select data and results for all study designs for a particular state. Selecting this filter will supply the user with IMBCR data and results for all strata and super strata within a particular state.

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

Management Entity: This filter will allow users to select data and results for All Other Lands, Colorado State Land Board, The Nature Conservancy (TNC), US Bureau of Indian Affairs (BIA),US Bureau of Land Management (BLM), US Department of Defense (DOD), US Fish and Wildlife Service (USFWS), US Forest Service (USFS), or National Park Service (NPS). 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.

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.

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

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

Super Stratum: This filter allows users to select IMBCR data and results for multiple strata that were analyzed jointly (e.g., the entire Bridger-Teton National Forest which was broken up into 2 strata or the entire state of Colorado which was broken up into 30 strata).

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

Hierarchy for the different management entities

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

Colorado State Land board:
Tier One – Management Entity – Colorado State Land Board
Tier Two – Management Region – Lowry Range
Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

TNC:
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

Tribal Lands:

Tier One – Management Entity – US Bureau of Indian Affairs
Tier Two – Management Region – Reservation
Tier Three – Management Unit – Not applicable
Tier Four – National Forest or Grassland – 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 – US DOD Installation
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 Management Unit, Refuge, etc.
Tier Four – National Forest or Grassland – Not applicable
Tier Five – Management District – Not applicable

USFS:
Tier One – Management Entity – US Forest Service
Tier Two – Management Region – USFS Regions
Tier Three – Management Unit – National Forest (NF) or National Grassland (NG) management units (used to represent situations where multiple forests are managed jointly)
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 NPS Parks, Monuments, Memorials, Recreation Areas, and Historic Sites
Tier Four – Management Forest – 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 multiple queries 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 separate query can be run. The two windows can then be viewed side by side.

Share a Created Query with a Colleague

It is possible to create a link to the Avian Data Center/ Explore the Data screen with a pre-loaded set of filters for a query. To do this, add the custom set of filters for your query per the instructions above and then click the "Generate URL" button near the top right corner of the screen. A pop-up box will appear with a highlighted URL address. Once you copy the highlighted text you may paste the URL address into an email or document using conventional means. Please note that whoever receives the URL address will need to run the query after clicking on the link to see the survey locations, results, and raw count statistics for the set of filters of interest.

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 sampling units 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 a survey was conducted and the target species was detected will have a pink dot in the center of the blue circle. To see the specific name of a survey location, hover the mouse arrow over the blue circle. After a moment the name of the surveyed sampling unit should appear. You may view the bird detection information for a sampling unit 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. Funding and/or implementation partners wishing for more precise location information to be displayed should request a password from RMBO IT staff via email. 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 map layers

You may add the following layers to the map: Bird Conservation Region boundaries, BIA boundaries, DOD boundaries, NPS boundaries, USFS boundaries, and BLM field office 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 sampling units expected to be occupied), the number of sampling units the species was detected on, the standard error (SE) of the estimate, and the percent coefficient of variation (% 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 km^2 (D), the total number of individuals expected to reside within the stratum (N), the percent coefficient of variation (% CV), and the number of independent detections used in analyses (*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 by clicking on the peach colored row in the table.

How to interpret the estimates

The Integrated Monitoring in Bird Conservation Regions Program annually collects breeding bird information in all or portions of 13 states. Each year, occupancy and density estimates are calculated at a variety of spatial scales. This information can be used in the following ways to inform avian conservation:

1. **Bird Population estimates can be compared in space and time.** For example, stratum-level estimates 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. **Population estimates of treatment areas can be compared to regional estimates to evaluate effectiveness of management actions.** For example, if sagebrush areas are being treated to improve habitat for Greater Sage-grouse (GRSG) and estimates for sagebrush-obligate birds increase in these areas in relation to regional estimates where treatment is not occurring, the results would suggest that the GRSG management actions are also beneficial to other sagebrush-obligate bird species;
4. **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;
5. **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.

Knowing which species have estimates
To restrict the species filter to display only those species for which occupancy and/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. Similarly, to save a chart click on the "View Image" button below the chart, right click on anywhere on the image and select "Copy image" or "Save image as".

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, the 2010 through 2013 occupancy results and density results for 2008 through 2013 are available via the ADC.

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 point count stations 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 Stratum. If you would prefer to view effort expressed as the number of sampling units surveyed, click on the "View Options" button located at the top of the screen and check the box labeled "Show effort by number of sampling units instead of by point".