# Integrated Monitoring in Bird Conservation Regions within Playa Lakes Joint Venture:

# 2016 Field Season Report

## April 2017

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# Bird Conservancy of the Rockies

*Connecting people, birds and land*

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

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

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

**Core Values**

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

**Goals**

1. Guide conservation action where it is needed most by conducting scientifically rigorous monitoring and research on birds and their habitats within the context of their full annual cycle.
2. Inspire conservation action in people by developing relationships through community outreach and science-based, experiential education programs.
3. Contribute to bird population viability and help sustain working lands by partnering with landowners and managers to enhance wildlife habitat.
4. Promote conservation and inform land management decisions by disseminating scientific knowledge and developing tools and recommendations.

**Suggested Citation**
Woiderski, Brittany. 2017. Integrated Monitoring in Bird Conservation Regions within Playa Lakes Joint Venture: 2016 Field Season Report. Bird Conservancy of the Rockies. Brighton, Colorado, USA.

**Cover Photo:** Scissor-tailed Flycatcher by Ken Slade (https://www.flickr.com/photos/texaseagle/7181937995/)

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## Acknowledgments

Expanding the IMBCR program into the Southern Great Plains on this scale would not have been possible without the dedicated collaboration and fund-raising efforts of Mike Carter, Anne Bartuszevige, and others at Playa Lakes Joint Venture (PLJV). Funding partners include Colorado Parks & Wildlife; Kansas Department of Wildlife, Parks & Tourism; Nebraska Game & Parks Commission; New Mexico Department of Game & Fish; Oklahoma Department of Wildlife Conservation; Texas Parks & Wildlife Department; USDA Farm Service Agency; USDA Forest Service; and Great Plains Landscape Conservation Cooperative. Stratification and allocation of survey effort were determined by a collaboration between PLJV and Bird Conservancy of the Rockies (Bird Conservancy).

Many individuals helped to make this inaugural field season in the Southern Great Plains a shining success despite the challenges we faced while implementing this program in a new region of the country. Bird Conservancy's landowner liaison, Jenny Berven, led the effort to compile contact information and reach out to hundreds of private landowners in order to obtain access to new survey locations. We thank the following field technicians who worked tirelessly to contact landowners, research survey locations, and collect quality avian and vegetation data: Andie Ladigo, Bianca Ramirez, Chris Winter, Chris Gray, Daniel Horton, Eric Ripma, Janine McManus, Jessie Gorges, John (Jack) Edelman, Taylor Gorman, Kit Mitchell, Katie Merewether, Richard Aracil, Earl Johnson, and Samantha Musgrave. Without the efforts of these technicians and the cooperation of private landowners, we would not have been able to accomplish our goals. We also thank the Lawton Public Library and Elk City Carnegie Library in Oklahoma for graciously allowing us to utilize their meeting rooms at no cost during training.

*Painted Bunting, Sergey Yeliseev*

# Introduction

The Integrated Monitoring in Bird Conservation Regions (IMBCR) program is one of the largest breeding bird monitoring programs in North America. The program was developed in 2007 to address the need for a collaborative avian monitoring program that produces scientifically defensible estimates of bird distribution and abundance across various spatial scales. The program's objectives were established following guidelines published by the North American Bird Conservation Initiative's (NABCI) Monitoring Subcommittee for improving avian monitoring in North America. NABCI outlined four recommendations: (1) fully integrate monitoring into bird management and conservation practices; (2) coordinate monitoring programs among organizations and integrate them across spatial scales; (3) increase the value of monitoring information by improving statistical design; and (4) maintain bird population monitoring data in modern data management systems (US North American Bird Conservation Initiative 2007).

The IMBCR program's objectives are to:

- provide a framework to integrate bird monitoring efforts across Bird Conservation Regions (BCR);
- provide robust population density and occupancy estimates that account for incomplete detection and are comparable at different geographic extents;
- use annual population estimates to monitor population trends and evaluate causes of population change;
- provide basic habitat association data for most landbird species to address habitat management issues;
- 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; and
- generate decision support tools that help guide conservation efforts and provide a quantitative measure of conservation success.

In 2008, the IMBCR program launched its pilot field season in parts of Colorado and Wyoming. By 2016, it encompassed all or portions of 13 western states, its growth fostered by more than 25 partner organizations. Not only are partnerships inherent to IMBCR, they are essential for its continued growth and success. In 2015, the Playa Lakes Joint Venture (PLJV) coordinated a partnership between several state wildlife agencies and Bird Conservancy to expand sampling in five of the joint venture's six states: Nebraska, Kansas, New Mexico, Oklahoma, and Texas. PLJV's sixth state, Colorado, was already included in the IMBCR program as of 2016. The addition of the PLJV study area increased the geographic extent of IMBCR by approximately 44%, or roughly 532,000 km² (131.4 million acres) from 2015 to 2016 (Figure 1). This expansion now provides the program with nearly complete coverage of two BCRs that were only sparsely covered in past years: Shortgrass Prairie (BCR 18) and Central Mixed Grass Prairie (BCR 19) (Figure 2).

IMBCR utilizes a robust spatially balanced sampling design which allows inferences to avian species occurrence and population sizes at various spatial scales, from local management units to entire BCRs or states, facilitating conservation at local and national levels. Collaboration across organizations and spatial scales increases sample sizes and improves the accuracy and precision of population estimates.

Analyzing the data collectively allows for the estimation of detection probabilities for species that would otherwise have insufficient numbers of detections at local scales.

The expanded coverage across the PLJV region helps to both strengthen the population estimates generated from IMBCR data and expand the knowledge of grassland birds—a suite of species that are experiencing exceptionally steep declines according to NABCI's recent report on The State of North America's Birds (North American Bird Conservation Initiative 2016). The data produced by the IMBCR program contributes to the creation of increasingly accurate population estimates, habitat models, and decision support tools. These products will provide private landowners, public land managers, wildlife biologists, and many other stakeholders with the information needed to guide their land management practices and conservation efforts throughout the region.

More information about IMBCR, including a detailed history of the program, can be found online in the "Integrated Monitoring in Bird Conservation Regions (IMBCR): 2015 Field Season Report" at the following location: http://rmbo.org/v3/Portals/5/Reports/2015_IMBCR_Report.pdf

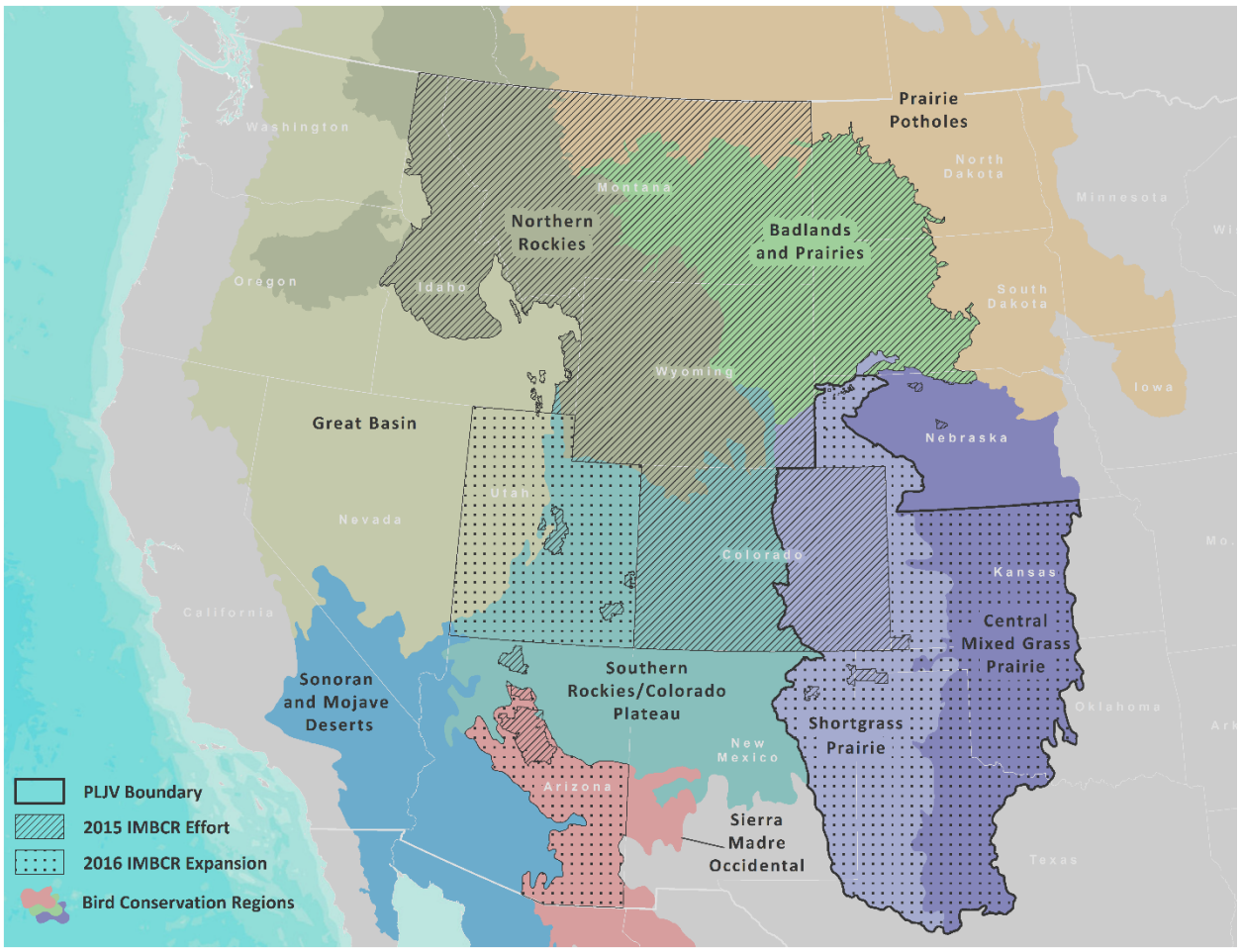



*Figure 1. Expansion of IMBCR effort from 2015 to 2016.*

# Methods

## Study Area

The PLJV region encompasses the majority of BCRs 18 and 19 (Shortgrass and Central Mixed Grass Prairies, respectively), or what is colloquially known as the Southern Great Plains. The area totals roughly 645,300 km² (159.5 million acres) and represents about 35% of the total IMBCR area surveyed in 2016. The region is host to a vast array of habitats, including dry shrublands, riparian woodlands adjacent to wide rivers, dry grasslands, and playa lakes, all crucial to birds migrating and breeding throughout the Central Flyway. It serves as the breeding grounds for some of North America's highest priority birds, including the Mountain Plover, Long-billed Curlew, Grasshopper Sparrow, and both Greater and Lesser Prairie-Chickens (US North American Bird Conservation Initiative 2000).

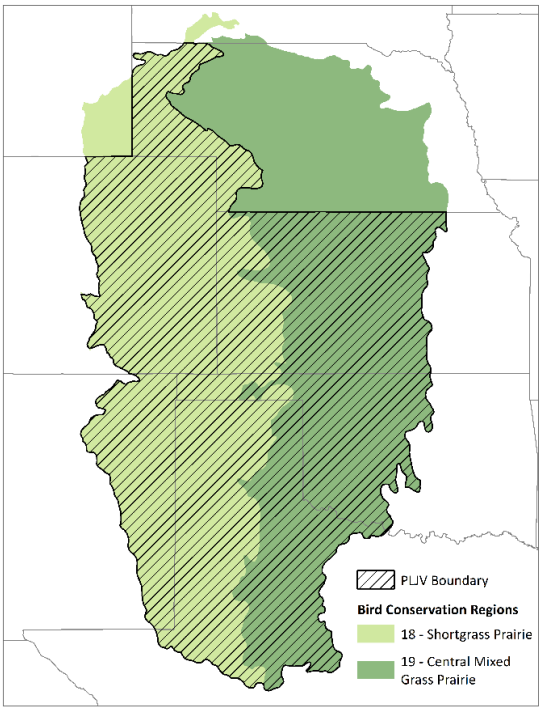



*Figure 2. PLJV study area and Bird Conservation Regions 18 & 19.*

## Sampling Frame & Stratification

A key component of the IMBCR design is the ability to infer across spatial scales, from small management units, such as individual national forests or BLM field offices, to entire states and BCRs. This is accomplished through hierarchical (nested) stratification, which allows data from smaller-order strata to be combined to make inferences about higher-order strata. For example, data from each individual national forest stratum in USFS Region 2 are combined to produce Region-wide avian population estimates; data from each individual stratum in Montana are combined to produce statewide estimates; data from each individual stratum in BCR 17 are combined to produce BCR-wide estimates.

The PLJV region is comprised of the following state and BCR intersections: Colorado BCR 18; Kansas BCRs 18 & 19; Nebraska BCR 18; New Mexico BCR 18; Oklahoma BCRs 18 & 19; and Texas BCRs 18 & 19 (Figure 2). Stratification of the region took place over time, beginning with the BCR 18 portion of Colorado in 2008. It includes strata representing two major rivers (Platte and Arkansas) and the large swaths of grassland between them, two National Grasslands, and Department of Defense lands. In 2009, US Forest Service (USFS) lands in Nebraska BCR 18 were stratified, followed by National Park units in 2013. The remaining strata, "All Other Ownership" and the three Biologically Unique Landscapes (BUL) were added in 2015 as part of the PLJV for IMBCR project. The stratification schemes for Kansas, Oklahoma, Texas, and New Mexico were developed specifically for the PLJV project and include Playas, Rivers, All Other Ownership, and national grasslands which had been sampled in the past. All of the strata are shown in Figure 3. Maps of the strata within each state are presented in the Results section.

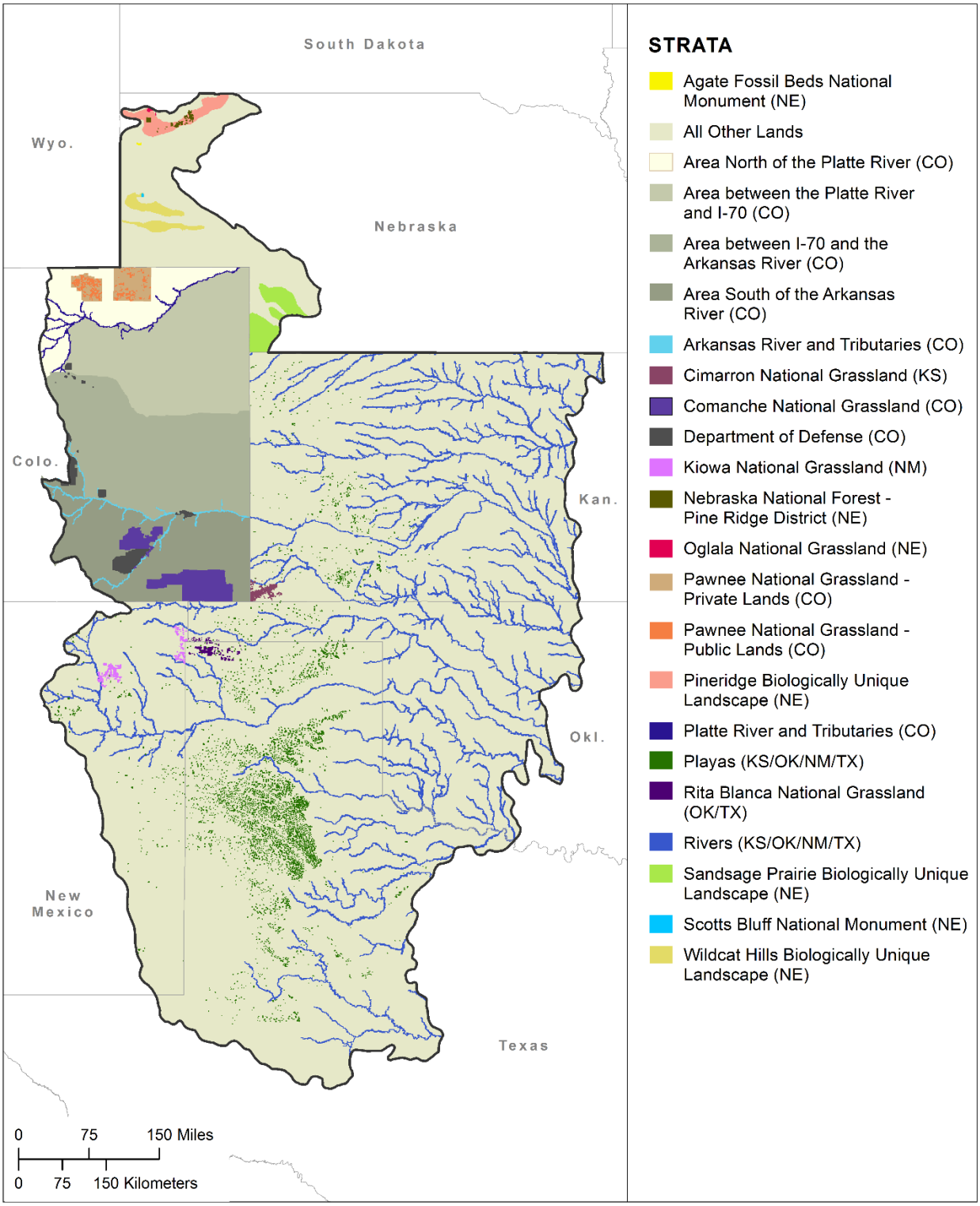



*Figure 3. Strata of the PLJV region.*

## Sampling Units

The IMBCR design defines sampling units as 1 km² cells, each containing 16 evenly-spaced sample points, 250 meters apart (Figure 4). We define potential sampling units by superimposing a uniform grid of cells over each state in the study area, then we assign each cell to a stratum using ArcGIS version 10.X and higher (Environmental Systems Research Institute 2006).

## Sample Selection

Within each stratum, the IMBCR design used generalized random-tessellation stratification (GRTS), a spatially-balanced sampling algorithm, to select sample units (Stevens and Olsen 2004). A minimum of two sampling units were required within each stratum to estimate the variances of population parameters.

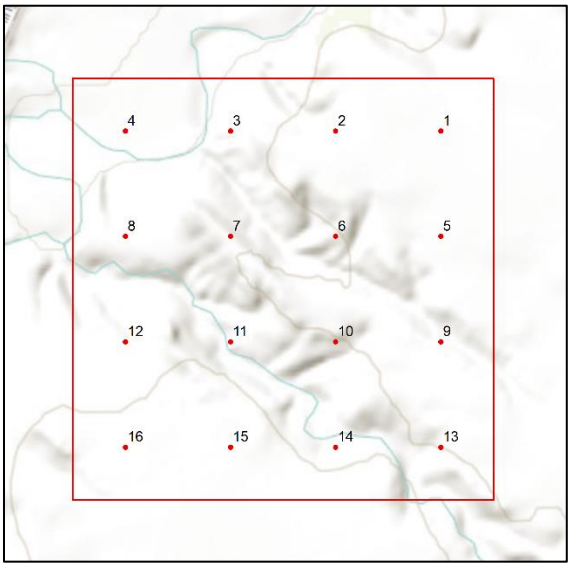



*Figure 4. Example 1 km² sampling unit using the IMBCR design.*

## Sampling Methods

IMBCR surveyors with excellent aural and visual bird-identification skills conducted field work in 2015. Prior to conducting surveys, technicians completed an intensive training program to ensure full understanding of the field protocol, review bird and plant identification, and practice distance estimation in a variety of habitats. Many field technicians attended a second, shorter mid-season training to review protocol and practice bird and plant identification at high-elevation sites that were inaccessible earlier in the season.

Field technicians (also referred to as technician, or observer in this report) conducted point counts (Buckland et al. 2001) following protocols established by IMBCR partners (Hanni et al. 2014). Observers conducted surveys in the morning, beginning one-half hour before sunrise and concluding no later than five hours after sunrise. Technicians recorded the start time for every point count conducted. For every bird detected during the six-minute period, observers recorded species; sex; horizontal distance from the observer; minute; type of detection (e.g., call, song, visual); whether the bird was thought to be a migrant; and whether or not the observer was able to visually identify each record.

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 object near the bird. In addition to recording all bird species detected in the area during point counts, observers recorded birds flying over but not using the immediate surrounding landscape. Observers also recorded American red squirrels and in other parts of the larger IMBCR study area, Abert's squirrels and American pika. While observers traveled between points within a sampling unit they recorded the presence of any species not recorded during a point count. The opportunistic detections of these species are used for distribution mapping purposes only.

Technicians considered all non-independent detections of birds (i.e., 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 Bird Conservancy's "Field Protocol for Spatially Balanced Sampling of Landbird Populations" on our Avian Data Center website at http://rmbo/v3/avian/DataCollection.aspx. There you will find links to current protocols and data sheets.

## Data Analysis

### Distance Analysis

Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that five critical assumptions be met: 1) all birds at and near the sampling location (distance = 0) are detected; 2) distances to birds are measured accurately; 3) birds do not move in response to the observer's presence (Buckland et al. 2001, Thomas et al. 2010); 4) cluster sizes are recorded without error; and 5) the sampling units are representative of the entire survey region (Buckland et al. 2008).

Analysis of distance data 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., 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 these data separately for each species. The development of robust density estimates typically requires 80 or more independent detections ($n \geq 80$) within the entire sampling area. 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 density for each species using a sequential framework where 1) year specific detection functions were applied to species with greater than or equal to 80 detections per year ($n \geq 80$), 2) global detection functions were applied to species with less than 80 detections per year ($n < 80$) and greater than or equal to 80 detections over the life of the project ($n \geq 80$), and 3) remedial measures were used for species with moderate departures from the assumptions of distance sampling (Buckland et al. 2001).

In 2014, we streamlined the analysis by fitting models with no series expansions to all species using the recommended 10% truncation for point transects. For the year-specific detection functions, we fit Conventional Distance Sampling models using the half-normal and hazard-rate key functions with no series expansions (Thomas et al. 2010). For the global detection functions, in addition to the above models, we fit Multiple-Covariate Distance Sampling models using half-normal and hazard-rate key function models with a categorical year covariate and no series expansions (Thomas et al. 2010). We selected the most parsimonious detection function for each species using Akaike's Information Criterion adjusted for sample size (AICc; Burnham & Anderson 2002; Thomas et al. 2010) , and considered the most parsimonious model as the estimation model. We estimated population size ("N"ˆ) for each stratum as "N"ˆ"= " "D"ˆ"*A" , where "D"ˆ was the estimated population density and A was the number of 1 km² sampling units in each stratum. We calculated Satterthwaite 90% Confidence Intervals (CI) for the estimates of density and population size for each stratum (Buckland et al. 2001). In addition, we combined the stratum-level density estimates at various spatial scales, such as management entity, State and BCR, using an area-weighted mean. For the combined density estimates, we estimated the variance for detection and cluster size using the delta method (Powell 2007, Thomas et al. 2010) and the variance for the encounter rate using the design-based estimator of Fewster et al. (2009).

We reviewed the highest ranking detection function for each species to check the shape criteria, evaluate the fit of the model and identify species with moderate departure from the assumptions of distance sampling (Buckland et al. 2001). First, we checked the shape criteria of the histogram to make sure the detection data exhibited a "shoulder" that fell away at increasing distances from the point. Second, we evaluated the fit of the model using the Kolmogorov-Smirnov goodness-of-fit test. Finally, we visually inspected the detection histograms to identify species that demonstrated evasive movement and/ or measurement errors. We looked for a type of measurement error involving the heaping of detections at certain distances that occurs when observers round detection distances. We also looked for histograms with detections that were highly skewed to the right, which may indicate a pattern of evasive movement (Buckland et al. 2001).

For species with moderate departures from the assumptions and shape criteria, we used two sequential remedial measures. First, we truncated the data to the point where detection probability was approximately 0.1 [g(w) ~ 0.1] and included key functions with second order cosine series-expansion terms in the candidate set of models (Buckland et al. 2001). We did not include detection function models with a single cosine expansion term because the half-normal and hazard-rate models require the order of the terms are > 1 (Buckland et al. 2001). Second, when the goodness-of-fit test and/ or inspection of the detection histogram continued to suggest evasive movement and/or measurement errors, we grouped the distance data into four to eight bins, and applied custom truncation and second order expansion terms. These remedial measures can ameliorate problems associated with moderate levels of evasive movement and/ or distance measurement errors (Buckland et al. 2001).

**Occupancy Analysis**

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., 1 km² cells) occupied by an organism (MacKenzie et al. 2002). The application of occupancy modeling requires multiple surveys of the sample unit in space or time to estimate a detection probability (MacKenzie et al.

2006). The detection probability adjusts the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). We used a removal design (MacKenzie et al. 2006), to estimate a detection probability for each species, in which we binned minutes one and two, minutes three and four and minutes five and six 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" (MacKenzie et al. 2006).

The 16 points in each sampling unit served as spatial replicates for estimating the proportion of points occupied within the sampled sampling units. 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 (θ, Theta) and 3) the proportion of sampling units occupied by a species (ψ, Psi).

We truncated the data, using only detections less than 125 m from the sample points. Truncating the data at less than 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) (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, *p* and Theta were held constant across the BCRs and/or allowed to vary by BCR. Models are defined as follows:

Model 1: Held *p* and Theta 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 point detections in each BCR or less than 10 point detections in all but one BCR. We ran models 1 through 4 for species with greater than 10 point detections in more than one BCR. For the purpose of estimating regional variation in detection (*p*) and availability (Theta), we pooled data for BCRs with fewer than 10 point detections into adjacent BCRs with sufficient numbers of detections. We used model selection and AIC corrected for small sample size ($AIC_c$) to weight models from which estimates of Psi were derived for each species (Burnham and Anderson 2002). We model averaged the estimates of Psi from models 1 through 4 and calculated unconditional standard errors and 90% CIs (Burnham and Anderson 2002). We combined stratum-level estimates of Psi using an area-weighted mean. The variances and standard errors for the combined estimates of Psi were estimated using the delta method (Powell 2007).

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).

**Automated Analysis**

We estimated population density using point transect distance sampling and site occupancy using the multi-scale occupancy model within a modified version of the RIMBCR package (R Core Team 2014; Paul Lukacs, University of Montana, Missoula). The RIMBCR package streamlined the analyses by calling the raw data from the IMBCR Structured Query Language (SQL) server database and incorporated 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 global detection rates for population density and site occupancy. The RIMBCR package used package mrds (Thomas et al. 2010, R Core Team 2014) to fit the point transect distance sampling model, and program MARK (White and Burnham 1999) and package RMark (Laake 2013, R Core Team 2014) to fit the multi-scale occupancy model. The RIMBCR package provided an automated framework for combining strata-level estimates of population density and site occupancy at multiple spatial scales, as well as approximating the standard errors and CIs for the combined estimates.

In October 2014, we revised the RIMBCR distance sampling code to accommodate updates to package mrds 2.18. However, because we were unable to troubleshoot the complex structure of the RIMBCR code, we completely rewrote the distance sampling code between October 2014 and April 2015. The new distance sampling code retained the “roll-up” code for combining the strata-level estimates from the previous version of RIMBCR. In March 2015, we discovered a delta method (Powell 2007) error in the RIMBCR “roll-up” code (Powell 2007). We estimated the proportion of sampling units occupied (Psi) for all species that estimates the standard errors and CIs for the combined occupancy estimates. In April 2015, we revised RIMBCR to fix the error, but we were unable to troubleshoot the complex structure of the RIMBCR code. We plan to rewrite the RIMBCR occupancy code in way that allows testing, but in the mean time we developed an R “roll-up” patch that correctly estimates the standard errors and CIs for the combined occupancy estimates. We reran the “roll-up” patch for 2012-2014 to retroactively correct the standard errors and CIs for the previous combined (superstrata) occupancy estimates. We currently maintain version control of the automated analysis code in the Bird Conservancy repository (Atlassian Stash, version 3.6.1).

## Season Overview & Highlights

As the pilot year of this project, we dealt with many logistics typical of the first year surveying in a new region. These included reaching a sufficient number of (and acquiring permission from) landowners in areas of Texas and New Mexico; receiving permits to access leased state-owned lands; limited access to transects due to high water levels near large waterbodies; and ensuring the safety of our technicians working near oil and gas development, which can produce deadly amounts of Hydrogen Sulfide gas. While some of these logistics proved to be more of a challenge than expected, overall we had an extremely successful field season.

### Working with Landowners

The addition of the Nebraska, Kansas, Oklahoma, Texas, and New Mexico portions of the PLJV study area has been the largest expansion of IMBCR in a single season. We surveyed 300 of 330 planned grids

in the PLJV region. Twenty-nine of the 30 missed grids were not surveyed because we were unable to secure permission from enough landowners to survey during the optimal survey period (Table 2).

This massive effort required a significant amount of research with over 200 newly established grids in relatively uncharted territory for IMBCR. The land within the PLJV region is roughly 97% privately owned, making this area especially challenging to get started in. However, in states with similar private landownership, like Wyoming, we have found that once we develop a partnership with a landowner, they often continue to work with us for years to come. These positive landowner relationships are crucial to the success of the IMBCR program. They allow us to generate accurate population estimates by making all land types available for sampling which gives us the best possible picture of the landscape and the birds that live there.

In the spring of 2016, we sent out roughly 1,200 letters to private landowners in the PLJV region requesting permission to access their land, 1,000 of which were sent to landowners in new survey areas within Nebraska, Kansas, Oklahoma, Texas, and New Mexico. The permission request letters contained a self-addressed, stamped return card for the landowner to complete and send back to us. If a return card wasn't received, a Bird Conservancy staff member attempted to contact the landowner by phone. Hundreds of phone calls were made in the following weeks, primarily by technicians and crew leaders. This initial investment of time and resources is critical. We often find that when landowners have an opportunity to speak to a person and ask questions, they are more likely to grant permission and continue to work with us in future years.

These 1,200 letters and subsequent phone calls resulted in approximately 350 landowners granting permission for us to survey on nearly 250 grids across all strata (many grids intersect multiple parcels owned by different people). Ultimately, we completed surveys on 209 of these grids (310 landowners) as determined by the sample effort for each stratum. The remaining 91 grids were either on public land (e.g. state park, national forest, recreation area) or surveyed from public right-of-ways.


*Figure 5. 2016 landowner participation thank-you gift: a custom mini calendar featuring IMBCR data.*

During the field season, many landowners requested to meet technicians in person. We welcome face to face interactions because we value these partnerships immensely and want landowners to feel comfortable about their contribution to the program. All of the landowners who agreed to participate received a thank-you letter, a list of the bird species detected on their land, and a small gift of appreciation from Bird Conservancy after the field season. In 2016, this was a custom mini calendar, complete with species profiles for each month and corresponding IMBCR data (Figure 5).

### Seasonal Timing of Surveys

In order to complete the work in the field, we hired and trained 17 technicians—the largest single crew hired for any IMBCR study area to date. We assigned each technician 35-40 grids in the PLJV area to be completed by early June. One of the factors that led us to hire so many technicians was the uncertainty of the optimal seasonal timing for surveying breeding birds in the Southern Great Plains on such a large scale. Point counts should be performed after all migratory species have returned to their breeding areas and as early in the season as possible. Capturing the optimal survey time is important to mitigate counting too many transient birds that are still migrating through; however, we will never be able to fully avoid counting migrant individuals. In general, birds arrive at their breeding grounds both latitudinally (settling in southern latitudes first, then moving north) and elevationally.

The seasonal timing for many previously established IMBCR study areas is largely driven by elevation. In Colorado, for example, Lark Buntings and Western Meadowlarks begin breeding on the plains in early May, whereas alpine tundra dwelling species like American Pipit and Horned Lark may not begin breeding at those elevations until later in the spring when the snow has melted and their food sources are more readily available. Because changes in elevation are relatively insignificant in the Southern Great Plains, we decided to focus on latitude to determine optimal survey dates: start surveying in the southern portion of the study area and end in the north. We hired a larger than normal crew in order to distribute the work and complete surveys in Texas, New Mexico, and Oklahoma by the end of May. After reviewing the data, we decided that we could safely continue surveying in the northern portions of those states into mid-June.

### Species Detected

Technicians recorded a staggering 52,500 individual birds from over 226 species in the PLJV region (Appendix B: All Species Detected). Of the 226 species detected, 98 are listed as priority species with management designations by state wildlife agencies (Appendix A: Priority Species by State). Additionally, 15 new species were detected for IMBCR: Barn Owl, Black Vulture, Black-crested Titmouse, Carolina Chickadee, Carolina Wren, Chuck-will's-widow, Eastern Screech-Owl, Fish Crow, Golden-fronted, Woodpecker, Herring Gull (migratory), Painted Bunting, Scissor-tailed Flycatcher, Snowy Plover, Solitary Sandpiper (migratory), and Tufted Titmouse. We were able to generate occupancy estimates for five of these species (Black-crested Titmouse, Carolina Wren, Golden-fronted Woodpecker, Painted Bunting, and Scissor-tailed Flycatcher) and density estimates for three (Golden-fronted Woodpecker, Painted Bunting, and Scissor-tailed Flycatcher).

## Looking Ahead

As of April 2017, we have sent out more than 1,500 permission request letters to landowners in the PLJV area, increasing our mailing effort in Texas, New Mexico, and parts of Nebraska, and we have started the process of reaching out to landowners by phone. We were also able to secure a permit to survey on select lands owned by the New Mexico State Land Office (NMSLO) in late 2016. These lands are leased to private landowners and require an additional level of contact to be made with the lessees; however, many of our grids in New Mexico BCR 18 intersect some amount of NMSLO land, so this permit eases much of the pressure to obtain permission from landowners on other grids. Judging by the return cards

that we have already received, we are extremely optimistic that we will be able to meet our sampling goals in the upcoming field season.

The 2017 sampling effort will be very similar to 2016 with a slightly decreased effort in Kansas. We will also be stratifying and surveying in the BCR 18 portion of South Dakota, which will allow us to get BCR 18 wide estimates for the first time ever. This is a major accomplishment for the IMBCR program and would not be possible without the PLJV for IMBCR project.

## Summary of Results

In 2016, Bird Conservancy surveyed 300 of 330 (91%) planned grids in the entire PLJV Region. The number of planned grids and number of actual grids surveyed are shown in Table 1. Table 2 provides the reasons grids were not surveyed. Surveyed grid locations are shown in Figure 6. In total, 2,847 individual point counts were conducted on the 300 surveys (approximately 9.5 points per transect). Field technicians recorded more than 52,500 individual birds from over 226 species (Appendix B: All Species Detected).

Appendix C: Avian Data Center Usage Tips provides an overview of viewing an interactive map of survey locations, density and occupancy results, and species counts for any superstratum or individual stratum within IMBCR.

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 1. The number of planned grids, number of grids surveyed, number of point counts conducted, and average number of point counts per grid by Bird Conservancy staff within each stratum in the PLJV Region.*

| Stratum Code | Stratum Name | Planned Grids | Completed Grids | Point Counts | Average Count/Grid |
|---|---|---|---|---|---|
| CO-BCR18-AR | Arkansas River and Tributaries | 8 | 8 | 82 | 10 |
| CO-BCR18-CO | Comanche National Grassland | 8 | 8 | 92 | 12 |
| CO-BCR18-DO | Department of Defense - All Other Lands | 2 | 2 | 25 | 13 |
| CO-BCR18-IA | Area between I-70 and the Arkansas River | 8 | 8 | 108 | 14 |
| CO-BCR18-NP | Area North of the Platte River | 8 | 8 | 76 | 10 |
| CO-BCR18-PC | Pawnee National Grassland - Private Lands | 2 | 2 | 24 | 12 |
| CO-BCR18-PG | Pawnee National Grassland - Public Lands | 5 | 5 | 66 | 13 |
| CO-BCR18-PI | Area between the Platte River and I-70 | 8 | 8 | 110 | 14 |
| CO-BCR18-PT | Platte River and Tributaries | 8 | 8 | 85 | 11 |
| CO-BCR18-SA | Area South of the Arkansas River | 8 | 8 | 109 | 14 |
| KS-BCR18-AO | Kansas BCR 18 All Other Lands | 8 | 8 | 59 | 7 |
| KS-BCR18-CM | Cimarron National Grassland | 3 | 3 | 41 | 14 |
| KS-BCR18-PL | Kansas BCR 18 Playas | 2 | 2 | 14 | 7 |
| KS-BCR18-RV | Kansas BCR 18 Rivers | 2 | 2 | 17 | 9 |
| KS-BCR19-AO | Kansas BCR 19 All Other Lands | 8 | 8 | 74 | 9 |
| KS-BCR19-PL | Kansas BCR 19 Playas | 2 | 2 | 8 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| KS-BCR19-RV | Kansas BCR 19 Rivers | 2 | 2 | 20 | 10 |
| **Stratum Code** | **Stratum Name** | **Planned Grids** | **Completed Grids** | **Point Counts** | **Average Count/Grid** |
| NE-BCR18-AF | Agate Fossil Beds National Monument | 9 | 9 | 96 | 11 |
| NE-BCR18-AO | Nebraska BCR 18 All Other Lands | 8 | 7 | 59 | 8 |
| NE-BCR18-GG | Oglala National Grassland | 3 | 3 | 36 | 12 |
| NE-BCR18-PR | Nebraska BCR 18 Pineridge BUL | 8 | 8 | 86 | 11 |
| NE-BCR18-RD | Nebraska National Forest - Pine Ridge | 3 | 3 | 35 | 12 |
| NE-BCR18-SA | Nebraska BCR 18 Sandsage BUL | 8 | 8 | 74 | 9 |
| NE-BCR18-SB | Scotts Bluff National Monument | 7 | 7 | 65 | 9 |
| NE-BCR18-WH | Nebraska BCR 18 Wildcat Hills BUL | 8 | 8 | 54 | 7 |
| NM-BCR18-AO | New Mexico BCR 18 All Other Lands | 18 | 13 | 113 | 9 |
| NM-BCR18-KW | Kiowa National Grassland | 2 | 2 | 28 | 14 |
| NM-BCR18-PL | New Mexico BCR 18 Playas | 17 | 17 | 170 | 10 |
| NM-BCR18-RV | New Mexico BCR 18 Rivers | 15 | 8 | 65 | 8 |
| OK-BCR18-AO | Oklahoma BCR 18 All Other Lands | 8 | 8 | 72 | 9 |
| OK-BCR18-PL | Oklahoma BCR 18 Playas | 5 | 5 | 36 | 7 |
| OK-BCR18-RB | Rita Blanca National Grassland | 2 | 2 | 16 | 8 |
| OK-BCR18-RV | Oklahoma BCR 18 Rivers | 8 | 8 | 64 | 8 |
| OK-BCR19-AO | Oklahoma BCR 19 All Other Lands | 8 | 8 | 60 | 8 |
| OK-BCR19-PL | Oklahoma BCR 19 Playas | 2 | 2 | 20 | 10 |
| OK-BCR19-RV | Oklahoma BCR 19 Rivers | 8 | 8 | 49 | 6 |
| TX-BCR18-AO | Texas BCR 18 All Other Lands | 16 | 16 | 134 | 8 |
| TX-BCR18-PL | Texas BCR 18 Playas | 16 | 16 | 135 | 8 |
| TX-BCR18-RB | Rita Blanca National Grassland | 2 | 2 | 24 | 12 |
| TX-BCR18-RV | Texas BCR 18 Rivers | 16 | 14 | 134 | 10 |
| TX-BCR19-AO | Texas BCR 19 All Other Lands | 16 | 9 | 74 | 8 |
| TX-BCR19-PL | Texas BCR 19 Playas | 9 | 8 | 53 | 7 |
| TX-BCR19-RV | Texas BCR 19 Rivers | 16 | 9 | 85 | 9 |

*Table 2. Reasons planned grids were not surveyed.*

| Stratum Code | Number of Grids Not Surveyed | Reason |
|---|---|---|
| NE-BCR18-AO | 1 | Miscommunication between technician and supervisor |
| NM-BCR18-AO | 5 | Unable to secure landowner permission |
| NM-BCR18-RV | 7 | Unable to secure landowner permission |
| TX-BCR18-RV | 2 | Unable to secure landowner permission |
| TX-BCR19-AO | 7 | Unable to secure landowner permission |
| TX-BCR19-PL | 1 | Unable to secure landowner permission |
| TX-BCR19-RV | 7 | Unable to secure landowner permission |

| | |
|---|---|
| Total | 30 |

**Playa Lakes Joint Venture Area**

We obtained results for the Playa Lakes Joint Venture Area by compiling and jointly analyzing data from 43 strata in six states.

Field technicians completed 300 of 330 planned surveys (91%) in 2016. Technicians conducted 2847 point counts within the 300 surveyed grid cells between 26 April and 9 July. They detected 226 bird species.

Bird Conservancy estimated densities and population sizes for 156 species. The data yielded robust density estimates (CV < 50%) for 65 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout the Playa Lakes Joint Venture Area for 158 species. The data yielded robust occupancy estimates (CV < 50%) for 86 of these species.

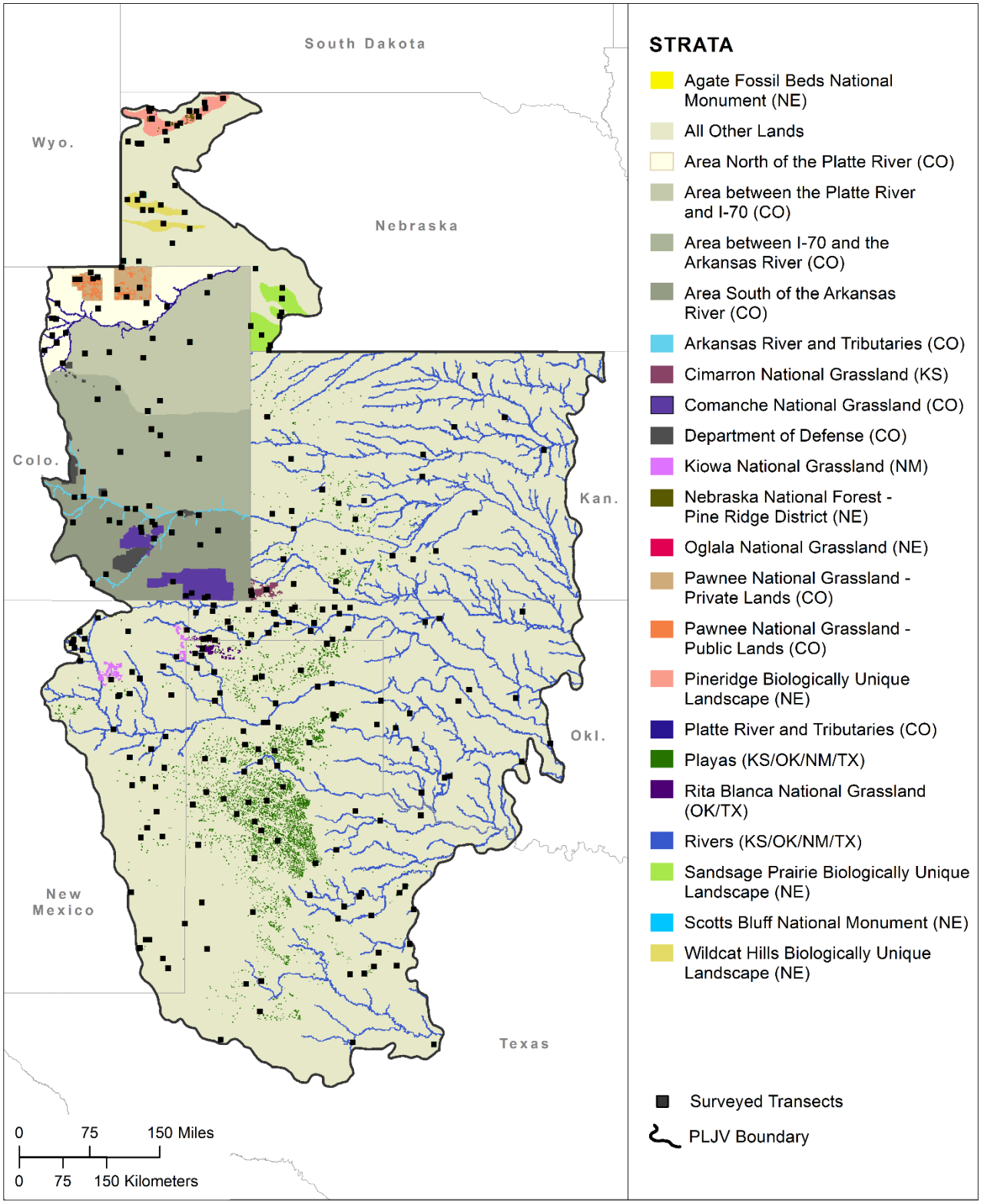



*Figure 6. Location of grids surveyed in 2016 in the PLJV region.*

## Texas

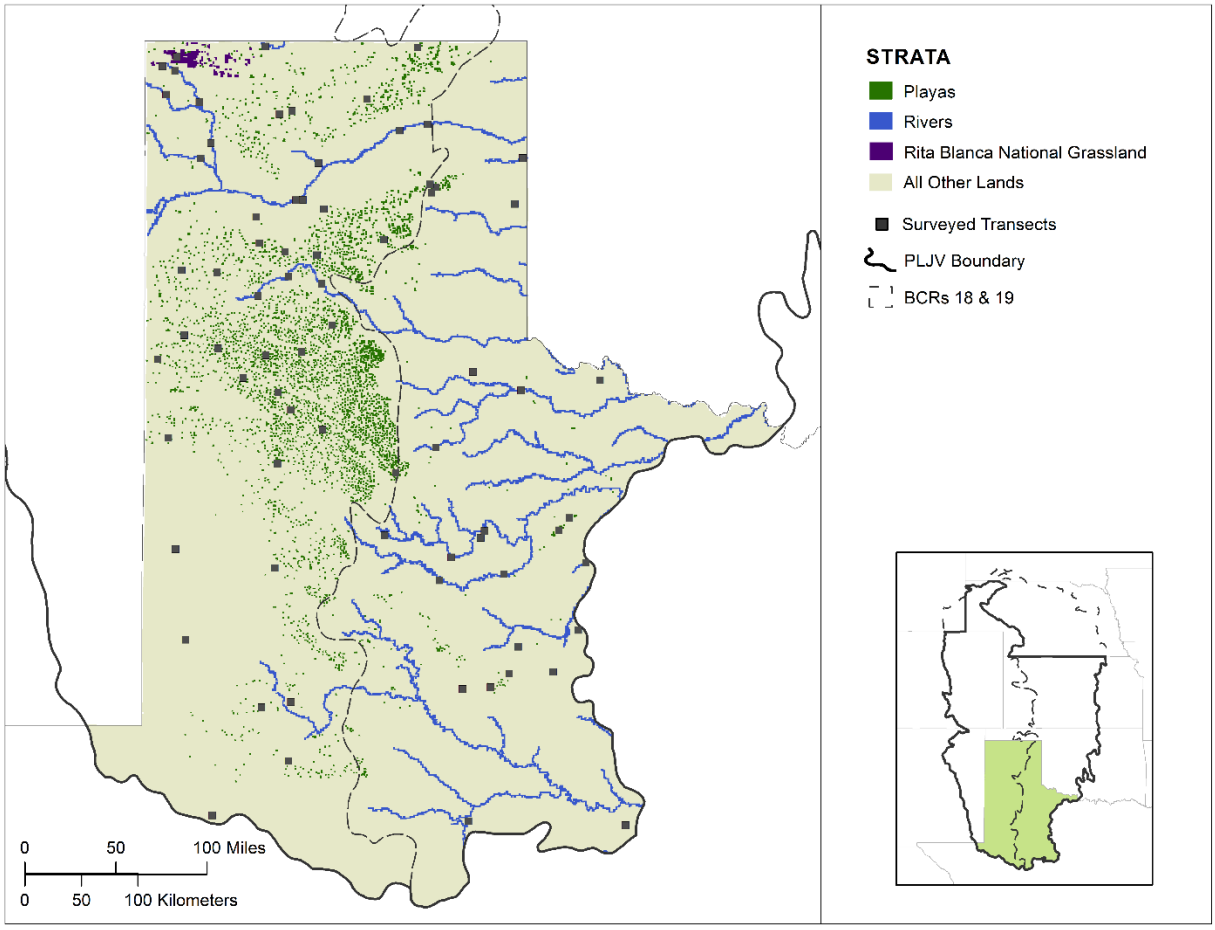



*Figure 7. Strata and 2016 survey locations in Texas BCRs 18 and 19.*

### Shortgrass Prairie (BCR 18) in Texas

We obtained results for Shortgrass Prairie (BCR 18) in Texas by compiling and jointly analyzing data from four strata.

Field technicians completed 48 of 50 planned surveys (96%) in 2016. Technicians conducted 427 point counts within the 48 surveyed grid cells between 26 April and 27 May. They detected 131 bird species, including 26 priority species.

Bird Conservancy estimated densities and population sizes for 90 species, 23 of which are priority species. The data yielded robust density estimates (CV < 50%) for 25 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in Texas for 87 species, 23 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 30 of these species.

**Central Mixed Grass Prairie (BCR 19) in Texas**

We obtained results for Central Mixed Grass Prairie (BCR 19) in Texas by compiling and jointly analyzing data from three strata.

Field technicians completed 26 of 41 planned surveys (63%) in 2016. Technicians conducted 212 point counts within the 26 surveyed grid cells between 27 April and 28 May. They detected 122 bird species, including 25 priority species.

Bird Conservancy estimated densities and population sizes for 74 species, 19 of which are priority species. The data yielded robust density estimates (CV < 50%) for 18 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Central Mixed Grass Prairie (BCR 19) in Texas for 75 species, 18 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 26 of these species.

**Playas in Texas BCRs 18 & 19**

We obtained results for Playas in Texas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed 24 of 25 planned surveys (96%) in 2016. Technicians conducted 188 point counts within the 24 surveyed grid cells between 26 April and 28 May. They detected 85 bird species, including 17 priority species.

Bird Conservancy estimated densities and population sizes for 57 species, 16 of which are priority species. The data yielded robust density estimates (CV < 50%) for 16 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Playas in Texas BCRs 18 & 19 for 50 species, 12 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 19 of these species.

**Rivers in Texas BCRs 18 & 19**

We obtained results for Rivers in Texas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed 23 of 32 planned surveys (72%) in 2016. Technicians conducted 219 point counts within the 23 surveyed grid cells between 27 April and 22 May. They detected 130 bird species, including 26 priority species.

Bird Conservancy estimated densities and population sizes for 86 species, 22 of which are priority species. The data yielded robust density estimates (CV < 50%) for 31 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Rivers in Texas BCRs 18 & 19 for 86 species, 21 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 37 of these species.

**All Other Lands in Texas BCRs 18 & 19**

We obtained results for All Other Lands in Texas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed 25 of 32 planned surveys (78%) in 2016. Technicians conducted 208 point counts within the 25 surveyed grid cells between 27 April and 27 May. They detected 111 bird species, including 27 priority species.

Bird Conservancy estimated densities and population sizes for 73 species, 21 of which are priority species. The data yielded robust density estimates (CV < 50%) for 28 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout All Other Lands in Texas BCRs 18 & 19 for 71 species, 21 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 38 of these species.

**All Other Lands in Texas BCR 18**

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 134 point counts within the 16 surveyed grid cells between 27 April and 27 May. They detected 78 bird species, including 15 priority species.

Bird Conservancy estimated densities and population sizes for 51 species, 12 of which are priority species. The data yielded robust density estimates (CV < 50%) for 15 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout All Other Lands in Texas BCR 18 for 49 species, 12 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 20 of these species.

**Playas in Texas BCR 18**

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 135 point counts within the 16 surveyed grid cells between 26 April and 20 May. They detected 64 bird species, including 14 priority species.

Bird Conservancy estimated densities and population sizes for 44 species, 14 of which are priority species. The data yielded robust density estimates (CV < 50%) for 14 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Playas in Texas BCR 18 for 42 species, 11 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 17 of these species.

**Rivers in Texas BCR 18**

Field technicians completed 14 of 16 planned surveys (88%) in 2016. Technicians conducted 134 point counts within the 14 surveyed grid cells between 27 April and 22 May. They detected 111 bird species, including 24 priority species.

Bird Conservancy estimated densities and population sizes for 77 species, 21 of which are priority species. The data yielded robust density estimates (CV < 50%) for 22 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Rivers in Texas BCR 18 for 73 species, 20 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 28 of these species.

**Rita Blanca National Grassland in Texas**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 24 point counts within the 2 surveyed grid cells between 3 May and 23 May. They detected 20 bird species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Playas in Texas BCR 19**

Field technicians completed 8 of 9 planned surveys (89%) in 2016. Technicians conducted 53 point counts within the 8 surveyed grid cells between 28 April and 28 May. They detected 61 bird species, including 11 priority species.

Bird Conservancy estimated densities and population sizes for 39 species, 9 of which are priority species. The data yielded robust density estimates (CV < 50%) for 14 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Playas in Texas BCR 19 for 31 species, 8 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 17 of these species.

**Rivers in Texas BCR 19**

Field technicians completed 9 of 16 planned surveys (56%) in 2016. Technicians conducted 85 point counts within the 9 surveyed grid cells between 27 April and 10 May. They detected 88 bird species, including 20 priority species.

Bird Conservancy estimated densities and population sizes for 56 species, 15 of which are priority species. The data yielded robust density estimates (CV < 50%) for 21 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Rivers in Texas BCR 19 for 57 species, 14 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 31 of these species.

**All Other Lands in Texas BCR 19**

Field technicians completed 9 of 16 planned surveys (56%) in 2016. Technicians conducted 74 point counts within the 9 surveyed grid cells between 2 May and 16 May. They detected 86 bird species, including 24 priority species.

Bird Conservancy estimated densities and population sizes for 56 species, 19 of which are priority species. The data yielded robust density estimates (CV < 50%) for 12 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout All Other Lands in Texas BCR 19 for 55 species, 18 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 23 of these species.

## Oklahoma

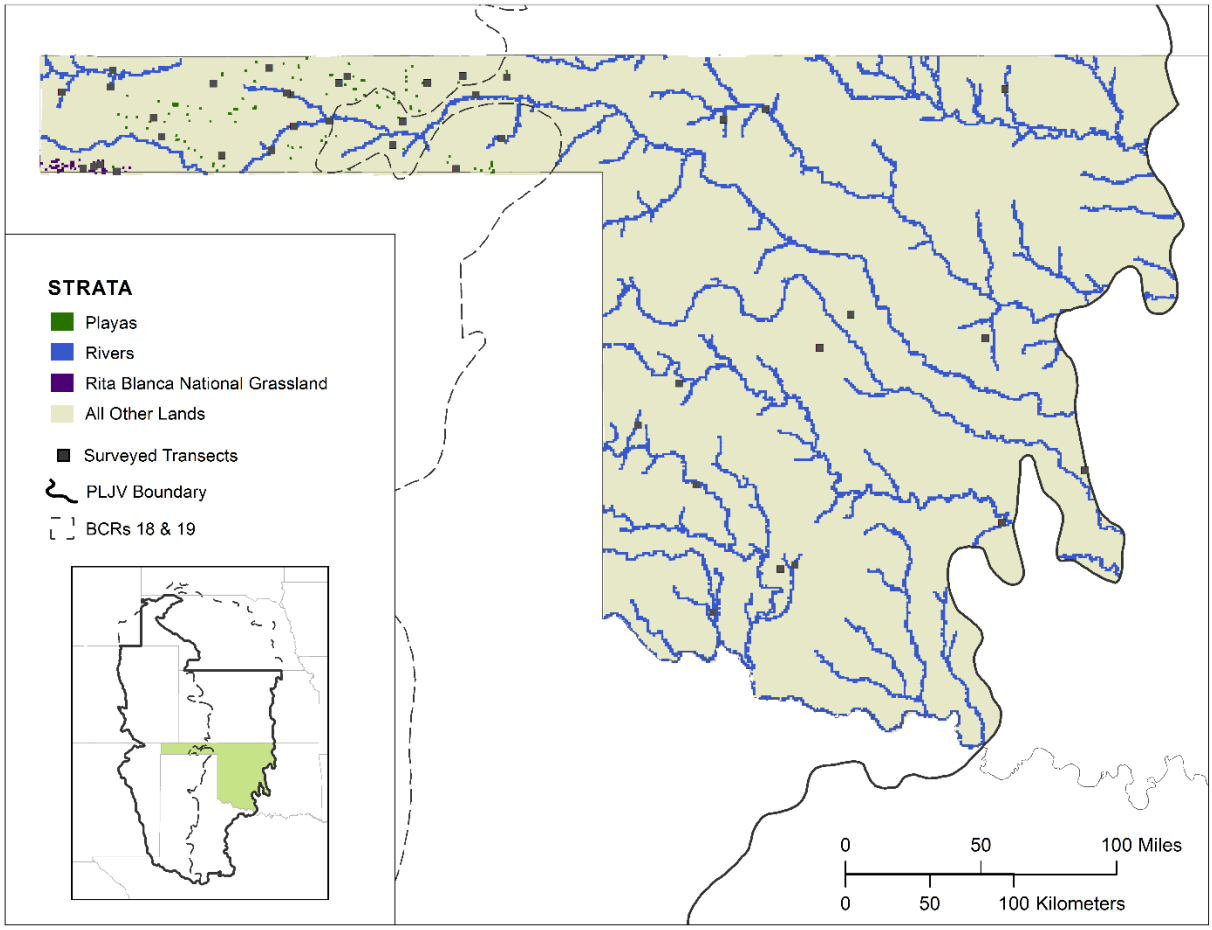



*Figure 8. Strata and 2016 survey locations in Oklahoma BCRs 18 and 19.*

### Shortgrass Prairie (BCR 18) in Oklahoma

We obtained results for Shortgrass Prairie (BCR 18) in Oklahoma by compiling and jointly analyzing data from four strata.

Field technicians completed all 23 planned surveys (100%) in 2016. Technicians conducted 188 point counts within the 23 surveyed grid cells between 4 May and 24 May. They detected 73 bird species, including 12 priority species.

Bird Conservancy estimated densities and population sizes for 58 species, 10 of which are priority species. The data yielded robust density estimates (CV < 50%) for 10 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in Oklahoma for 47 species, 8 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 10 of these species.

**Central Mixed Grass Prairie (BCR 19) in Oklahoma**

We obtained results for Central Mixed Grass Prairie (BCR 19) in Oklahoma by compiling and jointly analyzing data from three strata.

Field technicians completed all 18 planned surveys (100%) in 2016. Technicians conducted 129 point counts within the 18 surveyed grid cells between 26 April and 23 May. They detected 98 bird species, including 15 priority species.

Bird Conservancy estimated densities and population sizes for 66 species, 10 of which are priority species. The data yielded robust density estimates (CV < 50%) for 14 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Central Mixed Grass Prairie (BCR 19) in Oklahoma for 62 species, 7 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 19 of these species.

**Playas in Oklahoma BCRs 18 & 19**

We obtained results for Playas in Oklahoma BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 7 planned surveys (100%) in 2016. Technicians conducted 56 point counts within the 7 surveyed grid cells between 6 May and 21 May. They detected 43 bird species, including 8 priority species.

Bird Conservancy estimated densities and population sizes for 34 species, 5 of which are priority species. The data yielded robust density estimates (CV < 50%) for 11 of these species.

Bird Conservancy estimated the proportion of 1 km² grid cells occupied (Psi) throughout Playas in Oklahoma BCRs 18 & 19 for 32 species, 4 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 13 of these species.

**Rivers in Oklahoma BCRs 18 & 19**

We obtained results for Rivers in Oklahoma BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 113 point counts within the 16 surveyed grid cells between 26 April and 24 May. They detected 91 bird species, including 13 priority species.

Bird Conservancy estimated densities and population sizes for 63 species, 10 of which are priority species. The data yielded robust density estimates (CV < 50%) for 18 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in Oklahoma BCRs 18 & 19 for 55 species, 7 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 18 of these species.

**All Other Lands in Oklahoma BCRs 18 & 19**

We obtained results for All Other Lands in Oklahoma BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 132 point counts within the 16 surveyed grid cells between 27 April and 24 May. They detected 84 bird species, including 13 priority species.

Bird Conservancy estimated densities and population sizes for 60 species, 9 of which are priority species. The data yielded robust density estimates (CV < 50%) for 17 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Oklahoma BCRs 18 & 19 for 53 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 21 of these species.

**All Other Lands in Oklahoma BCR 18**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 72 point counts within the 8 surveyed grid cells between 9 May and 24 May. They detected 42 bird species, including 9 priority species.

Bird Conservancy estimated densities and population sizes for 35 species, 8 of which are priority species. The data yielded robust density estimates (CV < 50%) for 9 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Oklahoma BCR 18 for 28 species, 5 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 10 of these species.

**All Other Lands in Oklahoma BCR 19**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 60 point counts within the 8 surveyed grid cells between 27 April and 23 May. They detected 75 bird species, including 11 priority species.

Bird Conservancy estimated densities and population sizes for 52 species, 8 of which are priority species. The data yielded robust density estimates (CV < 50%) for 12 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Oklahoma BCR 19 for 49 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 18 of these species.

**Playas in Oklahoma BCR 18**

Field technicians completed all 5 planned surveys (100%) in 2016. Technicians conducted 36 point counts within the 5 surveyed grid cells between 6 May and 21 May. They detected 34 bird species, including 6 priority species.

Bird Conservancy estimated densities and population sizes for 27 species, 5 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Playas in Oklahoma BCR 18 for 23 species, 3 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 8 of these species.

**Playas in Oklahoma BCR 19**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 20 point counts within the 2 surveyed grid cells between 7 May and 18 May. They detected 31 bird species, including 5 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Rivers in Oklahoma BCR 18**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 64 point counts within the 8 surveyed grid cells between 4 May and 24 May. They detected 55 bird species, including 9 priority species.

Bird Conservancy estimated densities and population sizes for 42 species, 8 of which are priority species. The data yielded robust density estimates (CV < 50%) for 11 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in Oklahoma BCR 18 for 34 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 10 of these species.

**Rivers in Oklahoma BCR 19**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 49 point counts within the 8 surveyed grid cells between 26 April and 22 May. They detected 76 bird species, including 10 priority species.

Bird Conservancy estimated densities and population sizes for 50 species, 7 of which are priority species. The data yielded robust density estimates (CV < 50%) for 13 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in Oklahoma BCR 19 for 45 species, 4 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 17 of these species.

### Rita Blanca National Grassland in Oklahoma

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 16 point counts within the 2 surveyed grid cells between 19 May and 21 May. They detected 21 bird species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

## New Mexico

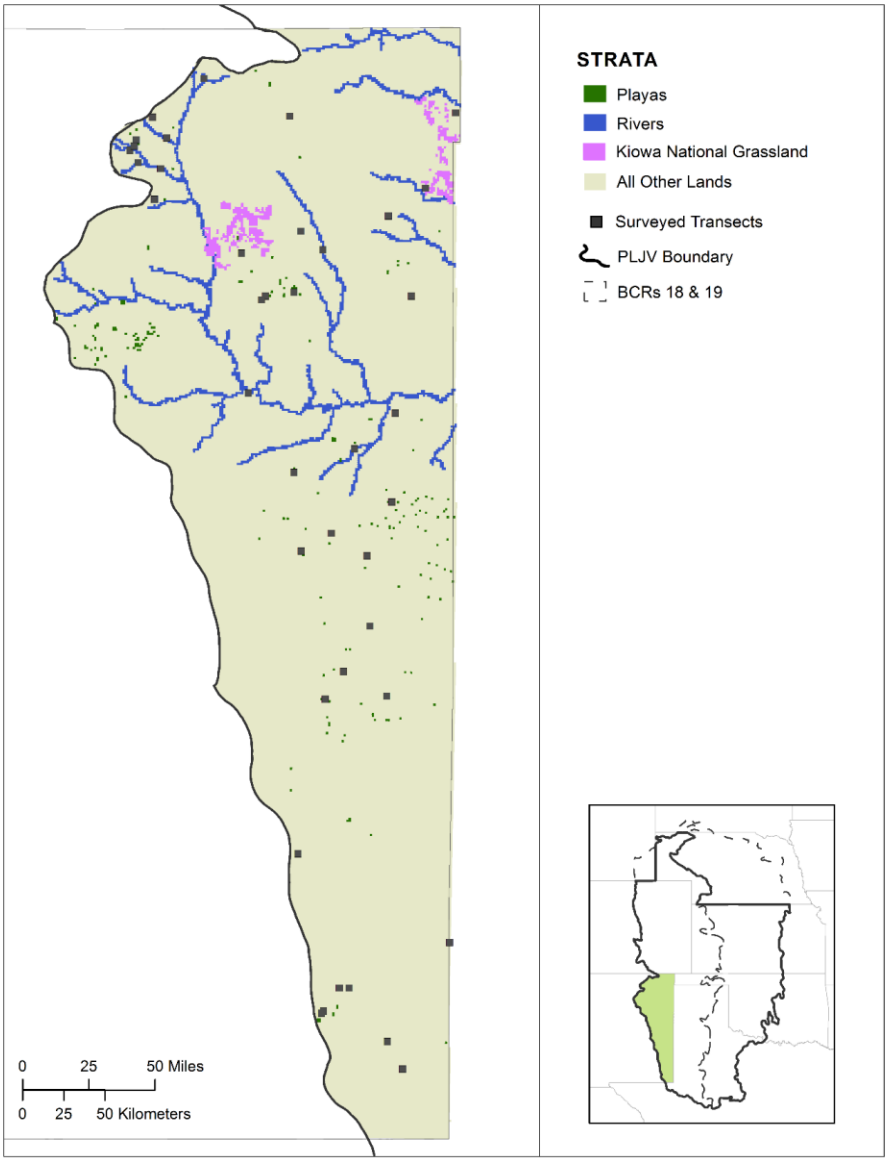



*Figure 9. Strata and 2016 survey locations in New Mexico BCR 18.*

**Shortgrass Prairie (BCR 18) in New Mexico**

We obtained results for Shortgrass Prairie (BCR 18) in New Mexico by compiling and jointly analyzing data from four strata.

Field technicians completed 40 of 52 planned surveys (77%) in 2016. Technicians conducted 376 point counts within the 40 surveyed grid cells between 27 April and 26 May. They detected 125 bird species, including 12 priority species.

Bird Conservancy estimated densities and population sizes for 81 species, 10 of which are priority species. The data yielded robust density estimates (CV < 50%) for 15 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in New Mexico for 80 species, 10 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 21 of these species.

**Playas in New Mexico BCR 18**

Field technicians completed 17 of 17 planned surveys (100%) in 2016. Technicians conducted 170 point counts within the 17 surveyed grid cells between 27 April and 25 May. They detected 77 bird species, including 7 priority species.

Bird Conservancy estimated densities and population sizes for 45 species, 6 of which are priority species. The data yielded robust density estimates (CV < 50%) for 10 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Playas in New Mexico BCR 18 for 40 species, 4 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 15 of these species.

**Rivers in New Mexico BCR 18**

Field technicians completed 8 of 15 planned surveys (53%) in 2016. Technicians conducted 65 point counts within the 8 surveyed grid cells between 4 May and 26 May. They detected 80 bird species, including 8 priority species.

Bird Conservancy estimated densities and population sizes for 62 species, 6 of which are priority species. The data yielded robust density estimates (CV < 50%) for 15 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in New Mexico BCR 18 for 55 species, 5 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 16 of these species.

**All Other Lands in New Mexico BCR 18**

Field technicians completed 13 of 18 planned surveys (72%) in 2016. Technicians conducted 113 point counts within the 13 surveyed grid cells between 2 May and 25 May. They detected 72 bird species, including 8 priority species.

Bird Conservancy estimated densities and population sizes for 56 species, 8 of which are priority species. The data yielded robust density estimates (CV < 50%) for 11 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in New Mexico BCR 18 for 45 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 12 of these species.

**Kiowa National Grassland**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 28 point counts within the 2 surveyed grid cells between 10 May and 21 May. They detected 25 bird species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

## Kansas

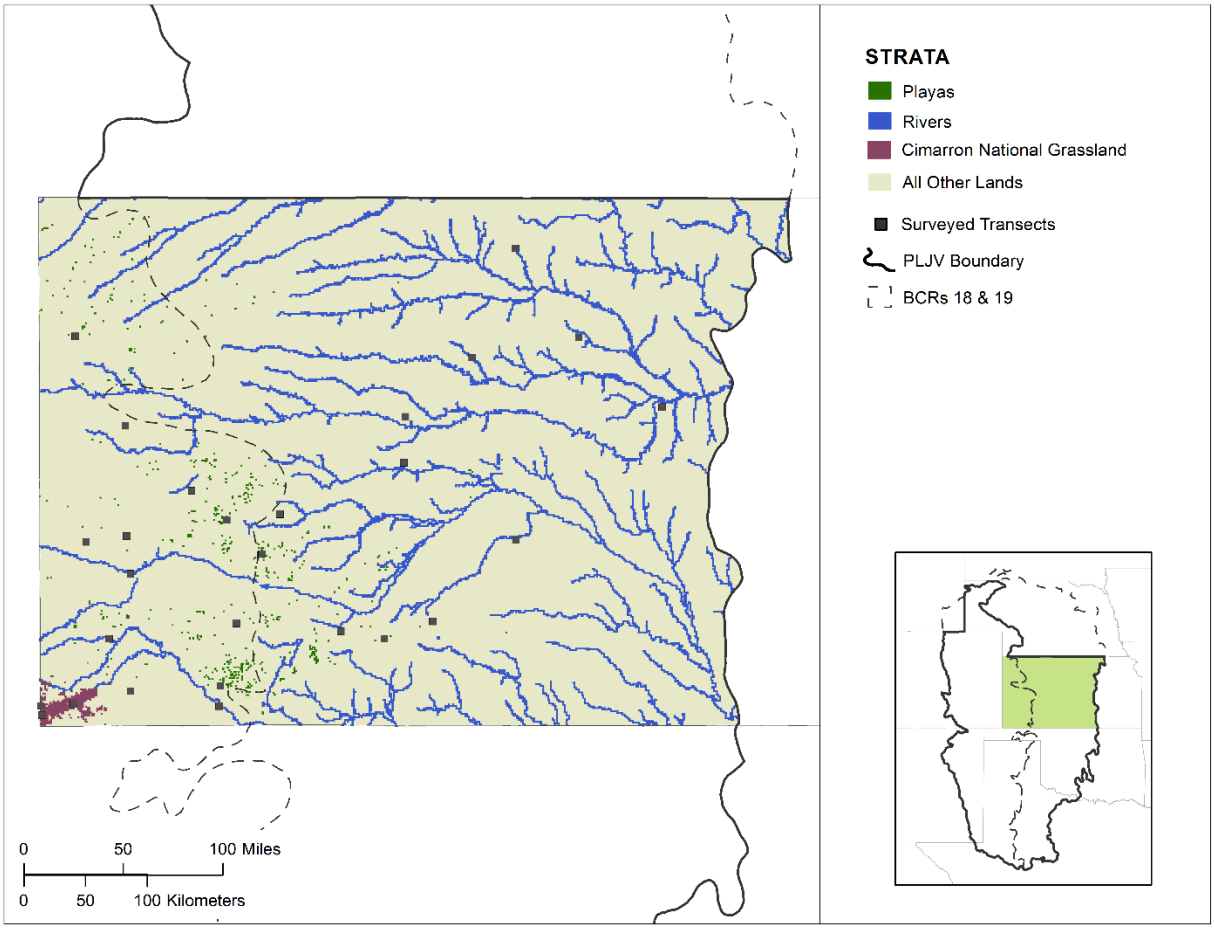



*Figure 10. Strata and 2016 survey locations in Kansas BCRs 18 and 19.*

### Shortgrass Prairie (BCR 18) in Kansas

We obtained results for Shortgrass Prairie (BCR 18) in Kansas by compiling and jointly analyzing data from four strata.

Field technicians completed all 15 planned surveys (100%) in 2016. Technicians conducted 131 point counts within the 15 surveyed grid cells between 8 May and 25 May. They detected 53 bird species, including 17 priority species.

Bird Conservancy estimated densities and population sizes for 41 species, 15 of which are priority species. The data yielded robust density estimates (CV < 50%) for 11 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in Kansas for 27 species, 10 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 15 of these species.

**Central Mixed Grass Prairie (BCR 19) in Kansas**

We obtained results for Central Mixed Grass Prairie (BCR 19) in Kansas by compiling and jointly analyzing data from three strata.

Field technicians completed all 12 planned surveys (100%) in 2016. Technicians conducted 102 point counts within the 12 surveyed grid cells between 18 May and 2 July. They detected 82 bird species, including 20 priority species.

Bird Conservancy estimated densities and population sizes for 65 species, 18 of which are priority species. The data yielded robust density estimates (CV < 50%) for 23 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Central Mixed Grass Prairie (BCR 19) in Kansas for 57 species, 16 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 23 of these species.

**Playas in Kansas BCRs 18 & 19**

We obtained results for Playas in Kansas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 4 planned surveys (100%) in 2016. Technicians conducted 22 point counts within the 4 surveyed grid cells between 8 May and 20 May. They detected 24 bird species, including 9 priority species.

Bird Conservancy estimated densities and population sizes for 19 species, 8 of which are priority species. The data yielded robust density estimates (CV < 50%) for 5 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Playas in Kansas BCRs 18 & 19 for 19 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 13 of these species.

**Rivers in Kansas BCRs 18 & 19**

We obtained results for Rivers in Kansas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 4 planned surveys (100%) in 2016. Technicians conducted 37 point counts within the 4 surveyed grid cells between 20 May and 27 May. They detected 71 bird species, including 19 priority species.

Bird Conservancy estimated densities and population sizes for 55 species, 17 of which are priority species. The data yielded robust density estimates (CV < 50%) for 21 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in Kansas BCRs 18 & 19 for 46 species, 13 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 21 of these species.

**All Other Lands in Kansas BCRs 18 & 19**

We obtained results for All Other Lands in Kansas BCRs 18 & 19 by compiling and jointly analyzing data from two strata.

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 133 point counts within the 16 surveyed grid cells between 18 May and 2 July. They detected 65 bird species, including 19 priority species.

Bird Conservancy estimated densities and population sizes for 54 species, 19 of which are priority species. The data yielded robust density estimates (CV < 50%) for 14 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Kansas BCRs 18 & 19 for 48 species, 17 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 18 of these species.

**All Other Lands in Kansas BCR 18**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 59 point counts within the 8 surveyed grid cells between 22 May and 25 May. They detected 35 bird species, including 12 priority species.

Bird Conservancy estimated densities and population sizes for 30 species, 12 of which are priority species. The data yielded robust density estimates (CV < 50%) for 9 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Kansas BCR 18 for 24 species, 9 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 13 of these species.

**Playas in Kansas BCR 18**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 14 point counts within the 2 surveyed grid cells between 8 May and 19 May. They detected 15 bird species, including 4 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Rivers in Kansas BCR 18**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 17 point counts within the 2 surveyed grid cells between 22 May and 24 May. They detected 29 bird species, including 11 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Cimarron National Grassland**

Field technicians completed all 3 planned surveys (100%) in 2016. Technicians conducted 41 point counts within the 3 surveyed grid cells between 8 May and 16 May. They detected 30 bird species, including 1 priority species.

Bird Conservancy estimated densities and population sizes for 19 species, 1 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Cimarron National Grassland for 14 species, 1 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 8 of these species.

**Playas in Kansas BCR 19**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 8 point counts within the 2 surveyed grid cells between 19 May and 20 May. They detected 21 bird species, including 8 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Rivers in Kansas BCR 19**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 20 point counts within the 2 surveyed grid cells between 20 May and 27 May. They detected 62 bird species, including 13 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**All Other Lands in Kansas BCR 19**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 74 point counts within the 8 surveyed grid cells between 18 May and 2 July. They detected 59 bird species, including 16 priority species.

Bird Conservancy estimated densities and population sizes for 47 species, 16 of which are priority species. The data yielded robust density estimates (CV < 50%) for 15 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Kansas BCR 19 for 42 species, 15 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 16 of these species.

## Nebraska

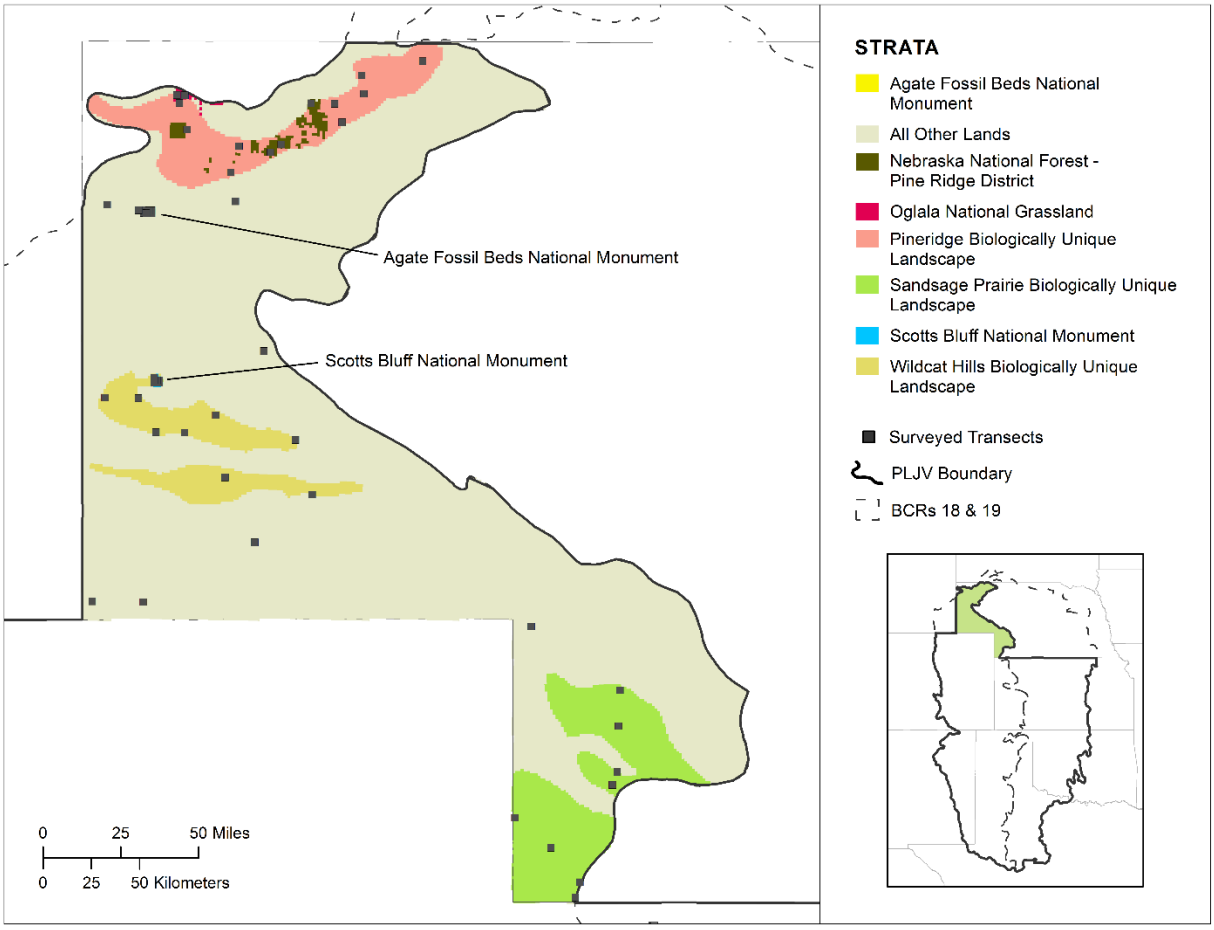



*Figure 11. Strata and 2016 survey locations in Nebraska BCR 18.*

### Shortgrass Prairie (BCR 18) in Nebraska

We obtained results for Shortgrass Prairie (BCR 18) in Nebraska by compiling and jointly analyzing data from eight strata.

Field technicians completed 53 of 54 planned surveys (98%) in 2016. Technicians conducted 505 point counts within the 53 surveyed grid cells between 25 May and 9 July. They detected 128 bird species, including 20 priority species.

Bird Conservancy estimated densities and population sizes for 109 species, 16 of which are priority species. The data yielded robust density estimates (CV < 50%) for 26 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in Nebraska for 105 species, 15 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 39 of these species.

**Pineridge Biologically Unique Landscape**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 86 point counts within the 8 surveyed grid cells between 30 May and 4 June. They detected 75 bird species, including 3 priority species.

Bird Conservancy estimated densities and population sizes for 62 species, 3 of which are priority species. The data yielded robust density estimates (CV < 50%) for 16 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Pineridge Biologically Unique Landscape for 63 species, 4 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 20 of these species.

**Sandsage Prairie Biologically Unique Landscape**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 74 point counts within the 8 surveyed grid cells between 25 May and 9 July. They detected 65 bird species, including 5 priority species.

Bird Conservancy estimated densities and population sizes for 48 species, 4 of which are priority species. The data yielded robust density estimates (CV < 50%) for 10 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Sandsage Prairie Biologically Unique Landscape for 43 species, 3 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 12 of these species.

**Wildcat Hills Biologically Unique Landscape**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 54 point counts within the 8 surveyed grid cells between 30 May and 7 July. They detected 53 bird species, including 6 priority species.

Bird Conservancy estimated densities and population sizes for 47 species, 4 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Wildcat Hills Biologically Unique Landscape for 42 species, 3 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 14 of these species.

**Oglala National Grassland**

Field technicians completed all 3 planned surveys (100%) in 2016. Technicians conducted 36 point counts within the 3 surveyed grid cells between 4 June and 23 June. They detected 55 bird species, including 1 priority species.

Bird Conservancy estimated densities and population sizes for 47 species, 1 of which are priority species. The data yielded robust density estimates (CV < 50%) for 2 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Oglala National Grassland for 42 species, 1 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 22 of these species.

**Nebraska National Forest - Pine Ridge**

Field technicians completed all 3 planned surveys (100%) in 2016. Technicians conducted 35 point counts within the 3 surveyed grid cells between 30 May and 5 June. They detected 53 bird species, including 1 priority species.

Bird Conservancy estimated densities and population sizes for 42 species, 1 of which are priority species. The data yielded robust density estimates (CV < 50%) for 9 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Nebraska National Forest - Pine Ridge for 39 species, 1 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 23 of these species.

**Agate Fossil Beds National Monument**

Field technicians completed all 9 planned surveys (100%) in 2016. Technicians conducted 96 point counts within the 9 surveyed grid cells between 1 June and 14 June. They detected 64 bird species.

Bird Conservancy estimated densities and population sizes for 52 species. The data yielded robust density estimates (CV < 50%) for 19 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Agate Fossil Beds National Monument for 50 species. The data yielded robust occupancy estimates (CV < 50%) for 22 of these species.

**All Other Lands in Nebraska**

Field technicians completed 7 of 8 planned surveys (88%) in 2016. Technicians conducted 59 point counts within the 7 surveyed grid cells between 29 May and 24 June. They detected 39 bird species, including 5 priority species.

Bird Conservancy estimated densities and population sizes for 31 species, 4 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands for 22 species, 3 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 9 of these species.

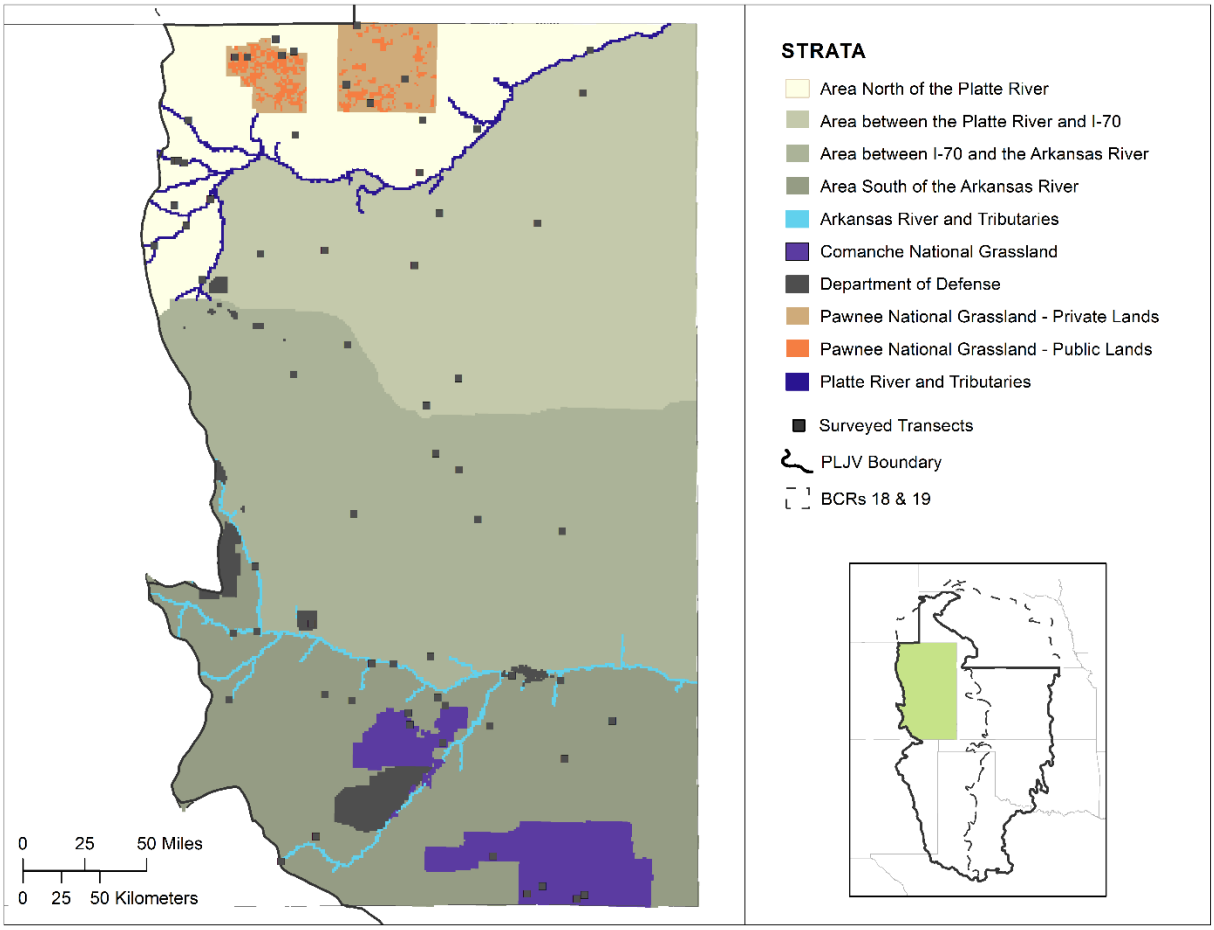
**Scotts Bluff National Monument**

Field technicians completed all 7 planned surveys (100%) in 2016. Technicians conducted 65 point counts within the 7 surveyed grid cells between 2 June and 2 July. They detected 57 bird species.

Bird Conservancy estimated densities and population sizes for 47 species. The data yielded robust density estimates (CV < 50%) for 16 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Scotts Bluff National Monument for 38 species. The data yielded robust occupancy estimates (CV < 50%) for 16 of these species.

## Colorado




### Shortgrass Prairie (BCR 18) in Colorado

We obtained results for Shortgrass Prairie (BCR 18) in Colorado by compiling and jointly analyzing data from 10 strata.

Field technicians completed all 65 planned surveys (100%) in 2016. Technicians conducted 777 point counts within the 65 surveyed grid cells between 9 May and 30 May. They detected 141 bird species, including 19 priority species.

Bird Conservancy estimated densities and population sizes for 110 species, 14 of which are priority species. The data yielded robust density estimates (CV < 50%) for 30 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Shortgrass Prairie (BCR 18) in Colorado for 104 species, 12 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 42 of these species.

**Rivers in Colorado BCR 18**

We obtained results for Rivers in Colorado BCR 18 by compiling and jointly analyzing data from two strata.

Field technicians completed all 16 planned surveys (100%) in 2016. Technicians conducted 167 point counts within the 16 surveyed grid cells between 16 May and 28 May. They detected 116 bird species, including 11 priority species.

Bird Conservancy estimated densities and population sizes for 91 species, 7 of which are priority species. The data yielded robust density estimates (CV < 50%) for 32 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Rivers in Colorado BCR 18 for 85 species, 6 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 40 of these species.

**All Other Lands in Colorado BCR 18**

We obtained results for All Other Lands in Colorado BCR 18 by compiling and jointly analyzing data from five strata.

Field technicians completed all 34 planned surveys (100%) in 2016. Technicians conducted 427 point counts within the 34 surveyed grid cells between 9 May and 30 May. They detected 73 bird species, including 14 priority species.

Bird Conservancy estimated densities and population sizes for 53 species, 9 of which are priority species. The data yielded robust density estimates (CV < 50%) for 17 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout All Other Lands in Colorado BCR 18 for 48 species, 9 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 23 of these species.

**Arkansas River and Tributaries**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 82 point counts within the 8 surveyed grid cells between 17 May and 28 May. They detected 97 bird species, including 6 priority species.

Bird Conservancy estimated densities and population sizes for 79 species, 5 of which are priority species. The data yielded robust density estimates (CV < 50%) for 17 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Arkansas River and Tributaries for 75 species, 5 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 26 of these species.

**Platte River and Tributaries**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 85 point counts within the 8 surveyed grid cells between 16 May and 23 May. They detected 78 bird species, including 7 priority species.

Bird Conservancy estimated densities and population sizes for 57 species, 3 of which are priority species. The data yielded robust density estimates (CV < 50%) for 23 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Platte River and Tributaries for 50 species, 2 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 31 of these species.

**Comanche National Grassland**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 92 point counts within the 8 surveyed grid cells between 9 May and 22 May. They detected 45 bird species, including 1 priority species.

Bird Conservancy estimated densities and population sizes for 37 species, 1 of which are priority species. The data yielded robust density estimates (CV < 50%) for 9 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Comanche National Grassland for 36 species, 1 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 10 of these species.

**Department of Defense**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 25 point counts within the 2 surveyed grid cells between 10 May and 19 May. They detected 55 bird species, including 5 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Area between I-70 and the Arkansas River**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 108 point counts within the 8 surveyed grid cells between 11 May and 25 May. They detected 37 bird species, including 6 priority species.

Bird Conservancy estimated densities and population sizes for 27 species, 4 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Area between I-70 and the Arkansas River for 26 species, 4 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 9 of these species.

**Area North of the Platte River**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 76 point counts within the 8 surveyed grid cells between 9 May and 25 May. They detected 48 bird species, including 9 priority species.

Bird Conservancy estimated densities and population sizes for 37 species, 7 of which are priority species. The data yielded robust density estimates (CV < 50%) for 6 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Area North of the Platte River for 31 species, 7 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 7 of these species.

**Pawnee National Grassland - Private Lands**

Field technicians completed all 2 planned surveys (100%) in 2016. Technicians conducted 24 point counts within the 2 surveyed grid cells between 11 May and 19 May. They detected 11 bird species, including 1 priority species.

Bird Conservancy did not generate density or occupancy results for this stratum, because results from strata with only two samples are not informative. However, these data were incorporated into larger scale estimates.

**Pawnee National Grassland - Public Lands**

Field technicians completed all 5 planned surveys (100%) in 2016. Technicians conducted 66 point counts within the 5 surveyed grid cells between 9 May and 23 May. They detected 28 bird species, including 2 priority species.

Bird Conservancy estimated densities and population sizes for 19 species, 1 of which are priority species. The data yielded robust density estimates (CV < 50%) for 5 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Pawnee National Grassland - Public Lands for 18 species, 1 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 5 of these species.

**Area between the Platte River and I-70**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 110 point counts within the 8 surveyed grid cells between 16 May and 30 May. They detected 33 bird species, including 7 priority species.

Bird Conservancy estimated densities and population sizes for 28 species, 5 of which are priority species. The data yielded robust density estimates (CV < 50%) for 7 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Area between the Platte River and I-70 for 24 species, 5 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 9 of these species.

**Area South of the Arkansas River**

Field technicians completed all 8 planned surveys (100%) in 2016. Technicians conducted 109 point counts within the 8 surveyed grid cells between 10 May and 25 May. They detected 46 bird species, including 9 priority species.

Bird Conservancy estimated densities and population sizes for 34 species, 7 of which are priority species. The data yielded robust density estimates (CV < 50%) for 9 of these species.

Bird Conservancy estimated the proportion of 1 $km^2$ grid cells occupied (Psi) throughout Area South of the Arkansas River for 34 species, 7 of which are priority species. The data yielded robust occupancy estimates (CV < 50%) for 13 of these species.

## Works Cited

American Ornithologists' Union. 2007. Checklist of North American Birds, 7th Edition. . Accessed 3/12/2013.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, UK.

Buckland, S., S. Marsden, and R. Green. 2008. Estimating bird abundance: making methods work. Bird Conservation International 18:S91-S108.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Springer-Verlag, New York, New York, USA.

Environmental Systems Research Institute. 2006. ArcGIS, version 9.2. Environmental Systems Research Institute, Incorporated, Redlands, California, USA.

Fewster, R. M., S. T. Buckland, K. P. Burnham, D. L. Borchers, P. E. Jupp, J. L. Laake, and L. Thomas. 2009. Estimating the encounter rate variance in distance sampling. Biometrics 65:225-236.

Hanni, D. J., C. M. White, J. J. Birek, N. J. Van Lanen, and M. F. McLaren. 2014. Field protocol for spatially-balanced sampling of landbird populations. Unpublished report. Bird Conservancy of the Rockies, Brighton, Colorado, USA.

Laake, J. L. 2013. RMark: an R Interface for analysis of capture-recapture data with MARK. Alaska Fisheries Science Center Processed Report 2013-01. Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington, USA.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248-2255.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier, Burlington, Massachusetts, USA.

Nichols, J. D., L. L. Bailey, A. F. O'Connell, N. W. Talancy, E. H. C. Grant, A. T. Gilbert, E. M. Annand, T. P. Husband, and J. E. Hines. 2008. Multi-scale occupancy estimation and modelling using multiple detection methods. Journal of Applied Ecology 45:1321-1329.

North American Bird Conservation Initiative. 2000. Bird Conservation Regions descriptions: a supplement to the North American Bird Conservation Initiative: Bird Conservation Regions map. US Fish and Wildlife Service, Arlington, Virginia, USA.

North American Bird Conservation Initiative. 2007. Opportunities for improving avian monitoring. Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Arlington, Virginia, USA.

North American Bird Conservation Initiative. 2016. The State of North America's Birds 2016. Environment and Climate Change Canada: Ottawa, Ontario. 8 pages. www.stateofthebirds.org

Pavlacky, D. C., Jr., J. A. Blakesley, G. C. White, D. J. Hanni, and P. M. Lukacs. 2012. Hierarchical multi-scale occupancy estimation for monitoring wildlife populations. Journal of Wildlife Management 76:154-162.

Powell, L. A. 2007. Approximating variance of demographic parameters using the delta method: a reference for avian biologists. Condor 109:949-954.

R Core Team. 2014. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <www.R-project.org/>. Accessed 10/31/2014.

Stevens, D. L., Jr., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262-278.

Thomas, L., S. T. Buckland, E. A. Rexstad, J. L. Laake, S. Strindberg, S. L. Hedley, J. R. B. Bishop, T. A. Marques, and K. P. Burnham. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5-14.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46:120-139.

# Appendix A: Priority Species by State

Priority species detected in 2016, by state, with management designations by state agencies. Agencies include Colorado Parks and Wildlife (CPW), Kansas Department of Wildlife, Parks and Tourism (KDWPT), Nebraska Game and Parks Commission (NGPC), New Mexico Department of Game and Fish (NMDGF), Oklahoma Department of Wildlife Conservation (ODWC), and Texas Parks & Wildlife Department (TPWD). An "X" in the Occupancy or Density Estimated columns indicates that estimates were generated for that species at some level in one or more of the states where it holds a priority designation.

| Species | State Agencies | | | | | | Density Estimated | Occupancy Estimated |
|---|---|---|---|---|---|---|---|---|
| | CPW | KDWPT | NGPC | NMDGF | ODWC | TPWD | | |
| American Avocet | | Tier II | | | | | X | X |
| American Kestrel | | | | | | S4B | X | X |
| American White Pelican | T2 | Tier II | | | | S2B,S3N | X | |
| American Wigeon | | | Tier II | | | | X | X |
| Baird's Sandpiper | | Tier II | | | | | | |
| Baird's Sparrow | | Tier II | Tier I | ST,SGCN | Tier III | S2 | X | X |
| Baltimore Oriole | | Tier II | | | | | X | X |
| Bank Swallow | | | | SGCN | | | X | X |
| Barn Owl | | Tier II | Tier II | | Tier III | | | |
| Bell's Vireo | | Tier II | Tier I | ST,SGCN | Tier II | S3B | X | X |
| Bewick's Wren | | | | | | S5B | X | X |
| Black-and-white Warbler | | | Tier II | | | | X | X |
| Black-billed Cuckoo | | Tier II | | | | | | |
| Black-billed Magpie | | | Tier II | | | | X | X |
| Black-crowned Night-Heron | | | Tier II | | | | | |
| Black-necked Stilt | | Tier II | Tier II | | | | | |
| Bobolink | T2 | Tier II | | | | | X | X |
| Brewer's Blackbird | | | Tier II | | | | X | X |
| Brewer's Sparrow | T2 | | Tier I | | | | X | X |
| Bullock's Oriole | | Tier II | | | Tier III | | X | X |
| Burrowing Owl | ST, T1 | Tier II | Tier I | SGCN | Tier II | S3B | X | X |
| Carolina Chickadee | | | | | | S5B | | |
| Carolina Wren | | | Tier II | | | | | X |
| Cassin's Kingbird | | | Tier II | | | | X | X |
| Cassin's Sparrow | T2 | Tier II | Tier II | SGCN | Tier II | S4B | X | X |
| Chestnut-collared Longspur | T2 | Tier II | Tier I | SGCN | Tier II | | X | X |
| Chihuahuan Raven | | Tier II | | | | | X | X |
| Chuck-will's-widow | | Tier II | Tier II | | | S3S4B | | |
| Cinnamon Teal | | | Tier II | | | | | |

| Species | CPW | KDWPT | NGPC | NMDGF | ODWC | TPWD | Density Estimated | Occupancy Estimated |
|---|---|---|---|---|---|---|---|---|
| Common Nighthawk | | Tier II | | SGCN | | | | |
| Common Yellowthroat | | | | | | S5B | X | X |
| Cordilleran Flycatcher | | | Tier II | | | | X | X |
| Curve-billed Thrasher | | Tier II | | | | | X | X |
| Dickcissel | | Tier II | | | | S4B | X | X |
| Eastern Kingbird | | Tier II | | | | | X | X |
| Eastern Meadowlark | | Tier II | | | | S5B | X | X |
| Eastern Wood-Pewee | | Tier II | | | | | X | X |
| Ferruginous Hawk | SSC, T2 | Tier II | Tier I | | Tier III | S2B,S4N | | X |
| Field Sparrow | | | | | | S5B | X | X |
| Franklin's Gull | | | | | | S2 | | |
| Golden Eagle | T1 | Tier II | Tier II | | Tier III | S3B | X | |
| Golden-fronted Woodpecker | | | | | Tier III | | X | X |
| Grasshopper Sparrow | T2 | Tier II | | ST,SGCN | | S3B | X | X |
| Greater Prairie-Chicken | T2 | Tier II | Tier I | | Tier III | S1B | X | |
| Greater Yellowlegs | | Tier II | | | | | | |
| Green Heron | | | | | | S5B | | |
| Ladder-backed Woodpecker | | Tier II | | | | | X | X |
| Lark Bunting | T2 | Tier II | | | | | X | X |
| Lark Sparrow | | Tier II | | | | S4B | X | X |
| Lazuli Bunting | T2 | | | | | | X | X |
| Lesser Prairie-Chicken | ST, T1 | Tier I | | SGCN | Tier II | S2B | X | X |
| Lesser Scaup | | | Tier II | | Tier III | | | |
| Loggerhead Shrike | T2 | Tier II | Tier I | SGCN | Tier I | S4B | X | X |
| Long-billed Curlew | SSC, T2 | Tier II | Tier I | SGCN | Tier I | S3B,S5N | X | X |
| Marbled Godwit | | Tier II | | | | | X | X |
| McCown's Longspur | T2 | Tier II | Tier I | SGCN | Tier II | S4 | X | X |
| Merlin | | | Tier II | | | | | |
| Mississippi Kite | | Tier II | Tier II | | | S4B | | X |
| Mountain Bluebird | | | | SGCN | | | X | X |
| Northern Bobwhite | T2 | Tier II | | | Tier III | S4B | X | X |
| Northern Harrier | T2 | | | | | S2B,S3N | X | X |
| Northern Pintail | | Tier II | | | Tier III | S3B,S5N | X | X |
| Orchard Oriole | | | | | | S4B | X | X |
| Painted Bunting | | Tier II | | | Tier II | S4B | X | X |
| Peregrine Falcon | SSC, T2 | Tier II | Tier II | ST,SGCN | Tier III | S3 | | |
| Pine Siskin | | | Tier II | | | | X | X |
| Plumbeous Vireo | | | Tier II | | | | X | X |
| Prairie Falcon | T2 | | Tier II | | Tier III | | X | |

| Species | CPW | KDWPT | NGPC | NMDGF | ODWC | TPWD | Density Estimated | Occupancy Estimated |
|---|---|---|---|---|---|---|---|---|
| Purple Martin | T2 | | | | | | X | X |
| Pygmy Nuthatch | | | Tier II | SGCN | | | X | X |
| Red-headed Woodpecker | | Tier II | | SGCN | Tier II | S3B | X | X |
| Rufous-crowned Sparrow | | | | | | S4B | X | X |
| Sandhill Crane | SSC, T1 | | Tier II | | | | X | |
| Savannah Sparrow | | | Tier II | | | | X | X |
| Scaled Quail | | Tier II | | | Tier III | S4B | X | X |
| Scissor-tailed Flycatcher | | Tier II | Tier II | | | S3B | X | X |
| Sharp-shinned Hawk | | | Tier II | | | | | X |
| Sharp-tailed Grouse | SSC, T1 | | | | | | X | X |
| Short-eared Owl | T2 | Tier II | Tier I | | Tier III | S4N | | X |
| Snowy Egret | | | | | Tier III | S5B | | |
| Snowy Plover | SSC, T2 | Tier I | Tier II | SGCN | Tier I | S3B | | |
| Solitary Sandpiper | | | | | Tier III | | | |
| Spotted Towhee | | Tier II | | | | | X | X |
| Summer Tanager | | | Tier II | | | S5B | X | X |
| Swainson's Hawk | T2 | Tier II | Tier II | | Tier II | S4B | X | X |
| Tufted Titmouse | | | Tier II | | | | | |
| Upland Sandpiper | T2 | Tier II | | | Tier III | | X | X |
| Vesper Sparrow | | | | SGCN | | | X | X |
| Violet-green Swallow | | | Tier II | | | | X | X |
| Western Grebe | | Tier II | Tier II | | | | | |
| Western Kingbird | | Tier II | | | | | X | X |
| White-faced Ibis | T2 | | Tier II | | | S4B | | |
| White-throated Swift | | | Tier II | | | | X | X |
| Wild Turkey | | | | ST,SGCN | | S5B | X | X |
| Willow Flycatcher | SE, T1 | | | SE,SGCN | Tier III | | X | X |
| Wilson's Phalarope | | Tier II | | | Tier III | | X | X |
| Wilson's Snipe | | | Tier II | | | | X | X |
| Yellow-billed Cuckoo | SSC, T1 | | | SGCN | | S4,S5B | X | X |

# Appendix B: All Species Detected

The number of individuals detected by species throughout the PLJV region in 2016.

| Common Name | Number Detected |
|---|---|
| Alder Flycatcher | 6 |
| American Avocet | 19 |
| American Coot | 1817 |
| American Crow | 222 |
| American Goldfinch | 226 |
| American Kestrel | 99 |
| American Pipit | 4 |
| American Redstart | 6 |
| American Robin | 480 |
| American Three-toed Woodpecker | 2 |
| American White Pelican | 23 |
| American Wigeon | 1 |
| Ash-throated Flycatcher | 110 |
| Baird's Sandpiper | 1 |
| Baird's Sparrow | 9 |
| Baltimore Oriole | 24 |
| Baltimore X Bullock's Oriole Hybrid | 1 |
| Bank Swallow | 30 |
| Barn Owl | 1 |
| Barn Swallow | 455 |
| Bell's Vireo | 27 |
| Belted Kingfisher | 10 |
| Bewick's Wren | 135 |
| Black Vulture | 1 |
| Black-and-white Warbler | 2 |
| Black-billed Cuckoo | 4 |
| Black-billed Magpie | 65 |
| Black-capped Chickadee | 90 |
| Black-chinned Hummingbird | 5 |
| Black-crested Titmouse | 39 |
| Black-crowned Night-Heron | 1 |
| Black-headed Grosbeak | 55 |
| Black-necked Stilt | 7 |
| Black-throated Sparrow | 38 |
| Blue Grosbeak | 186 |
| Blue Jay | 206 |
| Blue-gray Gnatcatcher | 70 |
| Blue-winged Teal | 59 |
| Bobolink | 6 |
| Brewer's Blackbird | 102 |
| Brewer's Sparrow | 108 |
| Broad-tailed Hummingbird | 5 |

| Common Name | Number Detected |
|---|---|
| Broad-winged Hawk | 1 |
| Brown Thrasher | 50 |
| Brown-headed Cowbird | 1236 |
| Bullock's Oriole | 174 |
| Burrowing Owl | 51 |
| Bushtit | 8 |
| Cactus Wren | 50 |
| Canada Goose | 433 |
| Canyon Towhee | 27 |
| Canyon Wren | 6 |
| Carolina Chickadee | 4 |
| Carolina Wren | 19 |
| Cassin's Kingbird | 48 |
| Cassin's Sparrow | 2634 |
| Cattle Egret | 46 |
| Cedar Waxwing | 720 |
| Chestnut-collared Longspur | 24 |
| Chihuahuan Raven | 85 |
| Chimney Swift | 44 |
| Chipping Sparrow | 178 |
| Chuck-will's-widow | 1 |
| Cinnamon Teal | 4 |
| Clay-colored Sparrow | 179 |
| Cliff Swallow | 1273 |
| Common Grackle | 673 |
| Common Nighthawk | 179 |
| Common Raven | 134 |
| Common Yellowthroat | 208 |
| Cooper's Hawk | 5 |
| Cordilleran Flycatcher | 1 |
| Curve-billed Thrasher | 28 |
| Dickcissel | 631 |
| Double-crested Cormorant | 17 |
| Downy Woodpecker | 37 |
| Dusky Flycatcher | 2 |
| Eastern Bluebird | 72 |
| Eastern Kingbird | 221 |
| Eastern Meadowlark | 510 |
| Eastern Phoebe | 29 |
| Eastern Screech-Owl | 8 |
| Eastern Wood-Pewee | 2 |
| Eurasian Collared-Dove | 411 |

| Common Name | Number Detected |
|---|---|
| European Starling | 444 |
| Ferruginous Hawk | 8 |
| Field Sparrow | 60 |
| Fish Crow | 2 |
| Franklin's Gull | 1 |
| Gadwall | 21 |
| Golden Eagle | 2 |
| Golden-fronted Woodpecker | 99 |
| Grasshopper Sparrow | 1899 |
| Gray Catbird | 8 |
| Great Blue Heron | 110 |
| Great Crested Flycatcher | 75 |
| Great Egret | 2 |
| Great Horned Owl | 33 |
| Great-tailed Grackle | 358 |
| Greater Prairie-Chicken | 86 |
| Greater Roadrunner | 108 |
| Greater Yellowlegs | 2 |
| Green Heron | 5 |
| Green-tailed Towhee | 5 |
| Green-winged Teal | 11 |
| Hairy Woodpecker | 20 |
| Hermit Thrush | 1 |
| Herring Gull | 10 |
| Horned Lark | 4401 |
| House Finch | 171 |
| House Sparrow | 351 |
| House Wren | 290 |
| Indigo Bunting | 24 |
| Killdeer | 562 |
| Ladder-backed Woodpecker | 33 |
| Lark Bunting | 4090 |
| Lark Sparrow | 946 |
| Lazuli Bunting | 50 |
| Least Flycatcher | 3 |
| Lesser Goldfinch | 3 |
| Lesser Nighthawk | 1 |
| Lesser Prairie-Chicken | 72 |
| Lesser Scaup | 3 |
| Lincoln's Sparrow | 10 |
| Loggerhead Shrike | 36 |
| Long-billed Curlew | 60 |
| MacGillivray's Warbler | 3 |
| Mallard | 184 |
| Marbled Godwit | 2 |
| Marsh Wren | 5 |

| Common Name | Number Detected |
|---|---|
| McCown's Longspur | 75 |
| Merlin | 1 |
| Mississippi Kite | 38 |
| Mountain Bluebird | 17 |
| Mourning Dove | 2947 |
| Northern Bobwhite | 874 |
| Northern Cardinal | 345 |
| Northern Flicker | 170 |
| Northern Harrier | 10 |
| Northern Mockingbird | 759 |
| Northern Pintail | 8 |
| Northern Rough-winged Swallow | 41 |
| Northern Shoveler | 45 |
| Northern Waterthrush | 1 |
| Orange-crowned Warbler | 18 |
| Orchard Oriole | 26 |
| Osprey | 3 |
| Ovenbird | 4 |
| Painted Bunting | 292 |
| Peregrine Falcon | 2 |
| Pied-billed Grebe | 4 |
| Pine Siskin | 10 |
| Plumbeous Vireo | 1 |
| Prairie Falcon | 3 |
| Purple Martin | 3 |
| Pygmy Nuthatch | 18 |
| Pyrrhuloxia | 51 |
| Red Crossbill | 11 |
| Red-bellied Woodpecker | 62 |
| Red-breasted Nuthatch | 8 |
| Red-eyed Vireo | 10 |
| Red-headed Woodpecker | 235 |
| Red-necked Phalarope | 1 |
| Red-tailed Hawk | 110 |
| Red-winged Blackbird | 2996 |
| Redhead | 2 |
| Ring-billed Gull | 11 |
| Ring-necked Pheasant | 1139 |
| Rock Pigeon | 129 |
| Rock Wren | 192 |
| Rose-breasted Grosbeak | 6 |
| Ruby-crowned Kinglet | 3 |
| Ruddy Duck | 100 |
| Rufous-crowned Sparrow | 45 |
| Sage Thrasher | 1 |
| Sandhill Crane | 3 |

| Common Name | Number Detected |
|---|---|
| Savannah Sparrow | 32 |
| Say's Phoebe | 92 |
| Scaled Quail | 394 |
| Scarlet Tanager | 1 |
| Scissor-tailed Flycatcher | 127 |
| Sharp-shinned Hawk | 2 |
| Sharp-tailed Grouse | 15 |
| Short-eared Owl | 3 |
| Snowy Egret | 5 |
| Snowy Plover | 5 |
| Solitary Sandpiper | 1 |
| Song Sparrow | 28 |
| Sora | 5 |
| Spotted Sandpiper | 12 |
| Spotted Towhee | 259 |
| Summer Tanager | 11 |
| Swainson's Hawk | 114 |
| Swainson's Thrush | 4 |
| Tree Swallow | 59 |
| Tufted Titmouse | 8 |
| Turkey Vulture | 147 |
| Upland Sandpiper | 83 |
| Verdin | 8 |
| Vermilion Flycatcher | 2 |
| Vesper Sparrow | 81 |

| Common Name | Number Detected |
|---|---|
| Violet-green Swallow | 46 |
| Virginia Rail | 4 |
| Warbling Vireo | 17 |
| Western Grebe | 74 |
| Western Kingbird | 807 |
| Western Meadowlark | 7643 |
| Western Scrub-Jay | 11 |
| Western Tanager | 33 |
| Western Wood-Pewee | 173 |
| White-breasted Nuthatch | 20 |
| White-crowned Sparrow | 86 |
| White-faced Ibis | 69 |
| White-throated Swift | 29 |
| White-winged Dove | 148 |
| Wild Turkey | 121 |
| Willow Flycatcher | 6 |
| Wilson's Phalarope | 10 |
| Wilson's Snipe | 40 |
| Wilson's Warbler | 4 |
| Wood Duck | 19 |
| Yellow Warbler | 230 |
| Yellow-billed Cuckoo | 41 |
| Yellow-breasted Chat | 141 |
| Yellow-headed Blackbird | 568 |
| Yellow-rumped Warbler | 27 |

# Appendix C: Avian Data Center Usage Tips

**Overview**

All results, including parameter estimates, distribution maps, raw count data, and effort are available online. 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/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, Superstratum, 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 statewide 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 Bird Conservancy 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 data and results for a particular Bird Conservation Region. Selecting this filter will provide you with results for all strata and superstrata 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 data and results for all strata and superstrata 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.

Superstratum: 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 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 Bird Conservancy 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 Bird Conservancy 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 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.

***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/superstrata 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.

**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 "Superstrata", viewing counts by Stratum is an excellent way of getting a list of all the strata that comprise a Superstratum. 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".