

Monitoring the Birds of the Shortgrass Prairie Bird Conservation Region (BCR 18) 2009 Annual Report



May 2010



ROCKY MOUNTAIN BIRD OBSERVATORY

Mission: *To conserve birds and their habitats*

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

Core Values:

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

RMBO accomplishes its mission by:

- **Monitoring** long-term bird population trends to provide a scientific foundation for conservation action.
- **Researching** bird ecology and population response to anthropogenic and natural processes to evaluate and adjust management and conservation strategies using the best available science.
- **Educating** people of all ages through active, experiential programs that create an awareness and appreciation for birds.
- **Fostering** good stewardship on private and public lands through voluntary, cooperative partnerships that create win-win situations for wildlife and people.
- **Partnering** with state and federal natural resource agencies, private citizens, schools, universities, and other non-governmental organizations to build synergy and consensus for bird conservation.
- **Sharing** the latest information on bird populations, land management and conservation practices to create informed publics.
- **Delivering** bird conservation at biologically relevant scales by working across political and jurisdictional boundaries in western North America.

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EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory, in conjunction with federal and state partners, conducted landbird monitoring in the Shortgrass Prairie Bird Conservation Region (BCR 18) in 2009. In 2008, RMBO implemented a new spatially-balanced sampling design in BCRs 16 and 18 in Colorado; this design is titled "Integrated Monitoring in Bird Conservation Regions (IMBCR)". The success of the IMBCR design led to its expansion into all National Grasslands and National Forests in BCR 18 in 2009. The IMBCR design allows estimation of density and occupancy rates of many landbird species across a variety of spatial scales.

We observed 7,483 birds of 119 species across all strata in Bird Conservation Region 18 in 2009. We obtained sufficient numbers of observations to estimate density for 25 species, with precise density estimates ($CV < 50\%$) for 24 species in at least one stratum, including 8 species of conservation concern.

ACKNOWLEDGEMENTS

Stratification and allocation of survey effort in Bird Conservation Region 18 were determined in collaboration with partner agencies and organizations, each of which provided funding in 2008 and/or 2009: Colorado Division of Wildlife, USDA Forest Service, USDI Bureau of Land Management and Wyoming Game and Fish Department. Many individuals helped make the 2009 field season a success. We thank Andrea Orabona of Wyoming Game and Fish Department and Robert Skorkowsky of the USDA Forest Service. We thank crew leaders Ross Lock, and Matt Gracey and the 2009 RMBO field crew. Chandman Sambuu managed and updated the RMBO database and produced a new online mapping tool allowing for easier planning of field crew schedules and navigation to survey sites. Rob Sparks of RMBO produced a sample allocation map for this report. RMBO office staff Paul Franco and Sarah Kormos contacted county assessors and private landowners, obtaining access and establishing the relationships that enabled monitoring on private lands. This report benefited greatly from review by RMBO staff.

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INTRODUCTION

The native grass prairies of the intermountain west are one of the most endangered ecosystems in North America (Samson et al. 1998), and prairie birds which rely on the grassland for successful breeding are experiencing dramatic declines (Samson and Knopf 1994, Peterjohn and Sauer 1999, Ribic et al. 2009). To track populations of grassland birds and identify specific causes of declines, long-term and large-scale monitoring is required. Despite the widespread use of monitoring to address these declines, there is an ongoing need to coordinate bird monitoring among organizations and integrate them across regional and international boundaries (NABCI 2007).

Population monitoring forms the backbone of avian conservation; without current monitoring data, conservation efforts may be misguided and inefficient. Population monitoring helps to achieve the intent of legislation such as the Migratory Bird Treaty Act (1918), National Environmental Policy Act (1969), Endangered Species Act (1973), the National Forest Management Act (1976) and various state laws (Manley et al. 1993, Sauer 1993).

The North American Bird Conservation Initiative's "Opportunities for Improving Avian Monitoring" (NABCI 2007) provided goals and recommendations for avian monitoring programs:

Goal 1: Fully integrate monitoring into bird management and conservation practices and ensure that monitoring is aligned with management and conservation priorities.

Goal 2: Coordinate monitoring programs among organizations and integrate them across spatial scales to solve conservation or management problems effectively.

Goal 3: Increase the value of monitoring information by improving statistical design.

Goal 4: Maintain bird population monitoring data in modern data management systems. Recognizing legal, institutional, proprietary, and other constraints, provide greater availability of raw data, associated metadata, and summary data for bird monitoring programs.

With the NABCI (2007) guidelines in mind, RMBO and its partners designed a broad-scale monitoring program titled "Integrated Monitoring in Bird Conservation Regions (IMBCR)" and implemented IMBCR in Colorado in 2008 (Blakesley and Hanni 2009). This program was extended to all BCR 18 National Grasslands and the Nebraska National Forest in 2009. Important properties of the IMBCR design are:

- All vegetation types are available for sampling.
- Strata are based on fixed attributes; this will allow us to relate changes in bird populations to changes on the landscape through time.
- Each states' portion of a BCR can be stratified differently, depending upon local needs and areas to which one wants to make inferences.
- Aggregation of strata-wide estimates to BCR- or state-wide estimates is built into the design.
- Local population trends can be directly compared to regional trends.
- Coordination among partners can reduce the costs of monitoring per partner.

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

1. Provide a design framework to spatially integrate existing bird monitoring efforts in the region to provide better information on distribution and abundance of breeding landbirds, especially for high priority species;
2. Provide basic habitat association data for most bird species to address habitat management issues;
3. Provide long-term status and trend data for all regularly occurring breeding species throughout BCR 18, with a target of detecting a minimum rate of population change of 3.0% per year within 30 years, with power = 0.8 and alpha = 0.1;
4. Maintain a high-quality database that is accessible to all of our collaborators as well as to the public over the internet, in the form of raw and summarized data and;
5. Generate decision support tools that help guide conservation efforts and provide a better measure of conservation success.

METHODS

Study Area

The Shortgrass Prairie Bird Conservation Region (BCR 18) comprises vast tracts of shortgrass prairie supporting populations of high-priority species such as Mountain Plover, Burrowing Owl, Long-billed Curlew and Lesser Prairie-Chicken. Each state within BCR 18 is characterized by different landscape features and land use compositions. In Colorado, BCR 18 covers 28 million acres, 12 million of which are shortgrass prairie (PLJV 2009); 681,701 acres (2,759 km²) are contained in the Comanche and Pawnee National Grasslands. In Nebraska, BCR 18 is comprised of 1 million acres of shortgrass prairie (PLJV 2009); 95,863 acres (388 km²) are contained in Oglala National Grassland and 229,600 (929 km²) in Nebraska National Forest. New Mexico's 16.4 million acres of BCR 18 supports 10 million acres of native shortgrass prairie habitat, including 229,401 acres (928 km²) in Rita Blanca and Kiowa National Grasslands. Within Texas, 26 million acres (30% in cropland and 27% in shortgrass prairie) fall within BCR 18; including a portion of Rita Blanca National Grassland. In Kansas, the nine million acres within BCR 18 are covered with a mosaic of shortgrass prairie and cropland, primarily winter wheat; 116,319 acres (471km²) occur in Cimarron National Grassland. Only a small portion of BCR 18, 2.7 million acres comprised of shortgrass prairie (47%) and cropland (40%), falls within the panhandle of Oklahoma (PLJV 2009); including a portion of Rita Blanca National Grassland.

In 2008 we sampled the Colorado portion of BCR 18. In 2009 we sampled the Colorado and Wyoming portions of BCR 18 as well as all lands outside of Colorado and Wyoming administered by the USDA Forest Service within BCR 18, including National Grasslands and the Nebraska National Forest (Figure 1).

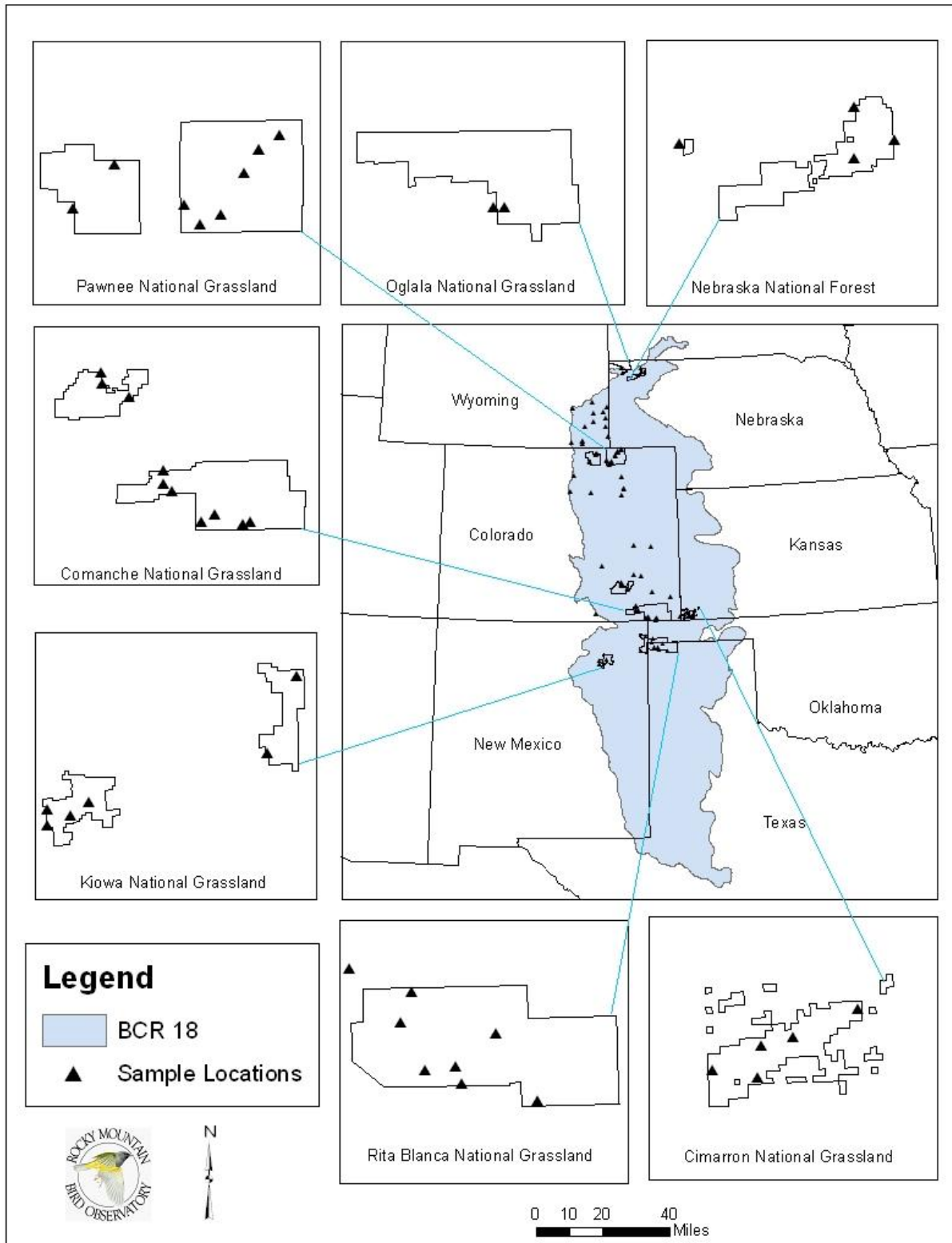


Figure 1. Stratification and sample locations in the Shortgrass Prairie Bird Conservation Region (18), 2009.

Sampling Design

RMBO and its partners defined BCR 18 as the sampling frame; the broad-scale area selected to make inferences about bird populations. Within the BCR, RMBO and its partners established strata and substrata based on smaller-scale areas to which we also wanted to make inferences; e.g., states or individual National Grasslands (Table 1). The strata within BCRs are based on fixed attributes, without regard to existing vegetation conditions.

Within each stratum, the IMBCR design uses generalized random-tessellation stratification (GRTS), a spatially balanced sampling algorithm, to select sample units (Stevens and Olsen 2004). The GRTS design has several appealing properties with respect to long-term monitoring of birds at large spatial scales:

- Spatially-balanced sampling is generally more efficient than simple random sampling of natural resources (Stevens and Olsen 2004). Incorporating information about spatial autocorrelation in the data can increase precision in density estimates;
- Sample units can be weighted according to any factor expected to influence species' distributions, to adjust the probability that sample units will be selected (Stevens and Olsen 2004). The sample weight can be accounted for in data analyses;
- All sample units in the sampling frame are ordered, such that any set of consecutively numbered units is a spatially well-balanced sample (Stevens and Olsen 2004). In the case of fluctuating budgets, we can adjust the sampling effort among years within each stratum while still preserving a random, spatially-balanced sampling design.

The IMBCR design defines sampling units as 1-km² cells that are used to create a uniform grid over the entire BCR, with a random starting point. All spatial data were compiled using ARCGIS 9.2 (ESRI). The hierarchical nature of our data analysis required that a minimum of two transects were sampled within each stratum. The remaining allocation of sampling effort among strata was based on the priorities of our funding partners (Table 1).

Sampling Methods

Within each sample cell we established a 4 x 4 grid of 16 points spaced 250 meters apart. We surveyed birds from points using methods that allow for estimating detection probability through the principles of Distance sampling, Removal modeling, and Occupancy modeling. Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that three critical assumptions be met: 1) all birds at and near the sampling location (distance = 0) are detected; 2) distances of birds are measured accurately; and 3) birds do not move in response to the observer's presence.

Removal modeling is based on mark-recapture theory; detection probability is estimated based on the number of birds detected during consecutive sampling intervals (Farnsworth et al. 2002). In this design, sampling intervals consist of 1-2 minutes segments of a complete sampling period. Removal modeling can also incorporate distance data.

Occupancy estimation is most commonly used to quantify the proportion of sample units occupied by an organism (MacKenzie et al. 2002). Occupancy estimation uses a detection probability to adjust the proportion of sites occupied to account for species that were present but

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Table 1. Sample allocation among strata in the Shortgrass Prairie Bird Conservation Region (BCR 18), 2008-2009.

State	Stratum	Area (km ²)	Samples	
			2008	2009
Colorado	Arkansas River and Tributaries	1,127	*6	2
Colorado	Comanche National Grassland	4836	8	10
Colorado	Department of Defense	1,647	2	2
Colorado	I-70 to Arkansas River	34,757	8	2
Colorado	North of Platte River	11,455	8	2
Colorado	Pawnee National Grassland	3268	8	10
Colorado	Platte River and Tributaries	970	8	2
Colorado	Platte River to I-70	30,365	8	2
Colorado	South of Arkansas River	24,985	8	2
Kansas	Cimarron National Grassland	690		5
Nebraska	Nebraska National Forest	360		4
Nebraska	Oglala National Grassland	61		2
New Mexico	Kiowa National Grassland	565		*4
New Mexico	Rita Blanca National Grassland	} 1186		2
Oklahoma	Rita Blanca National Grassland			2
Texas	Rita Blanca National Grassland			5
Wyoming	All Other Lands	12064		10
Wyoming	Bureau of Land Management	171		2
Wyoming	Department of Defense	23		2
Total		128,530	64	72

* Two additional samples were planned but not surveyed in the Arkansas River stratum in 2008; one additional sample was planned but not surveyed on the Kiowa National Grassland (see text).

undetected (MacKenzie et al. 2002). We used our data to estimate the site occupancy of species of special concern for which we had too few detections to estimate population density. Occupancy estimation requires multiple surveys to the sample unit in time or space (MacKenzie and Royle 2005). The assumptions of occupancy estimation are 1) the probabilities of detection and occupancy are constant across the sample units; 2) each point is closed to changes in occupancy over the sampling season; 3) the detection of species at each point are independent; and 4) the target species are never falsely identified (MacKenzie et al. 2006).

Field technicians conducted point counts (Buckland et al. 2001) following protocol established by RMBO (Hanni et al. 2009). Observers surveyed in the morning, from ½-hour before sunrise to 11 AM. At each point, observers conducted a five-minute point count. For every bird detected during the five minute period, we recorded species, sex, horizontal distance from the observer, minute we detected the bird, and type of detection (e.g., call, song, visual). Observers measured distances using laser rangefinders. When it was not possible to measure the distance to a bird, observers estimated distance by measuring to some nearby object. Observers recorded birds flying over but not using the immediate surrounding landscape. Observers also recorded the presence of all low-density species heard and seen when traveling the 250 meters between points. Low density species are those rare or difficult to detect species

(i.e., woodpeckers, owls, raptors) for which we are not able to estimate density; we collect these data for distribution mapping purposes.

We 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 separate independent observations. Observers recorded the number of birds detected within the cluster along with a letter code to keep track of each distinct cluster.

At the start and end of each transect, observers recorded time and atmospheric data (i.e., temperature, cloud cover, precipitation, and wind speed). We navigated to each point using hand-held Garmin® Global Positioning System (GPS) units. Before beginning each five-minute count, we recorded vegetation data (within a 50 meter radius) and distance from a road (if within 100 meters). For vegetation data, we recorded the dominant habitat type and structural stage, and the relative abundance, percent cover, and mean height of trees, shrubs, and groundcover. If there was a distinct subcanopy present, we recorded the species of sub-canopy trees. We recorded vegetation data quietly to allow birds, potentially disturbed by our approach, time to return to their normal habits prior to the beginning of the survey.

RMBO staff, biological technicians with excellent aural and visual bird-identification skills, conducted field work in 2009. Technicians completed an intensive five-day training program at the beginning of the field season to ensure full understanding of field protocols, practice bird identification, and practice distance estimation in a variety of habitats.

Data Analysis

Analysis of distance data is accomplished by fitting a detection function to the distribution of recorded distances. The distribution of distances can be a function of characteristics of the object (e.g., for birds, its size and color, movement, volume of song or call, and frequency of call), the surrounding environment (e.g., density of vegetation), and observer ability. Because detectability varies among species, we analyzed the data separately for each species.

We used the analysis software Distance 6.0 (Thomas et al. 2010) to estimate detection probabilities using our point count data. We estimated densities of species for which we obtained at least 60 independent detections (n) across years (2008-2009). We excluded birds flying over but not using the immediate surrounding landscape and birds detected between-point from analyses. We fit the following functions to the distribution of distances for each species: Half normal key function with cosine series expansion, Uniform function with cosine series expansion, Hazard rate key function with cosine series expansion, and Hazard rate key function with simple polynomial series expansion (Buckland et al. 2001). We combined data across years and strata to estimate global detection functions, and compared these models with models that estimated detection functions separately for each year (when sample sizes allowed). We used Akaike's Information Criterion (AIC) corrected for small sample size (AIC_c) and model selection theory to select the most parsimonious detection function for each species (Burnham and Anderson 2002).

We used the SPSURVEY package (Kincaid 2008) in Program R (R Development Core Team 2008) to estimate density and its variance for each bird species. This was greatly facilitated by R code written for us by Paul Lukacs of the Colorado Division of Wildlife.

RESULTS

In 2009, RMBO surveyed 72 of 73 (99%) assigned transects throughout BCR 18. We were unable to survey one transect because we could not contact the landowner during the optimal survey dates. We are actively improving our ability to contact landowners in a timely manner by hiring a landowner liaison and creating a landowner database.

We surveyed 865 points among the 72 transects between 12 May and 30 June 2009. We observed 7,483 birds of 119 species across all strata in Bird Conservation Region 18. We obtained sufficient numbers of observations to estimate density for 25 species, with precise density estimates ($CV < 50\%$) for 24 species in at least one stratum, including 8 species of conservation concern.

Estimated density and population size are presented by year for each species in each stratum in BCR 18 (Tables 2-9). Tables 2 -4 contain estimates for individual National Grasslands and combined Grassland administrative units; Table 5 contains global estimates across all National Grasslands. Table 6 contains estimates for individual strata in the Colorado portion of BCR 18 (excluding Comanche Grassland); Table 7 contains global results across all strata in the Colorado portion of BCR 18, including National Grasslands. Table 8 contains estimates for the three strata in the Wyoming portion of BCR 18; Table 9 contains global results across all strata in the Wyoming portion of BCR 18.

We followed the American Ornithological Union guidelines, 7th edition (<http://www.aou.org/checklist/north/full.php>) for common names of all bird species. Detailed species accounts including distribution maps, density estimate graphs and tables are available at <http://rmbo.org/public/monitoring/speciesAccounts.aspx>.

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Table 2. Estimated densities (D), estimated population sizes (N), percent coefficient of variation of estimates (%CV), and sample sizes (n) of breeding bird species in the Cimarron and Comanche National Grasslands, 2008-2009.

Species	Year	Cimarron				Comanche				Combined			
		D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Killdeer	2008					6.8	32,801	43	8				
	2009	1.3	864	86	1				0	0.2	864	86	1
Mourning Dove	2008					9.8	47,457	27	24				
	2009	33.8	23,334	23	56	3.6	17,523	27	12	7.4	40,857	17	68
Western Kingbird	2008					4.2	20,189	26	9				
	2009	32.9	22,690	38	48	1.7	8,283	27	5	5.6	30,972	29	53
American Crow	2008								0				
	2009				0				0				0
Horned Lark ³	2008					51.5	248,895	17	93				
	2009	2.5	1,694	69	3	13.9	67,295	31	34	12.5	68,989	30	37
Cliff Swallow	2008					5.0	24,297	40	5				
	2009				0				0				0
Barn Swallow	2008								0				
	2009	14.7	10,112	91	4				0	1.8	10,112	91	4
House Wren	2008								0				
	2009	2.2	1,485	83	2				0	0.3	1,485	83	2
American Robin	2008					1.2	6,011	91	1				
	2009	3.7	2,533	56	2	8.3	39,951	91	9	7.7	42,484	86	11
Northern Mockingbird	2008					1.1	5,385	40	6				
	2009	21.4	14,739	40	46	10.2	49,405	32	44	11.6	64,144	26	90
European Starling	2008								0				
	2009	6.1	4,182	84	3				0	0.8	4,182	84	3
Yellow Warbler	2008								0				
	2009	1.2	848	94	1				0	0.2	848	94	1

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Species	Year	Cimarron				Comanche				Combined			
		D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Cassin's Sparrow ³	2008					15.5	74,729	21	58				
	2009	26.0	17,920	39	66	40.1	194,098	21	204	38.4	212,018	20	270
Brewer's Sparrow ³	2008					2.4	11,812	37	10				
	2009				0				0				0
Lark Sparrow ³	2008					3.1	15,061	39	6				
	2009	4.6	3,174	18	6	20.3	98,246	20	53	18.4	101,419	20	59
Lark Bunting ³	2008					22.4	108,109	23	97				
	2009				0	8.4	40,580	62	32	7.3	40,580	62	32
Grasshopper Sparrow ³	2008					18.4	88,969	27	21				
	2009	10.4	7,142	43	8	4.5	21,900	67	7	5.3	29,042	52	15
McCown's Longspur ³	2008								0				
	2009				0				0				0
Red-winged Blackbird	2008								0				
	2009	12.4	8,522	81	9	2.7	13,272	88	4	3.9	21,794	62	13
Western Meadowlark ³	2008					17.4	84,145	24	117				
	2009	7.8	5,395	30	30	24.2	117,219	16	186	22.2	122,615	15	216
Common Grackle	2008								0				
	2009	5.6	3,865	90	2				0	0.7	3,865	90	2
Brown-headed Cowbird	2008					8.4	40,422	34	10				
	2009	14.8	10,222	20	12				0	1.8	10,222	20	12
Bullock's Oriole	2008								0				
	2009	60.7	41,906	38	41				0	7.6	41,906	38	41
House Finch	2008					4.4	21,209	91	2				
	2009	13.0	8,939	56	4	4.9	23,493	92	3	5.9	32,431	68	7
House Sparrow	2008								0				
	2009				0				0				0

¹ D = (birds/km²);

² n = number of independent detections used to estimate density;

³ Priority species in Bird Conservation Region 18 (see Appendix A)

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Table 3. Estimated densities (D), estimated population sizes (N), percent coefficient of variation of estimates (%CV), and sample sizes (n) of breeding bird species in the Kiowa and Rita Blanca National Grasslands, 2009.

Species	Kiowa				Rita Blanca				Combined			
	D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Killdeer	2.5	1,437	56	2	3.5	4,108	49	4	3.2	5,545	39	6
Mourning Dove	4.9	2,772	17	8	4.2	4,953	47	10	4.4	7,725	31	18
Western Kingbird	3.5	1,966	42	5	1.9	2,247	41	4	2.4	4,213	29	9
American Crow				0				0				0
Horned Lark ³	93.1	52,607	23	112	52.1	61,760	12	92	65.3	114,367	13	204
Cliff Swallow	4.5	2,555	55	3	1.0	1,217	83	1	2.2	3,772	46	4
Barn Swallow				0	2.5	3,005	84	1	1.7	3,005	84	1
House Wren				0				0				0
American Robin				0				0				0
Northern Mockingbird	0.9	533	55	2	1.0	1,142	61	3	1.0	1,675	45	5
European Starling				0				0				0
Yellow Warbler				0				0				0
Cassin's Sparrow ³	10.4	5,871	33	26	13.6	16,135	16	50	12.6	22,006	15	76
Brewer's Sparrow ³	1.5	828	48	4	0.5	592	54	2	0.8	1,420	36	6
Lark Sparrow ³	3.9	2,200	44	5	1.6	1,886	57	3	2.3	4,086	35	8
Lark Bunting ³	30.4	17,154	28	57	13.4	15,914	54	37	18.9	33,068	30	94
Grasshopper Sparrow ³	13.1	7,425	37	10	29.5	35,017	36	33	24.2	42,441	30	43
McCown's Longspur ³				0				0				0
Red-winged Blackbird				0				0				0
Western Meadowlark ³	18.5	10,469	22	70	16.8	19,878	23	93	17.3	30,348	17	163
Common Grackle				0				0				0
Brown-headed Cowbird	5.0	2,834	51	4	4.3	5,062	49	5	4.5	7,896	36	9
Bullock's Oriole				0	2.0	2,430	84	2	1.4	2,430	84	2
House Finch				0				0				0
House Sparrow				0				0				0

¹ Density = (birds/km²); ² n = number of independent detections used to estimate density;

³ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 4. Estimated densities (D), estimated population sizes (N), percent coefficient of variation of estimates (%CV), and sample sizes (n) of breeding bird species in the Nebraska National Forest (NF) and Oglala National Grassland (NG), 2009.

Species	Nebraska NF				Oglala NG			
	D ¹	N	%CV	n ²	D	N	%CV	n
Killdeer	3.0	165	89	2				0
Mourning Dove	33.5	1,276	18	47	5.1	309	7	4
Western Kingbird	3.2	1,166	54	4				0
American Crow	7.3	261	132	16	20.1	1,226	121	25
Horned Lark ³				0				0
Cliff Swallow	1.8	631	86	1				0
Barn Swallow	4.3	1,559	87	1				0
House Wren	85.2	368	36	67	33.8	2,064	37	15
American Robin	23.9	8,592	19	11				0
Northern Mockingbird				0				0
European Starling	2.4	859	86	1				0
Yellow Warbler	18.9	6,799	59	13	7.7	472	43	3
Cassin's Sparrow ³				0				0
Brewer's Sparrow ³				0				0
Lark Sparrow ³	17.2	6,198	46	19	35.4	2,157	27	22
Lark Bunting ³				0				0
Grasshopper Sparrow ³	22.9	8,257	73	15	13.6	827	101	5
McCown's Longspur ³				0				0
Red-winged Blackbird				0				0
Western Meadowlark ³	28.3	122	30	92	16.9	1,033	6	31
Common Grackle				0				0
Brown-headed Cowbird	39.4	14,181	41	27	18.1	1,105	42	7
Bullock's Oriole	1.8	63	86	1				0
House Finch	15.3	5,512	86	4				0
House Sparrow	8.9	3,215	85	2				0

¹ Density = (birds/km²); ² n = number of independent detections used to estimate density;

³ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 5. Estimated population sizes (N), with associated estimates of standard error (SE), percent coefficient of variation (%CV), and lower and upper 90% confidence limits (LCL and UCL) for breeding bird species across all National Grasslands in the Shortgrass Prairie Bird Conservation Region (BCR 18), 2009.

Species	N	SE(N)	CV(N)	LCL(N)	UCL(N)
Killdeer	18,838	7,970	0.42	9,664	36,722
Mourning Dove	68,073	11,010	0.16	52,260	88,671
Western Kingbird	47,425	10,163	0.21	33,468	67,203
American Crow	1,226	1,490	1.22	256	5,872
Horned Lark ¹	672,488	62,218	0.09	577,735	782,781
Cliff Swallow	27,341	9,467	0.35	15,719	47,557
Barn Swallow	42,212	18,284	0.43	21,340	83,499
House Wren	3,549	1,441	0.41	1,867	6,747
American Robin	42,484	36,551	0.86	12,487	144,536
Northern Mockingbird	65,820	16,800	0.26	43,539	99,503
European Starling	8,192	4,784	0.58	3,361	19,970
Yellow Warbler	1,320	823	0.62	514	3,388
Cassin's Sparrow ¹	242,616	42,140	0.17	182,706	322,170
Brewer's Sparrow ¹	7,149	2,886	0.40	3,773	13,546
Lark Sparrow ¹	110,706	20,140	0.18	82,273	148,966
Lark Bunting ¹	412,025	39,165	0.10	352,507	481,592
Grasshopper Sparrow ¹	87,722	20,605	0.23	59,916	128,432
McCown's Longspur ¹	191,623	91,775	0.48	90,739	404,671
Red-winged Blackbird	21,794	13,545	0.62	8,512	55,799
Western Meadowlark ¹	229,539	21,109	0.09	197,376	266,943
Common Grackle	9,425	5,801	0.62	3,710	23,944
Brown-headed Cowbird	31,476	7,799	0.25	21,067	47,028
Bullock's Oriole	44,336	16,240	0.37	24,732	79,479
House Finch	32,431	22,078	0.68	11,752	89,499
House Sparrow	7,501	6,156	0.82	2,304	24,423

¹ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 6. Estimated densities (D), estimated population sizes (N), percent coefficient of variation of estimates (%CV), and sample sizes (n) of breeding bird species by stratum in the Colorado portion of the Shortgrass Prairie Bird Conservation Region (BCR 18), 2008-2009. This table excludes the Comanche National Grasslands, which appears in Table 2.

Species	Year	Arkansas River and Tributaries				Department of Defense				I-70 to Arkansas River			
		D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Killdeer	2008	13.6	15,288	81	10	6.3	1,312	103	2	22.7	7,920	60	31
	2009	27.1	3,576	67	8				0	20.3	77,195	103	8
Mourning Dove	2008	17.0	19,170	35	26	13.6	22,379	13	9	12.0	417,875	25	34
	2009	19.6	22,120	74	12	12.5	257	34	7	7.4	255,795	34	6
Western Kingbird	2008	7.4	8,364	34	10	5.1	8,462	12	3	11.6	44,336	48	29
	2009	7.4	8,364	67	4	12.1	22	100	6				0
American Crow	2008	0.4	468	146	1				0				0
	2009				0				0				0
Horned Lark ³	2008	14.2	15,967	57	16	18.4	3,289	100	9	254.0	8,826,956	16	485
	2009				0	12.1	19,916	101	5	53.2	1,849,175	45	32
Cliff Swallow	2008	43.4	48,921	65	27	74.2	122,212	71	20	1.7	647	65	2
	2009				0				0				0
Barn Swallow	2008	23.8	26,840	55	6	27.5	45,258	101	3	36.5	1,267,649	83	17
	2009	19.8	22,367	101	2	10.8	17,829	101	1				0
House Wren	2008	8.2	9,196	68	7				0				0
	2009				0	3.2	5,236	100	1				0
American Robin	2008	31.8	35,863	44	16	18.4	3,236	67	4	1.1	37,363	89	1
	2009	14.9	1,681	101	3				0				0
Northern Mockingbird	2008	2.7	312	50	9	12.3	2,315	20	18	0.6	22,314	49	4
	2009	7.5	854	103	6	24.7	4,674	36	18	0.9	32,783	103	1
European Starling	2008	65.7	73,993	48	30				0	1.2	41,114	83	1
	2009	43.8	49,328	101	8				0				0
Yellow Warbler	2008	17.3	19,511	70	13	18.4	337	105	6				0
	2009	16.6	18,761	80	5	18.2	3,000	36	5				0

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Species	Year	Arkansas River and Tributaries				Department of Defense				I-70 to Arkansas River			
		D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Cassin's Sparrow ³	2008	5.5	6,245	67	13	5.9	9,721	100	6	14.7	512,534	32	64
	2009				0	14.0	22,977	86	12	29.7	13,242	40	36
Brewer's Sparrow ³	2008	0.4	44	83	1	0.9	1,485	101	1	0.8	29,367	70	4
	2009				0				0				0
Lark Sparrow ³	2008	9.1	1,296	70	11	9.1	1,530	26	5	1.8	6,249	82	4
	2009	2.1	2,340	101	1	9.1	14,922	47	4	4.7	162,362	101	3
Lark Bunting ³	2008	6.6	748	72	18				0	3.4	117,766	62	17
	2009				0				0	43.7	1,517,998	18	41
Grasshopper Sparrow ³	2008	1.4	1,580	82	1				0	9.1	315,994	49	12
	2009				0				0				0
McCown's Longspur ³	2008				0				0				0
	2009				0				0				0
Red-winged Blackbird	2008	42.7	4,872	71	29	28.4	46,692	32	9	10.4	36,365	72	13
	2009	48.3	5,446	80	13	32.4	5,342	103	8	8.4	29,627	103	3
Western Meadowlark ³	2008	11.9	1,348	37	50	15.4	25,322	101	28	32.7	1,135,416	20	254
	2009	16.2	18,297	37	23	6.9	11,415	16	9	13.8	478,392	10	26
Common Grackle	2008	57.6	64,969	64	19	7.0	11,532	101	1	4.9	171	60	3
	2009	22.8	25,646	55	3				0				0
Brown-headed Cowbird	2008	5.3	629	63	4	12.3	2,332	67	4	1.4	5,250	56	2
	2009	10.0	1,134	101	3				0				0
Bullock's Oriole	2008	1.6	189	88	1	14.8	24,397	33	4	0.9	3,148	93	1
	2009	16.0	1,886	101	4	8.8	14,417	101	2				0
House Finch	2008	38.6	43,495	92	11				0				0
	2009	8.8	9,885	101	1				0				0
House Sparrow	2008	49.1	55,355	91	12				0				0
	2009				0				0				0

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Species	Year	North of Platte River				Pawnee National Grassland				Platte River and Tributaries			
		D ¹	N	%CV	n ²	Density	N	%CV	n	D	N	%CV	n
Killdeer	2008	12.4	14,194	63	14	3.3	10,747	62	4	15.3	1,483	43	18
	2009	15.1	172,687	103	5	3.8	12,429	61	5	3.3	3,158	103	1
Mourning Dove	2008	15.4	175,978	44	36	5.2	16,845	36	13	21.7	213	18	53
	2009	4.4	49,970	17	3	5.9	19,182	42	16	12.6	12,184	13	8
Western Kingbird	2008	6.3	71,914	48	14	0.4	1,470	91	1	9.3	8,999	65	20
	2009	3.3	3,780	100	2	3.7	12,240	40	9	1.8	1,728	100	1
American Crow	2008	0.8	9,312	146	3				0	1.6	1,511	147	6
	2009				0				0	6.0	582	157	6
Horned Lark ³	2008	188.3	2,156,843	19	326	190.0	620,823	8	354	1.7	161	82	3
	2009	92.6	161,123	38	47	149.7	489,131	12	301				0
Cliff Swallow	2008	3.1	3,639	88	3	1.9	6,369	81	2	33.2	32,241	64	18
	2009	14.3	16,374	37	4	7.2	23,570	39	8				0
Barn Swallow	2008	23.3	26,692	69	9	2.4	7,861	82	1	27.3	26,470	42	11
	2009	8.8	1,156	101	1	8.9	29,095	54	4				0
House Wren	2008				0				0	18.9	18,373	47	26
	2009				0				0				0
American Robin	2008	40.2	46,668	65	31				0	150.4	145,892	29	121
	2009	4.4	5,635	101	1				0	210.0	23,717	15	44
Northern Mockingbird	2008				0				0				0
	2009				0				0				0
European Starling	2008	35.7	4,886	49	25	1.3	4,335	81	1	104.0	1,834	37	76
	2009	9.7	111,438	101	2	1.2	4,010	81	1	99.8	969	40	19
Yellow Warbler	2008	5.2	5,975	87	6				0	22.5	21,800	42	27
	2009				0				0	16.0	1,552	32	5

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Species	Year	North of Platte River				Pawnee National Grassland				Platte River and Tributaries			
		D ¹	N	%CV	n ²	Density	N	%CV	n	D	N	%CV	n
Cassin's Sparrow ³	2008	8.3	95,555	59	30	3.9	12,664	81	15				0
	2009	4.7	54,266	100	5	2.6	8,593	56	11				0
Brewer's Sparrow ³	2008				0	3.6	11,610	49	15				0
	2009				0	1.8	5,729	50	8				0
Lark Sparrow ³	2008	2.7	3,128	85	5				0	0.5	53	82	1
	2009	5.5	63,434	101	3	0.9	3,044	50	2				0
Lark Bunting ³	2008	3.1	35,818	49	13	15.4	50,393	40	69				0
	2009	26.5	33,771	72	21	103.5	338,378	8	325				0
Grasshopper Sparrow ³	2008				0	5.9	19,433	56	7				0
	2009	12.5	142,748	101	4	4.7	15,412	36	6				0
McCown's Longspur ³	2008	54.2	621,122	84	82	45.5	148,579	32	74				0
	2009	49.2	563,179	103	11	58.6	191,623	48	52				0
Red-winged Blackbird	2008	2.9	33,324	87	3	2.7	8,833	58	3	94.8	91,928	45	102
	2009	114.2	13,898	103	32				0	60.7	58,834	26	17
Western Meadowlark ³	2008	17.7	22,682	26	114	13.4	43,829	21	93	7.4	7,213	50	50
	2009	25.1	287,548	30	40	23.1	75,543	10	146	2.0	1,972	100	3
Common Grackle	2008	93.0	16,553	65	47				0	206.7	2,497	22	109
	2009	13.5	154,496	101	2	1.7	5,560	84	1	94.7	91,824	17	13
Brown-headed Cowbird	2008	0.9	9,993	84	1				0	35.2	34,130	31	41
	2009	8.9	12,149	101	3	3.7	12,254	57	5				0
Bullock's Oriole	2008	2.1	23,981	85	2				0	10.0	9,729	49	10
	2009				0				0				0
House Finch	2008	50.3	576,736	83	22				0	221.5	214,829	40	101
	2009				0				0	210.5	24,194	17	25
House Sparrow	2008	154.8	1,773,854	76	58				0	220.0	21,346	33	86
	2009				0	2.3	7,501	82	1	245.6	23,822	33	25

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Species	Year	Platte River to I-70				South of Arkansas River			
		D ¹	N	%CV	n ²	D	N	%CV	n
Killdeer	2008	4.8	14,539	60	4	7.2	179,434	53	9
	2009				0				0
Mourning Dove	2008	11.5	35,564	26	20	13.1	326,912	21	34
	2009	18.9	57,264	51	6	1.8	44,579	100	1
Western Kingbird	2008	9.8	298,267	39	15	8.7	218,152	61	20
	2009	15.7	476,816	102	5				0
American Crow	2008				0				0
	2009				0				0
Horned Lark ³	2008	202.4	6,144,436	19	259	44.3	116,156	17	85
	2009	183.8	5,581,165	10	38	82.2	254,453	63	34
Cliff Swallow	2008				0	0.9	23,629	90	1
	2009	17.5	532,566	101	2				0
Barn Swallow	2008				0	11.7	291,679	73	5
	2009				0	10.8	27,466	101	1
House Wren	2008				0				0
	2009				0				0
American Robin	2008	7.0	213,141	53	4	2.3	58,460	88	2
	2009	10.8	329,400	101	1				0
Northern Mockingbird	2008				0	4.4	1,913	48	25
	2009				0	1.4	34,279	103	1
European Starling	2008				0	12.9	321,643	88	10
	2009				0				0
Yellow Warbler	2008				0				0
	2009				0				0

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Species	Year	Platte River to I-70				South of Arkansas River			
		D ¹	N	%CV	n ²	D	N	%CV	n
Cassin's Sparrow ³	2008	13.2	399,743	59	35	20.8	522	20	83
	2009				0	9.3	232,378	10	8
Brewer's Sparrow ³	2008				0	0.7	1,724	46	3
	2009				0				0
Lark Sparrow ³	2008	11.0	333,772	42	15	8.3	2,752	5	17
	2009				0				0
Lark Bunting ³	2008	12.7	38,536	70	39	18.9	471,493	4	87
	2009	24.8	752,819	100	8	6.2	154,859	7	4
Grasshopper Sparrow ³	2008	74.2	2,253,297	42	60	23.9	59,742	43	29
	2009				0	3.8	95,512	101	1
McCown's Longspur ³	2008				0				0
	2009				0				0
Red-winged Blackbird	2008	7.9	23,899	63	6				0
	2009	129.7	3,939,558	83	16				0
Western Meadowlark ³	2008	30.2	91,823	21	144	29.5	737,885	3	211
	2009	26.2	79,511	81	17	6.2	153,918	46	8
Common Grackle	2008	18.7	5,695	52	7	5.4	133,777	88	3
	2009				0				0
Brown-headed Cowbird	2008	1.2	35,832	88	1	0.8	19,655	89	1
	2009				0				0
Bullock's Oriole	2008				0	2.8	7,756	88	3
	2009				0				0
House Finch	2008				0				0
	2009	38.3	116,224	101	2				0
House Sparrow	2008	7.2	219,332	83	2				0
	2009	44.7	1,355,868	100	2				0

¹ Density = (birds/km²); ² n = number of independent detections used to estimate density;

³ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 7. Estimated population sizes (N), with associated estimates of standard error (SE), percent coefficient of variation (%CV), and lower and upper 90% confidence limits (LCL and UCL) for breeding bird species across the Colorado portion of the Shortgrass Prairie Bird Conservation Region (BCR 18), 2009.

Species	Year	N	SE(N)	CV(N)	LCL(N)	UCL(N)
Killdeer	2008	1,340,689	497,117	0.37	742,870	2,419,598
	2009	926,046	751,562	0.81	287,367	2,984,205
Mourning Dove	2008	1,398,199	173,032	0.12	1,141,547	1,712,554
	2009	1,014,561	308,007	0.30	622,521	1,653,493
Western Kingbird	2008	1,040,153	264,424	0.25	689,155	1,569,920
	2009	565,223	488,350	0.86	165,480	1,930,613
American Crow	2008	11,291	13,808	1.22	2,342	54,442
	2009	5,802	9,121	1.57	926	36,355
Horned Lark ¹	2008	19,151,974	1,881,561	0.10	16,300,289	22,502,553
	2009	11,122,258	1,688,824	0.15	8,676,260	14,257,828
Cliff Swallow	2008	354,114	109,766	0.31	215,155	582,819
	2009	719,866	539,895	0.75	239,879	2,160,285
Barn Swallow	2008	1,932,678	1,090,189	0.56	814,069	4,588,363
	2009	440,812	294,812	0.67	162,134	1,198,485
House Wren	2008	27,569	10,719	0.39	14,872	51,107
	2009	5,236	5,244	1.00	1,329	20,627
American Robin	2008	987,631	328,906	0.33	579,301	1,683,780
	2009	640,513	340,377	0.53	281,986	1,454,886
Northern Mockingbird	2008	160,128	53,313	0.33	93,936	272,961
	2009	165,646	54,096	0.33	98,120	279,644
European Starling	2008	950,724	353,205	0.37	526,226	1,717,657
	2009	261,577	128,857	0.49	121,507	563,117
Yellow Warbler	2008	131,385	63,100	0.48	62,098	277,980
	2009	64,172	19,185	0.30	39,657	103,843

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Cassin's Sparrow ¹	2008	1,631,194	311,195	0.19	1,195,165	2,226,298
	2009	1,544,354	419,901	0.27	995,302	2,396,288
Brewer's Sparrow ¹	2008	71,946	23,097	0.32	42,979	120,435
	2009	5,729	2,840	0.50	2,650	12,387
Lark Sparrow ¹	2008	675,602	185,137	0.27	433,961	1,051,795
	2009	344,347	176,907	0.51	155,324	763,402
Lark Bunting ¹	2008	1,176,365	318,459	0.27	759,538	1,821,943
	2009	3,108,404	830,592	0.27	2,018,002	4,787,990
Grasshopper Sparrow ¹	2008	3,276,693	992,091	0.30	2,013,058	5,333,536
	2009	275,572	173,375	0.63	106,579	712,520
McCown's Longspur ¹	2008	769,701	526,859	0.68	277,627	2,133,940
	2009	754,803	584,693	0.77	244,364	2,331,472
Red-winged Blackbird	2008	830,895	308,231	0.37	460,278	1,499,934
	2009	5,719,070	3,555,425	0.62	2,233,254	14,645,790
Western Meadowlark ¹	2008	3,167,923	341,084	0.11	2,655,073	3,779,834
	2009	1,939,316	651,741	0.34	1,132,272	3,321,593
Common Grackle	2008	2,216,336	771,184	0.35	1,270,924	3,865,020
	2009	277,526	157,037	0.57	116,622	660,431
Brown-headed Cowbird	2008	216,642	51,777	0.24	147,016	319,243
	2009	125,706	103,896	0.83	38,359	411,948
Bullock's Oriole	2008	160,819	71,914	0.45	79,673	324,610
	2009	32,502	23,332	0.72	11,254	93,863
House Finch	2008	856,269	488,109	0.57	357,810	2,049,124
	2009	1,399,776	1,175,702	0.84	420,801	4,656,297
House Sparrow	2008	2,261,947	1,368,851	0.61	902,401	5,669,768
	2009	1,601,589	1,363,563	0.85	475,415	5,395,468

¹ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 8. Estimated densities (D), estimated population sizes (N), percent coefficient of variation of estimates (%CV), and sample sizes (n) of breeding bird species by stratum in the Wyoming portions of the Shortgrass Prairie Bird Conservation Region (BCR 18), 2009.

Species	WY - All Other Lands				WY - Bureau of Land Mgmt				WY - Dept of Defense			
	D ¹	N	%CV	n ²	D	N	%CV	n	D	N	%CV	n
Killdeer	1.4	1,777	66	2	4.3	733	103	1	3.7	86	103	1
Mourning Dove	4.4	53,532	47	13				0	25.0	575	72	14
Western Kingbird	12.8	154,155	34	33	16.4	285	100	7	2.0	47	100	1
American Crow	0.4	5,229	147	2				0	3.4	78	157	3
Horned Lark ³	34.2	41,335	29	74	84.0	14,366	11	30	21.8	6	101	9
Cliff Swallow				0				0				0
Barn Swallow				0				0				0
House Wren	1.2	14,673	83	2				0				0
American Robin				0				0	195.3	4,492	101	36
Northern Mockingbird				0				0				0
European Starling	1.1	13,775	93	1				0	173.1	3,981	101	29
Yellow Warbler	5.6	6,760	69	8				0	3.6	84	105	1
Cassin's Sparrow ³				0				0				0
Brewer's Sparrow ³	3.7	44,276	84	18				0	2.1	49	101	2
Lark Sparrow ³	6.9	83,639	44	16	10.5	1,794	101	4				0
Lark Bunting ³	27.9	336,156	36	94	3.6	614	100	2				0
Grasshopper Sparrow ³	20.5	24,733	54	28				0				0
McCown's Longspur ³	1.0	12,657	93	1				0				0
Red-winged Blackbird	1.6	18,714	86	2				0	8.1	187	103	2
Western Meadowlark ³	44.6	538,493	9	303	35.7	699	16	40	28.5	655	84	37
Common Grackle				0				0	33.1	761	101	4
Brown-headed Cowbird				0				0				0
Bullock's Oriole	2.5	332	60	3				0				0
House Finch				0				0	57.4	132	101	6
House Sparrow				0				0	44.7	127	100	4

¹Density = (birds/km²); ²n = number of independent detections used to estimate density;

³ Priority species in Bird Conservation Region 18 (see Appendix A).

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Table 9. Estimated population sizes (N), with associated estimates of standard error (SE), percent coefficient of variation (%CV), and lower and upper 90% confidence limits (LCL and UCL) for breeding bird species across the Wyoming portion of the Shortgrass Prairie Bird Conservation Region (BCR 18), 2009.

Species	N	SE(N)	CV(N)	LCL(N)	UCL(N)
Killdeer	17,894	11,277	63	6,911	46,332
Mourning Dove	54,106	25,139	46	26,145	111,968
Western Kingbird	157,007	52,992	34	91,467	269,508
American Crow	5,308	7,676	145	925	30,472
Horned Lark ¹	427,900	121,106	28	271,037	675,547
Cliff Swallow					
Barn Swallow					
House Wren	14,673	12,156	83	4,468	48,190
American Robin	4,491	4,535	101	1,131	17,837
Northern Mockingbird					
European Starling	17,756	13,465	76	5,859	53,810
Yellow Warbler	67,143	46,409	69	24,019	187,696
Cassin's Sparrow ¹					
Brewer's Sparrow ¹	44,325	37,324	84	13,293	147,795
Lark Sparrow ¹	85,433	36,661	43	43,442	168,011
Lark Bunting ¹	336,770	121,718	36	189,238	599,320
Grasshopper Sparrow ¹	247,033	132,362	54	108,106	564,495
McCown's Longspur ¹	12,657	11,817	93	3,441	46,552
Red-winged Blackbird	18,901	16,182	86	5,581	64,009
Western Meadowlark ¹	545,247	50,270	9	468,669	634,337
Common Grackle	761	767	101	192	3,016
Brown-headed Cowbird					
Bullock's Oriole	30,302	18,301	60	12,108	75,834
House Finch	1,320	1,335	101	332	5,251
House Sparrow	1,027	1,031	100	260	4,056

¹ Priority species in Bird Conservation Region 18 (see Appendix A).

DISCUSSION

We were able to estimate density for 25 landbird species in BCR 18 in 2008-2009, including precise population estimates across BCR 18 National Grasslands for all 8 priority species. The portion of BCR 18 outside of National Grasslands was poorly sampled in Colorado in 2009 due to a spending freeze in the state government (Table 1). The ability to adapt to budget fluctuation was a primary goal of this design. Although sampling across Private lands in Colorado BCR 18 was very low, we were still able to create estimates of populations for the Colorado portion of BCR 18 (Table 7). In 2010 the Colorado Division of Wildlife will be contributing funding to Integrated Monitoring in Bird Conservation Regions state-wide.

The portion of BCR 18 outside of National Grasslands in states other than Colorado and Wyoming was not surveyed at all by Rocky Mountain Bird Observatory in 2009. RMBO will be working on the stratification of these areas during the summer and fall of 2010 in partnership with the Great Plains Landscape Conservation Cooperative (LCC) so that these areas are ready for sampling and BCR 18-wide densities can be estimated in 2011. We will continue to work with partners in other states as well as the Playa Lakes Joint Venture and the Great Plains LCC to seek additional resources to complete sampling in the remainder of BCR 18.

The IMBCR sampling design, which contributes to regional, BCR-wide monitoring, serves as a model for other long-term monitoring efforts because of its ability to address the conservation and management needs of a wide range of stakeholders, landowners and governmental entities at both local and regional scales. The IMBCR design represents one method for achieving effective collaboration and coordinated bird monitoring efforts in North America (NABCI 2007) and could be applied to other BCRs and regions across the continent.

The IMBCR sampling design is not limited to estimating population density and occupancy rates of birds. This design could be used to estimate nesting success or other demographic parameters. Furthermore, our sampling design could be used to monitor the distribution and population dynamics of additional taxonomic groups, including reptiles, small mammals and plants. A spatially balanced design using similar stratification and cell weighting for ponds and wetlands could be used to monitor shorebirds and amphibians, whereas a design with larger sample cells would be appropriate for monitoring large mammals. Identifying and monitoring the distributions of plants and animals at multiple spatial scales over time will help scientists and land managers face challenges associated with climate change and other natural and anthropogenic changes to the environment.

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APPENDIX A

Priority species detected within the Shortgrass Prairie Bird Conservation Region (18) by designation: USDI Fish and Wildlife Service (USFWS), USDA Forest Service (USFS), Partners in Flight (PIF).

Species	USFWS BCR 18	PIF-BCR 18	Region 2 USFS
Northern Harrier	BCC	RC	R2SS
Swainson's Hawk		CC,RS	
Ferruginous Hawk	BCC	RC,RS	R2SS
Lesser Prairie-chicken			R2SS
Scaled Quail			
Mountain Plover	BCC		R2SS
Upland Sandpiper			
Long-billed Curlew			R2SS
Burrowing Owl	BCC	RC,RS	R2SS
Say's Phoebe		RS	
Chihuahuan Raven			
Loggerhead Shrike		RC	R2SS
Horned Lark			
Cassin's Sparrow			R2SS
Brewer's Sparrow		CC,RC	R2SS
Lark Sparrow		RC	
Lark Bunting	BCC	RC,CS,RS	
Grasshopper Sparrow		RC,CS,RS	R2SS
McCown's Longspur	BCC	CC,CS,RS	R2SS
Western Meadowlark		RS	

Agency/Organization

US Fish and Wildlife Service (BCR 18)

US Forest Service (Region 2)

PIF Species Assessment Database 2005: BCR 18 (PIF-BCR18)

PIF Species Assessment Database 2005: BCR 18 (PIF-BCR18)

PIF Species Assessment Database 2005: BCR 18 (PIF-BCR18)

PIF Species Assessment Database 2005: BCR 18 (PIF-BCR18)

Code Definition

BCC Birds of Conservation Concern for BCR 18

R2SS US Forest Service Region 2 Sensitive Species

CC Continental Concern

CS Continental Stewardship

RC Regional Concern

RS Regional Stewardship