Population Densities and Trend Detection of Avian Management Indicator Species on the Pawnee National Grassland

December 2008

Rocky Mountain Bird Observatory
PO Box 1232
Brighton, CO 80601-1232
303.659.4348
www.rmbo.org
Tech. Report # M-MCB-USFS07-06

In Cooperation With:

ROCKY MOUNTAIN BIRD OBSERVATORY

***Mission**: To conserve birds and their habitats*

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

***Core Values**: (Our goals for achieving our mission)*

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:

***Partnering** with state and federal natural resource agencies, private landowners, schools, and other nonprofits for conservation.*

***Studying** bird responses to habitat conditions, ecological processes, and management actions to provide scientific information that guides bird conservation efforts.*

***Monitoring** long-term trends in bird populations for our region.*

***Providing** active, experiential, education programs that create an awareness and appreciation for birds.*

***Sharing** the latest information in land management and bird conservation practices.*

***Developing** voluntary, working partnerships with landowners to engage them in conservation.*

***Working** across political and jurisdictional boundaries including, counties, states, regions, and national boundaries. Our conservation work emphasizes the Western United States, including the Great Plains, as well as Latin America.*

***Creating** informed publics and building consensus for bird conservation needs.*

Suggested Citation:

Jennifer A. Blakesley. 2008. Population densities and trend detection of avian Management Indicator Species on the Pawnee National Grassland. Supplemental Report M-MCB-USFS07-06. Rocky Mountain Bird Observatory, Brighton, CO. 8 pp.

Cover Photo:

Female Lark Bunting with Nestlings. Amy Yackel. Used with permission.

Contact Information:

Jennifer Blakesley (Jennifer.blakesley@rmbo.org)
Rocky Mountain Bird Observatory
PO Box 1232
Brighton, CO 80601-1232
303-659-4348

EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory (RMBO) conducted bird surveys within the Shortgrass Prairie Bird Conservation Region (BCR 18) and within Grasslands of Colorado in 2001-2007, under three sampling designs (Beason et al. 2008).

The Pawnee National Grassland (PNG) designated four birds as Management Indicator Species (MIS): Ferruginous Hawk (*Buteo regalis*), Mountain Plover (*Charadrius montanus*), Burrowing Owl (*Athene cunicularia*), and Lark Bunting (*Calamospiza melanocorys*). Ferruginous Hawks, Mountain Plovers and Burrowing Owls were detected in extremely low numbers under the monitoring programs described here. I estimated densities, observed population trends, and ability to detect population trends for Lark Buntings on the PNG and within the Shortgrass Prairie and Grasslands within Colorado.

Simulation results indicated that it would require much longer than 40 years to detect a 3% average annual population decline in Lark Buntings on the PGN with the sampling level used in 1999-2007 under either the Monitoring Colorado's Birds (MCB) or Section-based Survey (SS) designs. In contrast, a similar decline could be detected state-wide in BCR 18 within 20 years using the MCB Grasssland transect data at the level sampled in 1999-2007.

These findings indicate that only one of the four PNG avian MIS was sufficiently monitored on the PNG under the sampling design used in 1999-2007. Different sampling designs would be required to monitor Ferruginous Hawks and Burrowing Owls. Additional transects or alternative techniques within the Pawnee National Grassland would be required to obtain monitoring information on Mountain Plovers

Broad-scale avian monitoring programs, such as MCB or BCR based sampling designs, will continue to be necessary for interpreting estimates of population status and trend for avian Management Indicator Species on the Pawnee National Grassland.

ACKNOWLEDGEMENTS

This project was funded by the U.S. Forest Service, through a challenge cost share agreement between the Forest Service Rocky Mountain Region and Rocky Mountain Bird Observatory (03-CS-11021300-023 Modification number 3). I sincerely thank Robert Skorkowsky of the U.S. Forest Service for his support of avian monitoring programs throughout Colorado and regionally. Thanks also to the many individual field technicians who collected the avian point count data used in this report. Special thanks to Paul Lukacs of the Colorado Division of Wildlife for providing the computer code used to conduct simulations of the power to detect population trends.

TABLE OF CONTENTS

INTRODUCTION

Rocky Mountain Bird Observatory (RMBO) surveyed birds in Grasslands in Colorado and within the Shortgrass Prairie Bird Conservation Region (BCR 18), including the Pawnee National Grassland, in 1999-2007. RMBO conducted surveys under two monitoring programs that used different sampling frames. Our objectives were to monitor population trends and distributions of breeding birds.

RMBO established the first program in 1998 to monitor bird populations throughout Colorado (Monitoring Colorado's Birds; MCB). Sampling design was based on habitat strata, with 30 transects randomly located in each of 11 habitats, including grasslands. RMBO sampled bird populations in grassland habitat in 1999-2005. In 2007, we used a new, spatially balanced sampling frame to select transects within the Colorado portion of the Shortgrass Prairie Bird Conservation Region (BCR18). We surveyed 3-5 MCB transects within the Pawnee National Grassland each year.

RMBO established a separate program in 2001 to monitor birds at the scale of BCR 18, including portions of Colorado, Nebraska, Kansas, Oklahoma, and New Mexico. Under this program, the sampling unit was a legal Section (1 mile x 1 mile, based on the Public Land Survey System), and sampling was conducted from roads. We surveyed 8-68 Sections within Pawnee National Grassland each year.

The PNG designated four avian species as Management Indicator Species (MIS) as part of its Management Plan: Ferruginous Hawk (*Buteo regalis*), Mountain Plover (*Charadrius montanus*), Burrowing Owl (*Athene cunicularia*), and Lark Bunting (*Calamospiza melanocorys*). Comparisons between trends in state- or BCR-wide populations and PNG populations of avian MIS may provide a basis for reviewing management actions (Ghormley and Wiley 2005). The comparison of trends can be evaluated to determine how bird populations are responding at local (PNG) scales compared to the state of Colorado and regionally. This information can assist in determining how individual Grasslands are managing for the designated MIS species.

Herein, I present density estimates and estimated ability to detect population trends for the avian MIS of the Pawnee National Grassland. In addition, I provide state-wide and BCR 18-wide estimates of the same species in similar habitats using MCB data and Section Survey Data.

METHODS

Study Area

RMBO and its partners used digital GAP vegetation maps to define habitat strata (e.g., Grasslands) for the Monitoring Colorado's Birds program, and placed transects within strata without respect to land ownership. RMBO did not survey MCB Grassland transects in 2006. In 2007, RMBO established a new sampling frame within native prairie habitat of BCR 18 in Colorado, using a spatially balanced sampling algorithm to establish new point transects (Table 1).

RMBO and its partners designed the Shortgrass Prairie (BCR 18) Section Survey program to sample birds within three habitat strata: native prairie, dryland agriculture, and Conservation Reserve Program. We randomly selected 1-mi^2 sections for sampling in proportion to the area of each stratum on the landscape. In 2002-2005, Pawnee National Grassland was specifically targeted for monitoring (Table 1).

Table 1. Numbers of transects surveyed under the Monitoring Colorado's Birds program (MCB) and sections surveyed under the BCR 18 Section Survey program on the Pawnee National Grassland. MCB transects consisted of 15 survey points. Section Survey samples usually consisted of 3 survey points.

	1999	2000	2001	2002	2003	2004	2005	2007	Total
MCB Transects	4	3	3	4	4	5	5	5	33
BCR 18 Sections			8	68	48	48	47		219

Field Methods

Both MCB and Section Survey monitoring used point transect sampling. MCB transects consisted of 15 points located at 250 m intervals along each transect. Additional details of the MCB program can be found in Beason et al. (2008). Section Surveys consisted of 3-4 points randomly located along roads bounding a 1-mi^2 section. If roads occurred on 3-4 sides of a section, one point was selected per side (up to 4 points in 2001 and up to 3 points in subsequent years). If roads occurred on only one or two sides of a section, two or three points would occur along individual roads. Survey points were at least 322 m apart and at least 161 m from section corners. Data were collected within the targeted section, 180 degrees surrounding the observer. Additional details of section-based monitoring of breeding birds within the shortgrass prairie can be found in Sparks and Hanni (2006). Each transect was surveyed by one observer collecting data for five minutes per point following protocol established by Leukering et al. (1998) and modified by RMBO in 2006. Technicians conducted all transect surveys in the morning, between ½-hour before sunrise and 11 AM; most surveys were completed before 10 AM.

Point transect sampling is based on distance sampling theory, which estimates detection probability as a function of the distances between the observer and the birds detected (Buckland et al. 1993). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Details of field sampling methods appear in the 2007 MCB annual report (Beason et al. 2008). Following is a brief summary of the sampling protocol.

Data 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). 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. These assumptions are reasonably well met following the MCB protocol. 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, I analyzed the data separately for each species.

I used Program Distance 5.0 (Thomas et al. 2006) to estimate the density of each bird species. I 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). I 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).

I modeled observed trends in populations of the one MIS for which there was sufficient data (see below), using both state-wide (MCB) and PNG data. I used weighted regression and Information-Theoretic model selection (Burnham and Anderson 2002). I modeled 4 different functions using Proc REG in program SAS (SAS Institute 2007): no trend (intercept only model), linear trend, quadratic trend, and log-linear (pseudo-threshold) trend. Input data were density estimates and their variances, with the inverse of the Coefficient of Variation used as a variable weight (giving more weight to more precise estimates).

I simulated the time to detect population trends on the PNG for each MIS in each habitat for which there were sufficient numbers of detections. Time to detect trends was evaluated at the MCB target levels of 3% average annual population change with power = 0.80 and alpha = 0.10 (Leukering et al. 2000). I used a power simulation created in Program R by Paul Lukacs of the Colorado Division of Wildlife. The simulation includes state and observation processes and uses empirical data from the MCB program as model input. The state model defines the initial population density and trend through time using estimated density and the variance of estimated density. The state model also includes the mean and variance of the trend we are hoping to detect; here I modeled an average annual change of 3%, allowing the change to vary stochastically between 1% and 5%. The observation model defines the detection process and sample size through time, using the coefficient of variation (CV) of estimated detection probability and the CV of estimated encounter rate. These are the two sources of variation that influence the variation in estimated density. I ran simulations for 5, 10, 15, …, 40 years with 1000 replications. Although a 3% annual population change (e.g., decline) may seem small, the result of a constant 3% decline over 24 years would be a loss of one-half of a population. Note that these simulations do not evaluate whether or not a change in the population has occurred; rather, they evaluate our power to detect a trend if the trend had occurred. Also note that we would be able to detect a greater rate of population change (e.g., 5% or 10% change annually) in a much shorter amount of time.

RESULTS

Buckland et al. (2001) recommend 60-80 observations to fit a detection curve to Distance data. Sample sizes were sufficient to estimate density each year for only one MIS (Lark Bunting) on the Pawnee NG. The remaining three species each yielded 0-3 observations per year, per program.

Simulation results indicated that it would require much longer than 40 years to detect a 3% average annual population decline in Lark Buntings on the PGN with the sampling level used in 1999-2007 under either the MCB or SS designs. In contrast, a similar decline could be detected state-wide within 20 years using the MCB Grasssland transect data at the level sampled in 1999-2007.

Ferruginous Hawk

Only 15 Ferruginous Hawks were detected over all years from both MCB and BCR 18 section surveys on the Pawnee NG (Table 2). These low counts are not surprising given that only 57 Ferruginous Hawks were detected in all years of the MCB program, from 9601 points surveyed in grassland, sage shrubland, and semi-desert shrubland habitat in 1999-2007. Similarly, only 18 Ferruginous Hawks were detected from 2533 section survey points in Colorado across years.

Table 2. Detections of Ferruginous Hawks on the Pawnee National Grassland from two monitoring programs: Monitoring Colorado’s Birds (MCB) and Section Surveys (SS).

	1999	2000	2001	2002	2003	2004	2005	2007	Total
MCB	2	1	0	3	1	0	1	2	10
SS			2	3	0	0	0		5
Total	2	1	2	6	1	0	1	2	15

Mountain Plover

Only 5 Mountain Plovers were detected over all years from BCR 18 section surveys and none were detected during MCB surveys on the Pawnee NG (Table 3). Twenty-seven Mountain Plovers were detected in all years of the MCB program, from 3590 points surveyed in grassland habitat in 1999-2007, and 8 were detected from 2533 section survey points in Colorado across years.

Table 3. Detections of Mountain Plovers on the Pawnee National Grassland from two monitoring programs: Monitoring Colorado's Birds (MCB) and Section Surveys (SS).

	1999	2000	2001	2002	2003	2004	2005	2007	Total
MCB	0	0	0	0	0	0	0	0	0
SS			0	3	0	0	2		5
Total	0	0	0	3	0	0	2	0	5

Burrowing Owl

Only 8 Burrowing Owls were detected over all years from BCR 18 section surveys and none were detected during MCB surveys on the Pawnee NG (Table 4). In contrast, 108 Burrowing Owls were detected statewide through MCB surveys in a variety of habitats in 1999-2007. Eighty-four Burrowing Owls were detected from 2533 section survey points in Colorado across years.

Table 4. Detections of Burrowing Owls on the Pawnee National Grassland from two monitoring programs: Monitoring Colorado's Birds (MCB) and Section Surveys (SS).

	1999	2000	2001	2002	2003	2004	2005	2007	Total
MCB	0	0	0	0	0	0	0	0	0
SS			0	3	0	3	2		8
Total	0	0	0	3	0	3	2	0	8

Lark Bunting

The Lark Bunting was the only avian MIS of the Pawnee National Grassland that was detected in large numbers (Table 5), allowing for estimation of density and population trend on the Pawnee NG.

Table 5. Detections of Lark Buntings on the Pawnee National Grassland from two monitoring programs: Monitoring Colorado's Birds (MCB) and Section Surveys (SS).

	1999	2000	2001	2002	2003	2004	2005	2007	Total
MCB	216	278	194	138	393	261	273	415	2168
SS			103	84	379	303	239		1108
Total	0	0	0	3	0	3	2	0	8

Lark Bunting Density estimates showed high annual variation and were similar using MCB and Section Survey data within the Pawnee NG (Tables 6 and 7 and Figure 1). Density estimates from the Pawnee NG were higher than in BCR 18 as a whole in most years and higher than from state-wide MCB grassland transects. Note that some MCB grassland transects fall outside of the normal breeding range of Lark Buntings, therefore one would expect LARB densities to be higher on PNG than state-wide.

Table 6. Estimated densities of Lark Buntings in grasslands throughout Colorado and on the Pawnee National Grassland from Point Transect surveys, 1999-2007[a].

	Colorado					Pawnee National Grassland				
Year	D	LCL	UCL	%CV	n	D	LCL	UCL	%CV	n
1999	79	61	103	16	883	90	68	118	13	203
2000	43	27	67	27	500	78	58	105	18	210
2001	69	50	97	20	643	257	199	332	14	186
2002	13	7	25	40	192	45	23	87	32	112
2003	60	43	83	19	986	174	152	200	7	389
2004	50	29	86	33	545	64	44	91	21	244
2005	33	25	42	16	751	56	37	85	25	250
2007	84	67	105	14	1481	140	120	163	9	389

[a] *D* = estimated density (birds/km^2); *LCL* and *UCL* = lower and upper 90% confidence limits on *D*; *%CV* = percent coefficient of variation of *D*; *n* = number of observations used to estimate *D*.

Table 7. Estimated densities of Lark Buntings within the Colorado Shortgrass Prairie (BCR 18) and on the Pawnee National Grassland from Section surveys, 2001-2005[a].

	CO excluding Pawnee NG					Pawnee National Grassland				
Year	D	LCL	UCL	%CV	n	D	LCL	UCL	%CV	n
2001	99	93	107	4	6452	307	161	587	40	96
2002	12	10	14	10	836	15	10	23	27	60
2003	138	122	156	7	3018	134	105	170	15	142
2004	37	35	40	4	2896	90	68	119	17	159
2005	53	45	62	10	2798	85	65	111	16	163

[a] *D* = estimated density (birds/km^2); *LCL* and *UCL* = lower and upper 90% confidence limits on *D*; *%CV* = percent coefficient of variation of *D*; *n* = number of observations used to estimate *D*.

Lark Buntings showed no evidence of population change from either state wide MCB surveys or within the Pawnee NG from either monitoring program; the best approximating model was the intercept-only (constant) model (Figure 1).

Simulation results indicated that it would require much longer than 40 years to detect a 3% average annual population decline in Lark Buntings on the PGN with the sampling level used in 1999-2007 under either the MCB or SS designs. In contrast, a similar decline could be detected state-wide within 20 years using the MCB Grasssland transect data at the level sampled in 1999-2007.

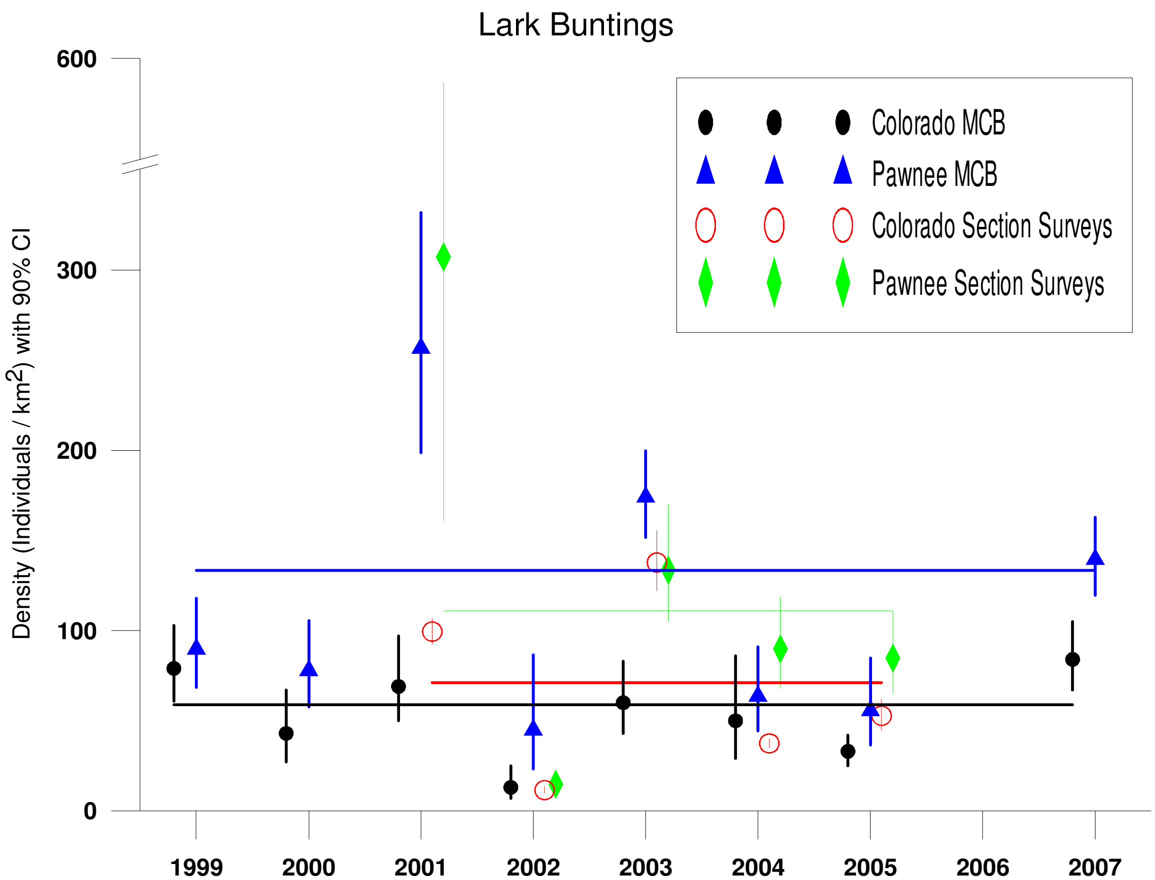

Figure 1. Estimated densities and population trend of Lark Buntings, 1999-2007. Error bars represent 90% confidence intervals. The solid lines represent the best estimates of observed population trend for each data set.

DISCUSSION AND RECOMMENDATIONS

Monitoring avian Management Indicator Species requires rigorous long-term sampling. The MCB transect and BCR 18 section survey sampling designs have yielded precise density estimates for many breeding landbirds, especially passerines (Beason et al. 2008). Of the four PNG avian Management Indicator Species, only the Lark Bunting was monitored sufficiently in 1999-2007 to estimate densities through RMBO's monitoring programs.

Monitoring Ferruginous Hawks may be best achieved through a combination of demographic monitoring and dual frame sampling. Demographic monitoring would entail estimation of survival and reproductive rates of individual hawks. Dual frame sampling could be employed by counting hawks at known nesting locations (the first sampling frame) and searching for additional nesting hawks elsewhere within the study area (the second sampling frame).

Mountain Plovers and Burrowing owls in eastern Colorado were shown to occupy prairie dog colonies at much higher rates than grasslands or dryland agriculture

(Tipton et al. 2007). Distance sampling from point transects can be effective for estimating densities and population trends of Mountain Plovers and Burrowing Owls and may be focused in the most suitable habitats for these species through stratified sampling designs.

LITERATURE CITED

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling. Oxford University Press, London, UK.

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

Beason, J., R. Sparks, J. Blakesley, C. White, A. Panjabi, and D. Hanni. 2008. *Monitoring Colorado's Birds: 2007 Field Season Report.* Tech. Rep. M-MCB07-01. Rocky Mountain Bird Observatory, Brighton, CO, 307 pp.

Ghormley, R., and L. K. Wiley. 2005. Rio Grande National Forest avian population monitoring protocol. 32 pp.

Hanni, D., C. McConnell, and T. Leukering. 2003. Section-based monitorig of grassland birds on National Grasslands. Rocky Mountain Bird Observatory, Brighton, CO, 53 pp.

Leukering, T., M. Carter, A. Panjabi, D. Faulkner, and R. Levad. 1998. Rocky Mountain Bird Observatory Point Transect Protocol: Revised 2006. Rocky Mountain Bird Observatory, Brighton, CO, 44 pp.

Sparks, R.A., and D. J. Hanni. 2006. Section-based Monitoring of Breeding Birds within the Shortgrass Prairie Bird Conservation Region (BCR 18). Rocky Mountain Bird Observatory, Brighton, CO, 160 pp.

Thomas, L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., Pollard, J.H., Bishop, J.R.B. and Marques, T.A. 2006. Distance 5.0. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Tipton, H. C., V. J. Dreitz, and P. F. Doherty, Jr. 2007. Occupancy of Mountain Plover and Burrowing Owl in Colorado. Journal of Wildlife Management 72:1001-1006.