Population Densities of Avian Management Indicator Species on the Medicine Bow National Forest

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In Cooperation With:

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EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory (RMBO) implemented habitat-stratified bird surveys on transects throughout Wyoming in 2002-2007. In 2005, the Medicine bow National Forest (MBNF) established additional transects within the MBNF boundaries. The RMBO and MBNF transects were surveyed following identical methods and protocols.

The MBNF designated five birds as Management Indicator Species (MIS) as part of its Forest Plan: Northern Goshawk (*Accipiter gentilis*), American Three-toed Woodpecker (*Picoides dorsalis*), Golden-crowned Kinglet (*Regulus satrapa*), Wilson's Warbler (*Wilsonia pusilla*), and Lincoln's Sparrow (*Melospiza lincolnii*).

I estimated density and ability to detect population trends for four of the five avian MIS of the Medicine Bow NF. I compared densities of the four species on the MBNF with densities in similar habitats throughout Wyoming.

Simulation results indicated that at the sampling level used in 2005-2007, we would be able to detect a 3% average annual population decline within 25 years for the Golden-crowned Kinglet, Wilson's Warbler, and Lincoln's Sparrow, and within 40 years for the American Three-toed Woodpecker within the MBNF.

These findings indicate that three of the MBNF MIS were sufficiently monitored within their primary habitats in the San Juan mountains under the sampling design used in 1998-2007. The fourth MIS could potentially be monitored with similar precision by adding several additional supplemental Spruce-Fir transects on the MBNF.

Broad-scale avian monitoring programs such as Monitoring Wyoming's Birds (MWB) will continue to be necessary for interpreting estimates of population status and trend for avian Management Indicator Species on the Medicine Bow NF.

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INTRODUCTION

In 2002, Rocky Mountain Bird Observatory (RMBO) established a program to monitor bird populations throughout Wyoming (Monitoring Wyoming's Birds; MWB). Sampling design was based on habitat strata, with 30 transects randomly located in 6 habitats. Bird populations were sampled each year, 2002-2007 (White and Sparks 2008). In 2005, the Medicine Bow National Forest (MBNF) established additional transects within the MBNF boundaries.

The MBNF designated five avian species as Management Indicator Species (MIS) as part of its Forest Plan: Northern Goshawk (*Accipiter gentilis*), American Three-toed Woodpecker (*Picoides dorsalis*), Golden-crowned Kinglet (*Regulus satrapa*), Wilson's Warbler (*Wilsonia pusilla*), and Lincoln's Sparrow (*Melospiza lincolnii*). The Northern Goshawk is monitored on National Forests through a bioregional monitoring design (Woodbridge and Hargis 2006).

Comparisons between trends in state-wide and MBNF biological populations of the remaining avian MIS may provide a basis of reviewing management actions (Ghormley and Wiley 2005). The comparison of trends can be evaluated to determine how bird populations are responding at local (MBNF) scales compared to the state of Wyoming. This information can assist in determining how individual Forests are managing for the designated MIS species.

Herein, I present density estimates and estimated ability to detect population trends for four of the avian MIS of the Medicine Bow NF. In addition, I provide state-wide estimates of the same species in similar habitats using MWB data when available.

METHODS

Study Area

Selection and locations of MWB point transects are described in the MWB annual reports (e.g., White and Sparks 2008). Habitat strata in the MWB program are: Aspen, Grassland, Juniper Woodland, Mid-elevation Conifer, Montane Riparian, and Shrubsteppe.

Ten Aspen, 3 Mid-elevation Conifer, and 5 Montane Ripairan MWB transects occurred within the MBNF (Table 1). In 2005, the MBNF established 26 supplemental transects within the MBNF: 10 in Montane Riparian, 11 in Spruce-Fir, and 5 transects selected without regard to habitat type. The supplemental transects on the MBNF were sampled each year through 2007, following the same protocol used to sample MWB transects.

Table 1. Point Transects used to estimate densities of Medicine Bow National Forest (MBNF) avian Management Indicator Species. Transect names beginning with "WY" are from the Monitoring Wyoming's Birds program conducted by Rocky Mountain Bird Observatory; names beginning with "WD" are supplemental transects added by the MBNF in 2005 and conducted by WYNDD.

Aspen	Mid-elevation Conifer	Montane Riparian	Spruce-Fir	Random
WY-AS11	WY-MC28	WY-MR65	WD-SF01	WD-NT03
WY-AS14	WY-MC33	WY-MR70	WD-SF08	WD-NT04
WY-AS20	WY-MC42	WY-MR78	WD-SF10	WD-NT05
WY-AS21-05		WY-MR79	WD-SF11	WD-NT14
WY-AS26		WY-MR82	WD-SF17	WD-NT15
WY-AS39		WD-RI01	WD-SF20	
WY-AS41		WD-RI02	WD-SF22	
WY-AS47		WD-RI03	WD-SF24	
WY-AS80		WD-RI04	WD-SF27	
WY-AS81		WD-RI05	WD-SF28	
		WD-RI07	WD-SF29	
		WD-RI08		
		WD-RI11		
		WD-RI14		
		WD-RI15		

Field Methods

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 MWB annual report (White and Sparks 2008). Following is a brief summary of the sampling protocol.

A transect consisted of 15 points located at 250 m intervals along each transect. 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.

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 MWB 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 pooled data across years to estimate a detection function for each species. 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).

Density estimates from the MWB program (White and Sparks 2008; used here for comparisons with MBNF estimates) included MWB transects that occurred on the MBNF but did not include supplemental transect.

Given that the number of transects sampled on the MBNF was low prior to 2005, there was insufficient data to estimate observed population trend (2005-2007).

I simulated the time to detect population trends on the MBNF for each MIS in each habitat for which there was a sufficient number of detections. Time to detect trends was evaluated at the MWB 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 MWB and MBNF transect samples 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 of each of the four MIS on the Medicine Bow NF in one or two habitats.

Simulation results indicated that at the sampling level used in 2005-2007, we would be able to detect a 3% average annual population decline within 25 years for the Golden-crowned Kinglet, Wilson's Warbler, and Lincoln's Sparrow, and within 40 years for the American Three-toed Woodpecker within the MBNF.

American Three-toed Woodpecker

Sixty-six of 96 American Three-toed Woodpeckers detected on the Medicine Bow National Forest occurred in Spruce-Fir habitat. Spruce-Fir habitat is not surveyed under the MWB program.

Table 2. Estimated densities of American Three-toed Woodpeckers in Spruce-Fir habitat on the Medicine Bow National Forest, 2005-2007[a].

	Medicine Bow National Forest				
Year	D	LCL	UCL	%CV	n
2005	10	3	29	69	6
2006	27	11	66	55	21
2007	37	16	84	50	30

[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*.

It would require 35-40 years to be able to detect a future population decline of 3% annually for the American Three-toed Woodpecker on the MBNF, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 2005-2007.

Golden-crowned Kinglet

Ninety-nine of 156 Golden-crowned Kinglets detected on the Medicine Bow National Forest occurred in Spruce-Fir habitat. Spruce-Fir habitat is not surveyed under the MWB program. The remaining detections were evenly spread between Aspen (17), Mid-elevation Conifer (10), Montane Riparian (17), and randomly placed transects (13); sample sizes within these strata were too small for density estimation.

Table 3. Estimated densities of Golden-crowned Kinglets in Spruce-Fir habitat on the Medicine Bow National Forest, 2005-2007[a].

	Medicine Bow National Forest				
Year	D	LCL	UCL	%CV	n
2005	78	40	152	39	12
2006	158	93	271	31	31
2007	221	136	358	28	40

[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*.

We would be able to detect a future population decline of 3% annually within 25 years for the Golden-crowned Kinglet on the MBNF, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 2005-2007.

Wilson's Warbler

Five hundred forty-six of 561 Wilson's Warblers detected on the Medicine Bow National Forest occurred in Montane Riparian habitat. Estimated density of Wilson's Warblers in Montane Riparian habitat of the MBNF was similar to state-wide (MWB) estimates in 2005 but was much higher in 2006 and 2007 (Table 4).

Table 4. Estimated densities of Wilson's Warblers in Montane Riparian habitat throughout Wyoming and on the Medicine Bow National Forest, 2002-2007[a].

	Wyoming					Medicine Bow National Forest				
Year	D	LCL	UCL	%CV	n	D	LCL	UCL	%CV	n
2002	60	32	112	38	82	40	7	225	99	17
2003	37	24	57	26	60	40	19	85	40	17
2004	48	29	78	29	64	41	23	76	33	16
2005	101	57	179	34	77	126	77	206	29	128
2006	25	14	44	36	53	226	134	382	32	166
2007	5	3	9	37	36	89	54	145	29	105

[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*.

We would be able to detect a future population decline of 3% annually within 25 years for the Wilson's Warbler on the MBNF, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 2005-2007.

Lincoln's Sparrow

Of 1173 Lincoln's Sparrows detected on the Medicine Bow National Forest, 941 occurred in Montane Riparian and 140 in Aspen habitats. The remaining detections were evenly spread between Mid-elevation Conifer (27), Spruce-Fir (39), and randomly placed transects (26); sample sizes within these strata were too small for density estimation.

Estimated densities of Lincoln's Sparrows in Aspen habitat were higher than state-wide (MWB) estimates. However, 90% confidence intervals of the MBNF and MWB estimates overlapped, due to the small sample sizes (and consequently large coefficients of variation) of the MBNF data (Table 5). Estimated density of Lincoln's Sparrows in Montane Riparian habitat was much higher on the MBNF than state-wide in 2005-2007.

Table 5. Estimated densities of Lincoln's Sparrows in Aspen habitat throughout Wyoming and on the Medicine Bow National Forest, 2002-2007[a].

	Wyoming					Medicine Bow National Forest				
Year	D	LCL	UCL	%CV	n	D	LCL	UCL	%CV	n
2002	2	1	7	83	5					0
2003	7	4	13	36	19					4
2004	13	8	23	33	31					12
2005	27	15	49	37	69	52	20	138	64	44
2006	17	9	32	38	49	35	14	90	62	23
2007	31	19	50	30	80	49	18	131	65	36

[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 6. Estimated densities of Lincoln's Sparrows in Montane Riparian habitat throughout Wyoming and on the Medicine Bow National Forest, 2002-2007[a].

	Wyoming					Medicine Bow National Forest				
Year	D	LCL	UCL	%CV	n	D	LCL	UCL	%CV	n
2002	109	40	300	67	116	210	83	529	56	39
2003	40	22	71	36	103	102	42	248	54	19
2004	67	42	108	28	155	280	93	843	66	42
2005	19	9	39	46	109	119	65	218	38	167
2006	39	26	58	24	189	714	478	1067	24	266
2007	22	16	32	22	178	330	203	536	29	231

[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*.

We would be able to detect a future population decline of 3% annually within 25 years for the Lincoln's Sparrow in Montane Riparian habitat on the MBNF, given the current estimates of density, variation in detection probability and encounter

rate, and the sampling design used in 2005-2007. However, it would require more than 40 years to detect a similar trend in Aspen habitat.

DISCUSSION AND RECOMMENDATIONS

Three of the MBNF MIS were sufficiently monitored within their primary habitats in the MBNF under the sampling design used in 2005-2007. The fourth MIS could probably be monitored with similar precision by adding several additional supplemental Spruce-Fir transects on the MBNF.

Monitoring avian Management Indicator Species requires rigorous long-term sampling. The habitat-stratified MWB program implemented in 2002-2008 provided a broad-scale reference of avian densities and population trends to which density and trend estimates from the individual Forests may be compared. We recommend adding Spruce-Fir habitat sampling to the MWB sampling design in order to compare estimates between individual forests and the state. National Forests can continue to contribute valuable information to understand broad-scale population status and trends of many avian species. At the same time, broad-scale programs will remain necessary to provide a context in which to interpret avian MIS monitoring programs.

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