# Population Densities and Trend Detection of Avian Management Indicator Species on the Rio Grande National Forest

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# EXECUTIVE SUMMARY

The Rio Grande National Forest (RGNF) is required to monitor six avian Management Indicator Species (MIS): Pygmy Nuthatch (*Sitta pygmaea*), Brown Creeper (*Certhia americana*), Hermit Thrush (*Catharus guttatus*), Wilson's Warbler (*Wilsonia pusilla*), Vesper Sparrow (*Pooecetes gramineus*) and Lincoln's Sparrow (*Melospiza lincolnii*). The RGNF avian MIS protocols require comparison of trends between the Forest or biological population and the state-wide population of each species. Biological populations were defined by the San Juan mountains geographic area.

Rocky Mountain Bird Observatory (RMBO) implemented habitat-stratified bird surveys on transects throughout Colorado in 1998-2007. In 2004, the RGNF established additional transects within the RGNF boundaries. The RMBO and RGNF transects were surveyed following identical methods and protocols. The comparison of trends can be accomplished through collaboration between the RGNF and RMBO.

I estimated density, observed population trends, and ability to detect population trends for the six avian MIS of the Rio Grande NF. Each analysis was conducted separately for two samples: (1), the Colorado state-wide (MCB) data, and (2) the RGNF or San Juan mountains (SJM) data.

None of the MIS showed evidence of population declines from 1998-2007 from the MCB data. The SJM data showed log-linear increases in populations of Pygmy Nuthatches in Ponderosa Pine, and Wilson's Warblers and Lincoln's Sparrows in High-elevation Riparian habitat. The SJM data showed a log-linear decrease in populations of Hermit Thrushes in Spruce-Fir habitat. The remaining MIS/habitat combinations showed no evidence of population change from the SJM or RGNF data.

Simulation results indicated that with the sampling level used in 1998-2007 for the RGNF or SJM, we would be able to detect a 3% average annual population decline within 20-30 years for the Pygmy Nuthatch in Ponderosa Pine, for the Hermit Thrush in both Ponderosa Pine and Spruce-Fir, for the Vesper Sparrow in Montane Grassland/Shrubland habitat, and for the Lincoln's Sparrow in High-elevation Riparian habitat. It would take 35 years to detect a similar trend from the Brown Creeper and Lincoln's Sparrow in Spruce-Fir. It would take > 40 years to detect a similar trend in Wilson's Warblers in High-elevation Riparian Habitat.

Simulation results indicated that with the sampling level used in 1998-2007 state-wide (MCB), we would be able to detect a 3% average annual population decline within 20-30 years for all MIS/habitat combinations except the Vesper Sparrow in Montane Grassland/Shrubland habitat (40 years).

These findings indicate that four of the RGNF MIS were sufficiently monitored within their primary habitats in the San Juan mountains under the sampling design used in 1998-2007. However, the Brown Creeper and especially the Wilson's Warbler were not sampled sufficiently to be able to detect substantial population declines within the San Juan mountains.

Broad-scale avian monitoring programs such as MCB will continue to be necessary for interpreting estimates of population status and trend for avian Management Indicator Species on the Rio Grande NF.

## ACKNOWLEDGEMENTS

This project was funded by the U.S. Forest Service, through a cooperative agreement between the San Juan National Forest and Rocky Mountain Bird Observatory. 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

In 1998, Rocky Mountain Bird Observatory (RMBO) established a program to monitor bird populations throughout Colorado (Monitoring Colorado's Birds; MCB). Sampling design was based on habitat strata, with 30 transects randomly located in 11 habitats. Bird populations were sampled each year, 1998-2007, although not all habitats were sampled each year. Many of the transects, especially in forested habitats, occurred on lands administered by the U.S. Forest Service (USFS). In addition, in 2004, the Rio Grande National Forest (RGNF) established additional transects within the RGNF boundaries: 1 in High-elevation Riparian Habitat, 9 in Montane Grassland habitat, and 5 in Ponderosa Pine habitat.

The RGNF designated six avian species as Management Indicator Species (MIS) as part of its Forest Plan. Each of the MIS was selected for monitoring by the RGNF to evaluate the quantity and quality of its primary habitat. Comparisons between trends in state-wide and RGNF biological populations of avian MIS would be the basis of reviewing management actions (Ghormley and Wiley 2005). The comparison of trends can be accomplished through collaboration between the RGNF and RMBO.

Recognizing that Forest boundaries rarely define bird populations, the RGNF defined the boundary of biological populations of five of its avian MIS as the San Juan mountains geographic area (Ghormley and Wiley 2005). Following the classification system used for the White River National Forest (Potter 2004, 2006a, 2006b), I delineated the San Juan mountains based the National Hierarchy of Ecological Units (Bailey 1995). Under this classification, the RGNF falls within the South-Central Highlands Section of the Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province. The RGNF chose to monitor six avian MIS: Pygmy Nuthatch, Brown Creeper, Hermit Thrush, Wilson's Warbler, Vesper Sparrow and Lincoln's Sparrow. Boundaries of the Vesper Sparrow population were defined by RGNF boundaries.

The Pygmy Nuthatch is found almost exclusively in Ponderosa Pine habitat and was monitored in this habitat in the San Juan mountains (SJM). The Brown Creeper is found in coniferous forests and was monitored in Spruce-Fir habitat in the SJM. The Brown Creeper was also observed in Ponderosa Pine habitat, but with insufficient sample size for monitoring its population in the SJM. The Hermit Thrush is found in coniferous forests and was monitored in Ponderosa Pine and Spruce-Fir habitats in the SJM. The Wilson's Warbler is found primarily in Riparian habitat and was monitored in High-elevation Riparian habitat in the SJM. The Vesper Sparrow was monitored in its primary habitat in the RGNF, Montane Grassland/Shrubland. The Lincoln's Sparrow inhabits Riparian and coniferous forest habitats and was monitored in High-elevation Riparian and Spruce-Fir habitats in the SJM.

Herein, I present (1) density estimates, (2) observed trends, and (3) estimated ability to detect population trends for the six avian MIS of the Rio Grande NF. Each analysis was conducted separately for two samples: (1), the Colorado state-wide (MCB) data, and (2) the RGNF or San Juan mountains data.

# METHODS

## Study Area

Selection and locations of MCB point transects are described in the MCB annual reports (e.g., Beason et al. 2008). Habitat strata in the MCB program are: Alpine Tundra, Aspen, Grassland, High-elevation Riparian, Mixed Conifer, Montane Shrubland, Pinyon-Juniper, Ponderosa Pine, Sage Shrubland, Semi-desert Shrubland, and Spruce Fir.

Six MCB High-elevation Riparian transects occurred within the San Juan mountains (Table 1). One "supplemental" High-elevation Riparian transect was established by the RGNF in 2004. One MCB Montane Shrubland transect occurred within the RGNF. The RGNF established nine "supplemental" Montane Shrubland transects on the RGNF in 2004. Twelve MCB Ponderosa Pine transects occurred within the San Juan mountains. The RGNF established five "supplemental" Ponderosa Pine transects on the RGNF in 2004. Twelve MCB Spruce-Fir transects occurred within the San Juan mountains. No additional Spruce-Fir transects were established by the RGNF. The supplemental transects on the Rio Grande National Forest were sampled each year through 2007, following the same protocol used to sample MCB transects.

Table 1. Point Transects used to estimate densities of Rio Grande National Forest (RGNF) Management Indicator Species. Transect names beginning with "CO" are from the MCB program; names beginning with "FS" are supplemental transects added by the RGNF in 2004.

| High-elevation Riparian | Montane Grassland/ Shrubland | Ponderosa Pine | Spruce-Fir |
|---|---|---|---|
| CO-HR01 | CO-MS24 | CO-PP02 | CO-SF01 |
| CO-HR03 | FS-MG01-04-RG | CO-PP04 | CO-SF06 |
| CO-HR16 | FS-MG02-04-RG | CO-PP07 | CO-SF07 |
| CO-HR22 | FS-MG03-04-RG | CO-PP08 | CO-SF11 |
| CO-HR26 | FS-MG06-04-RG | CO-PP09 | CO-SF18 |
| CO-HR28 | FS-MG07-04-RG | CO-PP17 | CO-SF19 |
| FS-HR01-04-RG | FS-MG10-04-RG | CO-PP18 | CO-SF21 |
| | FS-MG15-04-RG | CO-PP23 | CO-SF23 |
| | FS-MG16-04-RG | CO-PP24 | CO-SF24 |
| | FS-MG25-04-RG | CO-PP25 | CO-SF25 |
| | | CO-PP26 | CO-SF26 |
| | | CO-PP30 | CO-SF27 |
| | | FS-PP01-04-RG | |
| | | FS-PP03-04-RG | |
| | | FS-PP04-04-RG | |
| | | FS-PP10-04-RG | |
| | | FS-PP11-04-RG | |

## 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 MCB annual report (Beason et al. 2008). Following is a brief summary of the sampling protocol.

Each transect consisted of 15 points located at 250 m intervals along the 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 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 excluded all supplemental transects on the Rio Grande NF from analyses to estimate state-wide population densities from the MCB data. Therefore, estimates in the MCB 2007 annual report (Beason et al. 2008) may differ slightly from those reported herein.

I modeled observed trends in populations of the six MIS in their targeted habitats, using both state-wide (MCB) and RGNF or San Juan mountains (including supplemental transect) data. I used weighted regression and Information-Theoretic model selection (Burnham and Anderson 2002). For each species 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 for each MIS in its target habitat, separately for state-wide (MCB) transects and the RGNF or San Juan mountains transects (including RGNF supplemental transects). 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 of each MIS on the Rio Grande NF in one or two habitats.

None of the MIS showed evidence of population declines from 1998-2007 from the MCB data. The SJM data showed log-linear increases in populations of Pygmy Nuthatches in Ponderosa Pine, and Wilson's Warblers and Lincoln's Sparrows in High-elevation Riparian habitat. The SJM data showed a log-linear decrease in populations of Hermit Thrushes in Spruce-Fir habitat. The remaining MIS/habitat combinations showed no evidence of population change from the

SJM data. There were insufficient years of data from montane grassland/shrubland to evaluate observed population trends for Vesper Sparrows.

Simulation results indicated that at the sampling level used in 1998-2007, we would be able to detect a 3% average annual population decline within 30 years for five of the six species and within 40 years for the Vesper Sparrow with the state-wide (MCB) data. We would be able to detect a similar trend within 30 years for four species, and within 35 years for the Brown Creeper with the data from the RGNF or San Juan mountains. It would require more than 40 years to detect a 3% average annual population decline of Wilson's Warblers within the San Juan mountains.

## Pygmy Nuthatch

Estimated density of Pygmy Nuthatches in Ponderosa Pine habitat was consistently higher in the San Juan mountains than state-wide (Table 2).

Table 2. Estimated densities of Pygmy Nuthatches in Ponderosa Pine habitat throughout Colorado and within the San Juan mountains, 1998-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 19.1 | 10.8 | 33.8 | 35 | 80 | 33.6 | 20.1 | 56.2 | 30 | 40 |
| 1999 | 11.9 | 7.4 | 19.1 | 29 | 50 | 22.7 | 10.7 | 48.0 | 44 | 27 |
| 2000 | 24.3 | 15.9 | 37.1 | 25 | 85 | 36.1 | 25.5 | 51.2 | 20 | 43 |
| 2001 | 18.2 | 12.5 | 26.7 | 23 | 73 | 32.8 | 21.7 | 49.5 | 24 | 37 |
| 2002 | 20.6 | 13.5 | 31.4 | 26 | 58 | 48.2 | 28.7 | 81.0 | 30 | 50 |
| 2004 | 54.0 | 36.7 | 79.6 | 23 | 99 | 94.7 | 59.9 | 149.9 | 27 | 76 |
| 2005 | 18.0 | 11.7 | 27.7 | 26 | 63 | 34.4 | 22.0 | 53.9 | 26 | 54 |
| 2006 | 38.3 | 20.8 | 70.5 | 37 | 124 | 64.7 | 26.4 | 158.5 | 54 | 86 |
| 2007 | 76.3 | 55.3 | 105.1 | 19 | 223 | 114.0 | 75.1 | 172.9 | 24 | 109 |

[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*.

The SJM and MCB data showed a similar pattern of Pygmy Nuthatch population fluctuation over time. However, the best model of empirical population change for Pygmy Nuthatches showed an increase in the SJM and no evidence. of population change over the sampling period state-wide (Figure 1).

We would be able to detect a future population decline of 3% annually within 25 years for the Pygmy Nuthatch both state-wide and within the San Juan mountains, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1998-2007.

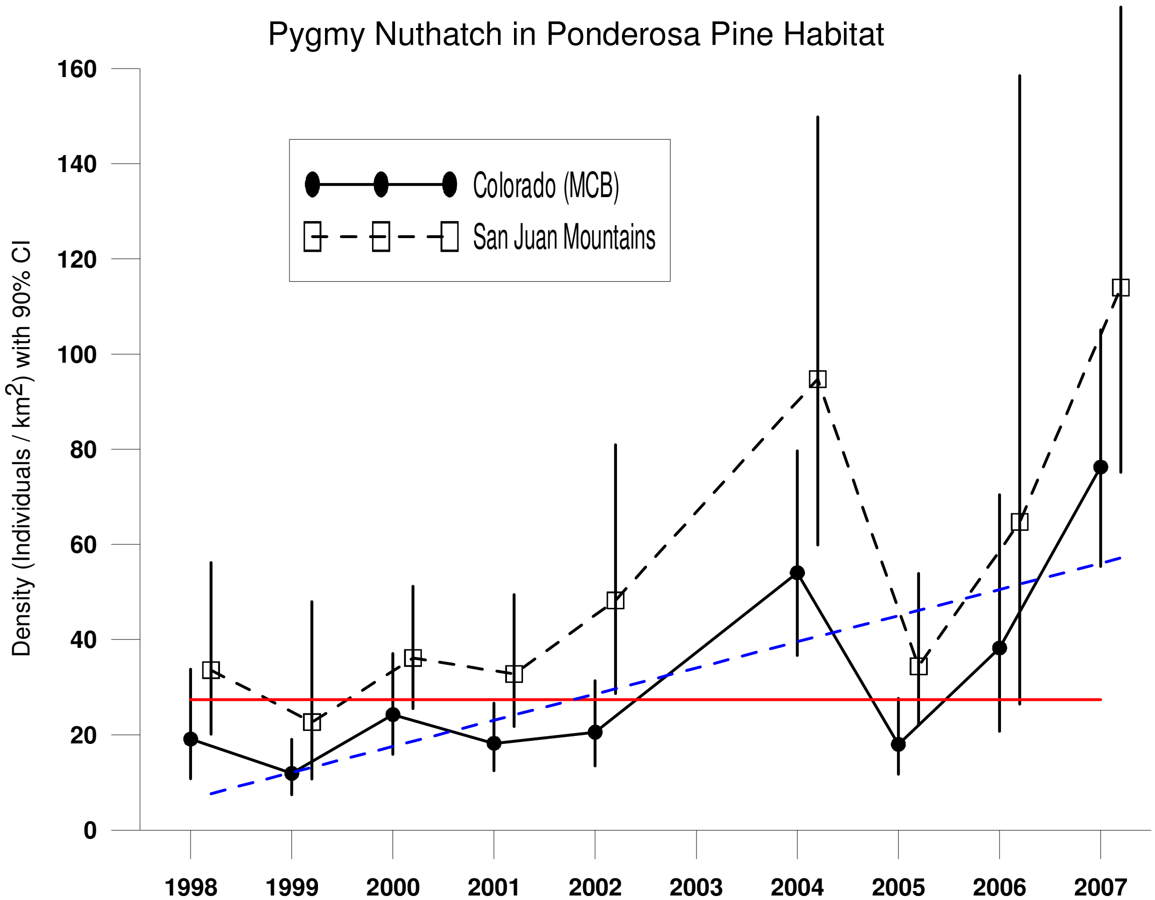


Figure 1. Estimated densities and population trend of Pygmy Nuthatches in Ponderosa Pine habitat throughout Colorado and in the San Juan mountains, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

## Brown Creeper

Estimated density of Brown Creepers in Spruce-Fir habitat was similar within Colorado (MCB) and the San Juan mountains in most years (Table 3).

Brown Creepers showed no evidence of population change either state wide or within the San Juan mountains from 1998-2007; the best approximating model was the intercept-only (constant) model (Figure 2).

Table 3. Estimated densities of Brown Creepers in Spruce-Fir habitat throughout Colorado and within the San Juan mountains, 1998-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 26.2 | 16.8 | 40.9 | 27 | 29 | 43.7 | 25.7 | 74.4 | 31 | 16 |
| 1999 | 30.2 | 19.1 | 47.7 | 28 | 30 | 49.2 | 28.6 | 84.7 | 31 | 15 |
| 2000 | 35.3 | 20.6 | 60.6 | 33 | 27 | 45.1 | 21.0 | 96.7 | 43 | 11 |
| 2001 | 18.2 | 10.4 | 31.7 | 34 | 18 | 6.0 | 1.9 | 18.6 | 70 | 2 |
| 2002 | 5.2 | 2.3 | 11.8 | 52 | 5 | 0.0 | | | | 0 |
| 2004 | 27.4 | 16.8 | 44.5 | 30 | 26 | 46.5 | 21.9 | 98.4 | 45 | 12 |
| 2005 | 18.4 | 10.7 | 31.7 | 33 | 19 | 33.3 | 16.0 | 69.4 | 43 | 12 |
| 2006 | 20.6 | 11.2 | 37.6 | 37 | 19 | 21.9 | 9.0 | 53.3 | 52 | 6 |
| 2007 | 38.6 | 23.5 | 63.3 | 30 | 38 | 56.6 | 24.7 | 129.9 | 49 | 19 |

[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*.

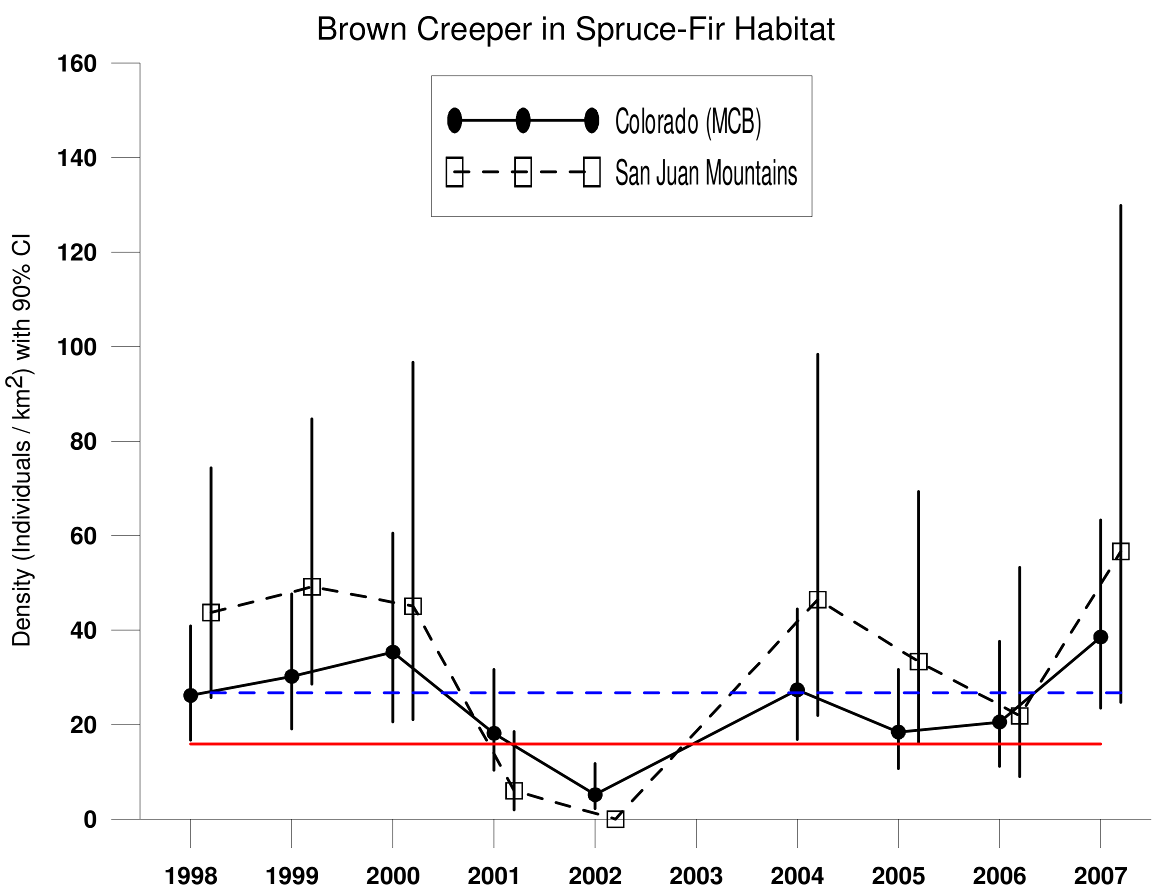


Figure 2. Estimated densities and population trend of Brown Creepers in Spruce-Fir habitat throughout Colorado and in the San Juan mountains, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

We would be able to detect a future population decline of 3% annually within 30 years for the Brown Creeper state-wide and within 35 years in the San Juan mountains, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1998-2007.

**Hermit Thrush**

Estimated density of Hermit Thrushes in Ponderosa Pine habitat was similar in Colorado (MCB) and within the San Juan mountains (Table 4). Estimated density of Hermit Thrushes in Spruce-Fir habitat was higher within the San Juan mountains than state-wide (MCB) in early years and similar in later years (Table 5). Densities of Hermit Thrushes were approximately four times higher in Spruce-Fir, the primary habitat of Hermit Thrushes, than in Ponderosa Pine.

Table 4. Estimated densities of Hermit Thrushes in Ponderosa Pine habitat throughout Colorado and within the San Juan mountains, 1998-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 7.2 | 4.0 | 12.8 | 36 | 102 | 10.0 | 5.2 | 19.2 | 38 | 76 |
| 1999 | 1.9 | 1.1 | 3.3 | 35 | 51 | 2.5 | 1.7 | 3.7 | 23 | 19 |
| 2000 | 6.1 | 3.9 | 9.4 | 26 | 94 | 5.0 | 2.7 | 9.2 | 35 | 38 |
| 2001 | 3.3 | 1.6 | 6.7 | 45 | 65 | 3.0 | 1.4 | 6.6 | 46 | 23 |
| 2002 | 1.9 | 1.1 | 3.0 | 29 | 58 | 5.0 | 2.7 | 9.3 | 35 | 34 |
| 2004 | 4.6 | 3.0 | 6.9 | 25 | 89 | 4.9 | 2.8 | 8.5 | 33 | 49 |
| 2005 | 2.7 | 1.4 | 5.3 | 41 | 115 | 4.7 | 3.2 | 7.0 | 23 | 51 |
| 2006 | 2.8 | 1.6 | 4.9 | 35 | 87 | 4.0 | 1.5 | 10.8 | 61 | 35 |
| 2007 | 7.1 | 4.1 | 12.1 | 33 | 99 | 4.1 | 2.3 | 7.1 | 33 | 31 |

[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 5. Estimated densities of Hermit Thrushes in Spruce-Fir habitat throughout Colorado and within the San Juan mountains, 1998-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 18.5 | 14.4 | 23.8 | 15 | 282 | 29.1 | 21.9 | 38.7 | 17 | 141 |
| 1999 | 14.5 | 10.6 | 19.8 | 19 | 220 | 23.5 | 14.6 | 37.8 | 27 | 115 |
| 2000 | 19.2 | 14.4 | 25.7 | 17 | 216 | 25.7 | 14.5 | 45.5 | 31 | 94 |
| 2001 | 17.6 | 13.5 | 23.0 | 16 | 288 | 18.4 | 13.8 | 24.5 | 16 | 144 |
| 2002 | 13.3 | 9.9 | 17.9 | 18 | 266 | 19.4 | 14.2 | 26.4 | 19 | 165 |
| 2004 | 13.0 | 9.5 | 17.8 | 19 | 202 | 19.3 | 13.3 | 28.1 | 23 | 90 |
| 2005 | 24.9 | 19.7 | 31.4 | 14 | 303 | 28.7 | 20.7 | 39.7 | 19 | 129 |
| 2006 | 17.9 | 14.5 | 22.2 | 13 | 290 | 13.2 | 7.5 | 23.5 | 32 | 78 |
| 2007 | 12.5 | 8.4 | 18.6 | 24 | 188 | 20.9 | 12.1 | 36.1 | 33 | 91 |

[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*.

Hermit Thrushes showed no evidence of population change in Ponderosa Pine Habitat either state wide or within the San Juan mountains, from 1998-2007; the best approximating model was the intercept-only (constant) model (Figure 3). Hermit Thrushes showed no evidence of population change in Spruce-Fir Habitat state wide from 1998-2007 (Figure 4). In contrast, there was evidence for a decreasing log-linear trend in population size between 1998 and 2007 in the San Juan mountains.

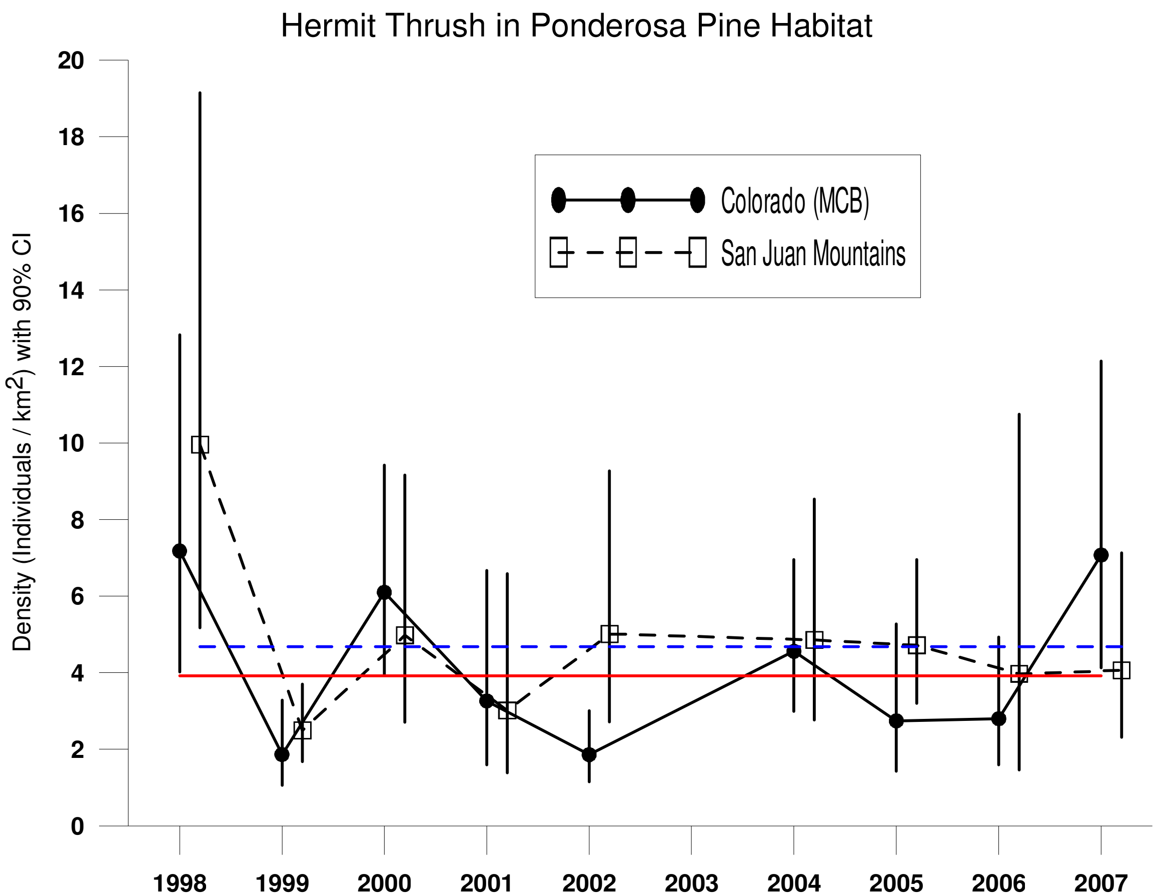


Figure 3. Estimated densities and population trend of Hermit Thrushes in Ponderosa Pine habitat throughout Colorado and in the San Juan mountains, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

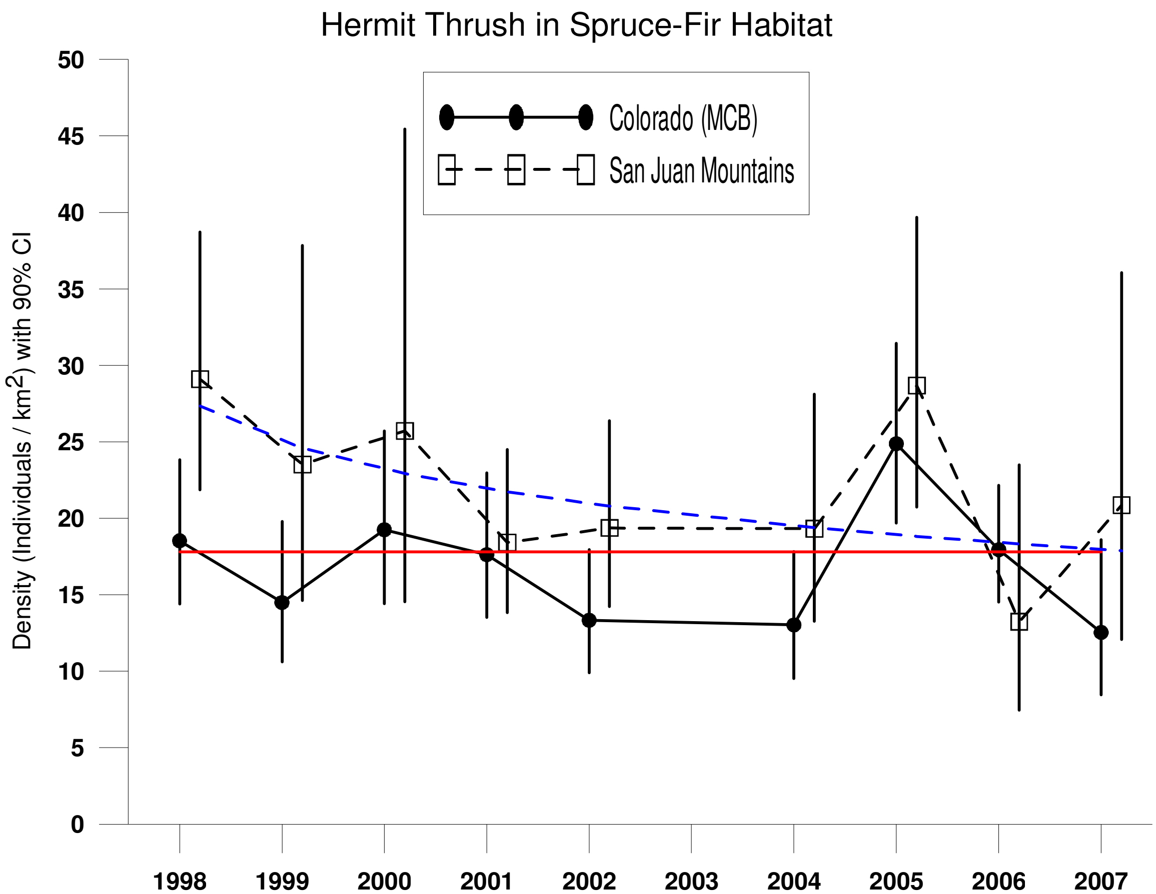


Figure 4. Estimated densities and population trend of Hermit Thrushes in Spruce-Fir habitat throughout Colorado and in the San Juan mountains, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

We would be able to detect a future population decline of 3% annually within 25 years for the Hermit Thrush in Ponderosa Pine habitat and within 20 years in Spruce-Fir habitat, both state-wide and within the San Juan mountains, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1998-2007.

## Wilson's Warbler

Estimated density of Wilson's Warblers in High-elevation Riparian habitat was higher in Colorado (MCB) than within the San Juan mountains (Table 6).

Table 6. Estimated densities of Wilson's Warblers in High-elevation Riparian habitat throughout Colorado and within the San Juan mountains, 1999-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1999 | 49.3 | 23.3 | 104.2 | 46 | 25 | 40.4 | 4.2 | 392.1 | 104 | 4 |
| 2000 | 98.7 | 56.2 | 173.4 | 35 | 59 | 20.2 | 7.6 | 53.9 | 57 | 4 |
| 2001 | 156.6 | 93.6 | 262.0 | 32 | 97 | 35.3 | 12.1 | 103.4 | 63 | 7 |
| 2002 | 209.3 | 119.5 | 366.7 | 34 | 123 | 66.6 | 15.6 | 283.9 | 83 | 11 |
| 2004 | 267.2 | 161.5 | 442.0 | 31 | 180 | 127.5 | 52.3 | 310.7 | 52 | 25 |
| 2005 | 181.0 | 118.6 | 276.2 | 26 | 119 | 122.6 | 50.8 | 295.8 | 52 | 27 |
| 2006 | 149.7 | 96.1 | 233.3 | 27 | 95 | 98.7 | 44.0 | 221.6 | 48 | 20 |
| 2007 | 204.2 | 126.7 | 329.2 | 29 | 136 | 60.5 | 16.8 | 218.2 | 72 | 8 |

[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*.

Wilson's Warblers showed no evidence of population change over the sampling period from the state-wide data. However, there was evidence for a log-linear increase in population size within the San Juan mountains (Figure 5).

We would be able to detect a future population decline of 3% annually within 25 years for the Wilson's Warbler state-wide given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1999-2007. However, we would be unable to detect a similar trend in the San Juan mountains within 40 years, given current estimates and the sampling design used in 1999-2007.

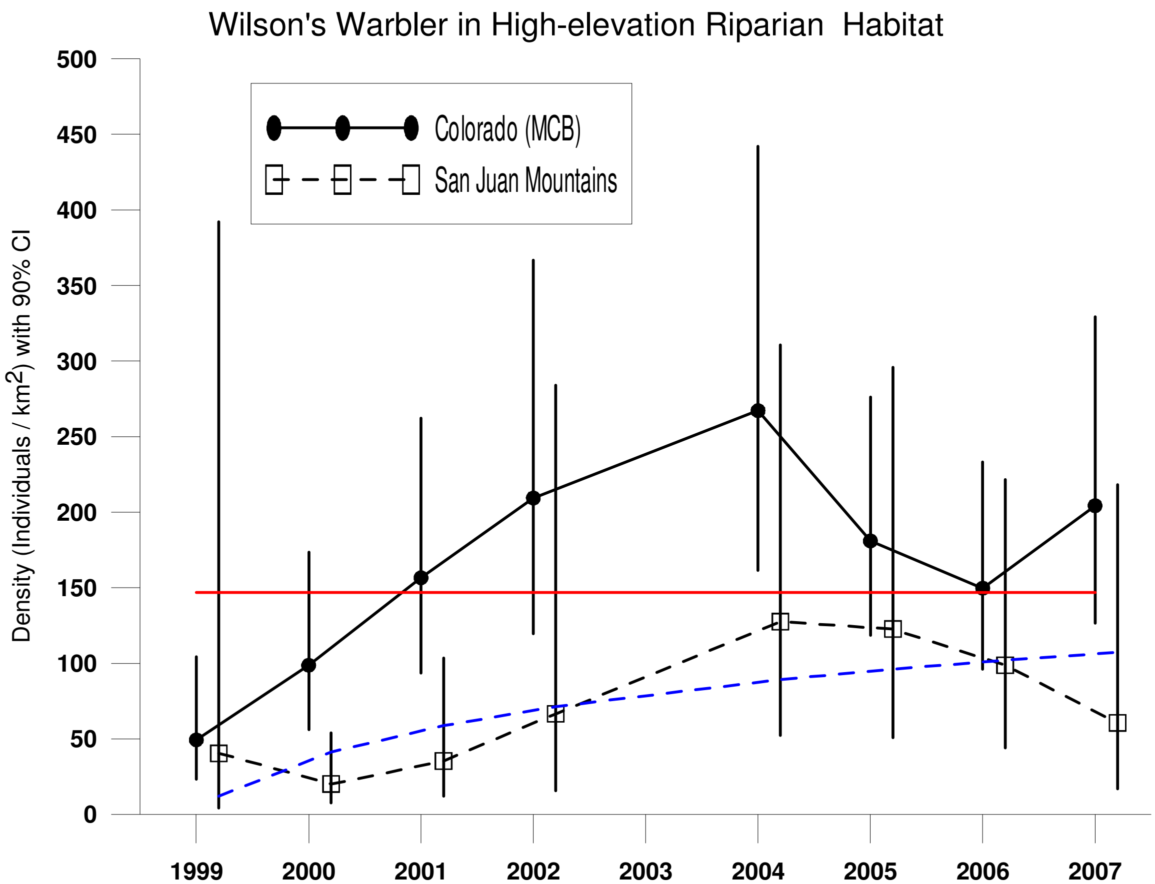


Figure 5. Estimated densities and population trend of Wilson's Warblers in High-elevation Riparian habitat throughout Colorado and in the San Juan mountains, 1999-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

## Vesper Sparrow

Although the estimated density of Vesper Sparrows in Montane Grassland/Shrubland habitat appeared to be higher in the Rio Grande National Forest than state-wide, this was likely driven by one year with a very high estimate for RGNF and few years of RGNF data overall (Table 7). Confidence intervals on estimates from MCB data were very large. Montane Shrubland habitat was not surveyed under the MCB program in 2006 nor 2007.

Vesper Sparrows showed no evidence of population change either state-wide from 1998-2005 or within the RGNF from 2004-2007 (Figure 6).

Table 7. Estimated densities of Vesper Sparrows in Montane Grassland/Shrubland habitat throughout Colorado and within the Rio Grande National Forest, 1999-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 7.4 | 2.9 | 18.6 | 59 | 15 | | | | | |
| 1999 | 3.9 | 1.3 | 12.0 | 73 | 10 | | | | | |
| 2000 | 4.3 | 1.8 | 10.4 | 57 | 11 | | | | | |
| 2001 | 8.3 | 3.4 | 20.3 | 57 | 18 | | | | | |
| 2002 | 6.0 | 2.4 | 15.0 | 59 | 17 | | | | | |
| 2004 | 3.9 | 1.7 | 8.6 | 51 | 11 | 22.5 | 14.9 | 33.9 | 23 | 37 |
| 2005 | 9.8 | 4.8 | 20.1 | 46 | 28 | 14.1 | 9.3 | 21.5 | 24 | 32 |
| 2006 | | | | | | 53.7 | 32.5 | 88.4 | 27 | 76 |
| 2007 | | | | | | 21.2 | 7.9 | 56.8 | 44 | 15 |

[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*.

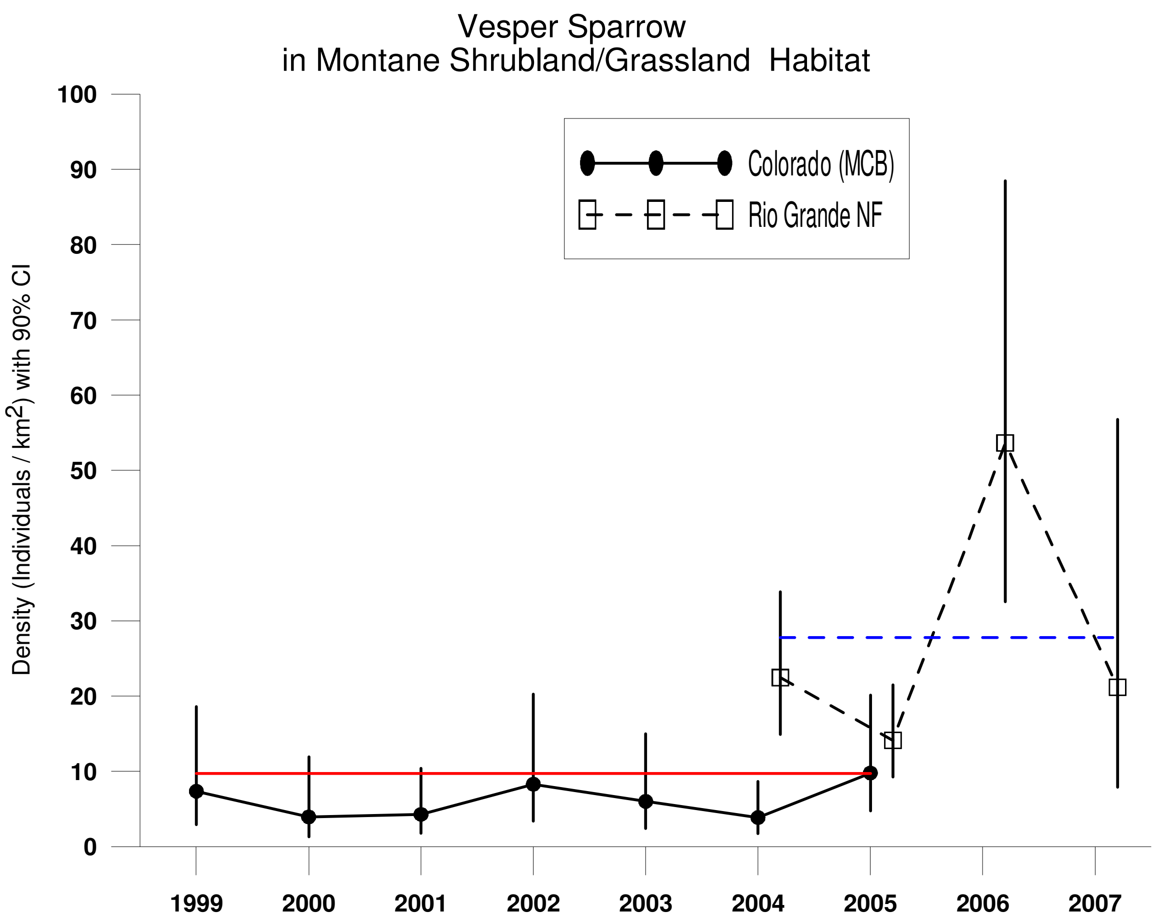


Figure 6. Estimated densities and population trend of Vesper Sparrows in Montane Grassland/Shrubland habitat throughout Colorado and in the Rio Grande National Forest, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the Rio Grande National Forest.

We would be able to detect a future population decline of 3% annually within 40 years for the Vesper Sparrow state-wide and within 25 years in the RGNF, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1998-2007.

## Lincoln's Sparrow

Estimated density of Lincoln's Sparrows in High-elevation Riparian habitat varied more state-wide (MCB) than within the San Juan mountains (Table 8). Estimated density of Lincoln's Sparrows in Spruce-Fir habitat was similar state-wide (MCB) and within the San Juan mountains in early years and higher state-wide in later years (Table 9). Density of Lincoln's Sparrows was more than ten times higher in High-elevation Riparian than in Spruce-Fir habitat.

Table 8. Estimated densities of Lincoln's Sparrows in High-elevation riparian habitat throughout Colorado and within the San Juan mountains, 1999-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1999 | 73.8 | 36.1 | 151.1 | 45 | 93 | 92.9 | 16.2 | 533.4 | 66 | 28 |
| 2000 | 208.0 | 120.4 | 359.5 | 34 | 208 | 107.9 | 36.8 | 316.5 | 58 | 65 |
| 2001 | 126.8 | 87.6 | 183.5 | 22 | 321 | 177.5 | 111.3 | 283.2 | 24 | 105 |
| 2002 | 434.6 | 206.6 | 914.2 | 47 | 307 | 125.4 | 62.2 | 253.1 | 34 | 63 |
| 2004 | 407.8 | 300.9 | 552.8 | 19 | 582 | 245.0 | 148.7 | 403.7 | 26 | 143 |
| 2005 | 289.5 | 193.7 | 432.6 | 25 | 559 | 219.5 | 124.5 | 387.0 | 30 | 146 |
| 2006 | 102.0 | 78.9 | 132.0 | 15 | 454 | 198.0 | 133.0 | 295.0 | 21 | 122 |
| 2007 | 121.4 | 93.2 | 158.2 | 16 | 516 | 243.9 | 148.1 | 401.8 | 24 | 98 |

[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 9. Estimated densities of Lincoln's Sparrows in Spruce-Fir habitat throughout Colorado and within the San Juan mountains, 1998-2007[a].

| | Colorado | | | | | San Juan Mountains | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | D | LCL | UCL | %CV | n | D | LCL | UCL | %CV | n |
| 1998 | 7.0 | 3.9 | 12.7 | 36 | 44 | 10.9 | 5.0 | 23.4 | 45 | 28 |
| 1999 | 4.3 | 2.5 | 7.2 | 31 | 24 | 6.0 | 2.6 | 13.8 | 48 | 13 |
| 2000 | 8.6 | 4.9 | 15.0 | 34 | 37 | 7.6 | 2.2 | 25.6 | 72 | 13 |
| 2001 | 9.3 | 6.1 | 14.1 | 25 | 52 | 10.2 | 6.4 | 16.3 | 27 | 24 |
| 2002 | 6.9 | 4.6 | 10.4 | 24 | 38 | 8.4 | 4.6 | 15.2 | 34 | 21 |
| 2004 | 11.1 | 6.9 | 17.8 | 29 | 69 | 3.5 | 1.3 | 9.7 | 62 | 9 |
| 2005 | 11.7 | 7.1 | 19.3 | 30 | 67 | 6.3 | 2.6 | 15.2 | 52 | 16 |
| 2006 | 13.6 | 8.5 | 21.8 | 28 | 71 | 6.7 | 3.6 | 12.7 | 35 | 13 |
| 2007 | 17.4 | 10.4 | 29.1 | 31 | 96 | 14.8 | 5.3 | 41.3 | 62 | 34 |

[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*.

Lincoln's Sparrows in High-elevation Riparian habitat showed no evidence of population change state wide from 1999-2007; the best approximating model was the intercept-only (constant) model (Figure 7). In contrast, there was evidence for an increasing log-linear trend in population size between 1999 and 2007 in the San Juan mountains. Lincoln's Sparrows in Spruce-Fir habitat showed no evidence of population change either state-wide or within the San Juan mountains from 1998-2007 (Figure 8).

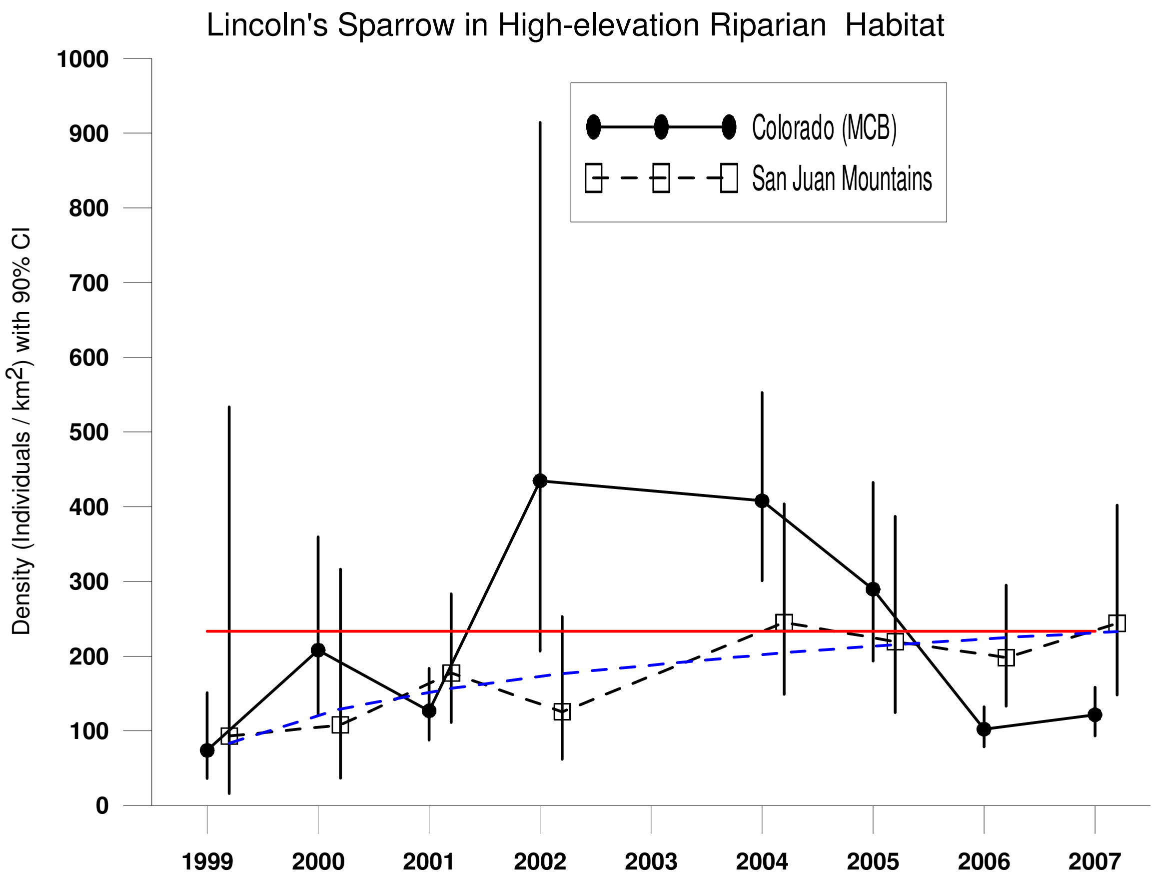


Figure 7. Estimated densities and population trend of Lincoln's Sparrows in High-elevation Riparian habitat throughout Colorado and in the San Juan mountains, 1999-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

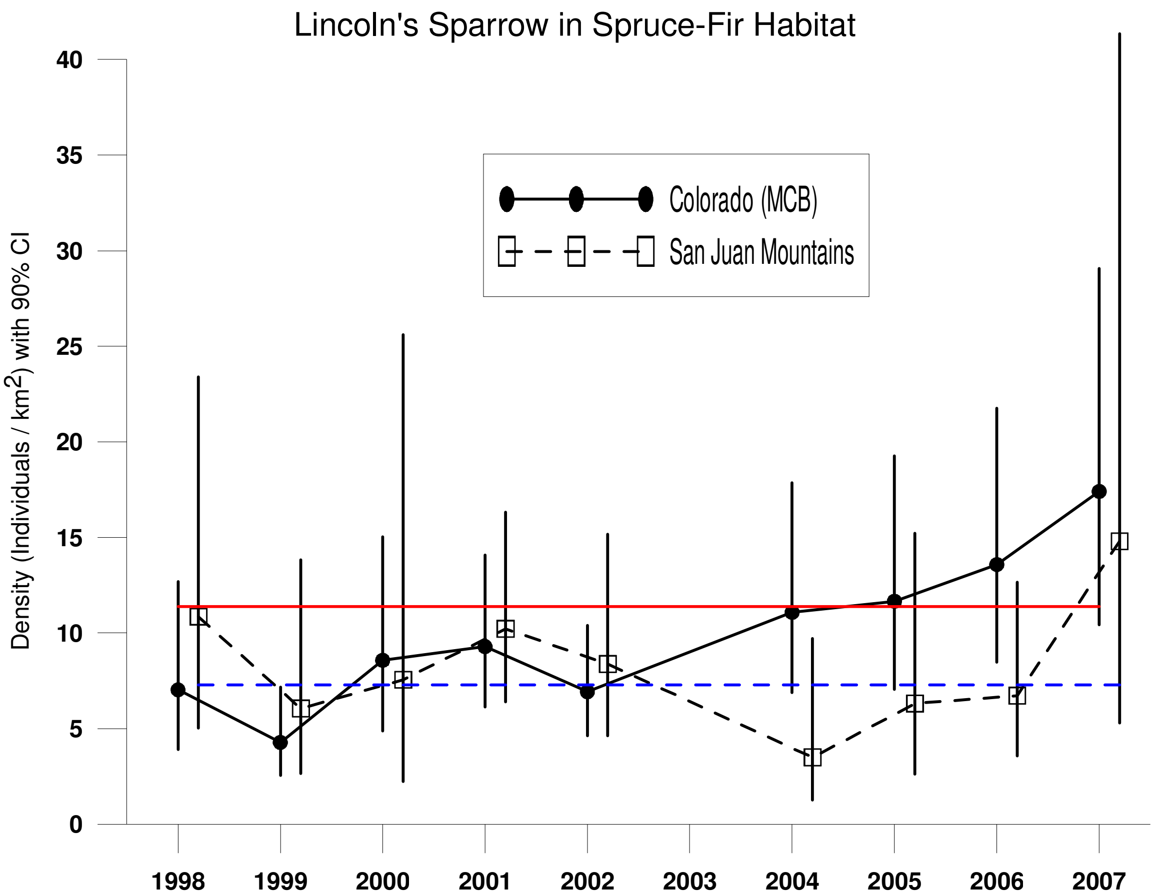


Figure 8. Estimated densities and population trend of Lincoln's Sparrows in Spruce-Fir habitat throughout Colorado and in the San Juan mountains, 1998-2007. Error bars represent 90% confidence intervals. The red (solid) line represents the best estimate of observed population trend for the MCB data. The blue (dashed) line indicates the best estimate of observed population trend for the San Juan mountains.

We would be able to detect a future population decline of 3% annually within 25 years for the Lincoln's Sparrow in High-elevation Riparian habitat state-wide and within in the San Juan mountains, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1999-2007. We would be able to detect a future population decline of 3% annually within 25 years for the Lincoln's Sparrow in Spruce-Fir habitat state-wide and within 35 years in the San Juan mountains, given the current estimates of density, variation in detection probability and encounter rate, and the sampling design used in 1998-2007.

## DISCUSSION AND RECOMMENDATIONS

Four of the RGNF MIS were sufficiently monitored within their primary habitats in the RGNF or San Juan mountains under the sampling design used in 1998-2007. However, the Brown Creeper and especially the Wilson's Warbler were not sampled sufficiently to be able to detect substantial population declines within the San Juan mountains.

The strategy used by the Rio Grande NF and other Forests in the Region to monitor avian Management Indicator Species relies upon rigorous long-term sampling of birds at two spatial scales. The habitat-stratified MCB program has provided a broad-scale reference of avian densities and population trends to which density and trend estimates from the individual Forests may be compared. Beginning in 2008, Rocky Mountain Bird Observatory and its partner agencies, including the US Forest Service, will be implementing a new sampling design for monitoring breeding landbirds in Colorado that is not based on habitat strata. However, each National Forest in Colorado will be a stratum. 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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# APPENDIX A

**Problems Encountered with RGNF Data**

During preparation of the data for Distance analysis, I noticed that some records appeared to be duplicates of others. On further inspection, I found that the exact same data had been entered for 2006 and 2007 for 9 transects, except for the date. Two additional transects had suspiciously similar data in 2006 and 2007. I did not include the 2007 data in analyses for these eleven transects (Table 10).

Table 10. Rio Grande National Forest transects for which 2007 data were excluded from analysis.

| Transect Number | Reason for exclusion |
|---|---|
| FS-HR01-04-RG | Duplicate of 2006 data |
| FS-MG02-04-RG | Duplicate of 2006 data |
| FS-MG03-04-RG | Suspiciously similar to 2006 data |
| FS-MG06-04-RG | Duplicate of 2006 data |
| FS-MG07-04-RG | Suspiciously similar to 2006 data |
| FS-MG10-04-RG | Duplicate of 2006 data |
| FS-MG15-04-RG | Duplicate of 2006 data |
| FS-PP01-04-RG | Duplicate of 2006 data |
| FS-PP04-04-RG | Duplicate of 2006 data |
| FS-PP10-04-RG | Duplicate of 2006 data |
| FS-PP11-04-RG | Duplicate of 2006 data |