Monitoring Birds in the Atlantic Rim Natural Gas Development Project Area; 2011 Report

March 2012

ROCKY MOUNTAIN BIRD OBSERVATORY
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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 the USDI Bureau of Land Management (BLM), conducted landbird monitoring on BLM and private lands south of Rawlins, WY, in the Atlantic Rim Natural Gas Development Project Area. 2011 marked the second year of an ongoing study to obtain data on avian species richness and individual species occupancy rates in areas currently undergoing different levels of energy development.

The study area was contained within lower elevations of Bird Conservation Region 10 (Northern Rockies) which is characterized by high-elevation mountain ranges with mixed conifer and intermountain regions dominated by sagebrush steppe and grasslands (US North American Bird Conservation Initiative Committee 2000). This project used a spatially balanced sampling design and a survey protocol similar to that implemented in a program entitled "Integrated Monitoring in Bird Conservation Regions (IMBCR)" (White et al. 2011). The IMBCR design allows inferences about avian species distributions and population sizes from small scales to entire BCRs, facilitating conservation at local and regional levels.

In 2011, we visited 16 survey locations, resulting in 209 individual point counts, in areas undergoing either "high-development" (*n* = 8 survey locations, 121 points) or "low-development" (*n* = 8 survey locations, 88 points) to compare levels of avian biodiversity and species occupancy rates. By collecting data during and after energy development, RMBO and its partners can ascertain the impact of different levels of energy development on individual species and avian species richness. Surveys were conducted between May 29th and July 3rd when the birds are known to be territorial and vocal. We observed 1,961 birds of 49 species during our surveys.

We used a multi-species extension to the multi-scale occupancy model to assess overall species richness among 23 avian species (total richness), species richness of 3 avian species designated as priority species by the Wyoming BLM (priority species richness), and the occupancy rates of each of the 23 individual species (species specific occupancy rates) at the survey location and point levels. Results indicated that there is currently no difference in total richness or priority species richness across the areas undergoing high and low levels of resource development. Species richness was found to be higher within the Atlantic Rim BLM lands than within other BLM lands in the Montana and Wyoming portions of BCR 10. Species specific occupancy rates differed across the two treatment groups in the Atlantic Rim for some species, with a single species occupying a higher proportion of 1 km^2 grid cells in areas undergoing low levels of energy development while five species preferred areas undergoing high levels of energy development.

ACKNOWLEDGEMENTS

Stratification and allocation of survey effort were determined in collaboration with the USDI Bureau of Land Management (BLM). Many individuals helped make the 2011 field season a success. We thank Frank Blomquist of the BLM-Wyoming for obtaining funds to conduct this research. We thank RMBO's IT personnel who 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's landowner liaison, Jenny Berven, contacted county assessors to determine land ownership of survey locations and determined road densities within the Atlantic Rim study area with ArcGIS. We thank Gary White, professor emeritus of Colorado State University, who implemented the multi-scale occupancy model in program MARK, which was used for estimating species richness. We also thank field technicians Geoff Gould, Tim Forrester, and Walt Wilson for collecting point count data in 2011. We are especially appreciative of the numerous private landowners that granted RMBO permission to survey on their lands. Finally, this report benefited greatly from review by RMBO staff.

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INTRODUCTION

Monitoring is an essential component of wildlife management and conservation science (Witmer 2005, Marsh and Trenham 2008). Common goals of population monitoring are to estimate the population status of target species and to detect changes in populations over time (Thompson et al. 1998, Sauer and Knutson 2008). Effective monitoring programs can identify species that are at-risk due to small or declining populations (Dreitz et al. 2006), provide an understanding of how management actions affect populations (Alexander et al. 2008, Lyons et al. 2008), evaluate population responses to landscape alteration and climate change (Baron et al. 2008, Lindenmayer and Likens 2009) as well as provide basic information on species distributions.

The apparent large-scale declines of avian populations and the loss, fragmentation and degradation of native habitats highlight the need for extensive and rigorous landbird monitoring programs (Rich et al. 2004, US North American Bird Conservation Initiative Committee 2009). As natural areas are developed due to a continuously increasing demand for energy resources, it is imperative for land managers to better understand the impacts subsequent landscape changes have on wildlife communities. Higher road densities to facilitate resource transportation may lead to an increase in non-native vegetation along the roads and fragmented habitats. Tall structures resulting from development provide prominent perches which may aid predators in locating prey and/or may dissuade prey species from residing in the area. Furthermore, noise associated with increased traffic volume and the operation of oil and natural gas rigs may interfere with aspects of avian communication that are vital to territory advertisement and attracting mates (Ingelfinger and Anderson 2004, Holloran 2005).

Before monitoring can be used by land managers to guide conservation efforts, sound program designs and analytic methods are necessary to produce unbiased population estimates (Sauer and Knutson 2008). At the most fundamental level, reliable knowledge about the status of avian populations requires accounting for spatial variation and incomplete detection of the target species (Pollock et al. 2002, Rosenstock et al. 2002, Thompson 2002). Addressing spatial variation entails the use of probabilistic sampling designs that allow population estimates to be extended over the entire area of interest (Thompson et al. 1998). Adjusting for incomplete detection involves the use of appropriate sampling and analytic methods to address the fact that few, if any, species are so conspicuous that they are detected with certainty during surveys, even when present (Pollock et al. 2002, Thompson 2002). Accounting for these two sources of variation ensures observed trends reflect true population changes rather than artifacts of sampling and observation processes (Pollock et al. 2002, Thompson 2002).

In order to provide local land managers with unbiased and reliable information regarding the effects of development on avian communities in Southern Wyoming, RMBO utilized a probabilistic sampling design based on the “Integrated Monitoring in Bird Conservation Regions (IMBCR)” (White et al. 2011) design for this study. Important properties of the IMBCR design that relate to this study 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.
- 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 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 robust occupancy estimates that account for incomplete detection and are comparable at different geographic extents;
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.

The continued collection of occupancy and species richness data concurrent with additional development of roads and well pads to facilitate resource extraction will allow RMBO and its partners to determine the relative effect of resource development on the avian community.

METHODS

Study Area

The study area was defined by the Atlantic Rim Natural Gas Development Project (hereafter, "Atlantic Rim") and was composed predominantly of sagebrush and semi-desert shrublands. The 1,093 km^2 study area was located south of Rawlins, WY between Highways 789 and 71 and bordered to the south by Highway 70 (Figure 1). In addition, Atlantic Rim data were compared to data collected under the IMBCR design on BLM lands in Wyoming and Montana within BCR 10 (hereafter, "BCR10").

Sampling Design

RMBO and its partners divided the Atlantic Rim study area into two separate sampling frames (strata) based on different levels of proposed energy development (low and high-intensity; Figure 1) following the IMBCR design. These strata represent the area selected to make inferences about avian occupancy and species richness. The strata represent different levels of fragmentation/road densities within the Atlantic Rim study area (Table 1) with the High Development strata (ARIM-Hi) containing a slightly higher density of paved roadways and nearly twice the density of gravel roadways compared to the Low Development strata (ARIM-Low). Additional data were collected on BCR10 lands through the IMBCR monitoring program (Hanni et al. 2009) to compare Atlantic Rim species richness and occupancy to areas of similar habitat and management techniques.

Table 1. Size of strata (km^2), length of roadways (km of Road), and road densities (km of road divided by strata size) by road surface type for ARIM-Hi, ARIM-Low, and total study area within the Atlantic Rim.

Strata	km^2	Road Surface Type	km of Road	Road Density (km of Road/km^2)
ARIM-Hi	736.72	Paved	5.152	0.007
	736.72	Gravel	348.19	0.473
	736.72	Natural	1,620.94	2.200
ARIM-Low	356.86	Paved	0.00	0.000
	356.86	Gravel	95.04	0.266
	356.86	Natural	794.84	2.227
Total	1093.58	All surfaces	2,864.16	2.619

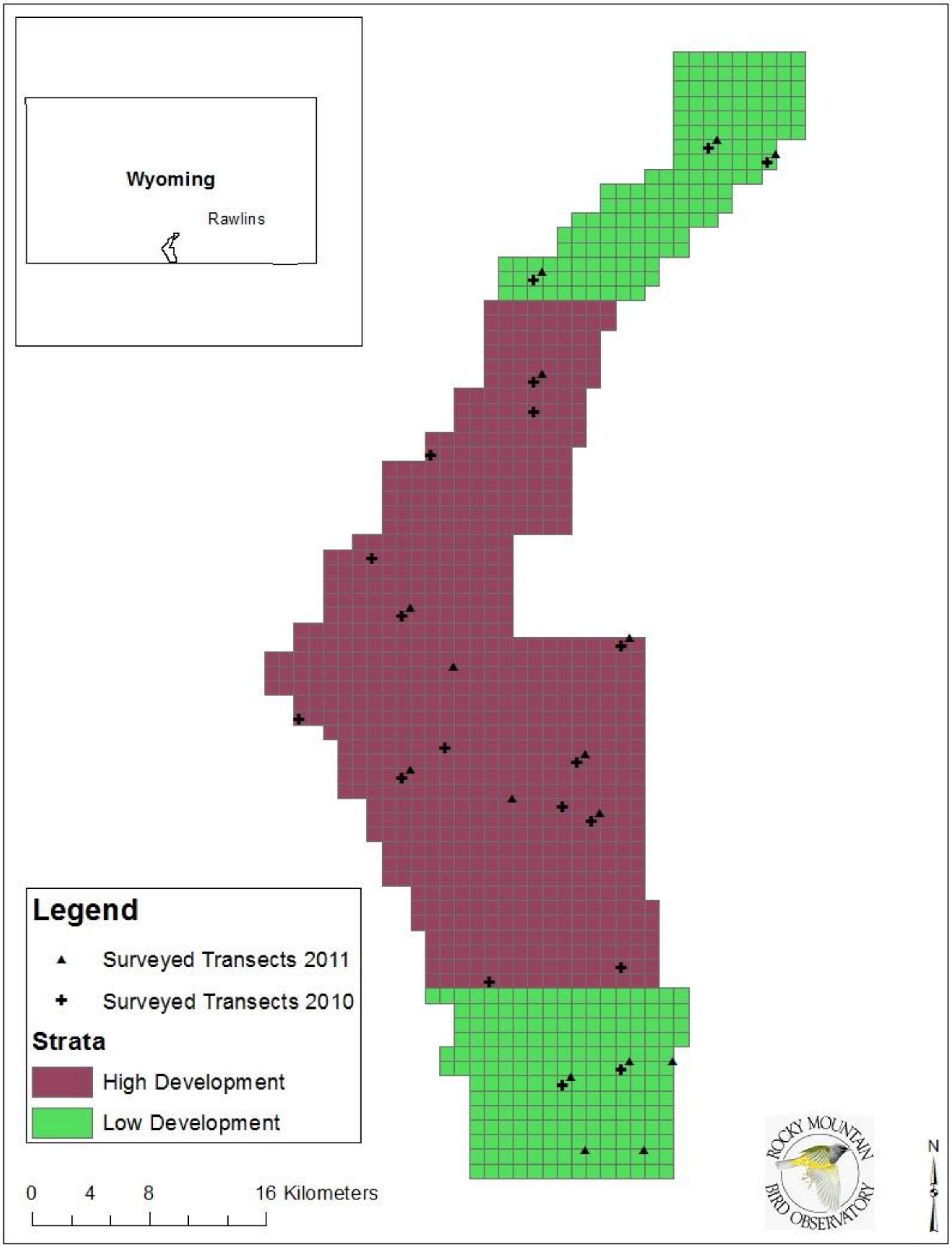


Figure 1. Study area and survey locations on the Atlantic Rim study area in southern Wyoming. 2011 surveys that were also conducted in 2010 are mapped on the northeast corner of the sampling grid.

Within each stratum, the IMBCR design used generalized random-tessellation stratification (GRTS), a spatially balanced sampling algorithm, to select sample units (Stevens and Olsen 2004a). Spatial data and grid cells were compiled and selected using ARCGIS 9.2 (ESRI 1999).

- 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 2004b). Incorporating information about spatial autocorrelation in the data can increase precision of density estimates;

- All grid cells in the sampling frame are ordered, such that any set of consecutively numbered units is a spatially-balanced sample (Stevens and Olsen 2004b). 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.

Sampling Methods

Within each grid cell we established a 4 x 4 grid of 16 points spaced 250 meters apart. Field technicians attempted to survey all points within a grid cell each morning; however, not all 16 points were surveyed within each grid cell. Inclement weather and landowners denying access to their private property were the most common reasons for not surveying all 16 points. We surveyed birds from points using methods that allow for estimating detection probability through the principles of Removal and Occupancy modeling. 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, the complete sampling period at a point consisted of three sampling intervals each consisting of two-minute segments.

Occupancy estimation is most commonly used to quantify the proportion of sample units (e.g., grid cells) occupied by an organism (MacKenzie et al. 2002). The application of occupancy models requires multiple surveys of the sample unit in space or time to estimate a detection probability (MacKenzie et al. 2006). Occupancy estimation uses a detection probability to adjust the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). 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 is independent; and 4) the target species are never falsely identified (MacKenzie et al. 2006).

RMBO staff and biological technicians with excellent aural and visual bird-identification skills conducted field work between May 29th and July 3rd in 2011. Prior to conducting surveys, technicians completed an intensive five-day training program to ensure technicians had a complete understanding of field protocols and sufficient knowledge of bird identification.

Field technicians conducted point counts (Buckland et al. 2001) following protocol established by RMBO (White et al. 2011). Observers surveyed in the morning, beginning ½-hour before sunrise and concluding their survey no later than 11 AM. The complete sampling interval at each point was six minutes. For every bird detected during each of the six minute counts, 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. The “flyover” detections were not included in the estimates of occupancy as it was unclear whether these birds were actively occupying the site. 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 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 survey technicians recorded the time, ambient temperature, cloud cover, precipitation, and wind speed. Technicians navigated to each point using hand-held Global Positioning System (GPS) units. Before beginning each count, surveyors recorded vegetation data (within a 50 meter radius) and distance from a road (if within 100 meters). We recorded vegetation data according to the dominant habitat type and structural stage, and the relative abundance, percent cover, and mean height of trees and shrubs by species, as well as grass height and groundcover. 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 each count.

For more detailed information about survey methods, refer to RMBO’s Field Protocol for Spatially Balanced Sampling of Landbird Populations on our Avian Data Center website: http://www.rmbo.org/PUBLIC/MONITORING/protocols/Field_protocol_for_spacially_balanced_sampling_final_2011.pdf.

Data Analysis

We used detections of 23 species [American Robin (*Turdus migratorius),* Black-billed Magpie (*Pica hudsonia*), Brewer’s Blackbird (*Euphagus cyanocephalus*), Brewer’s Sparrow (*Spizella breweri*), Brown-headed Cowbird (*Molothrus ater*), Cliff Swallow (*Petrochelidon pyrrhonota*), Common Raven (*Corvus* corax), Dusky Flycatcher (*Empidonax oberholseri*), Green-tailed Towhee (*Pipilo chlorurus*), Horned Lark (*Eremophila alpestris*), Mountain Bluebird (*Sialia currucoides*), Mourning Dove (*Zenaida macroura*), Northern Flicker (*Colaptes* auratus), Rock Wren (*Salpinctes* obsoletus), Sage Sparrow (*Amphispiza belli*), Sage Thrasher (*Oreoscoptes montanus*), Say’s Phoebe (*Sayornis saya*), Vesper Sparrow (*Pooecetes gramineus*), Violet-green Swallow (*Tachycineta thalassina*), Warbling Vireo (*Vireo gilvus*), Western Meadowlark (*Sturnella neglecta*), White-crowned Sparrow (*Zonotrichia leucophrys*), and Yellow Warbler (*Setophaga petechia*)] from all BLM lands within the Wyoming and Montana portions of BCR10 collected under the IMBCR design for analyses in this report, including the Atlantic Rim. We chose to evaluate occupancy rates for these species because there were a sufficient number of detections within the Atlantic Rim study area, using the 2010 and 2011 data combined, to estimate Psi (the proportion of grid cells expected to be occupied). By utilizing data collected outside of the Atlantic Rim we were able to produce more precise estimates of detection probability for individual species. The estimates of occupancy and species richness in BCR10 also provided a regional context for the Atlantic Rim estimates. Of the species analyzed, three are considered priority species by the Wyoming BLM (Brewer’s Sparrow, Sage Sparrow, and Sage Thrasher). We truncated the data, using only detections within 125 meters of the sample points to use bird detections over a consistent plot size and to ensure that data were independent (points were spread 250 meters apart).

Under the sampling framework, we used a removal design (MacKenzie et al. 2006) to estimate a separate detection probability for each of the 23 species listed above. By binning minutes one and two, minutes three and four, and minutes five and six into three sequential sampling intervals we met the assumption of a monotonic decline in detection rates through time. After each target species was detected at a point, we set all subsequent sampling intervals at that point to missing data (MacKenzie et al. 2006).

The 16 points within each grid cell served as spatial replicates for estimating the proportion of points occupied within each sampled grid cell. We used a multi-scale occupancy model (Nichols et al. 2008, Pavlacky et al. 2012) for individual species and a multi-species extension for species richness (MacKenzie et al. 2006) to estimate 1) the probability of detecting a species given presence (p); 2) the proportion of points occupied by a species given presence within sampled grid cells (Theta); and 3) the proportion of grid cells occupied by a species (Psi). All models were fit using program MARK (White and Burnham 1999) and package RMark (R Development Core Team 2011).

Our application of the multi-scale occupancy model was analogous to a within-season robust design (Pollock 1982) in which the minute intervals at each point were the secondary samples for estimating p and the points were the primary samples for estimating Theta (Nichols et al. 2008). Under the multi-scale occupancy model for species richness, Psi represents the proportion of the 23 species that are expected to occupy each survey location. The estimates of Psi from the multi-scale model are adjusted upward to account for the incomplete detection (p) and availability (Theta) of the constituent species.

We compared the richness of 23 bird species among 6 treatment levels representing combinations of years (2010 and 2011) and study areas (BCR10, ARIM-Hi and ARIM-Low in the Atlantic Rim) using detection data from the 2010 and 2011 breeding seasons. For the full species richness analyses, we considered models where the proportion of species present (Psi) 1) was held constant (no treatment or year effect), 2) varied by year, 3) varied by BCR10 and Atlantic Rim, 4) varied by year and by BCR10 and Atlantic Rim, 5) varied by BCR10, ARIM-Hi and ARIM-Low, and 6) varied by year and by BCR10, ARIM-Hi and ARIM-Low. The proportion of point counts occupied (Theta) and detection probability (p) varied by species.

Additionally, we compared the richness of three Wyoming BLM priority species (Brewer’s Sparrow, Sage Sparrow, and Sage Thrasher) across the six treatment levels. For this species richness analysis we considered models where the proportion of species present (Psi) was 1) held constant (no treatment or year effect), 2) varied by year, 3) varied by BCR10 and Atlantic Rim, 4) varied by year and by BCR10 and Atlantic Rim, 5) varied by BCR10, ARIM-Hi and ARIM-Low, and 6) varied by year and by BCR10, ARIM-Hi and ARIM-Low. The proportion of point counts occupied (Theta) 1) varied by species, 2) varied by species and by year and 3) varied by species and by BCR10, ARIM-Hi and ARIM-Low. The probability of detection (p) 1) varied by species, 2) varied by species and by year and 3) varied by species and by BCR10, ARIM-Hi and ARIM-Low.

Finally, we estimated individual Psi and Theta estimates for the 23 species included in the species richness analyses to assess species-specific responses across the treatment levels. For all 23 species, we considered models where the proportion of sample units occupied (Psi) was 1) held constant (no treatment or year effect), 2) varied by year, 3) varied by BCR10, ARIM-Hi and ARIM-Low, and 4) varied by year and by BCR10, ARIM-Hi and ARIM-Low. The proportion of point counts occupied (Theta) 1) was held constant, 2) varied by year and 3) varied by BCR10, ARIM-Hi and ARIM-Low. The detection probability (p) 1) was held constant, 2) varied by year and 3) varied by BCR10, ARIM-Hi and ARIM-Low. Low sample sizes for some species required a less complex model structure for p and Theta. Therefore, we estimated Psi for the Brewer’s Blackbird, Common Raven, Mountain Bluebird, Mourning Dove, Northern Flicker, Say’s Phoebe, Violet-green Swallow, and Warbling Vireo using reduced model structures for p and Theta. For these species, the proportion of points occupied (Theta) 1) was held constant and/or 2) allowed to vary by year. The detection probability was held constant for these species. The estimates of Theta that were produced by the reduced model structure are not presented in this report because they do not address differences across the treatment levels; the motivating question for this study.

We constructed the candidate set of models by investigating models with combinations of the structures on Psi, Theta and p listed above. We evaluated the strength of evidence for the candidate models using Akaike's Information Criterion (AIC) corrected for small sample size (AICc), and model selection theory (Burnham and Anderson 2002). We estimated Psi and Theta for the treatment levels by model-averaging estimates from the candidate models. We investigated differences in the estimates of Psi and Theta with respect to their associated standard errors. We calculated 95% confidence intervals for the species richness estimates.

RESULTS

Total Species Richness

The top model (AICc weight = 0.67) investigating potential differences in species richness between ARIM-Hi and ARIM-Low estimated a common Psi and Theta parameter for the two Atlantic Rim treatment groups and a separate Psi and Theta for the rest of BLM lands within BCR 10 (Table 2). This indicated that there was little difference in species richness across the two treatments within the Atlantic Rim study area. The estimated species richness expected at survey locations for the six treatment levels is shown in Table 3. No difference in species richness between ARIM-Hi and ARIM-Low is also evidenced by Figure 2 which displays Species richness (the number of the 23 species analyzed which are expected to be found at a survey location) estimates with overlapping standard error bars.

Although the analyses indicate no substantial difference between the high- and low-development regions of the Atlantic Rim, species richness was substantially higher in the Atlantic Rim than on other BLM lands in the Wyoming and Montana portions of BCR 10 (Figure 2). Also, species richness was substantially higher in 2011 than in 2010 within each of the three study areas (Figure 2).

Table 2. Ranking of models investigating differences in species richness via Psi (the proportion of species occupying a survey location) for breeding birds in BCR10, ARIM-Hi (Hi), and the ARIM-Low (Low) in 2010 and 2011. Only models within four delta AICc of the top model are displayed.

Top models estimating species richness of 23 species	K †	Deviance ‡	Δ AICc §	AICc Weights *
Psi[(BCR10, Hi+Low) * Year] Delta(Species) p(Species)	50	19905.20	0	0.67
Psi[(BCR10, Hi, Low) * Year] Delta(Species) p(Species)	52	19902.50	1.45	0.32

† number of parameters included in the model
‡ -2 log likelihood of the model
§difference in AICc units between a given model and the top-ranking model
*probability that a given model is the best-approximating model of the models in the set.

Table 3. Estimated number of the 23 species expected to be present on a survey location (Species richness), the standard error of species richness (SE), lower (LCL) and upper (UCL) 95% confidence limits for the estimate of species richness. Results are displayed for BCR 10, ARIM-Hi and ARIM-Low for 2010 and 2011.

Treatment	Year	Species richness	SE	LCL	UCL
ARIM-Hi	2010	12.10	0.91	10.31	13.86
ARIM-Hi	2011	15.44	1.11	13.14	17.44
ARIM-Low	2010	11.56	1.28	9.10	14.03
ARIM-Low	2011	14.68	1.17	12.29	16.81
BCR10	2010	8.74	0.49	7.80	9.72
BCR10	2011	10.17	0.53	9.15	11.21

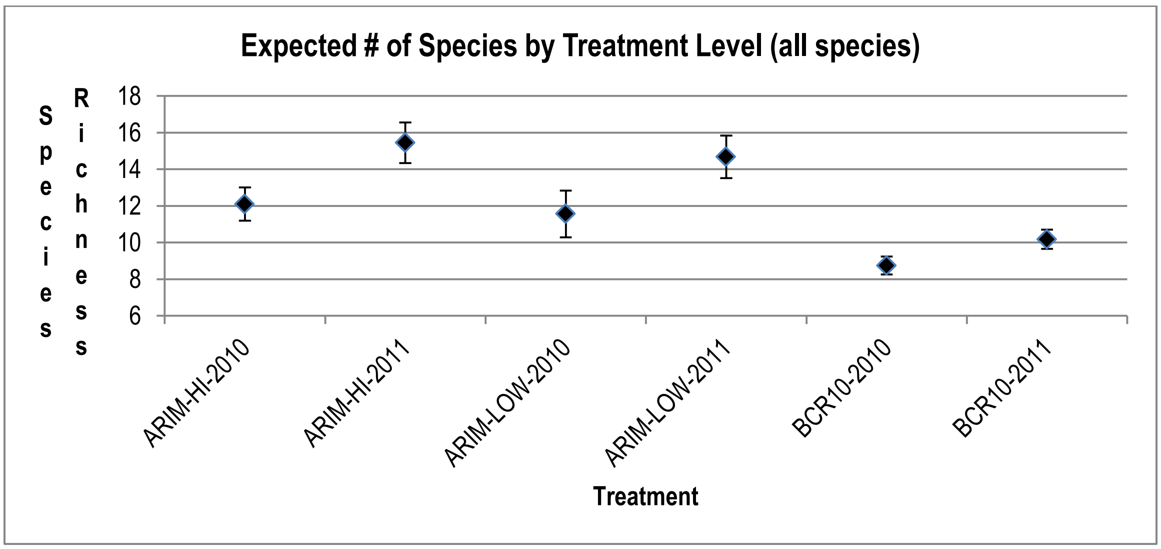


Figure 2. Number of the 23 species analyzed expected to occupy 1 km^2 grid cells (Species richness) on BCR10, ARIM-HI and ARIM-LOW in 2010 and 2011. Error bars represent the standard errors associated with the estimates.

Priority Species Richness

Results of the analyses for priority species richness were similar to the results of the total species richness. Again, the top model estimated a common Psi and Theta parameter for the two Atlantic Rim treatment groups and a separate Psi and Theta for BCR 10 (Table 4). This indicated that there was little difference in species richness across the two treatments within the Atlantic Rim study area. The estimated species richness expected at the level of the survey location for the six treatment levels is shown in Table 5. No difference in species richness between ARIM-Hi and ARIM-Low is also evidenced by Figure 3 which displays species richness (the number of the three species analyzed which are expected to be found on a survey location) estimates with overlapping standard error bars.

The results of the priority species richness analyses indicate that both ARIM-Hi and ARIM-Low have a higher expected number of priority species occupying the sites than other BLM lands within the Wyoming and Montana portions of BCR10 (Figure 3).

Table 4. Ranking of models investigating differences in species richness via Psi (the proportion of survey locations occupied) for Brewer's Sparrow, Sage Sparrow, and Sage Thrasher in BCR 10, ARIM-Hi (Hi) and ARIM-Low (Low) in 2010 and 2011.

Top models estimating species richness of 3 BLM priority species	K †	Dev ‡	Δ AICc §	AICc Weights *
Psi[BCR10, Hi + Low] Delta[(BCR10, Hi, Low) * Species] p[(BCR10, Hi, Low) * (Species)]	20	6206.03	0	0.64
Psi[BCR10, Hi, Low] Delta[(BCR10, Hi, Low) * Species] p[(BCR10, Hi, Low) * Species]	21	6205.47	1.68	0.28

†number of parameters included in the model
‡ -2 log likelihood of the model
§difference in AICc units between a given model and the top-ranking model
*probability that a given model is the best-approximating model of the models in the set.

Table 5. Estimated number of priority species expected to be present at a survey location (Species Richness), the standard error of Species Richness (SE), lower (Species LCL) and upper (Species UCL) 95% confidence limits for three BLM priority species. Results are displayed for BCR 10, ARIM-Hi and ARIM-Low for 2010 and 2011.

Treatment	Year	Species Richness	SE	Species LCL	Species UCL
Richness of 3 BLM priority species analyzed					
ARIM-Hi	2010	2.31	0.15	1.98	2.56
ARIM-Hi	2011	2.31	0.15	1.97	2.56
ARIM-Low	2010	2.26	0.18	1.87	2.55
ARIM-Low	2011	2.25	0.18	1.86	2.54
BCR10	2010	1.72	0.09	1.53	1.90
BCR10	2011	1.72	0.09	1.53	1.90

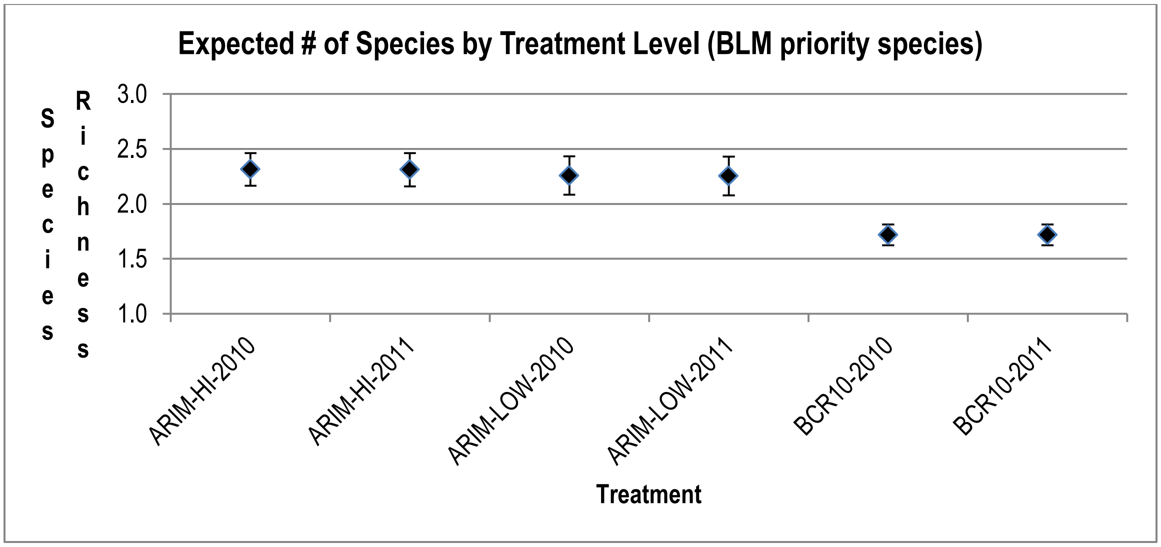


Figure 3. Number of BLM priority species (Species Richness) expected to occupy survey locations on BCR10, ARIM-HI and ARIM-LOW in 2010 and 2011. Error bars represent the standard errors associated with the estimates.

Single Species

Occupancy analyses are most effective when some surveyed areas are occupied by a particular target species while others are not. Unfortunately, due to small sample sizes, 17 of the species analyzed were either detected at all survey locations (e.g., Brewer's Sparrow) or not detected at any survey locations (e.g., Black-billed Magpie) within a particular treatment level (Table 6). We were unable to estimate Psi when the number of survey locations occupied (*n* Tran) was equal to the total number of survey locations visited (S) or where *n* Tran was equal to 0. In these instances Psi was fixed to "1" when S was equal to *n* Tran and fixed to "0" when *n* Tran was equal to "0". Dashes in the Psi, SE and Theta SE columns of Table 6 indicate the data were insufficient for estimating occupancy. We were unable to estimate Theta at the treatment level for eight species due to sparse detection data.

Results of the single species occupancy analyses indicate that most species (17 of 23 species investigated) occupy a similar proportion of survey locations (Psi) across the two treatment groups within the Atlantic Rim (Figure 4). The 2011 estimates of Psi for Common Raven, Dusky Flycatcher, Warbling Vireo, White-crowned Sparrow, and Yellow Warbler were substantially higher in ARIM-Hi than ARIM-Low (Figure 4). Conversely, only Green-tailed Towhee had a substantially higher Psi in ARIM-Low compared to ARIM-Hi (Figure 4). Psi's for three of the species investigated were substantially higher in 2011 than 2010: American Robin, Mountain Bluebird, and Rock Wren (Figure 4).

The proportion of points occupied given that the species was detected at the survey location (Theta) differed substantially between the two Atlantic Rim treatment groups for four species. Dusky Flycatcher, Sage Thrasher, White-crowned Sparrow, and Yellow Warbler occupied a substantially higher number of points at occupied survey locations (Theta) in ARIM-Hi compared to ARIM-Low in 2011 (Figure 5). Although the standard errors of the Theta estimates for Brewer's Sparrow in ARIM-Hi and ARIM-Low narrowly overlap, the highest ranking models estimated a separate Theta for each treatment level providing moderate evidence of a difference in occupancy rates between these strata (Appendix A). Theta's for two species, American Robin and Rock Wren, were substantially higher in the Atlantic Rim in 2011 than in

2010. Conversely, Theta's were lower in 2011 than in 2010 for Brewer's Sparrow and Horned Lark (Figure 5).

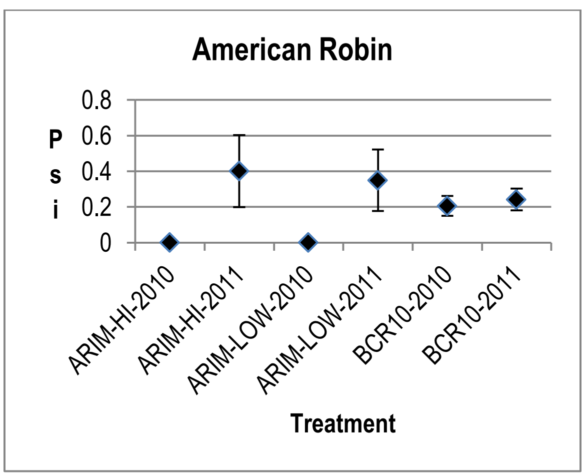
Table 6. The number of survey locations visited (S), the estimated proportion of sample units occupied (Psi), the standard error associated with the Psi estimate (Psi SE), number of survey locations with one or more detections (*n* Tran), the proportion of points occupied given that the species was detected at the survey location (Theta), the standard error associated with the Theta estimate (Theta SE), and the number of points with one or more detections (*n* Pts) of breeding bird species for BCR 10, ARIM-Hi and ARIM-Low in 2010 and 2011. Dashes indicate that data were insufficient for estimating occupancy. Priority species, designated by the BLM in Wyoming, are bolded.

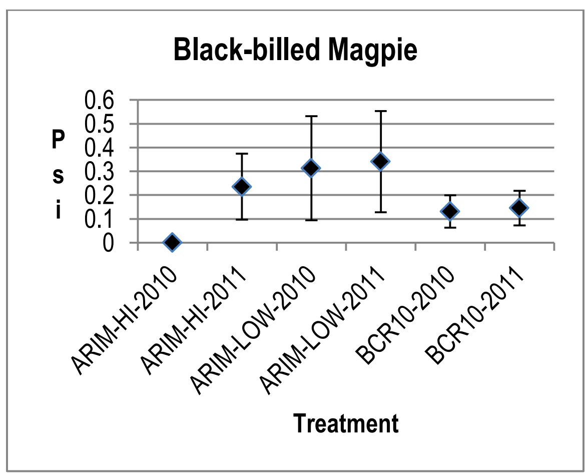
Species	Treatment	Year	S	Psi	Psi SE	*n* Tran	Theta	Theta SE	*n* Pts
American Robin	ARIM-Hi	2010	15	0	--	0	0	0	0
	ARIM-Hi	2011	8	0.40	0.20	4	0.19	0.07	10
	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0.35	0.17	3	0.21	0.08	7
	BCR10	2010	48	0.21	0.06	8	0.33	0.10	19
	BCR10	2011	44	0.24	0.06	10	0.33	0.05	40
Black-billed Magpie	ARIM-Hi	2010	15	0	--	0	0	0	0
	ARIM-Hi	2011	8	0.23	0.14	2	0.20	0.08	8
	ARIM-Low	2010	5	0.31	0.22	1	0.11	0.05	2
	ARIM-Low	2011	8	0.34	0.21	3	0.14	0.04	7
	BCR10	2010	48	0.13	0.07	3	0.09	0.05	4
	BCR10	2011	44	0.15	0.07	4	0.11	0.05	8
Brewer's Blackbird	ARIM-Hi	2010	15	0.46	0.21	2	--	--	3
	ARIM-Hi	2011	8	0.48	0.19	4	--	--	5
	ARIM-Low	2010	5	0.61	0.31	1	--	--	1
	ARIM-Low	2011	8	0.64	0.29	4	--	--	9
	BCR10	2010	48	0.23	0.08	4	--	--	6
	BCR10	2011	44	0.24	0.08	8	--	--	20
Brewer's Sparrow	ARIM-Hi	2010	15	1	--	15	0.80	0.03	121
	ARIM-Hi	2011	8	1	--	8	0.68	0.04	81
	ARIM-Low	2010	5	1	--	5	0.88	0.04	49
	ARIM-Low	2011	8	1	--	8	0.60	0.05	52
	BCR10	2010	48	0.76	0.05	37	0.62	0.02	290
	BCR10	2011	44	0.75	0.05	32	0.53	0.02	230
Brown-headed Cowbird	ARIM-Hi	2010	15	0.63	0.14	7	0.23	0.06	17
	ARIM-Hi	2011	8	0.68	0.14	6	0.23	0.06	14
	ARIM-Low	2010	5	0.59	0.16	2	0.30	0.08	10
	ARIM-Low	2011	8	0.64	0.16	5	0.29	0.07	16
	BCR10	2010	48	0.34	0.23	4	0.14	0.12	4
	BCR10	2011	44	0.38	0.26	6	0.15	0.11	9
Cliff Swallow	ARIM-Hi	2010	15	0.09	0.24	1	0.12	0.12	1
	ARIM-Hi	2011	8	0	--	0	0	0	0

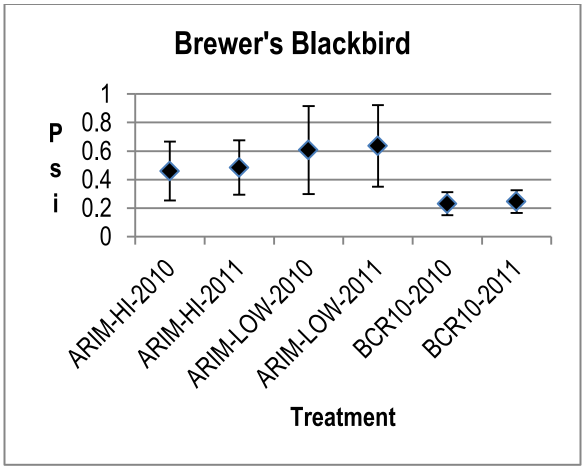
Species	Treatment	Year	S	Psi	Psi SE	*n* Tran	Theta	Theta SE	*n* Pts
Cliff Swallow cont'd	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0	--	0	0	0	0
	BCR10	2010	48	0.08	0.04	2	0.13	0.08	4
	BCR10	2011	44	0.10	0.05	4	0.12	0.05	6
Common Raven	ARIM-Hi	2010	15	0	--	0	--	--	0
	ARIM-Hi	2011	8	0.34	0.27	2	--	--	2
	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0	--	0	--	--	0
	BCR10	2010	48	0.10	0.06	3	--	--	8
	BCR10	2011	44	0.27	0.19	6	--	--	8
Dusky Flycatcher	ARIM-Hi	2010	15	0.20	0.09	3	0.19	0.05	7
	ARIM-Hi	2011	8	0.20	0.09	2	0.22	0.05	9
	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0	--	0	0	0	0
	BCR10	2010	48	0.15	0.04	6	0.19	0.04	13
	BCR10	2011	44	0.15	0.04	5	0.21	0.04	14
Green-tailed Towhee	ARIM-Hi	2010	15	0.59	0.14	8	0.51	0.05	48
	ARIM-Hi	2011	8	0.73	0.17	7	0.53	0.05	55
	ARIM-Low	2010	5	1	--	5	0.64	0.07	35
	ARIM-Low	2011	8	1	--	8	0.61	0.05	53
	BCR10	2010	48	0.31	0.07	11	0.17	0.04	28
	BCR10	2011	44	0.36	0.07	17	0.41	0.03	86
Horned Lark	ARIM-Hi	2010	15	0.74	0.05	12	0.64	0.05	79
	ARIM-Hi	2011	8	0.74	0.05	6	0.48	0.06	40
	ARIM-Low	2010	5	0.72	0.07	3	0.72	0.11	19
	ARIM-Low	2011	8	0.72	0.07	5	0.52	0.06	22
	BCR10	2010	48	0.74	0.04	35	0.59	0.02	278
	BCR10	2011	44	0.74	0.04	33	0.55	0.02	250
Mountain Bluebird	ARIM-Hi	2010	15	0	--	0	--	--	0
	ARIM-Hi	2011	8	0.24	0.08	1	--	--	1
	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0.24	0.09	1	--	--	2
	BCR10	2010	48	0.26	0.06	10	--	--	19
	BCR10	2011	44	0.26	0.06	11	--	--	24
Mourning Dove	ARIM-Hi	2010	15	0.25	0.12	3	--	--	6
	ARIM-Hi	2011	8	0.24	0.12	1	--	--	2
	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0.40	0.38	2	--	--	3
	BCR10	2010	48	0.56	0.38	3	--	--	3
	BCR10	2011	44	0.56	0.38	3	--	--	3
Northern Flicker	ARIM-Hi	2010	15	0.23	0.10	1	--	--	1
	ARIM-Hi	2011	8	0.23	0.10	1	--	--	2

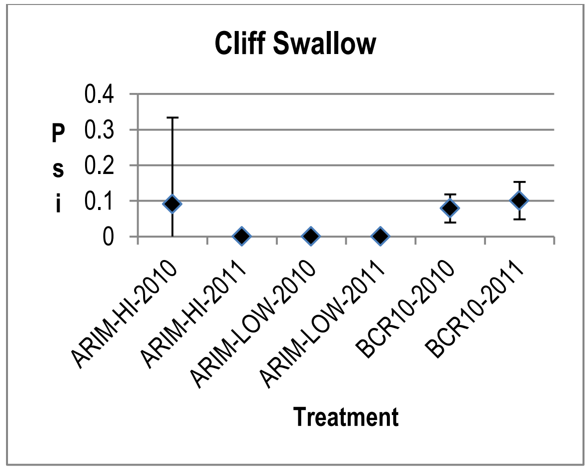
Species	Treatment	Year	S	Psi	Psi SE	*n* Tran	Theta	Theta SE	*n* Pts
Northern Flicker cont'd	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0.26	0.16	2	--	--	4
	BCR10	2010	48	0.23	0.09	6	--	--	8
	BCR10	2011	44	0.23	0.09	5	--	--	6
Rock Wren	ARIM-Hi	2010	15	0	--	0	0	0	0
	ARIM-Hi	2011	8	0.44	0.11	4	0.36	0.06	23
	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0.35	0.15	1	0.20	0.16	1
	BCR10	2010	48	0.42	0.07	16	0.23	0.08	34
	BCR10	2011	44	0.43	0.06	19	0.32	0.03	80
Sage Sparrow	ARIM-Hi	2010	15	0.44	0.06	7	0.38	0.11	19
	ARIM-Hi	2011	8	0.44	0.06	4	0.43	0.09	23
	ARIM-Low	2010	5	0.44	0.07	3	0.43	0.10	10
	ARIM-Low	2011	8	0.43	0.07	3	0.38	0.13	6
	BCR10	2010	48	0.44	0.05	20	0.51	0.03	148
	BCR10	2011	44	0.43	0.05	18	0.52	0.03	136
Sage Thrasher	ARIM-Hi	2010	15	0.76	0.12	12	0.51	0.04	57
	ARIM-Hi	2011	8	0.77	0.12	7	0.51	0.04	51
	ARIM-Low	2010	5	0.67	0.12	3	0.31	0.06	8
	ARIM-Low	2011	8	0.68	0.12	6	0.30	0.05	17
	BCR10	2010	48	0.56	0.06	24	0.34	0.02	107
	BCR10	2011	44	0.57	0.06	25	0.34	0.02	128
Say's Phoebe	ARIM-Hi	2010	15	0.20	0.10	2	--	--	3
	ARIM-Hi	2011	8	0.19	0.11	1	--	--	1
	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0.21	0.18	1	--	--	1
	BCR10	2010	48	0.19	0.07	6	--	--	11
	BCR10	2011	44	0.18	0.09	3	--	--	4
Vesper Sparrow	ARIM-Hi	2010	15	0.99	0.04	14	0.46	0.02	68
	ARIM-Hi	2011	8	1	--	8	0.43	0.02	45
	ARIM-Low	2010	5	1	--	5	0.46	0.03	21
	ARIM-Low	2011	8	1	--	8	0.44	0.03	41
	BCR10	2010	48	0.67	0.06	31	0.46	0.02	185
	BCR10	2011	44	0.69	0.06	31	0.43	0.02	176
Violet-green Swallow	ARIM-Hi	2010	15	0.18	0.14	1	--	--	1
	ARIM-Hi	2011	8	0.21	0.14	2	--	--	2
	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0.20	0.15	1	--	--	1
	BCR10	2010	48	0.15	0.08	2	--	--	3
	BCR10	2011	44	0.17	0.09	3	--	--	6
Warbling Vireo	ARIM-Hi	2010	15	0.10	0.09	1	--	--	1
	ARIM-Hi	2011	8	0.16	0.11	2	--	--	2

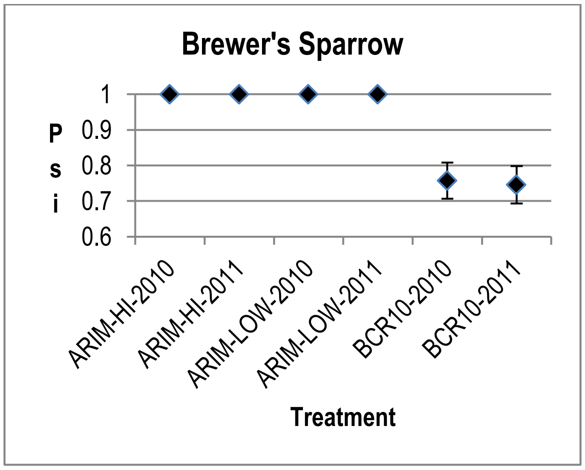
Species	Treatment	Year	S	Psi	Psi SE	*n* Tran	Theta	Theta SE	*n* Pts
Warbling Vireo cont'd	ARIM-Low	2010	5	0	--	0	--	--	0
	ARIM-Low	2011	8	0	--	0	--	--	0
	BCR10	2010	48	0.06	0.04	1	--	--	1
	BCR10	2011	44	0.11	0.06	4	--	--	11
Western Meadowlark	ARIM-Hi	2010	15	0.60	0.16	9	0.36	0.05	31
	ARIM-Hi	2011	8	0.67	0.16	6	0.33	0.04	26
	ARIM-Low	2010	5	0.26	0.16	1	0.26	0.11	4
	ARIM-Low	2011	8	0.30	0.16	2	0.23	0.10	5
	BCR10	2010	48	0.28	0.08	10	0.41	0.05	50
	BCR10	2011	44	0.40	0.09	20	0.38	0.04	94
White-crowned Sparrow	ARIM-Hi	2010	15	0	--	0	0	0	0
	ARIM-Hi	2011	8	0.10	0.08	1	0.14	0.07	2
	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0	--	0	0	0	0
	BCR10	2010	48	0.08	0.04	3	0.12	0.06	4
	BCR10	2011	44	0.08	0.04	3	0.16	0.06	7
Yellow Warbler	ARIM-Hi	2010	15	0.15	0.12	1	0.09	0.05	2
	ARIM-Hi	2011	8	0.18	0.14	2	0.10	0.05	4
	ARIM-Low	2010	5	0	--	0	0	0	0
	ARIM-Low	2011	8	0	--	0	0	0	0
	BCR10	2010	48	0.09	0.12	2	0.07	0.05	2
	BCR10	2011	44	0.08	0.07	1	0.08	0.05	2

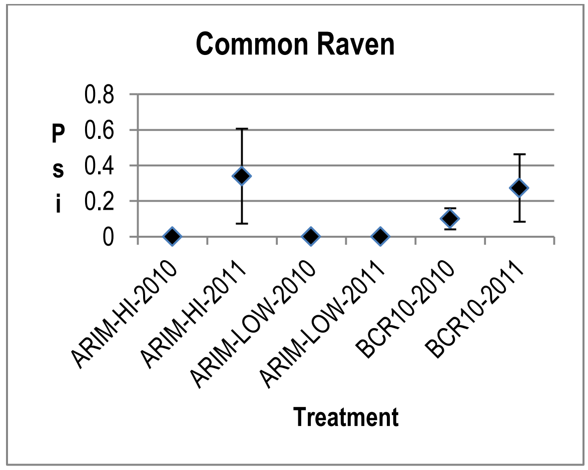


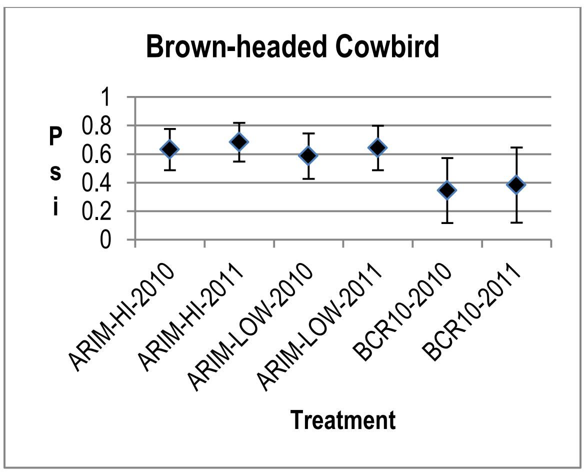


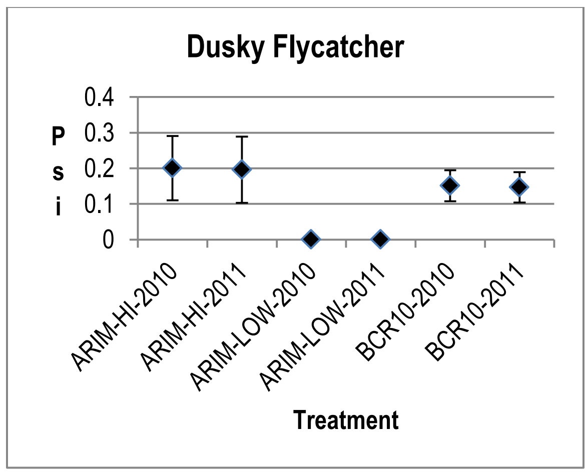

Brewer's Blackbird
Psi
1
0.8
0.6
0.4
0.2
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

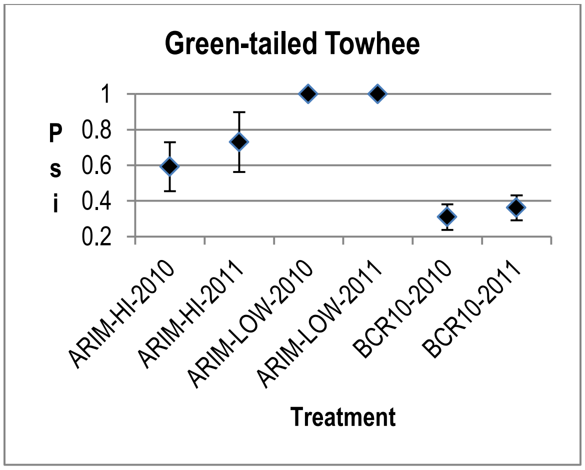

Cliff Swallow
Psi
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

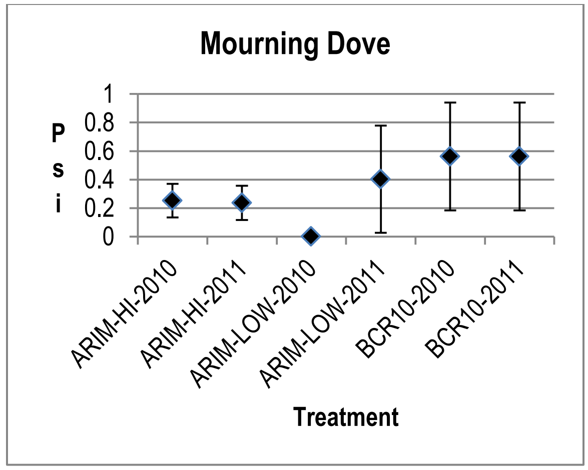

Brewer's Sparrow
Psi
1
0.9
0.8
0.7
0.6
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

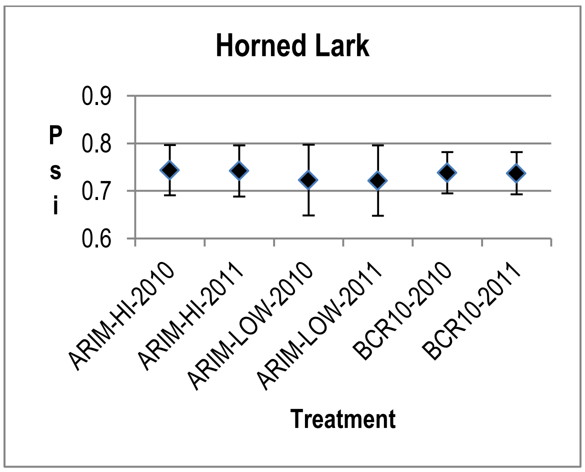

Common Raven
Psi
0.8
0.6
0.4
0.2
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

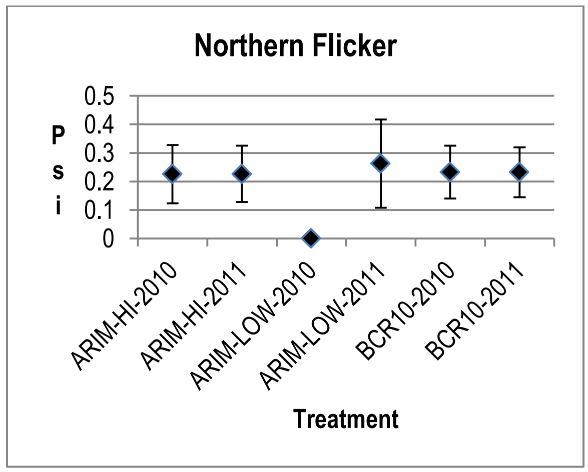

Brown-headed Cowbird
Psi
1
0.8
0.6
0.4
0.2
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

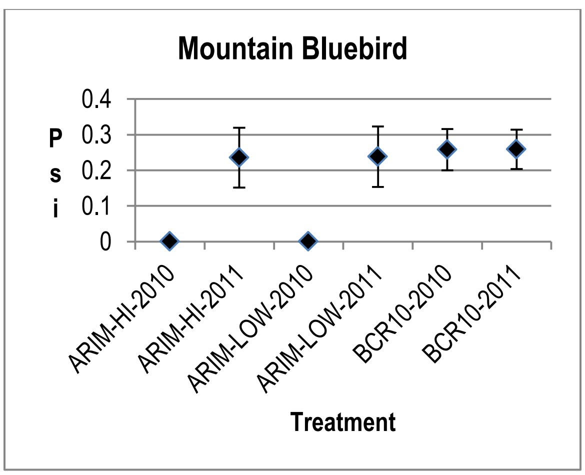

Dusky Flycatcher
Psi
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

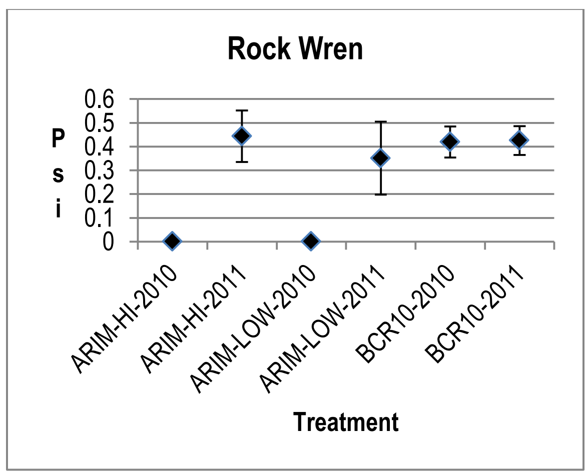

Green-tailed Towhee
Psi
1
0.8
0.6
0.4
0.2
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Mourning Dove
Psi
1
0.8
0.6
0.4
0.2
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Horned Lark
Psi
0.9
0.8
0.7
0.6
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Northern Flicker
Psi
0.5
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Mountain Bluebird
Psi
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Rock Wren
Psi
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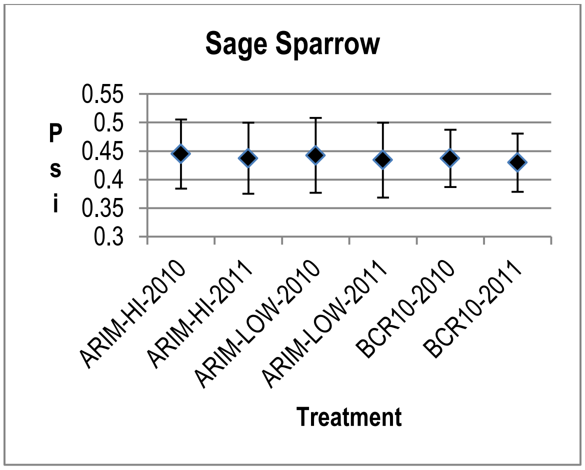
0.5
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Sage Sparrow
Psi
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0.5
0.45
0.4
0.35
0.3
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
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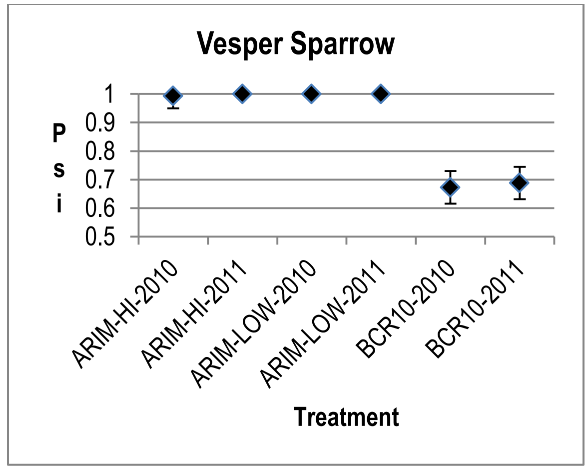
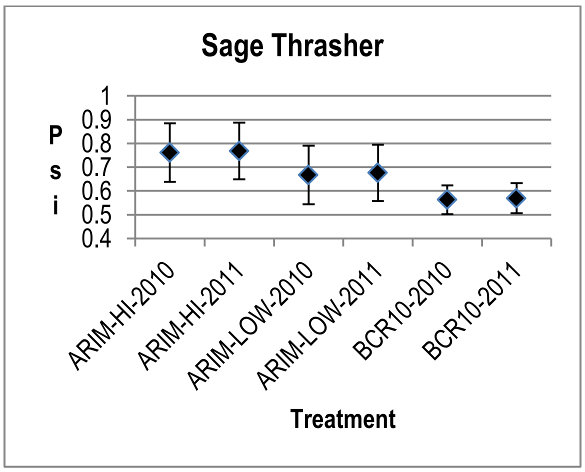
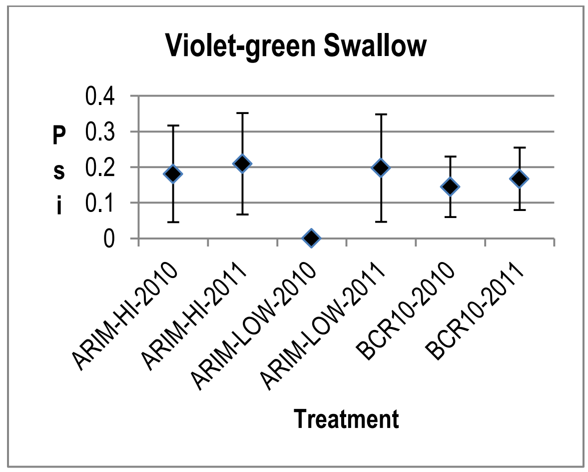
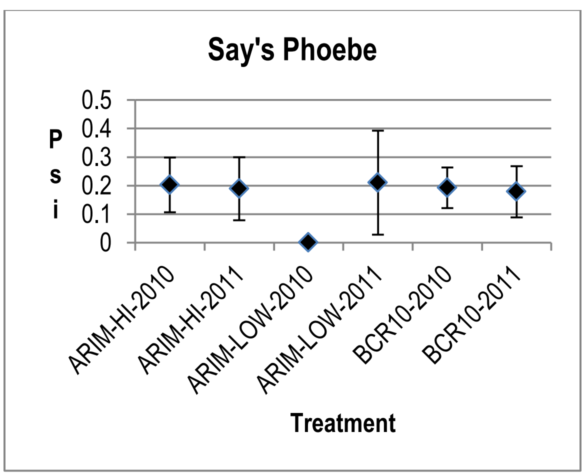
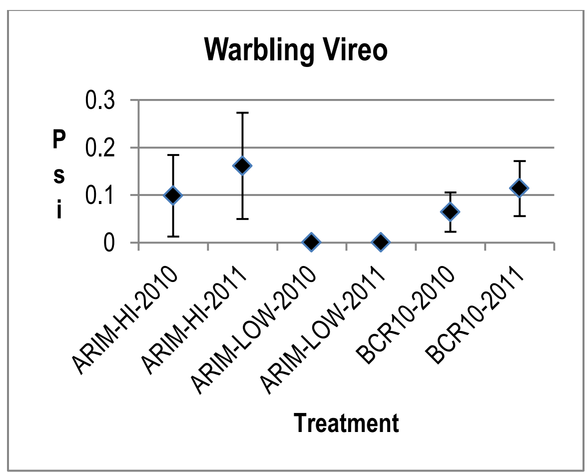
BCR10-2010
BCR10-2011
Treatment


Vesper Sparrow
Psi
1
0.9
0.8
0.7
0.6
0.5
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Sage Thrasher
Psi
1
0.9
0.8
0.7
0.6
0.5
0.4
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Violet-green Swallow
Psi
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Say's Phoebe
Psi
0.5
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Warbling Vireo
Psi
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

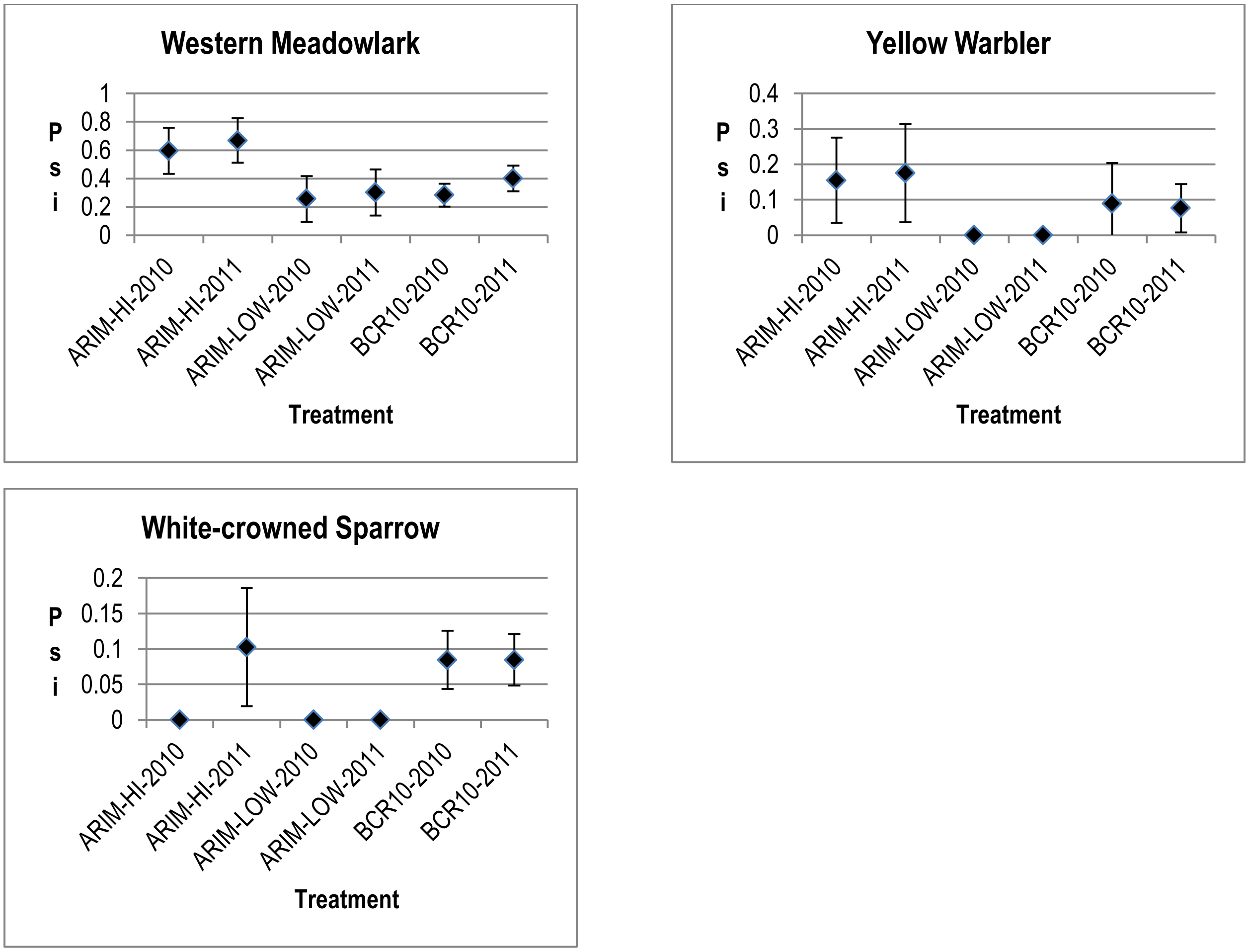
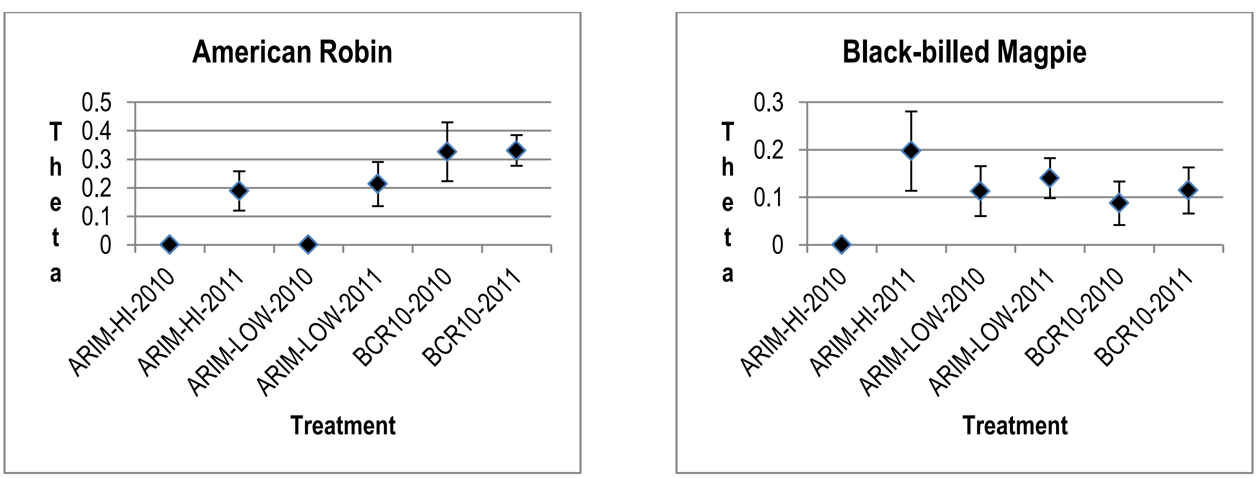
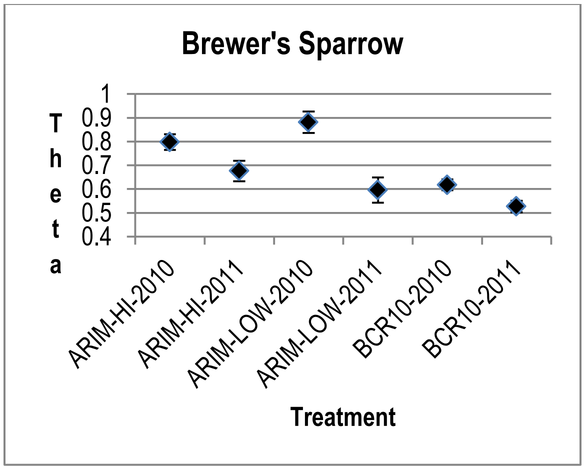
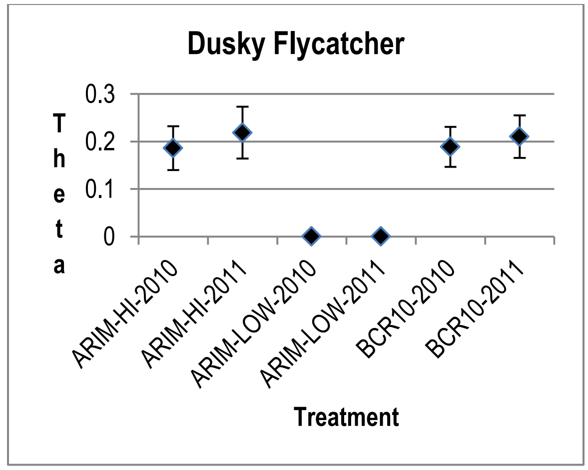
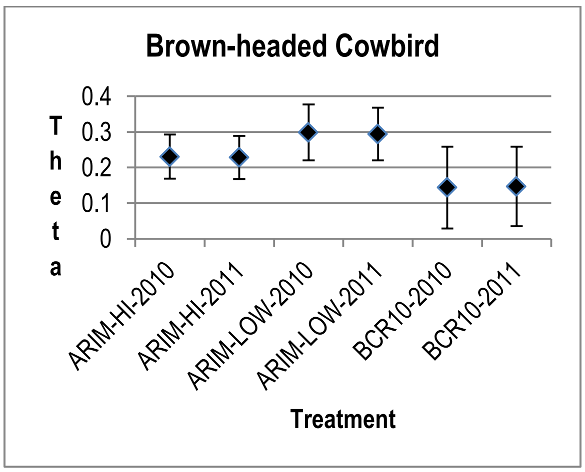


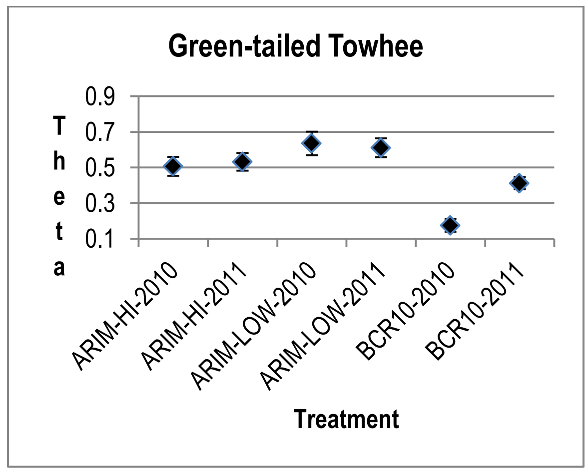
Figure 4. Estimated proportion of sample units occupied (Psi) for species on BCR10, WY-ARIM-HI and WY-ARIM-LOW in 2010 and 2011. Error bars represent the standard errors associated with the estimates.

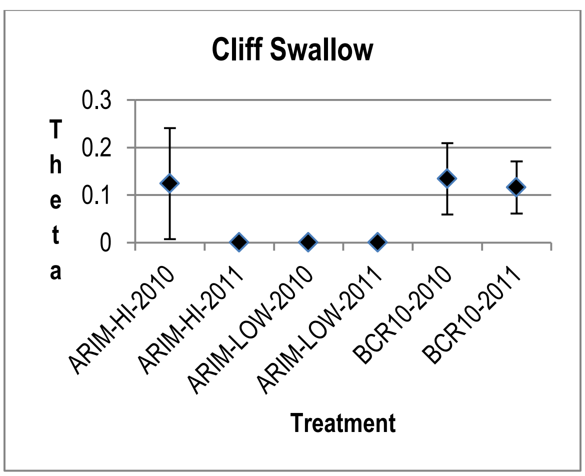


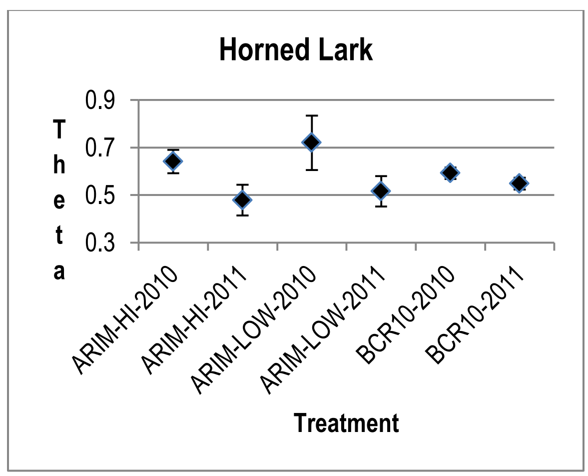

Brewer's Sparrow
T h e t a
1
0.9
0.8
0.7
0.6
0.5
0.4
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

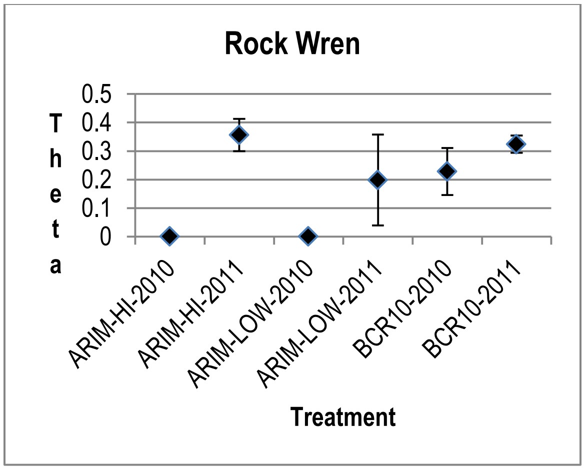

Dusky Flycatcher
T h e t a
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

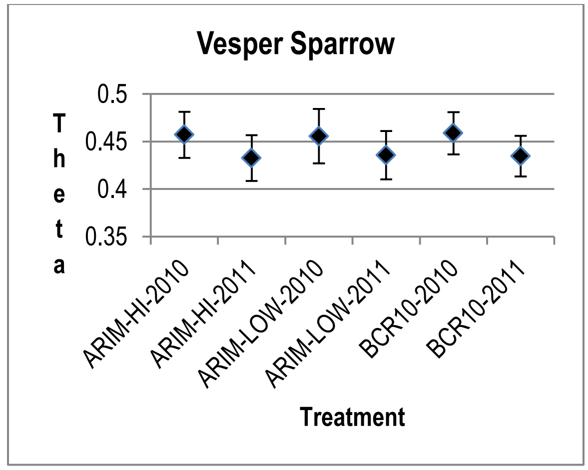

Brown-headed Cowbird
T h e t a
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

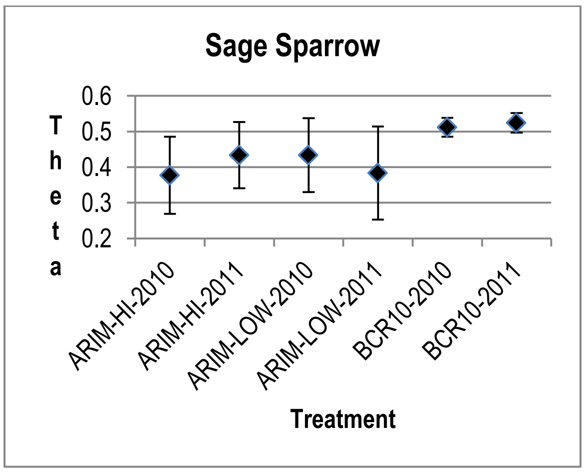

Green-tailed Towhee
T h e t a
0.9
0.7
0.5
0.3
0.1
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

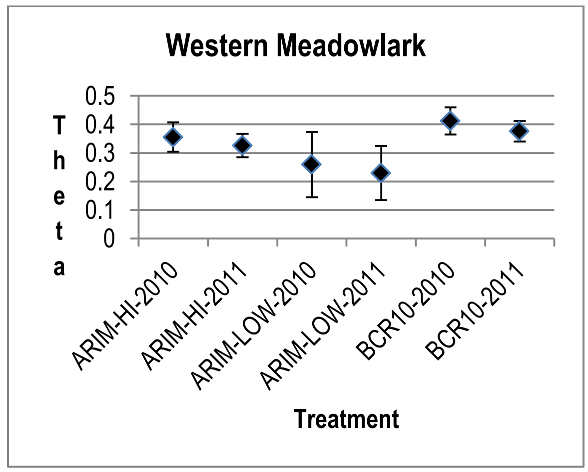

Cliff Swallow
T h e t a
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

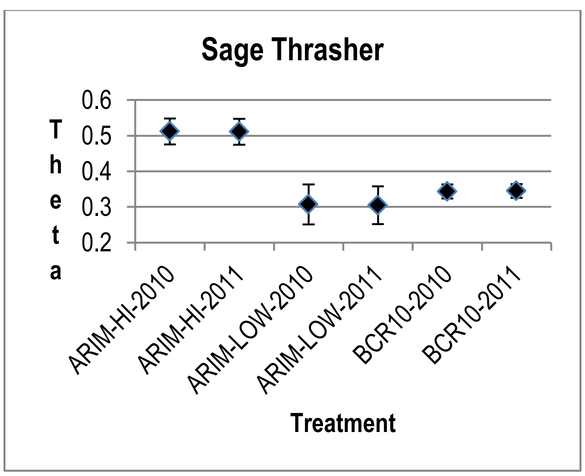

Horned Lark
T h e t a
0.9
0.7
0.5
0.3
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

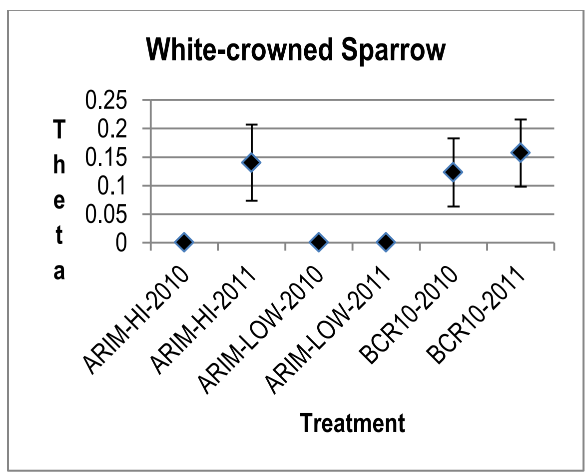

Rock Wren
Theta
0.5
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Vesper Sparrow
Theta
0.5
0.45
0.4
0.35
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Sage Sparrow
Theta
0.6
0.5
0.4
0.3
0.2
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Western Meadowlark
Theta
0.5
0.4
0.3
0.2
0.1
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


Sage Thrasher
Theta
0.6
0.5
0.4
0.3
0.2
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment


White-crowned Sparrow
Theta
0.25
0.2
0.15
0.1
0.05
0
ARIM-HI-2010
ARIM-HI-2011
ARIM-LOW-2010
ARIM-LOW-2011
BCR10-2010
BCR10-2011
Treatment

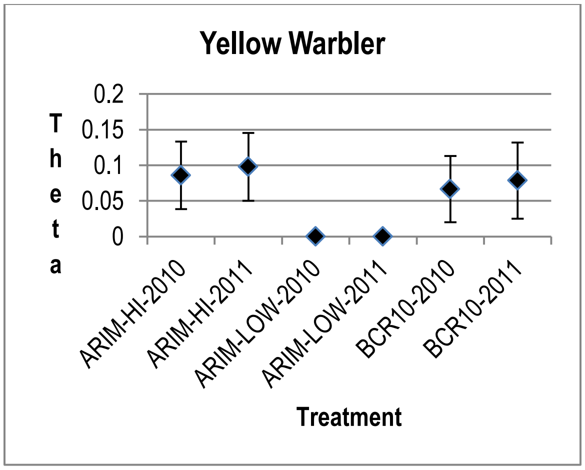


Figure 5. Estimated proportion of points occupied given that the species was detected at the survey location (Theta) for species on BCR10, WY-ARIM-HI and WY-ARIM-LOW in 2010 and 2011. Error bars represent the standard errors associated with the estimates.

DISCUSSION

The analyses discussed in this report utilized data collected in both 2010 and 2011. By utilizing data from two years of surveys we were able to produce Psi estimates and conduct species richness analyses for 23 species compared to 14 in 2010. Five of the nine additional species analyzed in 2011 occupied a higher proportion of survey locations within ARIM-Hi than within ARIM-Low. Four of these five species are generalists (e.g., Common Raven) or prefer riparian areas (e.g., Warbling Vireo, White-crowned Sparrow, and Yellow Warbler). The resulting Psi and Theta estimates from the analyses conducted using only 2010 data were similar to the estimates produced using both the 2010 and 2011 data for most species. Due to incorporating additional data and producing results with the use of model averaging, Psi and Theta values for 2010 presented in this report may differ from those values presented in the 2010 report. We believe the 2010 estimates presented in this report are more robust than those presented in the 2010 report because the estimates utilized more data and accounted for model selection uncertainty.

Another advantage of analyzing multiple years of data is that differences in Psi and Theta can be investigated between years; ultimately relating to information on trends in occupancy rates over time. Five species investigated had Psi, Theta, or both Psi and Theta estimates that differed substantially between 2010 and 2011. These differences could be attributed to environmental stochasticity (Sæther et al. 2002) or behavioral factors. Some species, such as the Lark Bunting (*Calamospiza melanocorys*), shift their breeding ranges from year to year based on environmental conditions (Shane 2000) resulting in abundance and occupancy estimates that fluctuate substantially among years. Another possibility is that the 2010 – 2011 winter was particularly snowy with an above average snow pack at higher elevations, more available water late into the summer, a delayed spring migration, and many breeding birds arriving on their breeding grounds later than usual. Mountain Bluebird and American Robin are two species in particular that may have been detected with greater frequency in 2011 than in 2010 due to the late spring migration. Finally, the different occupancy rates may be a result of a declining trend in occupancy of these species on the landscape. Additional years of sampling will allow RMBO and its partners to determine if the differences in occupancy estimates across years are a result of seasonal variation in climatic conditions or if they are related to changes in population size and species distribution.

As in 2010, the 2011 total species richness and priority species richness across the two Atlantic Rim treatments did not differ substantially. Despite differences in road densities and resulting fragmentation, the 23 species we analyzed are expected to be present in similar numbers at survey locations in the two regions of the Atlantic Rim. Individual species occupancy rates did vary between treatment groups with five species demonstrating increased occupancy within the high-development area and one species demonstrating increased occupancy in the low development area. The five species occupying the high-development region of the Atlantic Rim with greater frequency tended to be either habitat generalists or species that are associated with riparian habitats. The lone species exhibiting higher occupancy rates in the low-development region of the Atlantic Rim was the Green-tailed Towhee, a species expected to occur with high frequency in the arid shrubland environment present throughout the Atlantic Rim study area.

As new infrastructure continues to be constructed in order to facilitate resource extraction we expect some species inhabiting the Atlantic Rim area to be positively affected while others will be negatively affected. Past research has shown that species which forage in open areas where seeds may collect as a result of prevailing winds (e.g., Horned Lark) can be positively impacted by higher road densities. Additionally, some species (e.g., Brewer's Sparrow) may be negatively affected by habitat fragmentation and disturbance to surrounding vegetation (Ingelfinger and Anderson 2004).

The higher overall richness and site occupancy within the Atlantic Rim study area compared to other BLM lands within BCR 10 indicates that the Atlantic Rim represents important habitat for a number of species inhabiting sagebrush and semi-desert shrubland environments. This study did not investigate potential differences in landscape characteristics, habitat structure or management practices that might explain the difference in occupancy and species richness between the Atlantic Rim and other BLM lands within BCR 10. Future work to determine the factors influencing these differences could identify characteristics important for maintaining high species richness and occupancy rates. We believe this information would be extremely beneficial to BLM managers throughout BCR 10.

With continued monitoring throughout the Atlantic Rim we anticipate being able to evaluate species richness for a larger suite of species, develop more precise estimates of Psi and Theta for individual species, and evaluate potential trends in occupancy across the two regions within the Atlantic Rim.

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APPENDIX A

Ranking of models investigating differences in species richness via Psi, Theta and (p) for breeding birds in BCR10, ARIM-Hi (Hi) and the ARIM-Low (Low) in 2010 and 2011. (1) indicates that Psi, Theta and/or p were held constant across all study areas and years, (Year) indicates that Psi, Theta and/or p were estimated to be the same across treatments but varied by year, (BCR10,Hi,Low) indicates that Psi, Theta and/or p varied across study areas but were the same across years and ((BCR10, Hi, Low)*(Year)) indicates that Psi, Theta and/or p were estimated separately for each combination of study area and year. K represents the number of parameters included in the model, ΔAICc is the difference in AICc between each model and the top-ranked model, AICc Wt is the probability that an individual model is the best model in the model set, and Dev is the -2 log likelihood of the model. Only models within four ΔAICc of the top model are displayed.

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
American Robin	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(Year)	8	600.94	0.00	0.13	583.73
	Psi(1) Theta(BCR10, Hi, Low) p(Year)	6	601.40	0.46	0.10	588.71
	Psi(Year) Theta(BCR10, Hi, Low) p(Year)	7	601.81	0.86	0.09	586.87
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	7	602.48	1.54	0.06	587.54
	Psi((BCR10, Hi, Low)*(Year)) Theta(BCR10, Hi, Low) p(Year)	9	602.89	1.95	0.05	583.37
	Psi(1) Theta(BCR10, Hi, Low) p(1)	5	603.12	2.18	0.04	592.63
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	603.20	2.26	0.04	590.51
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(1)	8	603.21	2.27	0.04	586.00
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(Year)	9	603.23	2.29	0.04	583.71
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(Year)	7	603.62	2.68	0.03	588.69
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	6	603.68	2.74	0.03	590.99
	Psi(Year) Theta((BCR10, Hi, Low)*(Year)) p(Year)	8	604.04	3.10	0.03	586.83
	Psi(Year) Theta((BCR10, Hi, Low)*(Year)) p(1)	7	604.06	3.12	0.03	589.13
	Psi(1) Theta(1) p(1)	3	604.19	3.24	0.03	597.99
	Psi((BCR10, Hi, Low)*(Year)) Theta(BCR10, Hi, Low) p(1)	8	604.27	3.33	0.02	587.06
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	604.33	3.39	0.02	593.84
	Psi(1) Theta(1) p(Year)	4	604.36	3.42	0.02	596.04
	Psi(Year) Theta(1) p(1)	4	604.37	3.42	0.02	596.04
	Psi(BCR10, Hi, Low) Theta(1) p(Year)	6	604.72	3.77	0.02	592.02

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
American Robin cont'd	Psi(Year) Theta(1) p(Year)	5	604.81	3.87	0.02	594.32
Black-billed Magpie	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	281.23	0.00	0.16	268.54
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	281.31	0.08	0.16	270.81
	Psi(1) Theta(BCR10, Hi, Low) p(1)	5	281.44	0.21	0.15	270.94
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	7	281.52	0.29	0.14	266.59
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	282.62	1.39	0.08	269.93
	Psi(1) Theta(Year) p(1)	4	282.86	1.63	0.07	274.54
	Psi(1) Theta(1) p(1)	3	283.56	2.33	0.05	277.37
	Psi(Year) Theta(1) p(1)	4	284.29	3.06	0.04	275.96
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	7	284.52	3.29	0.03	269.59
	Psi(Year) Theta(Year) p(1)	5	284.85	3.62	0.03	274.36
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(1)	7	285.00	3.77	0.02	270.07
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(1)	9	285.05	3.82	0.02	265.52
Brewer's Blackbird	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	445.15	0.00	0.69	432.46
	Psi(1) Theta(Year) p(1)	4	448.41	3.26	0.14	440.08
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	8	2809.03	0	0.35	2791.82
	Psi(1)Theta((BCR10, Hi, Low)*(Year)) p(Year)	9	2809.79	0.7606	0.24	2790.26
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	10	2810.66	1.6297	0.15	2788.77
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(1)	9	2811.11	2.0767	0.12	2791.58
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(Year)	10	2811.91	2.877	0.08	2790.02
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	11	2812.82	3.7866	0.05	2788.54
Brown-headed Cowbird	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	7	609.01	0.00	0.16	594.08
	Psi(BCR10, Hi, Low) Theta(1) p(BCR10, Hi, Low)	7	609.28	0.27	0.14	594.35
	Psi(1) Theta(BCR10, Hi, Low) p(1)	5	610.23	1.21	0.09	599.73
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(Year)	8	610.75	1.73	0.07	593.54
	Psi(1) Theta(1) p(BCR10, Hi, Low)	5	610.84	1.83	0.07	600.35

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Brown-headed Cowbird cont'd	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	610.86	1.85	0.06	598.17
	Psi(Year) Theta(1) p(BCR10, Hi, Low)	6	611.42	2.41	0.05	598.73
	Psi(BCR10, Hi, Low) Theta(Year) p(BCR10, Hi, Low)	8	611.55	2.54	0.05	594.34
	Psi(Year) Theta(BCR10, Hi, Low) p(Year)	7	611.95	2.94	0.04	597.02
	Psi(1) Theta(BCR10, Hi, Low) p(Year)	6	611.97	2.96	0.04	599.28
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	612.85	3.84	0.02	602.36
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(BCR10, Hi, Low)	9	612.91	3.90	0.02	593.39
Cliff Swallow	Psi(1) Theta(1) p(1)	3	137.72	0.00	0.26	131.52
	Psi(Year) Theta(1) p(1)	4	139.23	1.51	0.12	130.90
	Psi(1) Theta(Year) p(1)	4	139.69	1.97	0.10	131.36
	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	139.83	2.12	0.09	131.51
	Psi(1) Theta(BCR10, Hi, Low) p(1)	4	139.84	2.12	0.09	131.51
	Psi(Year) Theta(Year) p(1)	5	140.68	2.96	0.06	130.19
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(1)	5	141.19	3.47	0.05	130.70
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	5	141.39	3.67	0.04	130.90
Common Raven	Psi(Year) Theta(Year) p(1)	5	213.37	0.00	0.39	202.88
	Psi((BCR10, Hi, Low)*(Year)) Theta(Year) p(1)	6	215.16	1.78	0.16	202.46
	Psi(1) Theta(1) p(1)	3	215.99	2.62	0.11	209.79
	Psi(Year) Theta(1) p(1)	4	216.28	2.91	0.09	207.95
	Psi(1) Theta(Year) p(1)	4	216.42	3.05	0.08	208.10
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	5	216.95	3.58	0.07	206.46
	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	217.04	3.66	0.06	208.71
Dusky Flycatcher	Psi(1) Theta(1) p(1)	3	387.22	0.00	0.15	381.02
	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	387.77	0.55	0.12	379.44
	Psi(1) Theta(Year) p(1)	4	388.09	0.88	0.10	379.77
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	5	388.55	1.33	0.08	378.06
	Psi(1) Theta(1) p(Year)	4	389.10	1.88	0.06	380.77

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Dusky Flycatcher cont'd	Psi(Year) Theta(1) p(1)	4	389.29	2.07	0.05	380.96
	Psi(1) Theta(BCR10, Hi, Low) p(1)	4	389.31	2.09	0.05	380.98
	Psi(BCR10, Hi, Low) Theta(1) p(Year)	5	389.66	2.44	0.05	379.17
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	5	389.94	2.72	0.04	379.44
	Psi(Year) Theta(Year) p(1)	5	390.06	2.84	0.04	379.57
	Psi(1) Theta(Year) p(Year)	5	390.25	3.03	0.03	379.76
	Psi(BCR10, Hi, Low) Theta(Year) p(Year)	6	390.74	3.53	0.03	378.05
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	6	391.07	3.85	0.02	378.37
	Psi(Year) Theta(1) p(Year)	5	391.18	3.97	0.02	380.69
	Psi(1) Theta(BCR10, Hi, Low) p(Year)	5	391.21	3.99	0.02	380.72
Green-tailed Towhee	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(1)	9	1456.91	0.00	0.29	1437.39
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(1)	11	1457.44	0.52	0.22	1433.16
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(Year)	10	1458.05	1.14	0.16	1436.17
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	12	1458.65	1.74	0.12	1431.94
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(BCR10, Hi, Low)	11	1459.49	2.57	0.08	1435.21
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	13	1460.18	3.26	0.06	1430.98
Horned Lark	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	10	2558.06	0.00	0.41	2536.18
	Psi(1) Theta(Year) p(BCR10, Hi, Low)	6	2559.25	1.20	0.23	2546.56
	Psi(Year) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	11	2560.44	2.39	0.12	2536.17
	Psi(Year) Theta(Year) p(BCR10, Hi, Low)	7	2561.49	3.43	0.07	2546.55
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(BCR10, Hi, Low)	12	2561.67	3.62	0.07	2534.96
Mountain Bluebird	Psi(1) Theta(1) p(1)	3	458.36	0.00	0.46	452.16
	Psi(1) Theta(Year) p(1)	4	460.40	2.04	0.16	452.08
	Psi(Year) Theta(1) p(1)	4	460.49	2.13	0.16	452.16
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	461.61	3.25	0.09	451.12
Mourning Dove	Psi(1) Theta(BCR10, Hi, Low) p(1)	5	209.46	0.00	0.36	198.96

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Mourning Dove cont'd	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	6	209.83	0.38	0.30	197.14
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	211.65	2.20	0.12	198.96
	Psi((BCR10, Hi, Low)*(Year)) Theta(BCR10, Hi, Low) p(1)	7	211.67	2.22	0.12	196.74
Northern Flicker	Psi(1) Theta(1) p(1)	3	256.62	0.00	0.32	250.42
	Psi(1) Theta(BCR10, Hi, Low) p(1)	5	257.61	0.99	0.20	247.11
	Psi(1) Theta(Year) p(1)	4	258.50	1.89	0.13	250.18
	Psi(Year) Theta(1) p(1)	4	258.71	2.09	0.11	250.39
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	259.57	2.95	0.07	249.08
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	259.80	3.19	0.07	247.11
Rock Wren	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(Year)	7	959.13	0.00	0.14	944.20
	Psi(1) Theta(Year) p(Year)	5	959.38	0.25	0.12	948.89
	Psi(1) Theta(BCR10, Hi, Low) p(Year)	6	959.43	0.30	0.12	946.74
	Psi(1) Theta(1) p(Year)	4	959.84	0.70	0.10	951.51
	Psi(BCR10, Hi, Low) Theta(Year) p(Year)	7	960.44	1.30	0.07	945.50
	Psi(BCR10, Hi, Low) Theta(1) p(Year)	6	960.88	1.74	0.06	948.18
	Psi(Year) Theta((BCR10, Hi, Low)*(Year)) p(Year)	8	961.30	2.16	0.05	944.09
	Psi(Year) Theta(BCR10, Hi, Low) p(Year)	7	961.47	2.34	0.04	946.54
	Psi(Year) Theta(Year) p(Year)	6	961.58	2.45	0.04	948.89
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	6	961.64	2.50	0.04	948.94
	Psi(1) Theta(Year) p(1)	4	961.96	2.83	0.03	953.64
	Psi(Year) Theta(1) p(Year)	5	962.00	2.87	0.03	951.51
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(Year)	8	962.66	3.52	0.02	945.45
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	962.94	3.81	0.02	950.25
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(Year)	7	963.00	3.87	0.02	948.07
Sage Sparrow	Psi(1) Theta(BCR10, Hi, Low) p(BCR10, Hi, Low)	7	1506.37	0.00	0.27	1491.43
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	10	1507.05	0.68	0.19	1485.17
	Psi(1) Theta(1) p(BCR10, Hi, Low)	5	1507.59	1.22	0.14	1497.10

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Sage Sparrow cont'd	Psi(Year) Theta(BCR10, Hi, Low) p(BCR10, Hi, Low)	8	1508.52	2.15	0.09	1491.31
	Psi(1) Theta(Year) p(BCR10, Hi, Low)	6	1508.81	2.45	0.08	1496.12
	Psi(Year) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	11	1509.29	2.92	0.06	1485.02
	Psi(Year) Theta(1) p(BCR10, Hi, Low)	6	1509.67	3.31	0.05	1496.98
Sage Thrasher	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(BCR10, Hi, Low)	9	1864.30	0.00	0.60	1844.78
	Psi(1) Theta(BCR10, Hi, Low) p(BCR10, Hi, Low)	7	1866.65	2.35	0.18	1851.72
Say's Phoebe	Psi(1) Theta(Year) p(1)	4	236.96	0.00	0.30	228.63
	Psi(1) Theta(1) p(1)	3	237.11	0.15	0.28	230.91
	Psi(Year) Theta(1) p(1)	4	238.28	1.32	0.15	229.95
	Psi(Year) Theta(Year) p(1)	5	239.10	2.14	0.10	228.61
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	240.82	3.86	0.04	228.12
Vesper Sparrow	Psi(BCR10, Hi, Low) Theta(Year) p(BCR10, Hi, Low)	6	2491.71	0.00	0.32	2479.02
	Psi(BCR10, Hi, Low) Theta(1) p(BCR10, Hi, Low)	5	2491.97	0.26	0.28	2481.48
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	7	2493.59	1.88	0.13	2478.66
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(BCR10, Hi, Low)	6	2493.84	2.13	0.11	2481.15
Violet-green Swallow	Psi(1) Theta(1) p(1)	3	167.52	0.00	0.34	161.33
	Psi(1) Theta(Year) p(1)	4	168.50	0.98	0.21	160.18
	Psi(Year) Theta(1) p(1)	4	168.71	1.19	0.19	160.39
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	169.84	2.31	0.11	159.34
	Psi(Year) Theta(Year) p(1)	5	170.62	3.09	0.07	160.12
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	170.89	3.37	0.06	158.20
Warbling Vireo	Psi(Year) Theta(1) p(1)	4	168.85	0.00	0.38	160.52
	Psi(1) Theta(1) p(1)	3	169.39	0.54	0.29	163.20
	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	169.90	1.05	0.22	161.57
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(1)	6	171.18	2.33	0.12	158.49
Western Meadowlark	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	7	1220.39	0.00	0.14	1205.45

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Western Meadowlark cont'd	Psi((BCR10, Hi, Low)*(Year)) Theta(BCR10, Hi, Low) p(1)	10	1220.66	0.27	0.12	1198.78
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(Year)	8	1221.15	0.76	0.10	1203.94
	Psi((BCR10, Hi, Low)*(Year)) Theta(BCR10, Hi, Low) p(Year)	11	1221.56	1.17	0.08	1197.28
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(1)	10	1222.82	2.43	0.04	1200.94
	Psi((BCR10, Hi, Low)*(Year)) Theta(Year) p(1)	9	1222.86	2.48	0.04	1203.34
	Psi(BCR10, Hi, Low) Theta(Year) p(Year)	7	1222.90	2.51	0.04	1207.97
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	6	1222.94	2.55	0.04	1210.24
	Psi(BCR10, Hi, Low) Theta((BCR10, Hi, Low) * (Year)) p(Year)	11	1222.94	2.55	0.04	1198.66
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(Year)	10	1222.95	2.56	0.04	1201.07
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	6	1223.12	2.74	0.04	1210.43
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(1)	13	1223.18	2.79	0.04	1193.99
	Psi((BCR10, Hi, Low)*(Year)) Theta((BCR10, Hi, Low)*(Year)) p(BCR10, Hi, Low)	14	1223.43	3.04	0.03	1191.71
	Psi(BCR10, Hi, Low) Theta(1) p(1)	5	1223.78	3.39	0.03	1213.29
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(1)	8	1223.82	3.44	0.03	1206.61
	Psi(Year) Theta(BCR10, Hi, Low) p(Year)	7	1223.88	3.49	0.02	1208.94
	Psi(BCR10, Hi, Low) Theta(1) p(Year)	6	1224.36	3.97	0.02	1211.67
White-crowned Sparrow	Psi(1) Theta(1) p(1)	3	140.30	0.00	0.25	134.10
	Psi(1) Theta(Year) p(1)	4	141.52	1.22	0.14	133.19
	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	142.16	1.86	0.10	133.83
	Psi(1) Theta(BCR10, Hi, Low) p(1)	4	142.32	2.02	0.09	133.99
	Psi(Year) Theta(1) p(1)	4	142.38	2.09	0.09	134.06
	Psi(1) Theta((BCR10, Hi, Low)*(Year)) p(1)	5	143.15	2.85	0.06	132.66
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	5	143.51	3.21	0.05	133.02
	Psi(Year) Theta(Year) p(1)	5	143.65	3.35	0.05	133.16
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	5	144.11	3.82	0.04	133.62
Yellow Warbler	Psi(BCR10, Hi, Low) Theta(1) p(1)	4	115.49	0.00	0.23	107.17

Species	Model	K	AICc	ΔAICc	AICc Wt	Dev
Yellow Warbler cont'd	Psi(1) Theta(1) p(1)	3	116.51	1.02	0.14	110.32
	Psi(1) Theta(BCR10, Hi, Low) p(1)	4	116.62	1.12	0.13	108.29
	Psi(BCR10, Hi, Low) Theta(Year) p(1)	5	117.03	1.53	0.11	106.54
	Psi(BCR10, Hi, Low) Theta(BCR10, Hi, Low) p(1)	5	117.53	2.04	0.08	107.04
	Psi(1) Theta(Year) p(1)	4	118.22	2.73	0.06	109.89
	Psi(Year) Theta(1) p(1)	4	118.63	3.13	0.05	110.30
	Psi((BCR10, Hi, Low)*(Year)) Theta(1) p(1)	6	118.63	3.14	0.05	105.94
	Psi(Year) Theta(BCR10, Hi, Low) p(1)	5	118.73	3.23	0.05	108.23