ASSESSING LAND USE PRACTICES ON THE ECOLOGICAL CHARACTERISTICS OF SAGEBRUSH ECOSYSTEMS: MULTIPLE MIGRATORY BIRD RESPONSES

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2015 Final Report

Contents

Assessing Land Use Practices on the Ecological Characteristics of Sagebrush Ecosystems: Multiple Migratory Bird Responses

2015 FINAL REPORT

Submitted to: United States Fish and Wildlife Service Plains and Prairie Pothole Landscape Conservation Initiative; *in conjunction* with the Bureau of Land Management and Montana Fish, Wildlife and Parks.

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SUMMARY OF PROGRESS

Rest-rotation grazing, defined as lack of livestock grazing in a pasture for 15-18 months, is suggested to improve the quality of sagebrush, shrubland, and grassland habitat for a wide range of species. However, little work has been done to evaluate impacts of rest-rotation grazing on migratory avian species which serve as indicators of sagebrush ecosystem integrity. Evaluating the impacts of rest-rotation grazing using indicator species can provide valuable insight into how rest-rotation grazing may affect multiple species in the ecosystem.

Our research is focused on how different grazing systems, rest-rotation and traditional, change songbird community structure (e.g., species abundance and richness). Traditional grazing, in contrast to rest-rotation grazing, is defined as repeated livestock grazing in a pasture over multiple vegetation growing seasons. From 2013-2015 we assessed abundance of the avian communities on lands with traditional grazing and a rest-rotation grazing scheme developed as a conservation strategy with the Sage Grouse Initiative.

Here we describe our findings from the 2013, 2014, and 2015 field seasons. We focused on five species that represent the range of vegetation use within our study area. Brewer's sparrow (*Spizella breweri*), a sagebrush obligate, depends on sagebrush for important life history requirements, including foraging and breeding activities. McCown's longspur (*Rhynchophanes mccownii*) is a grassland obligate. Horned lark (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*), and western meadowlark (*Sturnella neglecta*) are associated with both sagebrush and grassland vegetation.

General patterns in individual species abundance have been consistent for the three sampling years. Three species, Brewer's sparrow, horned lark, and vesper sparrow, have shown no significant difference in abundance between traditional and rest-rotation grazing. McCown's longspur and western meadowlark have shown significant differences in abundance between the traditional and rest-rotation grazing. McCown's longspur was more than twice as abundant on rest-rotation than traditional grazing. In contrast, western meadowlark was more than twice as abundant on traditional grazing as rest-rotation grazing.

BACKGROUND

Livestock grazing is the most widespread land use practice of sagebrush ecosystems (Knick et al. 2010). Due to our ability to manipulate the process, domestic livestock grazing is a suitable land management tool that can facilitate desired habitat conditions (Fuhlendorf and Engle 2001). Livestock grazing provides stakeholders an outlet to reduce conflicts between sagebrush conservation and livestock production goals. In the face of increased human consumption of natural resources and the uncertainty of the impacts of climate change, it is prudent to couple sensible and informed land use practices with the response of sagebrush ecosystems.

Migratory birds can serve as a barometer for sagebrush ecosystem integrity and the impacts of grazing management designed to positively benefit avian communities. Migratory birds are among the few groups of organisms in which community reassembly (e.g., Lemoine et al. 2007, Zuckerberg et al. 2009), adaptation of species to climate change (Schaefer et al. 2008), and effectiveness of conservation actions have been documented. Additionally, sagebrush-associated migratory birds respond quickly to habitat changes by shifting their distributions and adapting their reproductive performance.

The long-term goal of our study is to determine if and how grazing alters avian communities. We aim to accomplish this using avian community composition measures and demographic parameters to compare avian communities between two grazing systems: traditional and rest-rotation. To assess how avian community composition changes we will use adult abundance of multiple avian species. Avian abundance is known to change with vegetation heterogeneity, showing an increase where heterogeneity is high. Grazing has a known effect on vegetation heterogeneity, and we can track vegetative patterns that occur as a result of grazing by measuring changes in avian abundance.

2013 - 2015 FIELD STUDY

We conducted field surveys in 2013, 2014 and 2015. In 2013, we were granted access to private lands enrolled in SGI and were able to assess these lands for the duration of this study. This allowed us to evaluate the two grazing systems 1) traditional and 2) rest-rotation. The following sections provide an overview of the field methods, data analysis, and preliminary results for these three years.

SURVEY METHODS

Our sample plot was 500 x 500 m (25 ha). This size was designed to allow coverage of 125 m from a survey transect at all times (Figure 1) because ≥95% of songbird detections occur within 125 m of the observer (Ralph et al. 1995). We randomly selected a total of 80 sample plots, 40 per grazing system using ArcMap 10. We sampled the same 80 plots each year.

We used dependent double-observer (Nichols et al. 2000) transect surveys (hereafter known as "transect surveys") to obtain avian community composition information. This method is grounded in mark-recapture estimation methodology. By using two observers, an encounter history can be constructed for each individual (or individual species) observed. This method requires a two-person survey team, with one person designated as the 'primary' observer and the other person as the 'secondary' observer. Following Tipton et al. (2008 & 2009), the two observers walk the survey 'transect' single file within the 500 x 500 m sampling plot (Figure 1). The primary observer identifies all birds observed and communicates each individual detection, including species, detection type, and approximate location, to the secondary observer who records the information. In addition, the secondary observer records any detections not noted by the primary observer. The roles of primary and secondary observer within a survey team alternate on consecutive transect surveys.

We conducted transect surveys three times within each sample plot between late April and August from 2013 to 2015 (Table 1). Transect surveys were completed between sunrise (~0530 Mountain Standard Time [MST]) and 1100 MST. Sampling occasion three in year 2015 was not completed due to an early nesting season. Juveniles in 2015 quickly became indistinguishable between adults by the end of June.

We conducted nest searches to locate nests within each grazing treatment. All nest searches were within the 80 sampling plots along five transects at 100 m intervals (starting 50 m from the edge of the plot). We avoided conducting transect surveys and nest searches on a single plot on the same day to minimize the effect of disturbance on our survey results. We also avoided nest searches on plots when greater sage grouse (C*entrocercus urophasianus*) nests were active to avoid disturbance to their nests. We used one of three methods on these nest searching transects: 1) a systematic nest search along the transect using a rope/chain; 2) a systematic nest search along the transect using a dowel swept over the top of sagebrush bushes (Ruehmann et al. 2011); or 3) behavioral observations conducted from transects. Nests that were opportunistically observed in the plot were also included. When a nest was initially located, we recorded location information (UTM coordinates).

We monitored nests until fledging to obtain avian demographic information. We conducted a minimum of two nest monitoring visits to determine the fate of the nest. During each monitoring visit we recorded the stage of the young (eggs, nestling, or fledgling), whether the nest was parasitized (and if so the stage of the parasite young), and the number of young at each stage.

We defined a nest as successful when ≥ 1 nestling fledged from the nest. We assumed a nest had fledged if we observed nestlings of the appropriate age on the prior visit and observed an intact nest with signs of fledging (e.g. whitewash at the edge of the nest). When a nest failed, we attempted to determine if the cause of failure was predation, weather, or unknown.

Nest searching and monitoring were completed in 2013, 2014, and 2015. All plots were nest searched in 2014. In 2013, we were establishing nest search methods and ran into time constraints (56 plots, Table 1). In 2015 we monitored a large number of nests (136 nests, Table 2) and were time constrained to survey 66 plots out of the 80 plots (Table 1).

DATA ANALYSIS

We developed a multispecies dependent double-observer abundance model (MDAM) to assess differences in songbird communities between traditional and rest-rotation grazing (Golding 2015). The MDAM uses a Bayesian framework that incorporates the dependent double-observer transect survey method to estimate individual species detection probabilities. The MDAM provides abundance estimates for multiple species within a community. We used the MDAM to compare abundances of five avian species in the two grazing systems. Observed species richness was calculated by computing the average number of avian species detected on plots within each grazing system in each year. Analyses were conducted using program R (R Core Team 2012) and JAGS (Plummer 2013).

RESULTS

Five songbird species were detected the most often in each year of sampling and between grazing systems (Appendix A): Brewer's sparrow, horned lark, McCown's longspur, vesper sparrow, and western meadowlark. Observations of the avian community remained similar between years. In 2013, we detected a total of 13,525 individuals of 86 species. In 2014, we detected 13,755 individuals of 75 species, and in 2015 we detected 6016 individuals of 71 species (Appendix A).

Patterns in abundance of the top five species differed between grazing types (Table 4; Figure 2). In 2013, 2014, and 2015, McCown's longspur were more abundant on rest-rotation than traditional grazing land. In contrast, western meadowlark were more abundant on traditional grazing than rest-rotation grazing in all years. There was no difference in abundance between the grazing types for Brewer's sparrow, horned lark, and vesper sparrow. Overall, these five species were the most frequently observed (Appendix A) and most abundant (as predicted by the MDAM) (Table 4).

Nest counts were similar between grazing systems and years. For Brewer's sparrow, McCown's longspur, and vesper sparrow, total nest numbers were lower on traditional grazing systems than rest-rotation grazing systems for 2013 - 2015. The observed number of nests for each individual species was similar, except for McCown's longspur nests, which we consistently detected more on rest-rotation grazing systems (Table 2).

DISCUSSION

The results from the three year study indicate that the following species are the most abundant in the study area: Brewer's sparrow, vesper sparrow, western meadowlark, McCown's longspur, and horned lark. They may be good targets for continued monitoring for a number of reasons. These species represent the different nesting strategies of migratory songbirds within the sagebrush ecosystem; they include ground nesting species (vesper sparrow, western meadow lark, McCown's longspur, and horned lark) and shrub nesting species (Brewer's sparrow) and span a variety of habitats in the sagebrush ecosystem. They are easy to detect with survey methods (transect surveys and nest searching) that work well in sagebrush ecosystems.

When considering these five species, the difference between the two grazing types is driven by differences in the abundance of two species: McCown's longspur and western meadowlark. Both species may exploit a specific resources related to the different grazing types. While we have not seen a clear response of all bird species within the community, our results do suggest that rest-rotation grazing creates vegetation conditions that are more favorable for McCown's longspur and neutral for the three other species. Further exploration of the fitness consequences of these grazing systems may provide more insight into why there is not a more consistent pattern across species.

Nest counts from the three years show variable patterns between years and grazing types. These results may also reflect the variation in a sagebrush ecosystem. The observed difference in nest counts could be due to differences in nest detection probability between years, nest searching efforts (56 plots in 2013, 80 plots in 2014, and 66 plots in 2015), or phenology of the species.

FUTURE PRODUCTS

We anticipate two to four publications from this study. These will build off the work conducted by Jessie Golding, the Master's student on the project. Her thesis will be finalized and available in winter 2015. Topics covered in her thesis research include the development of the MDAM and an assessment of songbird communities in response to these two grazing systems.

Future work will focus on a more in-depth look at the consequences of grazing management on avian communities. Our goal is to link songbird abundance and breeding activity to understand the fitness consequences for avian communities in each grazing system. Songbirds within these grazing systems use the area exclusively to breed. The outcome of that breeding effort can influence the persistence of populations and existing community structure. It is therefore important to understand how grazing can affect breeding activity. By altering vegetation that songbirds use for nesting, grazing may have a direct effect on breeding outcomes. From 2013 to 2015 we have monitored nesting activity of three songbird species within each of these grazing systems. We selected these species because they occur in both grazing systems and represent the range of vegetation used by songbirds in the region for breeding: Brewer's sparrow (a shrub nester), vesper sparrow (a generalist ground nester), and McCown's longspur (a grassland ground nester). We are also currently exploring the two methods to account for nest detection probability to create more accurate estimates of nest density. Estimates of nest density can be used to estimate reproductive output for a given area. This information will be combined with breeding adult abundance using the MDAM framework.

We hope to create a user-friendly framework to run the MDAM that includes predictive functions to estimate how grazing management may affect the songbird community structure in the future. This framework will assist in long-term monitoring of songbird communities in response to grazing.

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Table 1. The number of transect surveys and nest searching efforts near Roundup, Montana, in 2013, 2014, and 2015.

Sampling Occasion	2013			2014			2015		
	Date	Transect Survey	Nest Search	Date	Transect Survey	Nest Search	Date	Transect Survey	Nest Search
1	April 26 – July 1	80	56	May 22 – July 13	80	30	May 21 – June 6	80	19
2	June 4 – July 31	80	30	June 3 – July 8	80	30	June 6 – June 29	80	47
3	June 9 – August 3	80	20	July 8 – July 23	80	20	-	-	-
Totals		**240**	**56**		**240**	**80**		**160**	**66**

Table 2. Number of nests of Brewer's sparrow, vesper sparrow, and McCown's longspur detected during nest search efforts in 2013, 2014, and 2015 on lands near Roundup, Montana.

Common Name	2013		2014		2015	
	Traditional	Rest-Rotation	Traditional	Rest-Rotation	Traditional	Rest-Rotation
Brewer's sparrow	17	19	27	30	72	74
McCown's longspur	10	24	7	41	5	18
vesper sparrow	29	37	26	25	39	44
Totals	**240**	**56**	**80**	**60**	**96**	**116**

Table 3. Total observations of the most common species detected during walking transect surveys in 2013, 2014, and 2015 near Roundup, Montana.

Common Name	2013*		2014		2015	
	Traditional	Rest-Rotation	Traditional	Rest-Rotation	Traditional	Rest-Rotation
Brewer's sparrow	979	804	1,101	927	636	580
horned lark	597	1,015	870	1,075	301	521
McCown's longspur	1,037	2,450	726	2,824	280	797
vesper sparrow	1,066	936	1,057	1,030	573	451
western meadowlark	795	400	779	471	386	258
Totals	4,474	5,605	4,533	6,327	2,176	2,607

*Table values from 2013 are different than values previously reported for 2013 due to surveys and replicates that were removed from analyses.

Table 4. Probability of detection and abundance estimates per 25 ha plot for five avian species were surveyed using the transect survey method in 2013, 2014, and 2015 on lands near Roundup, Montana. Estimates are derived from the multispecies dependent double-observer abundance model. Values in parentheses represent the 95% Bayesian credible interval.

Common Name	Detection Probability	2013 Abundance		2014 Abundance		2015 Abundance	
		Traditional	Rest-Rotation	Traditional	Rest-Rotation	Traditional	Rest-Rotation
Brewer's sparrow	0.50 (0.09-0.78)	13.64 (11.63-15.89)	15.78 (13.46-18.38)	10.67 (9.03-12.52)	12.34 (10.42-14.52)	8.35 (6.89-10.02)	9.66 (7.94-11.64)
horned lark	0.55 (0.29-0.86)	8.78 (7.49-10.22)	11.34 (9.69-13.2)	7.2 (6.07-8.46)	9.3 (7.85-10.93)	5.9 (4.84-7.11)	7.62 (6.27-9.19)
McCown's longspur	0.62 (0.26-0.85)	8.92 (7.6-10.41)	23.53 (20.14-27.31)	5.76 (4.87-6.76)	15.18 (12.9-17.76)	3.72 (3.08-4.44)	9.8 (8.17-11.67)
vesper sparrow	0.46 (0.10-0.82)	14.49 (12.37-16.88)	15.3 (13.05-17.84)	10.36 (8.77-12.16)	10.95 (9.25-12.86)	7.42 (6.11-8.94)	7.84 (6.43-9.45)
western meadowlark	0.47 (0.10-0.78)	10.72 (9.13-12.48)	6.35 (5.37-7.45)	9.17 (7.71-10.82)	5.43 (4.53-6.45)	7.85 (6.37-9.59)	4.65 (3.74-5.71)

Figure 1. Dependent double-observer method. The primary (open circle) and secondary observer (dashed circle) walk single-file along the transect (dotted line) within a 500 m x 500 m sampling plot. Observers survey up to 125 m on either side of the transect. All surveys start at the lower right corner of the transect. Red arrows indicate direction of travel.

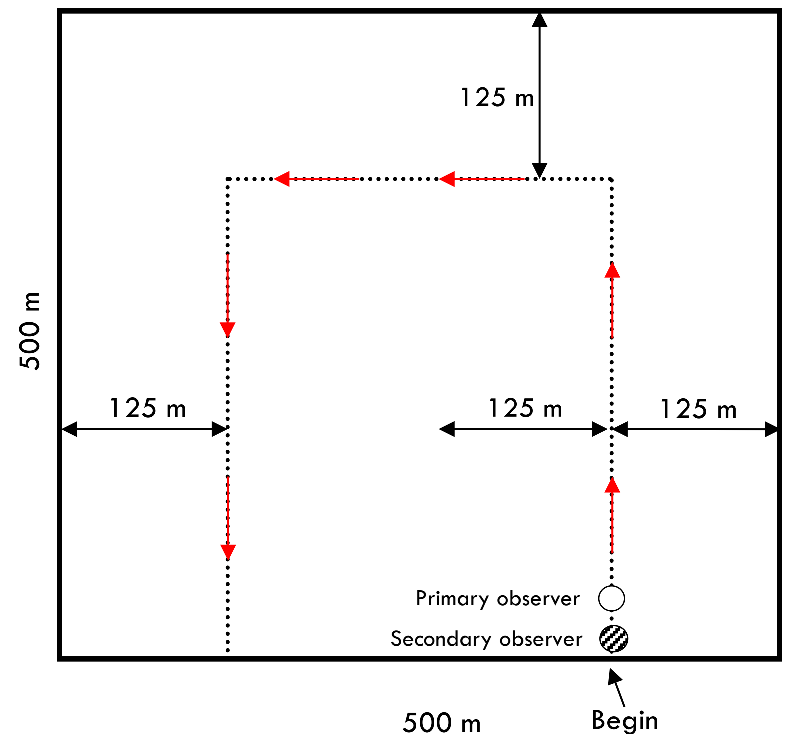
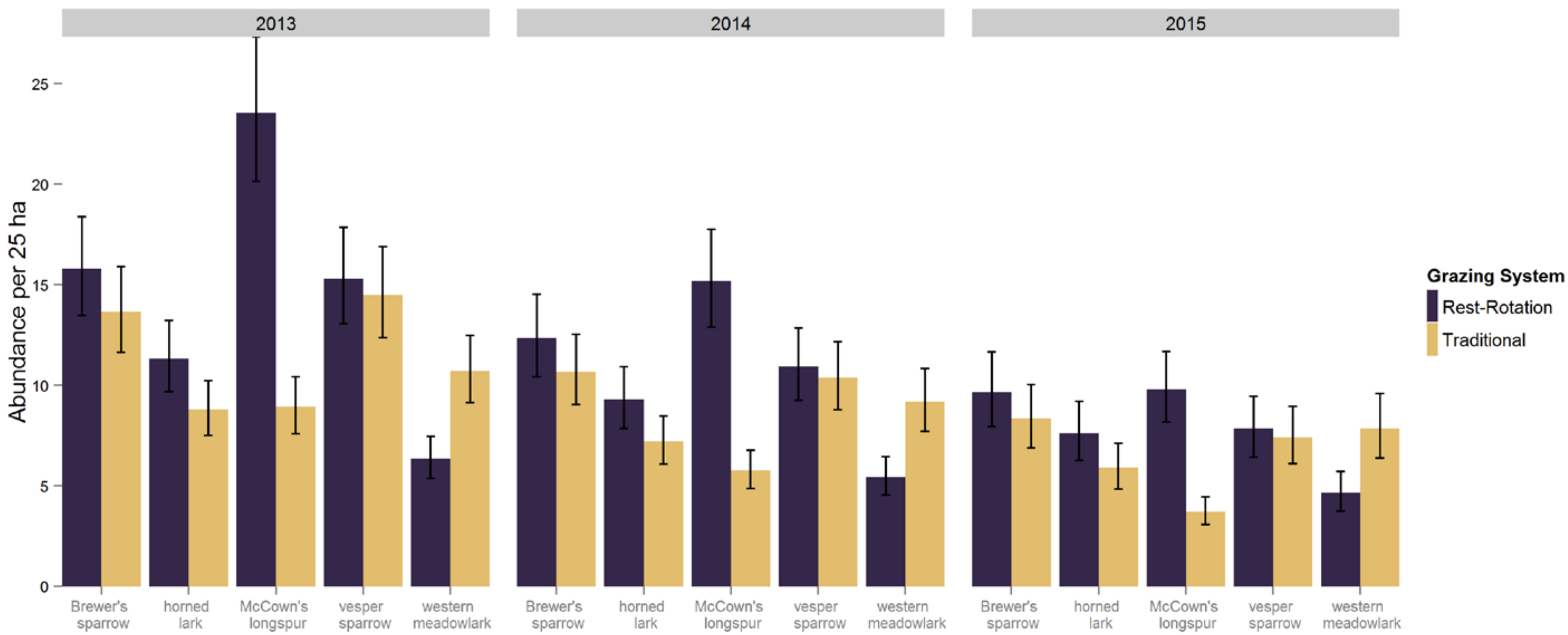


Figure 2. A comparison of the mean adult abundance per 25 ha by grazing system in 2013, 2014, and 2015. Individual species abundance patterns within the grazing systems are similar across years. McCown's longspur and western meadowlark show significantly different responses to grazing. In contrast, Brewer's sparrow, horned lark, and vesper sparrow show no significant difference in abundance between grazing systems. Estimates are derived from the multispecies dependent double-observer abundance model. Avian species were surveyed using the dependent double-observer transect survey method in 2013, 2014, and 2015 on lands near Roundup, Montana.



APPENDIX A

Appendix A. Total avian observations in 2013, 2014, 2015. The species detected during transect surveys on BLM and private lands near Roundup, Montana, in April through August in the years of 2013 through 2015.

Common Name	Scientific Name	2013	2014	2015
Totals		13,525	13,755	6,016
red-winged blackbird	*Agelaius phoeniceus*	109	105	48
Baird's sparrow	*Ammodramus bairdii*	10	4	1
grasshopper sparrow	*Ammodramus savannarum*	80	71	58
northern pintail	*Anas acuta*	4	-	2
American wigeon	*Anas americana*	20	9	6
northern shoveler	*Anas clypeata*	4	4	5
green-winged teal	*Anas crecca*	-	3	3
cinnamon teal	*Anas cyanoptera*	8	4	1
blue-winged teal	*Anas discors*	17	3	13
mallard	*Anas platyrhynchos*	30	16	25
gadwall	*Anas strepera*	11	20	7
American pipit	*Anthus rubescens*	-	-	1
Sprauge's pipit	*Anthus spragueii*	6	8	4
golden eagle	*Aquila chrysaetos*	3	-	2
great blue heron	*Ardea herodias*	3	2	-
short-eared owl	*Asio flammeus*	-	2	2
burrowing owl	*Athene cunicularia*	-	1	-
redhead	*Aythya americana*	-	-	1
upland sandpiper	*Bartramia longicauda*	33	28	10
cedar waxwing	*Bombycilla cedrorum*	10	-	-
Canada goose	*Branta canadensis*	167	46	121
red-tailed hawk	*Buteo jamaicensis*	13	4	3
rough-legged hawk	*Buteo lagopus*	1	-	-
ferruginous hawk	*Buteo regalis*	2	-	3
Swainson's hawk	*Buteo swainsoni*	1	-	-
lark bunting	*Calamospiza melanocorys*	458	586	64
chestnut-collared longspur	*Calcarius ornatus*	440	406	226
turkey vulture	*Cathartes aura*	10	-	1
greater sage-grouse	*Centrocercus urophasianus*	5	-	9
mountain plover	*Charadrius montanus*	4	3	3
semipalmated plover	*Charadrius semipalmatus*	22	-	-
killdeer	*Charadrius vociferus*	35	57	30
lark sparrow	*Chondestes grammacus*	76	89	36
common nighthawk	*Chordeiles minor*	5	21	2
northern harrier	*Circus cyaneus*	29	9	3
northern flicker	*Colaptes auratus*	25	11	4
rock pigeon	*Columba livia*	5	3	-

western wood-pewee	*Contopus sordidulus*	-	2	-
American crow	*Corvus brachyrhynchos*	13	1	-
common raven	*Corvus corax*	26	25	16
tundra swan	*Cygnus columbianus*	2	-	-
horned lark	*Eremophila alpestris*	1,612	1,945	822
Brewer's blackbird	*Euphagus cyanocephalus*	186	82	29
merlin	*Falco columbarius*	-	2	1
prairie falcon	*Falco mexicanus*	2	2	3
peregrine falcon	*Falco peregrinus*	1	-	-
American kestrel	*Falco sparvarius*	46	12	3
American coot	*Fulica americana*	-	13	-
Wilson's snipe	*Gallinago delicata*	-	3	-
sandhill crane	*Grus Canadensis*	-	4	-
pinyon jay	*Gymnorhinus cyanocephalus*	8	-	-
barn swallow	*Hirundo rustica*	16	20	6
Bullock's oriole	*Icterus bullockii*	-	1	-
loggerhead shrike	*Lanius ludovicianus*	28	20	13
herring gull	*Larus argentatus*	1	-	-
California gull	*Larus californicus*	19	-	3
ring-billed gull	*Larus delawarensis*	3	8	1
Franklin's gull	*Leucophaeus pipixcan*	13	-	-
marbled godwit	*Limosa fedoa*	9	7	2
brown-headed cowbird	*Molothrus ater*	290	323	197
Clark's nutcracker	*Nucifraga columbiana*	3	-	-
long-billed curlew	*Numenius americanus*	104	115	49
sage thrasher	*Oreoscoptes montanus*	11	8	1
savannah sparrow	*Passerculus sandwichensis*	8	21	26
grey partridge	*Perdix perdix*	2	15	-
cliff swallow	*Petrochelidon pyrrhonota*	487	222	2
double-crested cormorant	*Phalacrocorax auritus*	3	24	5
ring-necked pheasant	*Phasianus colchicus*	-	-	-
black-billed magpie	*Pica hudsonia*	25	20	2
pine grossbeak	*Pinicola enucleator*	-	-	-
eared grebe	*Podiceps nigricollis*	-	-	1
white-faced ibis	*Plegadis chihi*	-	3	-
black-capped chickadee	*Poecile atricapillus*	6	3	1
vesper sparrow	*Pooecetes gramineus*	2,002	2,087	1,024
sora	*Porzana carolina*	-	-	1
common grackle	*Quiscalus quiscula*	1	-	1
American avocet	*Recurvirostra americana*	28	31	5
McCown's longspur	*Rhynchophanes mccownii*	3,487	3,550	1,077
rock wren	*Salpinctes obsoletus*	7	9	6
Say's pheobe	*Sayornis saya*	24	10	5
yellow-rumped warbler	*Setophaga coronata*	3	-	-
mountain bluebird	*Sialia currucoides*	19	7	5

American goldfinch	*Spinus tristis*	2	3	-
Brewer's sparrow	*Spizella breweri*	1,783	2,028	1,216
Clay-colored sparrow	*Spizella pallida*	2	6	5
chipping sparrow	*Spizella passerina*	15	1	3
Wilson's phalarope	*Steganopus tricolor*	116	14	23
western meadowlark	*Sturnella neglecta*	1,195	1,250	644
European starling	*Sturnus vulgaris*	27	1	10
tree swallow	*Tachycineta bicolor*	17	18	4
violet green swallow	*Tachycineta thalassina*	5	2	-
brown thrasher	*Toxostoma rufum*	-	1	-
willet	*Tringa semipalmata*	19	6	3
sharp-shinned hawk	*Accipiter striatus*	1	-	-
house wren	*Troglodytes aedon*	1	-	-
American robin	*Turdus migratorius*	13	26	9
sharp-tailed grouse	*Tympanuchus phasianellus*	1	-	1
eastern kingbird	*Tyrannus tyrannus*	6	4	1
western kingbird	*Tyrannus verticalis*	2	3	1
Cassin's kingbird	*Tyrannus vociferans*	4	-	-
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	3	2	-
mourning dove	*Zenaida macroura*	173	279	95
White-crowned sparrow	*Zonotrichia leucophrys*	3	1	-