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

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Contents

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

2014 ANNUAL PROGRESS REPORT

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SUMMARY OF PROGRESS

Rest-rotation grazing, defined as rotating livestock through multiple pastures over a vegetation growing season, 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. In 2012 we initiated a research project building off of the existing US Department of Agriculture - Natural Resource Conservation Service's Sage Grouse Initiative (SGI) infrastructure in eastern Montana to evaluate the responses of migratory birds to rest-rotation grazing in a sagebrush 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 grazing livestock in the same area over a vegetation growing season. We are exploring the potential mechanisms, mainly nest success, that can explain these changes. In 2012 we had access to public land where only traditional grazing occurs. As a result, we used this year as a pilot year to assess survey methods for monitoring songbird communities. In 2013 and 2014, we expanded our

sampling efforts to include additional public lands with traditional grazing, as well as private lands where rest-rotation grazing associated with SGI occurs. In addition, in 2013 we began monitoring nest success of songbird species. Nest monitoring continued in 2014, although we narrowed the focus to three species that are representative of the songbird nesting strategies in the region: Brewer's sparrow (*Spizella breweri*) (a shrub obligate nester), vesper sparrow (*Pooecetes gramineus*) (a generalist ground nester), and McCown's longspur (*Rhynchophanes mccownii*) (a grassland obligate ground nester).

Here we describe our preliminary findings from 2014 field season, as well as a summary of findings to date. Preliminary results from 2013 and 2014 have shown little difference in avian abundance between rest-rotation and traditional grazing systems. General patterns in individual species abundance have been consistent for the three years. This supports our definition of the following species as the focal songbirds for our study: Brewer's sparrow, vesper sparrow, western meadowlark (*Sturnella neglecta*), McCown's longspur, and horned lark (*Eremophila alpestris*). There has been a significant difference in plot-level species richness between rest-rotation and traditional grazing in 2013 and 2014, but no clear difference at the regional level between the two grazing systems. We are in the process of analyzing nest success.

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). Additionally, using domestic livestock grazing to achieve sagebrush conservation objectives and outcomes provides land managers with opportunities to reduce conflicts between sagebrush conservation and livestock production goals. In the face of increasing global challenges, particularly increased human consumption of natural resources and the uncertainty of the impacts of climate change, it is prudent to couple modern land use practices and 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 community assemblages. 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 grazing. The primary community composition measures that we will use are species richness and abundance. Species richness represents the finest scale of community complexity. In general, it is thought to increase as heterogeneity in both biotic and abiotic factors increase (Chase & Myers 2011). Because grazing has a known effect on landscape heterogeneity, we have the potential to track changes that occur as a result of grazing by measuring changes in species richness. In addition, species abundance may also directly track these changes in the landscape. Because habitat quality is one of the main drivers of nest success, and grazing causes a known change in habitat quality, we are interested in tracking effects of grazing systems with nest success. Finally, we are interested in how this potential change in nest success may affect population growth rates.

PILOT STUDY

The 2012 pilot study addressed two main goals: to determine avian community composition in the study area and to evaluate sampling methods. We tested two field survey methods, point counts and dependent double observer transects (also referred to as walking transects). Analysis from that year revealed that the walking transects resulted in higher probability of detection with smaller confidence intervals, and therefore more accurate estimates of abundance. For more detailed information see Dreitz (2012).

2013 - 2014 FIELD STUDY

We conducted field surveys in 2013 and 2014. In 2013, we were granted access to private lands enrolled in SGI. 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 two years.

Survey Methods

Our survey methods were similar to those used in the 2012 pilot study. We kept the sample plot size of 500 x 500 m. This plot size is based on the passerine species that has the largest observed breeding territory in the ecosystem, the loggerhead shrike (*Lanius ludovicianus*) (Brooks 1988). 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 transect surveys (Nichols et al. 2000) 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) with which mark-recapture estimators can be used. This method required a two-person survey team, with one person designated as the 'primary' observer and the other person as the 'secondary' observer. Following Nichols et al. (2000), the two observers walked the survey 'transect' single file within the 500 x 500 m sampling plot. The primary observer identified all birds observed and communicated each individual detection, including species, detection type, and approximate location, to the secondary observer who recorded the information. In addition, the secondary observer recorded any detections not noted by the primary observer. The roles of primary and secondary observer within a survey team alternated on consecutive dependent double observer transect surveys.

We located and monitored nests until fledging to obtain avian demographic parameter information. We conducted all nest searches within the 80 sampling plots along five transects at 100 m intervals (starting 50 m from the edge of the plot). 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 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.

Field Efforts

We conducted field surveys using the methods described above between April 26 and August 3, 2013, and May 22 and July 23, 2014 (Table 1). We repeated three rounds of walking transect surveys on 80 plots (40 plots per grazing system). We conducted all transect surveys between sunrise (~0530 Mountain Standard Time [MST]) and 1100 MST. We nest searched all plots, except in 2013 when we were establishing nest search methods and ran into time constraints (56 plots, Table 1). We avoided conducting walking 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 (*Centrocercus urophasianus*) nests were active to avoid disturbance to their nests.

Data Analysis

We used a variety of summary statistics to determine if there were differences in songbird communities between traditional and rest-rotation grazing. We visually examined trends between the avian communities between the two grazing systems by comparing boxplots. We used a t-test to test for statistically significant differences in the mean species richness between the two grazing systems. We used a Huggins closed-captures model to estimate abundance for each of our top five most common species (Huggins 1989, 1991). We used program R (R Core Team 2012) and MARK to conduct these analyses (White and Burnham 1999).

RESULTS

We detected the same top five songbird species in all years of sampling and between grazing systems (Table 2). Abundance and species composition remained similar between years and grazing systems. In 2013, we detected a total of 15,574 individuals of 86 species. In 2014, we detected 14,108 individuals of 77 species (Table A-1, Appendix A). Abundance estimates of the top five species are similar among 2013 and 2014 (Table 3). In both years, McCown's longspur was the most abundant species. We observed a difference in community structure at the plot-level between the two grazing systems for both 2013 and 2014. The mean plot-level species richness is higher in the traditional grazing systems (by 2 to 3 species) and this difference is significant in both years (p <0.005) (Table 4 and Figure 1).

Nest abundance patterns were similar between grazing systems and years. For the three focal nest species, 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 and 2014. The observed number of nests of for each individual species is similar, except for McCown's longspur nests, which we consistently detected more of on rest-rotation grazing systems (Table 5 and Table A-2, Appendix A).

DISCUSSION AND FUTURE WORK

The results from the three years indicate a potential group of focal songbird species for the region: Brewer's sparrow, vesper sparrow, western meadowlark, McCown's longspur, and horned lark. 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 (walking transect and nest searching) that work well in sagebrush ecosystems.

Results from the 2013 and 2014 sampling years show consistent patterns between years but not necessarily consistent patterns between grazing systems. While it appears that observed abundance is similar between years and grazing systems, particularly for the most common species, species richness on average differs significantly by grazing system on a small, plot-level scale. Species richness is the finest-scale measure of community structure and is sensitive to a variety of factors, so this is not surprising. These results may also reflect the variation in a sagebrush ecosystem. The observed difference in nest abundance could be due to differences in nest detection probability between years, nest searching efforts (56 plots in 2013 and 80 plots in 2014), or phenology of the species.

Future work will include more in-depth analysis of these songbird communities. We will model species richness using hierarchical models that examine individual species associations with grazing treatments, along with linking species at the community-level. We will incorporate a number of covariates into these community analyses, including time and environmental variables to explain potential sources of variation. We are currently exploring the possible confounding factors of grazing system and land ownership because each grazing system is associated exclusively with a land ownership type; traditional grazing only occurs on public land and rest-rotation only occurs on private land. Our approach is to measure baseline differences in land quality based on land ownership. In addition, we plan to estimate nest detection probability to create more accurate estimates of nest abundance and density. We also hope to model potential population effects resulting from differences in density and success.

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Table 1. Survey Effort. The number of sampling plots surveyed using walking transects and nest searching near Roundup, Montana, in 2013 and 2014.

Sampling Occasion	2013 Date	2013 Walking Transects	2013 Nest Searching	2014 Date	2014 Walking Transects	2014 Nest Searching
1	April 26 – July 1	80	56	May 22 – June 13	80	30
2	June 4 – July 31	80	30	June 3 – July 8	80	30
3	June 9 – August 3	80	20	July 8 – July 23	80	20
	Totals	**240**	**56**		**240**	**80**

Table 2. Top Five Most Abundant Species. The most common species detected during walking transect surveys in 2012, 2013, and 2014 near Roundup, Montana.

Common Name	Scientific Name	2012 Observations		2013 Observations		2014 Observations	
		Traditional Grazing	Rest-Rotation Grazing	Traditional Grazing	Rest-Rotation Grazing	Traditional Grazing	Rest-Rotation Grazing
McCown's longspur	*Rhynchophanes mccownii*	1,085	-	802	407	726	2,824
vesper sparrow	*Pooecetes gramineus*	577	-	1,037	2,737	1,057	1,030
Brewer's sparrow	*Spizella breweri*	384	-	1,077	946	1,101	927
horned lark	*Eremophila alpestris*	338	-	597	1,103	870	1,075
western meadowlark	*Sturnella neglecta*	276	-	980	1,039	779	471

Table 3. Abundance and Probability of Detection Estimates for Top Five Most Abundant Species. Detection probability and estimates abundances for the top five most commonly identified species using walking transect surveys in 2013 and 2014 on lands near Roundup, Montana. Parentheses in the detection probability column show the standard errors and in the estimated abundance column show the 95% confidence intervals.

Common Name	2013 Detection Probability	2013 Estimated Abundance**	2014 Detection Probability	2014 Estimated Abundance**
McCown's longspur	0.90 (0.060)	3,812 (3,800 – 3,830)	0.92 (0.0050)	3,547 (3,539 – 3,560)
vesper sparrow	0.81 (0.011)	2,104 (2,083 – 2,132)	0.88 (0.0085)	2,100 (2,090 – 2,118)
Brewer's sparrow	0.79 (0.013)	1,860 (1,837 – 1,891)	0.87 (0.0093)	2,034 (2,022 – 2054)
horned lark	0.82 (0.012)	1,757 (1,739 – 1,781)	0.90 (0.0077)	1,947 (1,940 – 1,960)
western meadowlark	0.84 (0.014)	1,243 (1,231 – 1,263)	0.87 (0.011)	1,265 (1,257 – 1,279)

**Abundance estimates for each species are reported as the estimated number of individuals present in the surveys that covered a total of 1,000 hectares.

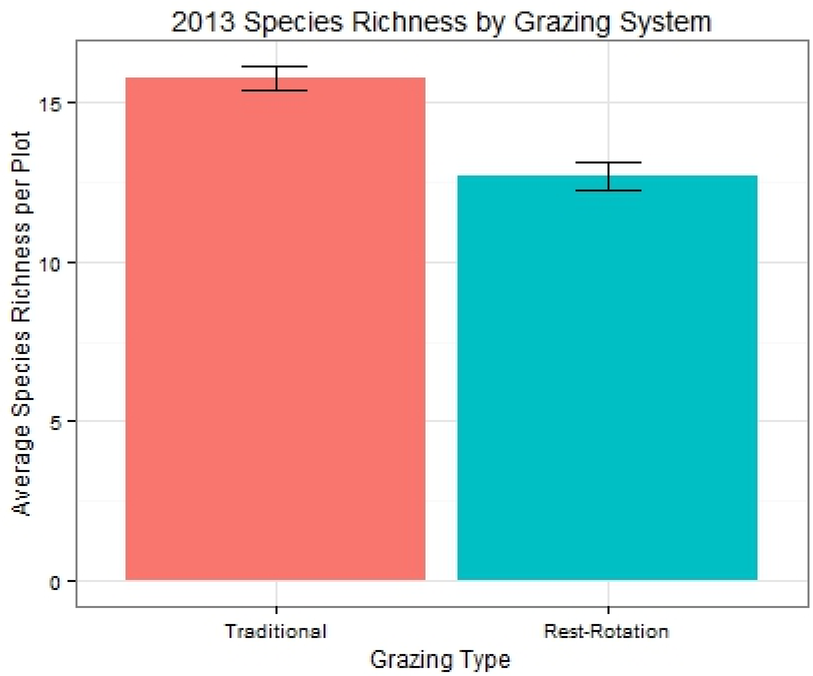
Table 4. Comparison of Plot-level Species Richness. A comparison of the mean plot species richness values by grazing treatment. The standard deviation (SD), 95% confidence interval (CI), and results of a *t*-test comparison between the grazing systems are presented. Plot-level species richness was calculated using three sampling occasions to obtain an average plot-level species richness for each grazing system. The plots are located on lands near Roundup, Montana, in 2013 and 2014

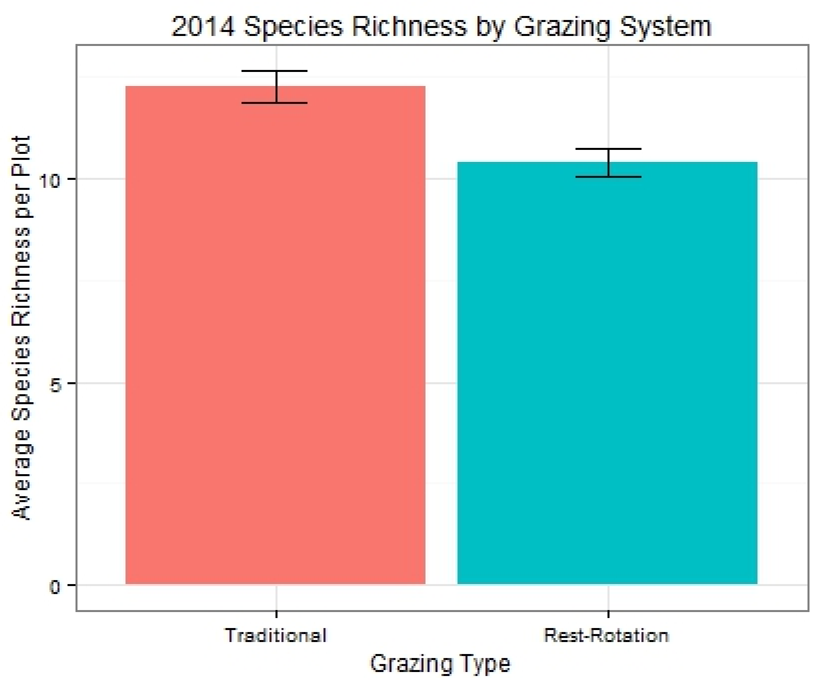
	Plot-level Species Richness							
	Traditional Grazing			Rest-Rotation Grazing			T-test	
	Mean	SD	95% CI	Mean	SD	95% CI	Difference?	p-value
2013	15.75	4.820	15.35 - 16.09	12.63	5.0343	12.19 -13.07	Yes	2.260×10^{-12}
2014	12.25	4.0223	11.87 - 12.63	10.36	3.426	10.01 - 10.71	Yes	1.059×10^{-12}

Table 5. Abundant Nesting Species. Nests of Brewer's sparrow, vesper sparrow, and McCown's longspur detected during nest search efforts in 2013 and 2014 on lands near Roundup, Montana.

Common Name	Scientific Name	2013 Observed Nests		2014 Observed Nests	
		Traditional Grazing	Rest-Rotation Grazing	Traditional Grazing	Rest-Rotation Grazing
vesper sparrow	*Pooecetes gramineus*	29	37	26	25
McCown's longspur	*Rhynchophanes mccownii*	10	24	7	41
Brewer's sparrow	*Spizella breweri*	17	19	27	30
Totals		**56**	**80**	**60**	**96**

Figure 1. Comparison of Plot Species Richness by Grazing System. A comparison of the mean plot species richness and the distribution of the mean values by grazing treatment in 2013 and 2014. Plot species richness was calculated using all three walking transect sampling occasions to obtain an average plot-level species richness for each grazing system. The surveys were conducted near Roundup, Montana, in 2013 and 2014.





APPENDIX A

Table A-1. Total Avian Observations in 2014, 2013, and 2012. The species detected during walking transect surveys on BLM and private lands near Roundup, Montana, in April through August in the years of 2012 through 2014.

Common Name	Scientific Name	Total Observations		
		2012	2013	2014
red-winged blackbird	*Agelaius phoeniceus*	30	109	105
Baird's sparrow	*Ammodramus bairdii*	-	10	4
grasshopper sparrow	*Ammodramus savannarum*	72	82	71
northern pintail	*Anas acuta*	-	4	-
American wigeon	*Anas americana*	-	20	9
northern shoveler	*Anas clypeata*	-	4	4
green-winged teal	*Anas crecca*	-	-	3
cinnamon teal	*Anas cyanoptera*	-	8	4
blue-winged teal	*Anas discors*	2	17	3
mallard	*Anas platyrhynchos*	5	30	16
gadwall	*Anas strepera*	-	11	20
Sprauge's pipit	*Anthus spragueii*	-	6	8
golden eagle	*Aquila chrysaetos*	-	3	-
great blue heron	*Ardea herodias*	-	3	2
short-eared owl	*Asio flammeus*	7	-	2
burrowing owl	*Athene cunicularia*	-	-	1
upland sandpiper	*Bartramia longicauda*	3	33	28
cedar waxwing	*Bombycilla cedrorum*	-	10	-
Canada goose	*Branta canadensis*	-	167	46
red-tailed hawk	*Buteo jamaicensis*	-	14	4
rough-legged hawk	*Buteo lagopus*	-	1	-
ferruginous hawk	*Buteo regalis*	2	2	-
Swainson's hawk	*Buteo swainsoni*	1	1	-
lark bunting	*Calamospiza melanocorys*	179	459	586

Common Name	Scientific Name	Total Observations		
		2012	2013	2014
chestnut-collared longspur	*Calcarius ornatus*	63	496	406
turkey vulture	*Cathartes aura*	-	10	-
greater sage-grouse	*Centrocercus urophasianus*	1	5	-
mountain plover	*Charadrius montanus*	-	4	3
semipalmated plover	*Charadrius semipalmatus*	-	22	-
killdeer	*Charadrius vociferus*	16	35	57
lark sparrow	*Chondestes grammacus*	9	107	89
common nighthawk	*Chordeiles minor*	2	5	21
northern harrier	*Circus cyaneus*	8	28	9
northern flicker	*Colaptes auratus*	11	30	11
rock pigeon	*Columba livia*	19	5	3
western wood-pewee	*Contopus sordidulus*	-	-	2
American crow	*Corvus brachyrhynchos*	-	13	1
common raven	*Corvus corax*	6	26	25
tundra swan	*Cygnus columbianus*	-	2	-
horned lark	*Eremophila alpestris*	338	1,700	1,945
Brewer's blackbird	*Euphagus cyanocephalus*	122	186	82
merlin	*Falco columbarius*	-	-	2
prairie falcon	*Falco mexicanus*	-	2	2
peregrine falcon	*Falco peregrinus*	-	1	-
American kestrel	*Falco sparvarius*	4	47	12
pinyon jay	*Gymnorhinus cyanocephalus*	-	8	-
barn swallow	*Hirundo rustica*	13	17	20
Bullock's oriole	*Icterus bullockii*	-	-	1
loggerhead shrike	*Lanius ludovicianus*	1	28	20
herring gull	*Larus argentatus*	-	1	-

Common Name	Scientific Name	Total Observations		
		2012	2013	2014
California gull	*Larus californicus*	-	19	-
ring-billed gull	*Larus delawarensis*	-	3	8
Franklin's gull	*Leucophaeus pipixcan*	-	13	-
marbled godwit	*Limosa fedoa*	5	9	7
brown-headed cowbird	*Molothrus ater*	72	352	323
Clark's nutcracker	*Nucifraga columbiana*	-	3	-
long-billed curlew	*Numenius americanus*	16	104	115
sage thrasher	*Oreoscoptes montanus*	5	11	8
savannah sparrow	*Passerculus sandwichensis*	2	8	21
grey partridge	*Perdix perdix*	-	2	15
cliff swallow	*Petrochelidon pyrrhonota*	21	491	222
double-crested cormorant	*Phalacrocorax auritus*	-	3	24
ring-necked pheasant	*Phasianus colchicus*	3	-	-
black-billed magpie	*Pica hudsonia*	3	25	20
pine grossbeak	*Pinicola enucleator*	4	-	-
white-faced ibis	*Plegadis chihi*	-	-	3
black-capped chickadee	*Poecile atricapillus*	-	6	3
vesper sparrow	*Pooecetes gramineus*	1,085	2,023	2,087
common grackle	*Quiscalus quiscula*	-	1	-
American avocet	*Recurvirostra americana*	-	28	31
McCown's longspur	*Rhynchophanes mccownii*	276	3,774	3,550
rock wren	*Salpinctes obsoletus*	-	7	9
Say's pheobe	*Sayornis saya*	3	30	10
yellow-rumped warbler	*Setophaga coronata*	-	3	-
mountain bluebird	*Sialia currucoides*	-	19	7
American goldfinch	*Spinus tristis*	-	2	3

Common Name	Scientific Name	Total Observations		
		2012	2013	2014
Brewer's sparrow	*Spizella breweri*	577	1,773	2,028
Clay-colored sparrow	*Spizella pallida*	-	2	6
chipping sparrow	*Spizella passerina*	-	15	1
Wilson's phalarope	*Steganopus tricolor*	-	116	14
western meadowlark	*Sturnella neglecta*	384	1,209	1,250
European starling	*Sturnus vulgaris*	-	27	1
tree swallow	*Tachycineta bicolor*	3	17	18
violet green swallow	*Tachycineta thalassina*	-	5	2
brown thrasher	*Toxostoma rufum*	-	-	1
willet	*Tringa semipalmata*	-	19	6
sharp-shinned hawk	*Accipiter striatus*	-	1	-
house wren	*Troglodytes aedon*	-	1	-
American robin	*Turdus migratorius*	20	14	26
sharp-tailed grouse	*Tympanuchus phasianellus*	6	1	-
eastern kingbird	*Tyrannus tyrannus*	3	9	4
western kingbird	*Tyrannus verticalis*	3	2	3
Cassin's kingbird	*Tyrannus vociferans*	-	4	-
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	-	3	2
mourning dove	*Zenaida macroura*	53	179	279
White-crowned sparrow	*Zonotrichia leucophrys*	-	3	1
	Totals	**3,458**	**14,108**	**13,755**

Table A-2. Total Nest Observations in 2013 and 2014. The number of nests located and monitoring near Roundup, Montana, in 2013 and 2014. In 2013, all nests found on the 56 plots that were nest searched were monitored. In 2014, nest search efforts occurred on all 80 sampling plots and focused on Brewer's sparrow, vesper sparrow, and McCown's longspur. A "-" indicates that we did not find any nests of that species in that specific grazing treatment.

Common Name	Scientific Name	2014 Observed Nests		2013 Observed Nests	
		Traditional Grazing	Rest-Rotation Grazing	Traditional Grazing	Rest-Rotation Grazing
red-winged blackbird	*Agelaius phoeniceus*	-	-	-	1
grasshopper sparrow	*Ammodramus savannarum*	-	-	1	-
lark bunting	*Calamospiza melanocorys*	-	-	1	1
chestnut-collared longspur	*Calcarius ornatus*	-	-	2	14
killdeer	*Charadrius vociferus*	-	-	1	-
lark sparrow	*Chondestes grammacus*	-	-	2	-
northern flicker	*Colaptes auratus*	-	-	1	1
horned lark	*Eremophila alpestris*	-	-	8	8
loggerhead shrike	*Lanius ludovicianus*	-	-	1	-
long-billed curlew	*Numenius americanus*	-	-	-	1
black-billed magpie	*Pica hudsonia*	-	-	1	-
vesper sparrow	*Pooecetes gramineus*	26	25	29	37
McCown's longspur	*Rhynchophanes mccownii*	7	41	10	24
Brewer's sparrow	*Spizella breweri*	27	30	17	19
chipping sparrow	*Spizella passerina*	-	-	1	-
western meadowlark	*Sturnella neglecta*	-	-	6	5
American robin	*Turdus migratorius*	-	-	1	-
mourning dove	*Zenaida macroura*	-	-	5	-
	Totals	**60**	**96**	**86**	**111**