Annual Report Vol. 41 (2018)

Effects of sagebrush restoration on plant and bird communities in Grand Teton National Park

Anna D. Chalfoun[1*] and Tracey N. Johnson[2]

1 **Associate Professor and Assistant Unit Leader, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, WY**
2 **Assistant Professor, Department of Fish and Wildlife Sciences, University of Idaho, Moscow, ID**
* **Author for correspondence: achalfou@uwyo.edu**

Abstract Approximately half of sagebrush steppe range-wide has been converted to non-native grasslands, which has contributed to population declines of sagebrush-associated songbirds. Removal of non-native grasses and restoration treatments are time-, resource- and energy-intensive, but could lead to the return of functional habitat for sagebrush wildlife. The extent to which restoration efforts repair the structure and functionality of sagebrush steppe for different types of wildlife, however, remains largely untested. To determine breeding songbird community responses to sagebrush restoration treatments, we are conducting a longitudinal study with sampling every 5 years within restoration units at different stages of restoration in the Kelly Hayfields restoration area in Grand Teton National Park, Wyoming. Thus far, in 2013 and 2018 we compared bird and plant communities in unrestored (largely smooth brome [*Bromus inermis*]) units to those in various stages of restoration treatments, and to areas of native sagebrush. The sagebrush plots will serve as desired comparators for the endpoints of restoration efforts. The in-progress and recently replanted units were either dominated by bare ground (following herbicidal application) or native forbs with very little shrub cover ($< 0.1\%$). Native sagebrush units were dominated by shrubs and native bunchgrasses. Bird community composition was distinct among the different unit types. Abundance of grassland birds was highest in unrestored units, whereas the abundance of shrubland birds was highest in native sagebrush and positively associated with shrub cover. There were very few detections of birds in recently re-seeded units. Restored areas may initially provide little breeding bird habitat, especially prior to the establishment of native bunch grasses and a mature shrub layer. Plant and bird sampling efforts will continue every five years to document how plant and bird assemblages shift over time in response to restoration efforts.

Introduction

Non-native, invasive species are some of the greatest threats to global biodiversity (Butchart et al., 2010). The effects of invasive species on ecosystems are mixed, but can include altered species interactions, the disruption of ecosystem functioning, habitat loss, alteration and degradation, and ultimately extinction of native species (Brooks et al., 2004; Clavero and García-Berthou, 2005). Given the potentially negative effects of invasive species, control and restoration is a common priority for conservation and management practitioners.

Non-native, invasive plants can be particularly problematic because they alter habitat composition and structure, often resulting in habitat homogenization which has cascading effects to other taxa (Ceradini and Chalfoun, 2017). Invasive plants, moreover, can be incredibly difficult to eradicate once they have

established, and restoration of communities to pre-disturbance conditions is challenging, sometimes impossible, and labor-intensive (Van Haveren et al., 1997; Briske et al., 2006). A more feasible option may be to restore communities to functional surrogates of their past states, which may be evaluated by whether the restoration provides suitable conditions for native fauna (Block et al., 2001).

One system that has been highly altered and influenced by non-native plant encroachment is the sagebrush steppe. The sagebrush biome once covered nearly 63 million ha in western North America (Miller and Eddleman, 2000; Knick et al., 2003), but has become highly fragmented with only approximately 1% remaining in a pristine state (Paige and Ritter, 1999). Sagebrush lands provide substantial services to the nation's economy, including livestock grazing, renewable and non-renewable resources, and recreational opportunities. It also serves as habitat for $>$ 350 species of wildlife for at least part of their life cycle (Wisdom et al., 2002; Hanser and Knick, 2011). Sagebrush systems, however, are among the most threatened in North America (Noss and Peters, 1995). Approximately 50-60% of native sagebrush steppe has been lost to non-native grasses, for example, which were introduced primarily to provide forage for livestock (West, 2000; Knick et al., 2003). The loss of native sagebrush steppe has resulted in concomitant population declines of several species of wildlife associated with sagebrush habitat (Knick et al., 2003).

Grand Teton National Park (GTNP) is home to some of the most pristine, high-elevation, mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) habitats in the world. Historically, however, some areas within the park were cleared and planted with smooth brome (*Bromus inermis*), a non-native grass introduced from Eurasia that is well adapted to cooler temperatures, highly palatable for livestock, and now highly invasive across the U.S. (NRCS, 2002). The Park began an intensive effort in 2008 to restore areas historically converted to monocultures of smooth brome back to native sagebrush steppe habitats. These efforts have necessitated a multi-step approach, including herbicidal treatments and subsequent re-seeding. The restoration efforts within GTNP provide a rare and important opportunity to evaluate the efficacy of such restoration in returning sites back to native plant assemblages that are functional for co-occurring wildlife, and how the transitions manifest.

In 2013, we began a longitudinal study to examine the effects of sagebrush restoration efforts in GTNP on plant and bird communities over time. Birds are ideal study subjects for the evaluation of whether sites provide value for wildlife because they are readily observed and counted, and rely on the habitat structure and composition with which they evolved for fitness-enhancing behaviors such as attracting mates, nesting, and foraging (Block et al., 2001). We are therefore comparing the occurrence, density, and community composition of birds at restored and in-progress sites relative to unrestored habitats, and to nearby native, undisturbed sagebrush sites every five years until restored sites approximate the composition and structure of adjacent native sagebrush patches (or reach an alternative mature state). Our ultimate goal is to determine whether areas that are restored return to functional wildlife habitat.

Our study leverages a unique opportunity to empirically track the success of targeted restoration and the local reduction of a widespread, invasive grass. Currently, there is little information available in the primary literature on songbird responses to restoration in sagebrush steppe ecosystems. A review by Ortega-Álvarez and Lindig-Cisneros (2012) focused on the effects of ecological restoration on birds and the role birds play in evaluating restoration outcomes, for example, yielded zero studies focused on sagebrush steppe habitats. More recently, bird responses to juniper removal as a restoration treatment within existing sagebrush habitats have been evaluated (Holmes et al., 2017), but to our knowledge there have been no investigations of bird responses to intensive efforts that restore sagebrush to areas in which a significant shrub layer is not already intact. As such, our evaluation will comprise a valuable contribution to understanding of the effects of habitat restoration efforts for wildlife, and what habitat "restoration," from the standpoint of wildlife, necessi-

tates to ensure functionality.

Methods

Prior to the establishment of GTNP, the area known as the Kelly Hayfields was settled by homesteaders who converted native sagebrush steppe vegetation to non-native pasture for agricultural use. Since the National Park Service (NPS) acquired the land in the 1960s, agricultural use has been minimal. Non-native vegetation in areas previously used as pastures, however, remains dominant. In 2007, in cooperation with the US Fish and Wildlife Service, the NPS committed to restoring the Kelly Hayfields to native sagebrush steppe in accordance with the Bison and Elk Management Plan. Restoration treatments began in 2008 and are ongoing, with a total restoration goal of 1,821 hectares. In 2013, we began monitoring responses of the songbird and vegetation community to restoration efforts. At that time, restoration treatments had been completed on 36 ha, and an additional 184 ha were in-progress. We conducted bird and vegetation surveys on units that were in various stages of restoration (either very recently completed or being actively treated in the year of our surveys, n = 4). Surveys also were conducted at units in which restoration treatments had not yet been implemented (n = 9) for a baseline comparator. Finally, to serve as a restoration endpoint of comparison, we sampled units of native sagebrush (n = 3) adjacent to the Kelly Hayfields.

In 2018 we re-surveyed the previously established points in and near the Kelly Hayfields, and added one new unit (Elbo West) in which the Park had completed restoration treatments and two unrestored units. In sum, and given changes in status of some plots between time periods, surveys in 2018 were distributed across units as follows: restored units (n = 3) considered by NPS to be complete from the standpoint of restoration activity except for occasional herbicide treatments to control weeds; in-progress units (n = 5) which are in various stages of restoration but not complete; unrestored units (n = 11) which have not experienced any type of restoration treatment and serve as a baseline point of comparison; and native sagebrush units (n = 3). We conducted point count surveys during June 4–18 at the same 2–5 locations in each unit that were surveyed in 2013. Each point was visited twice, once by each PI, to account for potential surveyor bias. Surveys began within 15 minutes of dawn, continued no later than 1000, and did not take place during inclement weather. Surveys lasted five minutes to minimize the likelihood that individual birds were counted more than once (Fuller and Langslow, 1984). During each survey, we recorded all birds seen or heard, and estimated the distance to each detected bird using a laser range finder.

Vegetation measurements occurred at two point count locations within each restored, in-progress, unrestored, or native (control) plot. Data were collected along the same 90-m transects established in 2013 that began at plot centers and followed randomly-generated angles. We assessed vegetation characteristics previously demonstrated in the primary literature to be related to bird occurrence and density in sagebrush and grassland habitats. We assessed shrub cover by recording where shrubs of different species intercepted the transect, and then dividing the aggregate distances by the total transect length. Shrub height was measured using a meter stick for each shrub intersecting the line. The foliar cover of plant species or functional group was assessed using the point intercept method. At every meter mark along the transect, we placed a pin flag and recorded the top two plant species that touched the flag to species or genus, the basal substrate (i.e., bare soil, rock, litter, lichen, cryptobiotic crust), litter depth, and herbaceous plant height.

Data collected in 2018 will be compared to those obtained in 2013 to evaluate changes in avian density over time and the trajectory of plant and bird community composition. Bird densities will be estimated from detection data using the Farnsworth Removal Model (Farnsworth et al., 2002) which allows estimation of detection probabilities and adjusts estimates of abundance accordingly. To compare songbird community composition among restored, in-progress, unrestored, and sagebrush plots, and describe relationships among songbird communities and habitat characteristics, we will use a Multi-Response Permutation Procedure (MRBP; Mielke Jr, 1984) and

		Restoration Treatment		
Restoration Unit	Acres	Sprayed	Burned	Seeded/Planted
Aspen Ridge	89	Glyphosate June 2008	September 2008	October 2009[a]
		Glyphosate July 2009		
		Milestone summer 2010		
Elbo East	225	Glyphosate June 2011	May 2010	Fall 2011-2016[b]
Henrie	324	Glyphosate 2012-16	unknown	Fall 2014-16[c]
Riniker	317	Glyphosate 2014-17	unknown	
Harthoorn	300	Glyphosate 2015-17	unknown	
Hunter East/West[1]	64/122	Glyphosate June 2009	September 2008	Fall 2012[b]
		Glyphosate June 2010		2017[c]
Elbo West[1]	43	Glyphosate 2010	September 2010	October 2011[d]
		Milestone 2014		Fall 2016[e]

[a] Native grass-forb mix; [b] Native shrub-forb mix; [c] Native grass only mix; [d] Native grass-sagebrush mix; [e] Planted with shrub and forb seedlings

[1] These units are considered fully restored, however, targeted treatments for invasive plants will continue.

Table 1. Restoration units and associated schedule of restoration treatments at Kelly Hayfields in Grand Teton National Park, Wyoming.

non-metric multidimensional scaling (Kruskal, 1964; Mather, 1976) in future analyses.

Preliminary Results

As of June 2018, three units are considered by NPS to be complete from a restoration treatment standpoint, and five units are in progress (Table 1). We observed 25 bird species during our 2018 surveys, eight of which have established associations with some component of native sagebrush steppe habitat (Table 2; Rich et al., 2005). The eight most common species (in order of most to least common) were shrubland and grassland-associated species, including: Savannah sparrow (*Passerculus sandwichensis*), Brewer's sparrow (*Spizella breweri*), Vesper sparrow (*Pooecetes gramineus*), Western meadowlark (*Sturnella neglecta*), Green-tailed towhee (*Pipilo chlorurus*), Brewer's blackbird (*Euphagus cyanocephalus*), Horned lark (*Eremophila alpestris*), and Sage thrasher (*Oreoscoptes montanus*). Mean number of species per plot ranged from 1-9 (Table 2). Savannah sparrow was the most common species in unrestored units and at most units that were "in progress" (Table 2). Brewer's sparrow was the most common species in control units and at some unrestored units that had a significant shrub component (e.g., Warm Creek East; Table 2). Habitat

data were collected at a subset (n = 25) of plots at which birds were surveyed. Habitat data will be summarized and evaluated in terms of relationships with bird occurrence in a future peer-reviewed manuscript. Restored and in-progress units were characterized by a large forb component, sparse shrubs or grasses, and low numbers of bird detections. Unrestored plots were dominated by non-native grasses and primarily occupied by grassland-associated species such as Vesper sparrow, Savannah sparrow, and Western meadowlark.

Conclusions

In 2013, songbird communities varied among native sagebrush steppe, restored, in progress, and unrestored plots, and these patterns were largely related to the degree to which a shrub layer was present. Unsurprisingly, native sagebrush plots with high shrub cover were occupied by sagebrush-associated species including Brewer's sparrow, Sage Thrasher, and Green-tailed towhee. Sparse detections of birds during and shortly after restoration treatments ($\leq$ 10 yrs) suggest that restored plots provide little breeding habitat for birds of any species. Plots treated with herbicides within the past few years provided very little breeding habitat for many grassland birds, as grass cover was low and bare ground too extensive. In 2013 and 2018, restored plots still had very little shrub cover ($<$ 0.1%), thereby precluding shrub-nesting birds. To provide adequate breeding habitat for sagebrush-associated birds, shrub canopy should be approximately 15-30%, or higher (Connelly et al., 2000; Chalfoun and Martin, 2007). The shrub species included in restoration treatments in this study (e.g., *Artemisia tridentata vaseyana*, *Chrysothamnus* spp.) may immediately begin to establish following seeding, but it may take *A. tridentata* many decades to dominate a site (Tirmenstein, 1999). Grass cover will likely increase before shrub cover, and in the near-term, restored plots may again provide habitat for grassland birds once the extent of bare ground is reduced and a grass canopy and litter layer develops (Fisher and Davis, 2010).

Although unrestored plots were occupied by grassland birds, we did not evaluate whether they provided high-quality breeding habitat. Unrestored plots were dominated by non-native grasses, which may differ from native habitat in phenology, cover, and invertebrate abundance or species composition (Lloyd and Martin, 2005; Kennedy et al., 2009; Johnson and Sandercock, 2010; Litt and Steidl, 2010), all of which may influence the reproductive success of breeding birds. Thus, without habitat-specific demographic rates, we cannot determine whether the unrestored areas versus those re-seeded to native grasses and forbs comprise more productive nesting habitat for grassland birds.

Future Work

The power of our study will largely be realized once additional periods of sampling have been conducted. Our planned longitudinal analyses will reveal how plant and bird communities evolve within sites following efforts to reduce non-native grasses, and the extent to which restored plots can resemble sagebrush habitats that had not been initially converted. Data generated by the study will also be used to build state and-transition (STM) models to determine if and when ecological functions (such as the provision of wildlife habitat) return. Our next planned field data collection will take place in June, 2023.

Acknowledgements

We are grateful to the UW-NPS small grants program for making the study possible. John Stephenson and Dan Reinhart of GTNP provided helpful logistical assistance. Penny Maldonado graciously provided housing during our 2018 field work.

References

Block, W. M., A. B. Franklin, J. P. Ward Jr, J. L. Ganey, and G. C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. Restoration Ecology **9**:293–303.

Briske, D. D., S. D. Fuhlendorf, and F. Smeins. 2006. A unified framework for assessment and application of ecological thresholds. Rangeland Ecology & Management **59**:225–236. https://doi.org/10.2111/05-115R.1.

Brooks, M. L., C. M. D'antonio, D. M. Richardson, J. B. Grace,

J. E. Keeley, J. M. DiTomaso, R. J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. BioScience **54**:677–688.

Butchart, S. H. M., M. Walpole, B. Collen, A. van Strien, J. P. W. Scharlemann, R. E. A. Almond, J. E. M. Baillie, B. Bomhard, C. Brown, J. Bruno, K. E. Carpenter, G. M. Carr, J. Chanson, A. M. Chenery, J. Csirke, N. C. Davidson, F. Dentener, M. Foster, A. Galli, J. N. Galloway, P. Genovesi, R. D. Gregory, M. Hockings, V. Kapos, J.-F. Lamarque, F. Leverington, J. Loh, M. A. McGeoch, L. McRae, A. Minasyan, M. H. Morcillo, T. E. E. Oldfield, D. Pauly, S. Quader, C. Revenga, J. R. Sauer, B. Skolnik, D. Spear, D. Stanwell-Smith, S. N. Stuart, A. Symes, M. Tierney, T. D. Tyrrell, J.-C. Vié, and R. Watson. 2010. Global biodiversity: indicators of recent declines. Science **328**:1164–1168.

Ceradini, J. P., and A. D. Chalfoun. 2017. Species' traits help predict small mammal responses to habitat homogenization by an invasive grass. Ecological Applications **27**:1451–1465.

Chalfoun, A. D., and T. E. Martin. 2007. Assessments of habitat preferences and quality depend on spatial scale and metrics of fitness. Journal of Applied Ecology **44**:983–992.

Clavero, M., and E. García-Berthou. 2005. Invasive species are a leading cause of animal extinctions. Trends in Ecology & Evolution **20**:110.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin **28**:967–985.

Farnsworth, G. L., K. H. Pollock, J. D. Nichols, T. R. Simons, J. E. Hines, and J. R. Sauer. 2002. A removal model for estimating detection probabilities from point-count surveys. The Auk **119**:414–425.

Fisher, R. J., and S. K. Davis. 2010. From Wiens to Robel: a review of grassland-bird habitat selection. The Journal of Wildlife Management **74**:265–273.

Fuller, R., and D. Langslow. 1984. Estimating numbers of birds by point counts: how long should counts last? Bird Study **31**:195–202.

Hanser, S. E., and S. T. Knick, 2011. Greater sage-grouse as an umbrella species for shrubland passerine birds: a multiscale assessment. Pages 473–487 *in* S. Knick and J. Connelly, editors. Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

Holmes, A. L., J. D. Maestas, and D. E. Naugle. 2017. Bird responses to removal of western juniper in sagebrush-steppe. Rangeland Ecology & Management **70**:87–94.

Johnson, T. N., and B. K. Sandercock. 2010. Restoring tallgrass prairie and grassland bird populations in tall fescue pastures with winter grazing. Rangeland ecology & management **63**:679–688.

Kennedy, P. L., S. J. DeBano, A. M. Bartuszevige, and A. S. Lueders. 2009. Effects of native and non-native grassland plant communities on breeding passerine birds: implications for restoration of northwest bunchgrass prairie. Restoration Ecology **17**:515–525.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry, M. A. Schroeder, W. M. Vander Haegen, and C. Van Riper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. The Condor **105**:611–634.

Kruskal, J. B. 1964. Nonmetric multidimensional scaling: a numerical method. Psychometrika **29**:115–129.

Litt, A. R., and R. J. Steidl. 2010. Insect assemblages change along a gradient of invasion by a nonnative grass. Biological Invasions **12**:3449–3463.

Lloyd, J. D., and T. E. Martin. 2005. Reproductive success of Chestnut-collared Longspurs in native and exotic grassland. The Condor **107**:363–374.

Mather, P. M. 1976. Computational methods of multivariate analysis in physical geography. John Wiley & Sons.

Mielke Jr, P. 1984. Meteorological applications of permutation techniques based on distance functions. Handbook of statistics. Elsevier Science Publishers **4**:813–830.

Miller, R. F., and L. Eddleman, 2000. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Technical report, Corvallis, Or.: Oregon State University, Agricultural Experiment Station.

Noss, R., and R. Peters. 1995. Endangered ecosystems. A status report on America's vanishing habitat and wildlife. Defenders of Wildlife, Washington, DC .

NRCS, 2002. Plant fact sheet, smooth brome (*Bromus inermis* Leyss). https://plants.usda.gov/factsheet/pdf/fs_brin2.pdf.

Ortega-Álvarez, R., and R. Lindig-Cisneros. 2012. Feathering the scene: the effects of ecological restoration on birds and the role birds play in evaluating restoration outcomes. Ecological Restoration **30**:116–127.

Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

Rich, T. D., M. J. Wisdom, and V. A. Saab, 2005. Conservation of priority birds in sagebrush ecosystems. *in* In: Ralph, C. John; Rich, Terrell D., editors 2005. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. 2002 March 20-24; Asilomar, California, Volume 1 Gen. Tech. Rep. PSW-GTR-191. Albany, CA: US Dept. of Agriculture, Forest Service, Pacific Southwest Research Station: p. 589-606, volume 191.

Tirmenstein, D. 1999. Artemisia tridentata spp. tridentata. Fire Effects Information System [Online] http://www.fs.fed.us/database/feis/.

Van Haveren, B. P., J. E. Williams, M. L. Pattison, and J. R. Haugh. 1997. Restoring the ecological integrity of public lands. Journal of Soil and Water Conservation **52**:226–231.

West, N. E., 2000. Synecology and disturbance regimes of sagebrush steppe ecosystems. Pages 15–26 *in* P. Entwistle, A. M. DeBolt, K. J. H., and K. Steenhof, editors. Proceedings of the sagebrush steppe ecosystems symposium: 2000.

Wisdom, M. J., M. M. Rowland, B. C. Wales, M. A. Hemstrom, W. J. Hann, M. G. Raphael, R. S. Holthausen, R. A. Gravenmier, and T. D. Rich. 2002. Modeled effects of sagebrush-steppe restoration on greater sage-grouse in the Interior Columbia Basin, USA. Conservation Biology **16**:1223–1231.

Table 2. Total number of detections of each bird species (excluding birds with directed flight overhead and presumably not using the habitat of interest) in June 2018 at Kelly Hayfields in Grand Teton National Park, Wyoming.

[1]Status categories for study units are as follows: "In progress" includes units that are currently in any phase of restoration activity (see Table 1 for detailed information); "Restored" includes units that are considered fully restored by NPS and are not scheduled for additional restoration activities aside from herbicide applications to help control invasive weeds; "Unrestored" includes units that are dominated by smooth brome and have not undergone any restoration activity as of June 2018; "Control" includes areas of native sagebrush steppe included as a point of comparison for bird and vegetation community composition

Unit	Status [1]	Species	Detections
Aspen Ridge	In progress	Savannah Sparrow	8
		Vesper Sparrow	5
		Western Meadowlark	2
		Total	**15**
Elbo East	In progress	Mountain Bluebird	2
		Savannah Sparrow	3
		Vesper Sparrow	7
		Western Meadowlark	2
		American Kestrel	1
		Total	**15**
Henrie	In progress	Brewer's Blackbird	3
		Horned Lark	3
		Long-billed Curlew	3
		Savannah Sparrow	11
		Unidentified Sparrow	1
		Vesper Sparrow	4
		Western Meadowlark	3
		Total	**28**
Riniker	In progress	Brewer's Blackbird	3
		Horned Lark	6
		Long-billed Curlew	3
		Savannah Sparrow	9
		Vesper Sparrow	3
		Western Meadowlark	1
		Total	**25**

Continued on next page

Unit	Status [1]	Species	Detections
Harthoorn	In progress	American Crow	6
		Brewer's Blackbird	8
		Common Raven	2
		Horned Lark	4
		Long-billed Curlew	1
		Savannah Sparrow	13
		Vesper Sparrow	1
		Western Meadowlark	2
		Total	**37**
Hunter East	Restored	Vesper Sparrow	2
		Western Meadowlark	2
		Total	**4**
Hunter West	Restored	Brewer's Blackbird	3
		Northern Flicker	1
		Savannah Sparrow	1
		Vesper Sparrow	4
		Western Meadowlark	7
		Total	**16**
Elbo West	Restored	Prairie Falcon	1
		Savannah Sparrow	4
		Unidentified Sparrow	2
		Vesper Sparrow	1
		Western Meadowlark	2
		Total	**10**
Ditch Creek	Unrestored	Savannah Sparrow	7
		Western Meadowlark	1
		Total	**8**

Continued on next page

Unit	Status [1]	Species	Detections
Historic District East	Unrestored	Brewer's Sparrow	2
		Canada Goose	1
		European Starling	2
		Green-Tailed Towhee	1
		Osprey	1
		Savannah Sparrow	8
		Unidentified Sparrow	1
		Western Meadowlark	3
		Total	**19**
Historic District North	Unrestored	American Kestrel	1
		Common Raven	4
		Eastern Kingbird	1
		Greater Sage-Grouse	3
		Savannah Sparrow	34
		Vesper Sparrow	1
		Western Meadowlark	1
		Total	**45**
Historic District South	Unrestored	Northern Flicker	1
		Savannah Sparrow	18
		Total	**19**
May	Unrestored	Brewer's Sparrow	11
		Savannah Sparrow	22
		Unidentified Sparrow	4
		Vesper Sparrow	7
		Western Meadowlark	3
		Total	**47**
Slough North	Unrestored	Savannah Sparrow	39
		Western Meadowlark	1
		Total	**40**

Continued on next page

Unit	Status [1]	Species	Detections
Slough South	Unrestored	Savannah Sparrow	37
		Total	**37**
Teton Valley Ranch North	Unrestored	Brewer's Blackbird	2
		Savannah Sparrow	1
		Unidentified Sparrow	1
		Vesper Sparrow	3
		Western Meadowlark	1
		Total	**8**
Teton Valley Ranch South	Unrestored	Black-billed Magpie	1
		Common Raven	1
		Savannah Sparrow	2
		Western Meadowlark	5
		Total	**9**
Warm Creek East	Unrestored	Brewer's Blackbird	2
		Brewer's Sparrow	17
		Savannah Sparrow	4
		Vesper Sparrow	3
		Western Meadowlark	3
		Total	**29**
Warm Creek West	Unrestored	Brewer's Blackbird	1
		Brewer's Sparrow	8
		European Starling	1
		Sage Thrasher	1
		Savannah Sparrow	8
		Vesper Sparrow	3
		Western Meadowlark	2
		Total	**24**

Continued on next page

Unit	Status [1]	Species	Detections
Ditch Creek Reserve	Control	Brewer's Sparrow	19
		Green-Tailed Towhee	12
		Northern Flicker	1
		Sage Thrasher	5
		Savannah Sparrow	5
		Unidentified Sparrow	1
		Vesper Sparrow	4
		Western Meadowlark	1
		White-Crowned Sparrow	2
		Total	**80**
Schwartz	Control	Brewer's Sparrow	20
		Common Raven	1
		Green-Tailed Towhee	1
		Sage Thrasher	4
		Unidentified Sparrow	1
		Vesper Sparrow	8
		Western Meadowlark	2
		Total	**37**
Snowberry	Control	Brewer's Sparrow	31
		Common Raven	2
		Green-Tailed Towhee	11
		Sage Thrasher	2
		Unidentified Sparrow	1
		Western Meadowlark	5
		Total	**52**
Total Number of Detections			**574**