EFFECTS OF LIVESTOCK GRAZING MANAGEMENT ON THE ECOLOGY OF SHARP-TAILED GROUSE, GRASSLAND BIRDS, AND THEIR PREDATORS IN NORTHERN MIXED GRASS PRAIRIE HABITATS

PROJECT No. 58308

2017 2nd QUARTER REPORT

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June 2017

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2nd Quarter Report
Reporting Period: 1 April – 30 June

EXECUTIVE SUMMARY

Field efforts this quarter focused on capturing and banding sharp-tailed grouse and marking females with radio transmitters in both the rest-rotation grazing system implemented by Montana Fish, Wildlife, and Parks (hereafter "easement") and reference sections of the study area, tracking and locating nests of radio-marked females, conducting habitat surveys at nest and brood locations as well as random points throughout the study area, conducting point counts for grassland birds, collecting habitat information at the point count locations, and deploying remote cameras to evaluate predator occupancy.

Sharp-tailed grouse were trapped at 7 leks using walk-in funnel traps from 23 March – 5 May 2017. Overall, 156 sharp-tailed grouse (87 males, 69 females) were captured, including 121 new captures (58 males, 63 females) and 35 recaptures from 2016 (29 males, 6 females). A total of 58 female grouse were fitted with radio-collars during the 2017 trapping season. An additional 13 females that were radio-marked during the 2016 field season were still present in the study area and therefore monitored for a second year. A total of 71 radio-marked females were monitored ≥ 3 times per week throughout the nesting and brood-rearing period.

We collected 1,679 locations on 71 radio-marked females during 2 April – 16 June. As of 16 June, radio-marked females have initiated 73 nests (60 first nests, 13 renests). Twenty-five nests have successfully hatched and 30 failed (23 depredated, 1 abandoned, 6 female mortalities). Apparent nest success for nests that were completed by 16 June was 0.45 ± 0.07. As of 16 June, 18 nests are still active. Habitat conditions were measured at both nest and brood locations, as well as random points within the study area. Of the 25 nests that successfully hatched, 23 broods are still alive, while two have failed.

Avian point count surveys were conducted during 19 May – 12 June 2017. We detected 6,875 birds of 62 species at 305 independent survey locations; 3,362 birds of 56 species were detected in pastures with rest-rotation grazing systems and 3,513 birds of 52 species were detected on reference properties adjacent to the easement with traditional grazing systems. We measured specific vegetation characteristics at each survey location to assess grassland bird habitat selection. Remote cameras were deployed for two 3-week sessions at 62 random locations within the study area. We checked cameras every week, rebaiting each station, clearing photos, and replacing batteries as needed.

OBJECTIVES

Objective 1: Investigate rest rotation grazing as a rangeland management technique to improve sharp-tailed grouse fecundity and survival.

Accomplishments Since Last Quarter:

Efforts this quarter focused on capturing and radio-marking female sharp-tailed grouse and intensive monitoring of radio-marked females to locate nests and broods. Sharp-tailed grouse were trapped using walk-in funnel traps on both the easement and reference areas of the study site. We recorded standard morphometrics including body mass, wing chord, tarsus length, and culmen length, and fitted all birds with a uniquely numbered metal leg band. Birds were sexed and aged by plumage characteristics. Males were fitted with a unique combination of color bands to allow for resighting at leks next year. We fitted captured females with 18-g necklace-style radio-transmitters with a 6-8 hour mortality switch and an expected battery life of 12 months (model A4050; Advanced Telemetry Systems, Insanti, MN). Previous work found no impact of necklace-style radio-transmitters on prairie-grouse demography (Hagen et al. 2006).

Radio-marked females were located by triangulation or homing ≥3 times/week using portable radio receivers and handheld Yagi antennas during the nesting and brood-rearing period (April—June). When females localized in an area and their estimated location did not change for 2 successive visits, we assumed that the female was sitting on a nest. For half of the females, we used portable radio receivers and handheld Yagi antennas to locate and flush the female so eggs could be counted and nest location recorded with a handheld GPS unit. We marked nest locations with natural landmarks at a distance ≥ 25 m to aid in relocation. Nests were visited a second time, during which eggs were removed and carried >200 m from the nest and floated in a small container of lukewarm water to assess stage of incubation, estimate hatch date, and estimate the date of clutch initiation by backdating. Nest sites were not visited again until it was determined that the female had departed (i.e., was located away from the nest for ≥ 2 days during incubation and ≥ 1 day after expected hatch date) due to successful hatching of the clutch or failure due to either predation or abandonment. Nesting females were otherwise monitored by triangulation from a distance > 25 m. Thus, nest sites for half of the females were only disturbed by the presence of an observer a maximum of 2 times during the laying and incubation period. The remaining half of the females were never flushed and nest attempts were monitored from a distance of >25 m to evaluate whether the protocol of flushing females has a negative effect on nest survival. A female was assumed to be incubating if she was located in the same location for 2 consecutive visits and nest sites were only visited after the female was located away from the nest for ≥ 2 days during incubation or ≥ 1 day after expected hatch date.

Once the female departed the nest, we classified nest fate as successful (>1 chick produced), failed, depredated, or abandoned. Nests were considered abandoned if eggs were cold and unattended for >5 days. Nests were considered failed if the eggs were destroyed by flooding, trampling by livestock, or construction equipment. Nests were considered depredated if the entire clutch disappeared before the expected date of hatching, or if eggshell and nest remains indicated that the eggs were destroyed by a predator. When a depredation event occurred, the egg remains were evaluated and the area was searched for predator sign. For successful nests, hatchability was calculated as the percentage of eggs that hatched and produced chicks. Eggs that failed to hatch were opened to determine stage of development and possible timing of embryo failure.

Successful broods were relocated ≥3 times/week until failure. Pre-fledging brood survival was estimated by conducting flush counts between 14 and 16 days post hatch. Flush counts were conducted at dawn when chicks were close to radio-marked females to determine the number of surviving chicks in the brood. After females were flushed, the area was systematically searched and the behavior of the female observed to assess whether chicks were present but undetected. For counts of 0 chicks, the brood female was flushed again the following day to be certain no chicks remained in the brood. Broods were considered successful if ≥ 1 chick survived until fledging at 14-d post-hatch (Pitman et al. 2006). Flush counts were repeated at 14, 30, and 60 days post-hatch or until we were confident that no chicks remained with the female.

We evaluated habitat conditions at each nest and brood flush site within 3 days of hatching or expected hatch date in the case of failure (Figure 1). We recorded visual obstruction readings (VOR) at the nest bowl and at four points 6 m from the nest in each cardinal direction. At each point, VOR was measured in each cardinal direction from a distance of 2 m and a height of 0.5 m using a Robel pole (Robel et al. 1970). We estimated non-overlapping vegetation cover (percent new grass, residual grass, forbs, shrubs, bare ground, and litter) at 12 subsampling locations within 6 m of the nest using a 20 x 50 cm sampling frame (Daubenmire 1959). At each subsampling plot, we measured the heights of new grass, residual grass, forbs, and shrubs. We also estimated shrub cover using the line-intercept method, recording the species, height, and length of each shrub intersecting the transect. For nests, we conducted parallel sampling at randomly selected points within a study area defined by a minimum convex polygon placed around the leks of capture and buffered to 2 km. For broods, we conducted parallel sampling at paired points in a randomly determined direction and distance (maximum of 250 m) from each flush location to represent available habitat within the average daily distance traveled by broods (Goddard et al. 2009). Random points that fell within unsuitable habitat (i.e., water, cultivation, etc.) or were located on properties to which we did not have access were replaced.

We monitored radio-marked females ≥3 times per week to estimate survival. Transmitters were equipped with a mortality switch that activated after 6–8 hours of inactivity. Once the mortality switch activated, transmitters were located and the area searched to determine probable cause of death. Mortality events were classified as either predation, hunter, other, or unknown. Predation mortalities were further identified as either mammal, avian, or unknown predator. A mortality event was classified as mammalian predation if bite marks, chewed feathers, or mammalian tracks were present. Mortality was determined to be avian predation if the carcass had been decapitated and/or cleaned of the breast muscle with no bite marks, or if the feathers had been plucked. If none of these signs were present or if there were conflicting signs of mortality, the event was classified as unknown predation. Females were censored from the study if their collars were found with no sign of death or if they could not be located for ≥2 months.

Seven sharp-tailed grouse leks were monitored during 15 March – 5 May 2017. Sharp-tailed grouse were trapped at 4 easement and 3 reference leks during 23 March – 5 May 2017. Mean overall lek attendance was 14.4 birds (average of 12.6 males and 2.1 females) during this period (Table 1). We captured a total of 156 sharp-tailed grouse (124 males, 95 females), including 121 new captures (58 males, 63 females) and 35 recaptures from 2016 (29 males, 6 females) and 58 females were radio-marked (Table 2). An additional 13 females that were radio-marked during the 2016 field season were still present in the study area and therefore monitored for a second year. Overall, 71 radio-marked females were monitored ≥ 3 times per week throughout the nesting and brood-rearing period.

As of 16 June, 73 nests have been located (60 first nests, 13 renests; Table 3; Figure 2). Median nest initiation date was 28 April. Twenty-five nests have successfully hatched and 30 failed (23 depredated, 1 abandoned, 6 female mortalities). Apparent nest success for nests that were completed by 16 June was 0.45 ± 0.07. Apparent nest success (± SE) was 0.41 ± 0.12 and 0.47 ± 0.08, for the easement and reference areas, respectively. Hatch rate of eggs in successful nests was 0.91 ± 0.03. Mean clutch size for completed nests was 11.8 ± 0.30 eggs.

At present, 18 nests (9 first nests, 9 renests) are still active, so information on final fate for these nests and nest success for the season is not yet available. Of the 25 nests that successfully hatched, 23 broods are still alive, while two have failed.

As of 16 June, 16 females have been predated: 10 and 6 by avian and mammalian predators, respectively. Three females were censored from the study when their transmitters were found with no sign of death. An additional two females were censored after they could not be relocated for more than two months.

Goals For Next Quarter:

We will continue to monitor radio-marked females ≥ 3 times/week and all existing nests and any further renesting attempts. Nests will be monitored to determine fate and habitat will be evaluated at each nest site within three days of hatching or at expected hatch date for failed nests.

We will continue to monitor successful broods to estimate brood survival. Initial brood size will be identified by the number of chicks that were known to hatch. Systematic flush counts will be conducted within an hour of dawn to estimate pre-fledge (0–14 days) and post-fledge (14-60 days) survival. Broods will be considered successful if at least 1 chick survives until fledging. Fledging success will be calculated as the percentage of chicks that survive until fledging (14-d post-hatch) among successful broods. Habitat will be evaluated at each brood flush site. We will use dropnets and spotlights to capture >30 day old chicks by relocating radio-marked females at night. We will record morphometrics and equip 1–2 fledglings/brood with radio-transmitters lasting 400 days and attached with glue and sutures. Through the remainder of the brood-rearing season, radio-marked fledglings will be monitored ≥ 3 times/week until death or transmitter failure or loss. During the non-breeding season (September – March) radio-marked fledglings and females will be monitored ≥ 1 time/month from the ground or by plane until death or transmitter failure or loss.

Objective 2: Investigate impacts of rest-rotation grazing on sharp-tailed grouse home ranges, movements and habitat selection.

Accomplishments Since Last Quarter:

Efforts this quarter focused on capturing, radio-marking and monitoring female sharp-tailed grouse. Sharp-tailed grouse were trapped at a total of 7 leks on both the easement and reference areas of the study site during 23 March – 5 May 2016. Captured females were fitted with necklace-style radio-transmitters. Radio-marked females were located via triangulation or homing ≥ 3 times/week using portable radio receivers and handheld Yagi antennas.

As of 15 June, we have collected 1,679 locations from 71 radio-marked females, including 1,256 unique locations that exclude duplicate nest locations. To date, 27 females have over 20 unique locations during the 2017 breeding season.

Goals For Next Quarter:

We will continue to track radio-marked females ≥ 3 times/week through the remainder of the brood-rearing season. During the non-breeding season (September – March) radio-marked fledglings and females will be monitored ≥ 1 time/month from the ground or by plane until death or transmitter failure or loss. Coordinates for triangulated locations will be calculated using Location of a Signal software (LOAS; Ecological Software Solutions LLC). All locations will be examined for spatial error and locations with excessive error (i.e., > 200 m error ellipse) will be discarded with the level of acceptable error being examined on a case-by-case basis. Analyses of space use will be restricted to birds with > 25 unique locations per season after excluding multiple nest locations.

We will use the fixed kernel method (Worton 1989) with the default smoothing parameter to calculate 95% home ranges for the breeding season (April – August) using the adehabitatHR package in Program R (R Core Team 2017). We will also calculate centroids for each home range using the ‘rgeos’ package in Program R and calculate the distance each female traveled from lek of capture to the home range centroid in ArcGIS 10.4 (Environmental Systems Research Institute, Redlands, CA). We will use resource utilization functions (RUFs) to examine habitat selection within the breeding season home range.

Objective 3. Develop a mechanistic understanding of the ecological effects of various grazing treatments with a focus on rest rotation grazing by examining abundance and space use of the grassland bird and mesopredator communities

Accomplishments since the last quarter:

Efforts this quarter were focused on conducting late spring grassland bird and mesopredator surveys to test primary hypotheses regarding effects of grazing management on abundance and diversity. In 2016, we randomly generated 305 points across gradients of habitat conditions within the conservation easement and on adjacent private and federal lands managed with alternative grazing methods (Figure 3). Grassland birds show low site fidelity between breeding seasons, and we used the same survey points as the 2016 field season (Jones et al. 2007). We randomly generated 150 points on the conservation easement, with 50 points in each of the three rotational pasture types. We generated 155 points in reference pastures adjacent to the easement, with 60 points located in season-long grazing systems and 95 points in intensive summer rotational grazing systems, where cattle are turned out at the end of May and are moved between pastures after 6–8 weeks. To avoid double counting of individuals and assure statistical independence, points were spaced ≥ 300 m apart (Hutto et al. 1986). Points were located ≥ 200 m from pasture boundaries to avoid counting birds using multiple treatments, ≥ 400 m from oil pads, and ≥ 250 m from gravel roads to control for bird avoidance of these areas (Thompson et al. 2015).

Avian point count surveys began 19 May 2017, after all breeding species had arrived. Surveys needed to be completed within a 5-week period to guarantee population closure; our surveys concluded 12 June, 2017. At each randomly generated location, grassland birds were surveyed with three replicated 5-minute point count surveys. A single trained observer identified and tallied all birds detected visually or aurally within 100 m of the point, noting the time of first detection and the distance from observer to the bird when it was first detected (0-25m, 26-50m, 51-75m, 76-100m; Ralph et al. 1993). Other data recorded included sex (dichromatic species only), group size, vocalization, and behavior of each species identified. At each survey location, the observer recorded the point and pasture to be surveyed, date and time, percent overcast, precipitation, temperature, and wind speed. Point count surveys were conducted from one-half hour before sunrise through no later than 0900h MST. Surveys were not conducted if average wind speed exceeded 10 mph or during rainfall.

We detected 6,875 birds of 62 species during 915 point count surveys; 3,362 birds of 56 species were detected in pastures with rest-rotation grazing systems and 3,513 birds of 52 species were detected on reference properties adjacent to the easement with traditional grazing systems (Table 4, 6). We identified 23 species of grassland obligate birds, Baird's sparrow (*Ammodramus bairdii*), bobolink (*Dolichonyx oryzivorus*), Brewer's sparrow (*Spizella breweri*), clay-colored sparrow (*Spizella pallida*), common yellowthroat (*Geothlypis trichas*), eastern bluebird (*Sialia sialis*), eastern kingbird (*Tyrannus tyrannus*), field sparrow (*Spizella pusilla*), grasshopper sparrow (*Ammodramus savannarum*), horned lark (*Eremophila alpestris*), killdeer (*Charadrius vociferus*), lark bunting (*Calamospiza melanocorys*), lark sparrow (*Chondestes grammacus*), loggerhead shrike (*Lanius ludovicianus*), marbled godwit (*Limosa fedoa*), mountain bluebird (*Sialia currucoides*), red-winged blackbird (*Agelaius phoeniceus*), Say's phoebe (*Sayornis saya*), Sprague's pipit (*Anthus spragueii*), sharp-tailed grouse (*Tympanuchus phasianellus*), upland sandpiper (*Bartramia longicauda*), vesper sparrow (*Pooecetes gramineus*), western kingbird (*Tyrannus verticalis*), and western meadowlark (*Sturnella neglecta*; Table 7). Based on their dependence on quality grassland for breeding, recruitment, and survival, along with adequate sample sizes, 9 of these grassland bird species will be focal species used in analyses. This subset consists of the clay-colored sparrow, eastern kingbird, field sparrow, grasshopper sparrow, horned lark, upland sandpiper, vesper sparrow, western kingbird, and western meadowlark (Table 5). Additionally, we will include brown-headed cowbird in analyses due to this species' potential impact on grassland bird reproductive success. During the 2017 field season, we observed 123 clay-colored sparrow ($\bar{x}$ per point = 0.40), 209 eastern kingbird ($\bar{x}$ = 0.69), 187 field sparrow ($\bar{x}$ = 0.61), 1783 grasshopper sparrow ($\bar{x}$ = 5.85), 44 horned lark ($\bar{x}$ = 0.14), 52 upland sandpiper ($\bar{x}$ = 0.17), 507 vesper sparrow ($\bar{x}$ = 1.66), 68 western kingbird ($\bar{x}$ = 0.22), and 1828 western meadowlark ($\bar{x}$ = 5.99; Table 5).

Habitat conditions were measured within bird survey areas the same day point counts were conducted. Three 20-m transects were established within 100 m of each survey point, with one transect originating at the point and oriented in a random direction, and two transects located and oriented randomly within 100 m of the survey point. Subplots were spaced 5 m apart along each transect. At each subplot, visual obstruction was measured from the north at a distance of 2 m and a height of 0.5 m (VOR; Robel et al. 1970), and vegetation coverages were measured using methods of Daubenmire (1959). Percent coverage of new growth grass, residual grass, litter, shrub, forb, tree, bare ground, rock, and cowpie were measured in percentage classes (0-5, 5-25, 25-50, 50-75, 75-95, and 95-100%). Heights (cm) of the nearest plant were measured for each new growth grass, residual grass, litter, shrub, subshrub, and forb. We estimated shrub cover using line intercept surveys, where the species of each shrub intersecting the transect was recorded, as well as the height and length of the shrub as it crossed the transect (Canfield 1941).

Passive infrared remote field cameras (Browning BTC 5HD) were used to survey the mesopredator community within the study area. Remote cameras have been cited as the best survey method for detecting medium and large sized carnivores in most habitats (Silveira et al. 2003). Automated cameras also recorded the time and date for every photographic event captured, making them useful for temporal associations, such as daily and seasonal activity patterns. Ninety-three predator survey points were randomly selected within the study site, with 45 points in rest-rotation pasture treatments (easement) and 48 in season-long and summer rotation grazing pasture treatments (reference areas). Cameras were set in the most optimal location within 200 m of the point, where detection of predators was maximized, and spaced ≥ 600 m apart to ensure independence (Lesmeister et al. 2015). Cameras were often set at heavy use areas along a habitat edge, where land cover changes on the landscape at the intersection of water, grassland, agriculture, and/or trees and shrubs (Burr 2014). Habitat edges and game trails were used with a goal of increasing detection probabilities, as mammalian predators are thought to prefer such edges while traveling and foraging (Andrén 1995).

Cameras were programmed to be active 24 hours a day with a 1-minute delay between photographic events and a two photo burst for each event. For each photographic event, the date and time of the event were recorded, along with the temperature (°C), barometric pressure, moon phase, and camera ID. Cameras were secured to tree trunks or, if not available, mounted on metal stakes, and positioned approximately 0.5m above the ground and 2m in front of a scent lure. When present, cameras were faced toward game trails to maximize detections.

For each three-week sampling period, camera sites were revisited weekly to re-bait stations, download and clear memory cards of digitally recorded images, change camera batteries, and remove any obstructive vegetation. Each camera trap was baited with a long-distance trapping lure (Gusto; Minnesota Trapline Products, Inc.) in an attempt to increase detection frequencies of predators. Following each 3-week survey period, cameras were moved to new random points for another 3 weeks. Two of three sampling periods were surveyed this quarter, with one sampling period to be conducted early next quarter. Thus, 31 camera traps will be used to survey 93 sites during the 2017 field season.

Goals for Next Quarter:

Habitat and vegetation data will be entered into the database and proofed. Analyses of grassland bird point count data will be conducted, relating bird abundances to vegetation measurements using N-Mixture modeling techniques within R program unmarked (Fiske and Chandler 2011). Associations with habitat conditions, grazing intensity, and grassland bird presence may then be evaluated for all focal species from 2016 and 2017 avian point count surveys. Following the 2017 field season, we will analyze all photos from the remote camera traps and identify predators based on body shape and coloration. Invertebrate samples collected during the 2016 field season will continue to be sorted and processed. We will also prepare data for presentation at The Wildlife Society 24th annual conference in Albuquerque, New Mexico on September 25, 2017.

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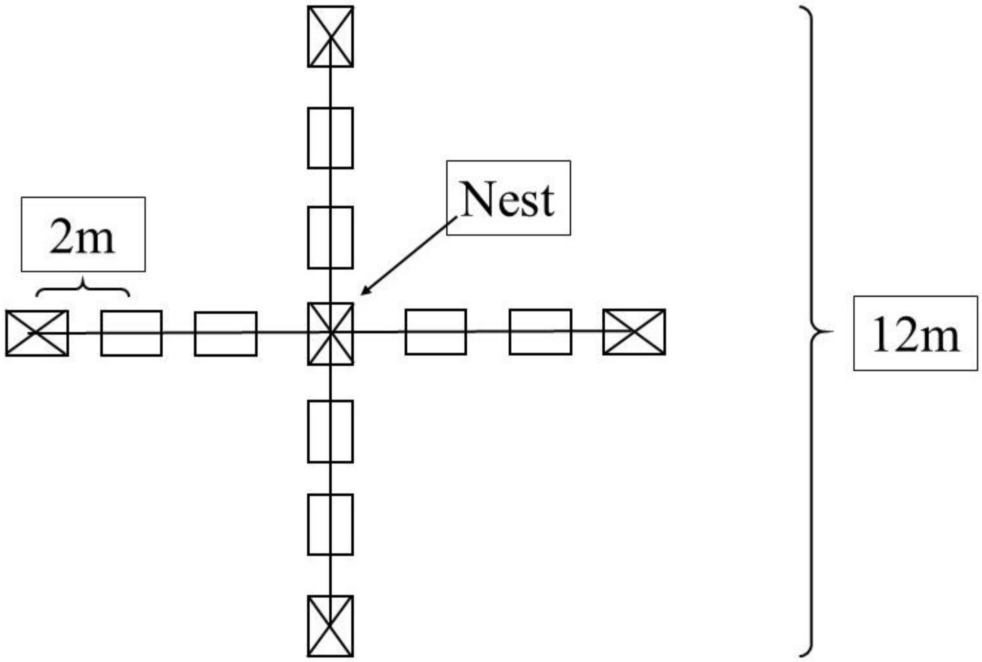

Figure 1. Setup of a vegetation plot. Vegetation cover and height were measured using a Daubenmire frame at each rectangle and visual obstruction with a Robel pole at each X. The lines represent the 12 m transects that were used to estimate shrub cover with the line-intercept method.

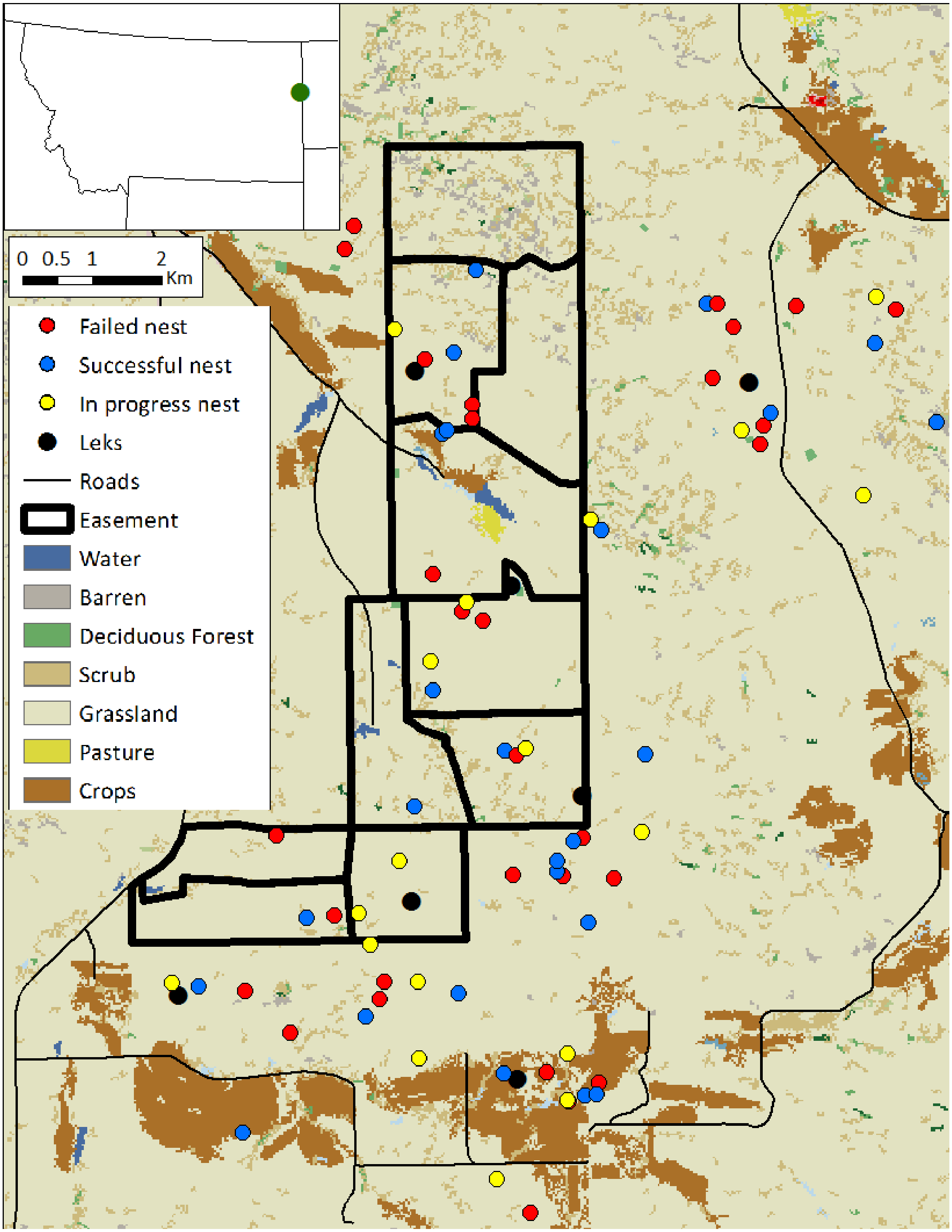

Figure 2. Locations of successful (blue), failed (red) and in progress (yellow) nests in relation to leks of capture and the easement boundaries outlined in black.

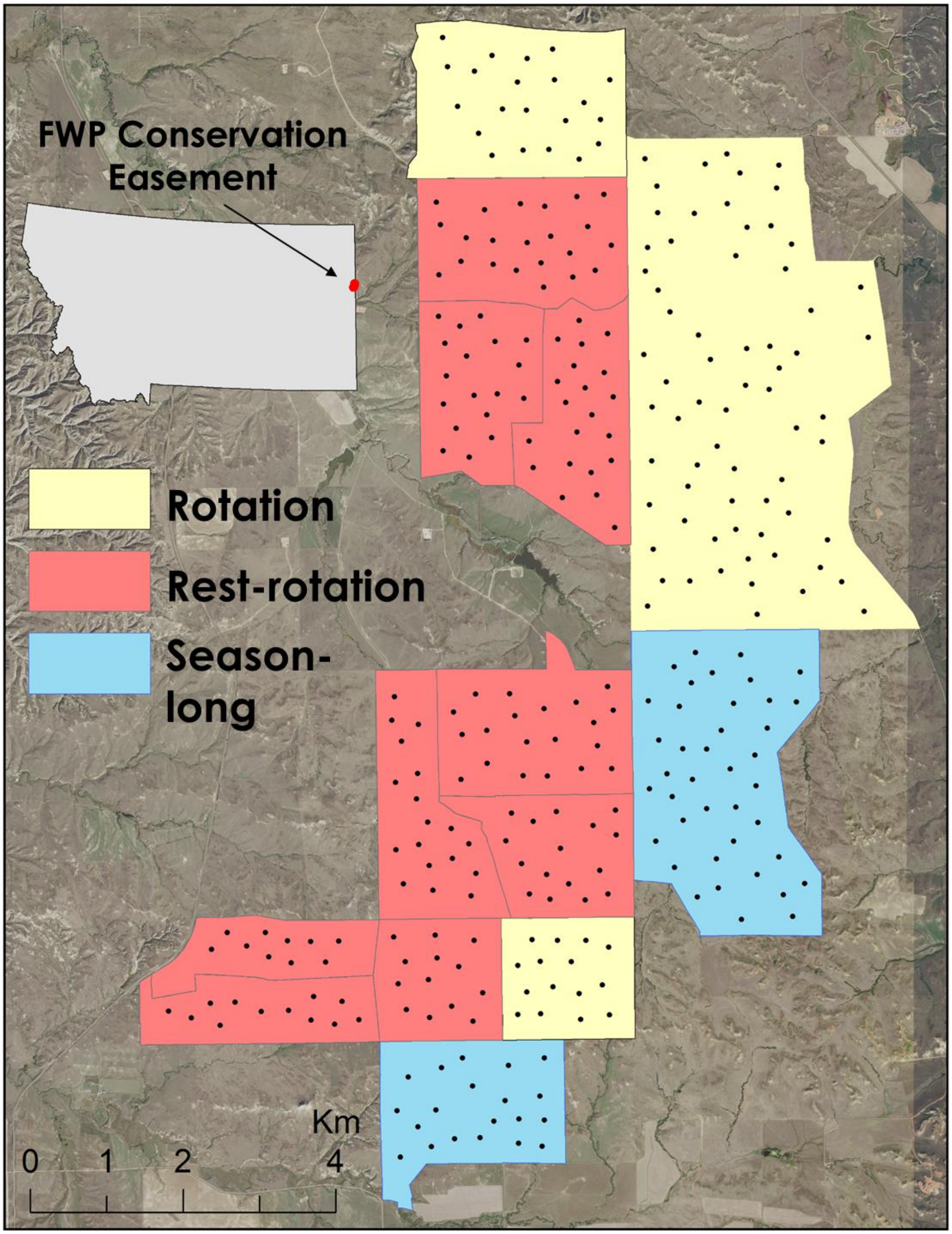

Figure 3. All bird point count survey locations on the Buxbaum conservation easement managed under rest-rotation grazing (red), and on adjacent private and federal lands managed under traditional grazing methods (blue and yellow) in Richland County, Montana surveyed in 2017.

Table 1. Average attendance at 7 leks during 15 March – 5 May 2017. The four leks located within the easement are listed first.

Lek	Average Total Attendance	Minimum Total Attendance	Maximum Total Attendance	Average Male Attendance	Average Female Attendance
EasState1	14.0	7.0	26.0	12.9	1.6
Prewitt1	15.4	8.0	25.0	13.0	2.7
Laumeyer2	18.6	12.0	27.0	15.6	3.4
OilpadLek	8.0	3.0	18.0	6.1	1.9
Pennington01	16.6	9.0	35.0	13.9	2.7
Iversen1	14.9	3.0	24.0	12.9	1.6
Ullman01	18.2	11.0	29.0	16.2	1.9
Total	14.4	3.0	35.0	12.6	2.1

Table 2. Total number of grouse captured and radio-marked on and off the easement in 2017. The total radio-marked females includes females radio-marked in 2016 but monitored again in 2017

	Males	Females	New Radio-marked Females	Total Radio-marked Females
Easement	44	40	29	39
Reference	43	29	29	32
Total	87	69	58	71

Table 3. Overview of nests in the easement and reference sections of the study area. Egg hatch rate is the percentage of eggs that hatched from the initial clutch size. Eighteen nests are still active, so information on final fate and nest success are not yet available.

	Median Initiation Date	Clutch Size	First Nests	Renests	Nests Hatched	Median Hatch Date	Egg Hatch Rate	Apparent Nest Success
Easement	29 April	11.6 ± 0.60	20	3	7	2 June	0.94 ± 0.02	0.41 ± 0.12
Reference	28 April	11.9 ± 0.34	40	10	18	3 June	0.90 ± 0.04	0.47 ± 0.08
Total	28 April	11.8 ± 0.30	60	13	25	2 June	0.91 ± 0.03	0.45 ± 0.07

Table 4. Bird detections and species diversity from 915 point count surveys at 305 survey sites on the Buxbaum conservation easement and adjacent reference properties in eastern Richland County, Montana in 2017.

	Buxbaum Conservation Easement[a]				Reference Pastures[b]					Total
	[1] Pastures	[2] Pastures	[3] Pastures	**Subtotal**	Season-long	Rotation1	Rotation2	Rotation3	**Subtotal**	
Number points	50	50	50	**150**	60	59	21	15	**155**	305
Total birds	1109	1189	1064	**3362**	1175	1404	595	339	**3513**	6875
Mean birds / Point	22.2	23.8	21.3	**22.4**	19.6	23.8	28.3	22.6	**22.7**	22.5
Number species	43	42	44	**56**	39	39	38	27	**52**	62

[a] Easement pasture designations: [1] A1, B3, C1; [2] A2, B1, C2; [3] A3, B2, C3

[b] Reference Pastures include 2 pastures that are grazed annually during the growing season (season-long), and three pastures managed with intensive summer rotational grazing.

Table 5. Focal species detected during 915 point count surveys at 305 survey sites within the Buxbaum conservation easement and adjacent reference properties in eastern Richland County, Montana in 2017, and the mean number of birds per survey site in each of the pastures.

	Buxbaum Conservation Easement[a]				Reference Pastures[b]					Total
	[1] Pastures	[2] Pastures	[3] Pastures	**Subtotal**	Season-long	Rotation1	Rotation2	Rotation3	**Subtotal**	
Brown-Headed Cowbird	136	92	55	**283**	48	44	55	14	**161**	444
Mean birds / point	2.72	1.84	1.1	**1.89**	1.2	0.75	2.67	0.93	**1.05**	1.46
Clay-Colored Sparrow	8	51	2	**61**	7	50	3	2	**62**	123
Mean birds / point	0.16	1.02	0.04	**0.41**	0.175	0.85	0.14	0.13	**0.4**	0.4
Eastern Kingbird	33	51	31	**116**	25	24	31	13	**93**	209
Mean birds / point	0.66	1.02	0.62	**0.77**	0.625	0.41	1.48	0.87	**0.6**	0.685
Field Sparrow	50	23	13	**86**	5	51	35	10	**101**	187
Mean birds / point	1	0.46	0.26	**0.57**	0.125	0.86	1.67	0.67	**0.65**	0.61

Grasshopper Sparrow	91	331	323	**745**	435	472	16	115	**1038**	1783
Mean birds / point	1.82	6.62	6.46	**4.97**	10.875	8.0	0.76	7.67	**6.7**	5.85
Horned Lark	1	1	19	**21**	16	2	3	2	**23**	44
Mean birds / point	0.02	0.02	0.38	**0.42**	0.4	0.07	0.14	0.13	**0.15**	0.14
Upland Sanpiper	6	4	10	**20**	15	10	0	7	**32**	52
Mean birds / point	0.12	0.08	0.2	**0.13**	0.375	0.17	0	0.47	**0.11**	0.17
Vesper Sparrow	89	79	71	**239**	60	142	48	18	**268**	507
Mean birds / point	1.78	1.58	1.42	**1.59**	1.5	2.41	2.29	1.2	**1.73**	1.66
Western Kingbird	25	8	13	**46**	2	4	16	0	**22**	68
Mean birds / point	0.5	0.16	0.26	**0.18**	0.05	0.07	0.76	0	**0.14**	0.22
Western Meadowlark	270	320	284	**874**	384	381	116	73	**954**	1828
Mean birds / point	5.4	6.4	5.68	**5.83**	9.6	6.46	5.52	4.87	**6.15**	5.99

[a] Easement pasture designations: [1] A1, B3, C1; [2] A2, B1, C2; [3] A3, B2, C3

[b] Reference Pastures include 2 pastures that are grazed annually during the growing season (season-long), and three pastures managed with intensive summer rotational grazing.

Table 6. Total birds of each species detected during 915 point count surveys at 305 survey sites on the Buxbaum conservation easement and adjacent reference properties during the 2017 field season.

	Buxbaum Conservation Easement			**Total**	Reference Pastures				**Total**	Grand Total
	[1] Pastures	[2] Pastures	[3] Pastures		Season-long	Rotation1	Rotation2	Rotation3		
AMCR	0	0	0	**0**	0	2	0	0	**2**	2
AMGO	27	23	23	**73**	6	15	31	5	**57**	130
AMKE	2	1	1	**4**	2	1	0	0	**3**	7
AMRO	8	4	11	**23**	1	3	12	4	**20**	43
BAIS	0	0	0	**0**	21	29	0	0	**50**	50
BANS	2	0	2	**4**	0	1	0	0	**1**	5
BAOR	0	0	0	**0**	3	0	0	0	**3**	3

BARS	8	4	1	**13**	1	1	2	0	**4**	17
BBMA	1	0	0	**1**	1	4	0	0	**5**	6
BHCO	136	92	55	**283**	48	44	55	14	**161**	444
BHGR	4	1	0	**5**	0	0	0	0	**0**	5
BOBO	0	1	5	**6**	1	0	0	14	**15**	21
BRBL	9	12	36	**57**	30	0	6	2	**38**	95
BRSP	3	0	0	**3**	0	0	0	0	**0**	3
BRTH	24	8	10	**42**	6	3	9	3	**21**	63
BUOR	11	5	3	**19**	0	1	2	1	**4**	23
CCSP	8	51	2	**61**	7	50	3	2	**62**	123
CEDW	0	1	4	**5**	1	0	5	3	**9**	14
CHSP	3	0	7	**10**	0	0	3	0	**3**	13
CLSW	2	0	1	**3**	0	0	0	0	**0**	3
COGR	0	6	0	**6**	3	0	1	2	**6**	12
CONI	1	3	2	**6**	0	6	2	0	**8**	14
COYE	0	4	0	**4**	0	3	0	0	**3**	7
EABL	0	1	0	**1**	0	0	0	0	**0**	1
EAKI	33	52	31	**116**	25	24	31	13	**93**	209
EUST	5	1	2	**8**	1	2	2	0	**5**	13
FISP	50	23	13	**86**	5	51	35	10	**101**	187
GRCA	0	2	0	**2**	0	0	2	1	**3**	5
GRSP	91	331	323	**745**	435	472	16	115	**1038**	1783
HAWO	1	0	0	**1**	0	0	0	0	**0**	1
HOLA	1	1	19	**21**	16	2	3	2	**23**	44
HOWR	39	24	13	**76**	5	19	33	9	**66**	142
KILL	0	0	3	**3**	0	3	3	0	**6**	9
LARB	31	1	1	**33**	0	0	0	0	**0**	33
LASP	15	7	11	**33**	5	2	11	0	**18**	51
LEFL	0	3	1	**4**	0	5	5	1	**11**	15
LOSH	3	7	3	**13**	1	3	0	1	**5**	18
MAGO	0	0	1	**1**	0	0	0	0	**0**	1

MOBL	7	1	2	**10**	2	7	6	5	**20**	30
MODO	30	21	29	**80**	31	20	38	9	**98**	178
NOFL	12	6	6	**24**	5	9	10	4	**32**	56
NRWS	5	8	1	**14**	1	7	3	0	**11**	25
OROR	0	3	3	**6**	1	3	2	0	**6**	18
PRFA	0	0	0	**0**	0	0	1	0	**1**	1
RNEP	1	3	1	**5**	0	0	1	0	**1**	6
ROPI	2	0	0	**2**	0	0	0	0	**0**	2
ROWR	9	2	0	**11**	2	1	0	0	**3**	14
RTHA	0	0	0	**0**	0	0	0	1	**1**	1
RWBL	0	3	5	**8**	17	4	0	1	**22**	30
SAPH	8	0	0	**8**	0	1	1	0	**2**	10
SPPI	1	3	13	**17**	9	1	0	0	**10**	27
SPTO	64	17	16	**97**	9	36	31	7	**83**	180
STGR	0	1	2	**3**	4	2	1	0	**7**	10
TRES	0	0	2	**2**	1	0	0	0	**1**	3
UPSA	6	4	10	**20**	15	10	0	7	**32**	52
VESP	89	79	71	**239**	60	142	48	18	**268**	507
WEKI	25	8	13	**47**	2	4	16	0	**22**	69
WEME	270	320	284	**874**	384	381	116	73	**954**	1828
WEWP	2	0	0	**2**	0	0	0	0	**0**	2
WIFL	0	0	0	**0**	0	0	1	0	**1**	1
YBCH	11	3	1	**15**	0	10	14	0	**24**	39
YWAR	49	40	21	**110**	5	22	33	14	**74**	184

Table 7. Bird species observed during 2017 avian point count surveys at 305 survey sites located on the Buxbaum conservation easement and adjacent reference properties.

4-letter Code	Common Name	Scientific Name
AMCR	American Crow	*Corvus brachyrhynchos*
AMGO	American Goldfinch	*Carduelis tristis*
AMKE	American Kestrel	*Falco sparverius*
AMRO	American Robin	*Turdus migratorius*
BAIS*	Baird's Sparrow	*Ammodramus bairdii*
BANS	Bank Swallow	*Riparia riparia*
BAOR	Baltimore Oriole	*Icterus galbula*
BARS	Barn Swallow	*Hirundo rustica*
BBMA	Black-billed Magpie	*Pica hudsonia*
BHCO	Brown-headed Cowbird	*Molothrus ater*
BHGR	Black-headed Grosbeak	*Pheucticus melanocephalus*
BOBO*	Bobolink	*Dolichonyx oryzivorus*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*
BRSP*	Brewer's Sparrow	*Spizella breweri*
BRTH	Brown Thrasher	*Toxostoma rufum*
BUOR	Bullock's Oriole	*Icterus bullockii*
CCSP*	Clay-colored Sparrow	*Spizella pallida*
CEDW	Cedar Waxwing	*Bombycilla cedrorum*
CHSP	Chipping Sparrow	*Spizella passerina*
CLSW	Cliff Swallow	*Petrochelidon pyrrhonota*
COGR	Common Grackle	*Quiscalus quiscula*
CONI	Common Nighthawk	*Chordeiles minor*
COYE*	Common Yellowthroat	*Geothlypis trichas*
EABL*	Eastern Bluebird	*Sialia sialis*
EAKI*	Eastern Kingbird	*Tyrannus tyrannus*
EUST	European Starling	*Sturnus vulgaris*
FISP*	Field Sparrow	*Spizella pusilla*

GRCA	Gray Catbird	*Dumetella carolinensis*
GRSP*	Grasshopper Sparrow	*Ammodramus savannarum*
HAWO	Hairy Woodpecker	*Leuconotopicus villosus*
HOLA*	Horned Lark	*Eremophila alpestris*
HOWR	House Wren	*Troglodytes aedon*
KILL*	Killdeer	*Charadrius vociferus*
LARB*	Lark Bunting	*Calamospiza melanocorys*
LASP*	Lark Sparrow	*Chondestes grammacus*
LEFL	Least Flycatcher	*Empidonax minimus*
LOSH*	Loggerhead Shrike	*Lanius ludovicianus*
MAGO*	Marbled Godwit	*Limosa fedoa*
MOBL*	Mountain Bluebird	*Sialia currucoides*
MODO	Mourning Dove	*Zenaida macroura*
NOFL	Northern Flicker	*Colaptes auratus*
NRWS	Northern Rough-Winged Swallow	*Stelgidopteryx serripennis*
OROR	Orchard Oriole	*Icterus spurius*
PRFA*	Prairie Falcon	*Falco maxicanus*
RNEP	Ring-necked Pheasant	*Phasianus colchicus*
ROPI	Rock Pigeon	*Columba livia*
ROWR	Rock Wren	*Salpinctes obsoletus*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
RWBL*	Red-winged Blackbird	*Agelaius phoeniceus*
SAPH	Say’s Phoebe	*Sayornis saya*
SPPI*	Sprague’s Pipit	*Anthus spragueii*
SPTO	Spotted Towhee	*Pipilo maculatus*
STGR*	Sharp-tailed Grouse	*Tympanuchus phasianellus*
TRES	Tree Swallow	*Hirundo nigricans*
UPSA*	Upland Sandpiper	*Bartramia longicauda*
VESP*	Vesper Sparrow	*Pooecetes gramineus*
WEKI*	Western Kingbird	*Tyrannus verticalis*
WEME*	Western Meadowlark	*Sturnella neglecta*

WEWP	Western Wood-Pewee	*Contopus sordidulus*
WIFL	Willow Flycatcher	*Empidonax traillii*
YBCH	Yellow-breasted Chat	*Icteria virens*
YWAR	Yellow Warbler	*Dendroica petechia*

[*]Designates grassland obligate species.