STATE: **Montana**
AGENCY: **Fish, Wildlife & Parks**
GRANT: **Sage-Grouse Grazing Evaluation**
MT TRACKING: **W-158-R**

Annual Report

Sage-Grouse Grazing Evaluation Study

July 1, 2014 – June 30, 2015

Submitted by:
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BACKGROUND

The greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) is a gallinaceous bird species endemic to semi-arid sagebrush (*Artemisia* spp.) habitats in western North America (Schroeder et al. 1999). The loss and degradation of the sagebrush habitats upon which this species depends has led to its extirpation from over half of its original range (Schroeder et al. 2004). Threats to sage-grouse populations and the sagebrush landscapes on which they depend vary across their range, including increasing oil and gas development (Naugle et al. 2011), conifer invasion into sage steppe habitats (Baruch-Mordo et al. 2013), conversion of sagebrush to crop fields ("sod-busting"; Walker 2008), disease (i.e., West Nile virus; Walker and Naugle 2011), urban encroachment in sagebrush landscapes (Brunson and Huntsinger 2008), and in some cases livestock grazing (Connelly et al. 2004). Dramatic declines in sage-grouse populations have led to the recent designation of this species as 'warranted' for protection under the federal Endangered Species Act (ESA), but precluded by more pressing issues (ESA; United States Department of the Interior 2010). A new decision on whether to list the sage-grouse is expected to be finalized by the U.S. Fish and Wildlife Service (USFWS) by Sep 30, 2015.

Private lands contain 30% of the 48 million ha of sagebrush habitat on which sage-grouse depend, including key sage-grouse breeding areas. Montana is among the states with the most sagebrush in private ownership (Connelly et al. 2004). For landscape species such as sage-grouse, private lands conservation and maintaining "working landscapes" has become a major means by which conservation and management occurs (Raven 1990; Brunson and Huntsinger 2008). Sod-busting and ranchland conversion to commercial or residential developments are occurring at high rates in the West, and the effort to sustain working ranches is a forward looking approach to landscape conservation (Brunson and Huntsinger 2008).

Research suggests that, done appropriately, livestock grazing can be used as a tool to improve sagebrush habitat for sage-grouse (Connelly et al. 2004). Still, no study has quantified the direct effects of grazing systems on sage-grouse populations. Currently there are at least 4 sage-grouse grazing studies that have been implemented across the range of sage-grouse, including this project, to begin to fill that knowledge gap. A major goal of this project is to evaluate the effectiveness of grazing systems designed by the Natural Resources Conservation Service (NRCS) under the Sage-Grouse Initiative (SGI) to improve sage-grouse habitat, and provide this agency with information regarding best grazing management practices for sage-grouse. In addition, we categorize both SGI-enrolled land and land not enrolled in SGI on our study area into more specific grazing treatments related to the timing of grazing (see **Work Completed** below), enabling us to generalize the results of this study to other grazing systems (e.g., systems managed by Montana Fish, Wildlife, and Park [FWP]). This will allow multiple agencies, private entities, and landowners to better manage for sage-grouse in relation to livestock grazing. Several partners including NRCS, The University of Montana, FWP, the Department of Natural Resources and Conservation, and the U.S. Bureau of Land Management (BLM) oversee this project and are regularly consulted regarding its design and results to ensure that our products are meeting their needs.

OBJECTIVES

The short-term objective of the FY15 funding period, representing the 4th – 5th years of this project that began in March 2011, was to study the direct effects of livestock grazing systems on the population dynamics of sage-grouse and their associated habitat in Musselshell and Golden Valley counties, Montana (Fig. 1) during the 2014-2015 field seasons.

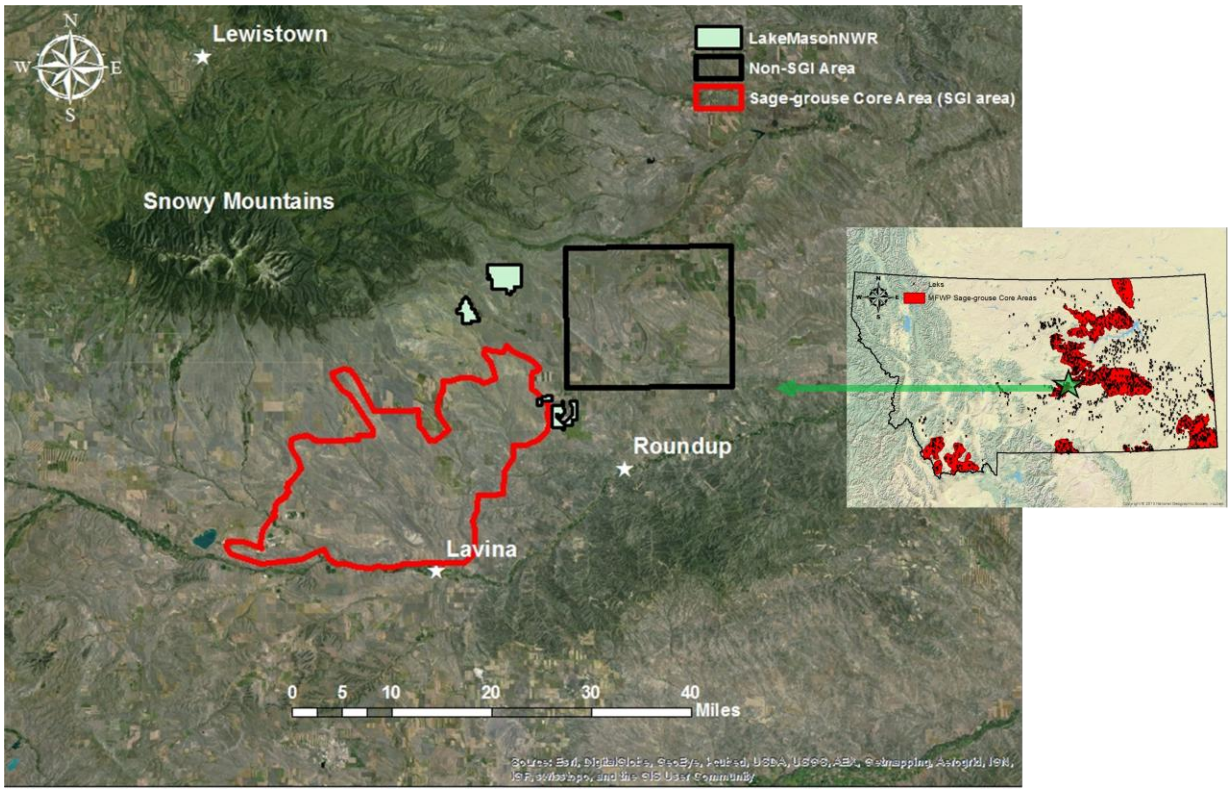

Figure 1. A map of the project area north of Lavina and Roundup, Montana, in Golden Valley (western portion) and Musselshell (eastern portion) counties. The project area includes a sage-grouse core area (red boundary) delineated by FWP where SGI grazing systems have been implemented and an area 25 mi north of Roundup, Montana (black border) where no SGI systems have been implemented. The light green polygons represent the locations of the 3 Lake Mason satellite units of the Charles M. Russell National Wildlife Refuge in Musselshell County, Montana that we expanded our study area to in 2014: the Willow Creek, North, and Lake Mason units (in order from left to right).

Adult female (hen) survival, nest success, and chick survival are the three most important factors influencing the population growth of sage-grouse—more influential than, for example, nest initiation dates or clutch sizes (Taylor et al. 2012). In addition, past research in other locations has shown that vegetation variables such as taller grass height translate into higher nest success for sage-grouse hens (Doherty et al. 2010). Thus we continued to collect data on these vital rates, which will enable us to accomplish the following long-term objectives:

1. To measure and compare the vegetation response in pastures among different grazing treatments, relative to published sage-grouse habitat needs;

2. Identify seasonal movements and habitat selection by sage-grouse hens and chicks to quantify use of different grazing treatments in proportion to habitat availability and other drivers of sage-grouse resource selection; and
3. Measure individual vital rates known to impact population growth in sage-grouse and relate these estimated vital rates directly to habitat variables and other important drivers.

It is increasingly important to make evaluations at an ecosystem level; grazing systems will not only impact sage-grouse, but also vegetation, many other wildlife species, and the food (i.e., insects and plants) that sage-grouse and other wildlife depend on. Thus, it is important to evaluate the effects of grazing systems on these multiple components because these components are interconnected. We are incorporating these components into our project by collaborating with The University of Montana and Montana State University to evaluate the effects of grazing systems on songbirds and insects, respectively. These evaluations are funded and conducted independently of our sage-grouse evaluation, but dovetail with our sage-grouse work to look at impacts of grazing on other sagebrush and grassland birds as well as availability of insects that are an important food resource for sage-grouse. This collaborative approach is essential to understand multiple facets of the impacts of grazing on rangelands and wildlife, and it further leverages the funding contributions and landowner relationships of this project. This approach also presents an opportunity to determine the long-term impacts of changes in land-use practices at the larger ecosystem scale—the scale at which these changes are occurring.

WORK COMPLETED

We have completed 4.5 years of data collection for this 10-yr, long-term study to help evaluate the effectiveness of SGI grazing systems as a habitat management tool for stabilizing or improving sage-grouse habitat and populations in central Montana. During the FY15 funding period we continued the collection of data including monitoring of sage-grouse hens, nests, and chicks on SGI-enrolled lands (hereafter SGI area) and on lands with no SGI grazing systems (hereafter non-SGI areas) using radiotelemetry. To this end, we captured and marked 54 hens with radio transmitters to increase our sample size of marked hens back up to 100; found and monitored 77 nests; captured and marked 58 chicks with radio transmitters and monitored them throughout the summer; and measured key sage-grouse habitat vegetation characteristics at 344 plots within grazing treatments. One-hundred and fifty-four of these plots were located at nests and unused sites in potential sage-grouse nesting habitat to measure the influence of vegetation and grazing treatments on sage-grouse vital rates and habitat use. One-hundred and ninety of these plots were randomly located within grazing treatments to distinctly measure vegetation response to grazing in sage-grouse habitat.

We use 2 sets of grazing treatments. The first set includes 3 broad categories targeted towards the specific evaluation of SGI grazing systems and lumps pastures together within a particular year according to:

1. Pastures that have been rested at least 12 months,
2. Pastures that have been grazed within the year, and
3. Non-SGI pastures.

The second set of treatments categorizes each pasture used by sage-grouse into 1 of 4 grazing treatments that have been defined with respect to sage-grouse ecology and timing of grazing. These treatments also coincide roughly with the phenology of plants, which is impacted by timing of grazing and is the target of NRCS SGI grazing management. The treatments include:

1. Grazed during the nesting season (April 1st – July 20th) which coincides with the period of initial plant growth,
2. Grazed during brood-rearing (July 21st – September 15th) which coincides with the period of plant reproduction (seed-set),
3. Grazed during fall/winter after broods break-up until the start of the next breeding/nesting season (September 15th – Apr 1st) which coincides with the period during which plants are dormant (important because of the residual vegetation that sage-grouse are dependent on for cover during the early nesting period), or
4. Rested the entire year (Apr 1st – Apr 1st the following year).

SGI grazing systems are designed to change the timing of grazing in pastures each year to help plants recover. For example, a pasture grazed before reproduction (seed-set) in one year will likely have grazing deferred until after seed-set the following year to allow plants to reproduce.

The actual duration of rest (number of months) and the previous year's rest history for each pasture will be included as covariates in analyses. We record the grazing status, relative to the above categories, for pastures in our study area on an annual basis. We are currently compiling 2015-2016 grazing data from landowners and the local NRCS Roundup office, and this process will continue through the fall and winter of 2015-2016. We may begin using 2011-2014 data in analyses, such as chick survival analyses, through fall/winter 2015-2016. However, as of summer 2014 we did not have a large enough sample size of sage-grouse use in all grazing treatments to conduct analyses. The sample size will increase over the next funding period.

Preliminary results are and will continue to be reported during the interim before the 10-yr project completion, such as the impacts of the 3 broad SGI grazing treatments on vegetation in sage-grouse habitat, the impacts of vegetation on nest success, and resource selection of nesting hens (see the FY14 Annual Report for this project). Results and inferences will be reported as they are completed. The long-term aspect of this project and the delay in presenting some of the effects of grazing treatments on habitats and sage-grouse populations is important for several reasons. Habitat may not immediately improve to the desired condition due to changes or management (e.g., a new grazing system; Crawford et al. 2004), especially in areas that have been slowly degraded over time, because habitat improvements may not be immediately measurable. In addition, annual weather fluctuations, particularly of precipitation,

are a major driver of the vegetative structure and composition of rangeland ecosystems (Gillen and Sims 2006). Weather effects are one of the most important drivers of prairie grouse production (Flanders-Wanner et al. 2004) and powerful enough that they can negate effects of grazing or act in concert with grazing to determine the succession of plant communities (Gillen and Sims 2006). Thus, long-term data is needed to tease out the effects of grazing versus weather on sage-grouse and their habitats. There may also be a lag in the response of sage-grouse populations to management because yearlings do not always breed and nest during their first potential breeding season (Emmons and Braun 1984b, Connelly et al. 1993, Gregg et al. 1994, Crawford et al. 2004). In addition to the effects on vegetation, annual variation may confound effects of treatments on population vital rates. Finally, hens have a tendency to exhibit site tenacity where they return to the same area in which they nested in previous years, even though the habitat has been substantially altered since the hen began nesting there. This suggests that the abundance of nests in a pasture may reflect previous rather than current habitat conditions (Rotenberry and Wiens 2009). Consequently, this species may not respond quickly to habitat changes. Knick and Rottenbery (2000) showed that several shrub-steppe avian species including Brewer's sparrow (*Spizella breweri*), horned lark (*Eremophila alpestris*), and sage sparrow (*Amphispiza belli*) seem to exhibit this "habitat memory" up to ten years. Thus population vital rates should be assessed over long intervals in order to make more effective management decisions (Taylor et al. 2012).

Partnerships

During the FY15 funding period we have continued our partnership on a sage-grouse study with Montana State University in Beaverhead County, Montana. This study experimentally tests the effect of grazing on sage-grouse brood survival and resource use by adding or removing cattle in pastures containing sage-grouse broods. This study is independently funded and operated relative to our study. We have collected tissue samples (e.g., feathers, hatched egg shells; in accordance with our current IACUC protocol # 011-14DNWB-031914) for this project to assist with part of their study pertaining to habitat quality during each life phase (breeding, nesting, brood-rearing, fall/winter) as determined by stable isotope analysis on tissue samples. We also have met with this group during the FY15 funding period to discuss project goals and ensure the project continues in a direction agreeable to all partners.

We continued our partnership with USFWS, for which we expanded our vegetation sampling protocols to the Lake Mason satellite units of the Charles M. Russell National Wildlife Refuge (Musselshell County, Montana). These sites have not been grazed in 3-12 years, and USFWS plans to work with NRCS and adjacent landowners to implement SGI grazing systems on these refuge units. In addition we contracted with Montana State University to sample the diversity and abundance of insects on the refuge units, using the same protocols we are implementing in our core study area. Sampling these sites presents a unique opportunity to monitor these rangelands before and after grazing which will improve our inferences about grazing as a habitat management tool.

With funding from the USFWS survey and inventory program to collect vegetation data on the refuge, we contracted with Open Range Consulting, Inc. to extend the current geographical

information system landscape layer that they initially created for our study area to the refuge satellite units as well as new areas used by our marked sage-grouse since the original layer was created but that had not yet been mapped. This layer provides data on percent coverage of sagebrush, herbaceous plants (including grass and forbs), and bare ground at a 1x1m or 30x30m resolution over the entire 202,300+ ha over which we monitor sage-grouse, vegetation, and grazing. This layer has been completed is now available on FWP's website.

PRELIMINARY RESULTS

We highlight that this is a long-term study intended to last ≥ 10 years, and that these results are preliminary and subject to change because data entry and proofreading have not been fully completed. The results presented are data summaries and not formal analyses.

Apparent annual survival of sage-grouse hens (number of hens alive at the end of the monitoring period / total number of marked hens alive at the start of the monitoring period) as well as apparent nest success (number of successful nests / total number of nests monitored; successful nest = at least one chick hatched and left the nest) and apparent chick survival (number of marked chicks alive at the end of the monitoring period / number of chicks marked and alive at the start of the monitoring period) for the first 4.5 years of the project suggest that chick survival might be the vital rate to focus on for conservation in our sage-grouse population (Table 1), though this has not yet been formally evaluated.

	2011	2012	2013	2014	2015
Hen Survival (Annual)	57%	65%	76%	67%	96% (not complete)
Nest Success	30%	54%	40%	64%	52%
Chick Survival	21%	10%	20%	15%	28% (not complete)

***2015 hen and chick monitoring are not yet complete.*

Table 1. Apparent annual survival of marked hens, nests, and chicks (number of marked individuals or nests still alive at the end of the monitoring period / total number monitored) for greater sage-grouse chicks in Golden Valley and Mussellshell Counties, Montana from 2011-2015.

Hen Survival

Sage-grouse differ from other prairie grouse in that they are relatively long-lived with higher adult survival and low annual production relative to other grouse species (Connelly et al. 2004). However, there may be variation among studies or populations due to site-specific differences in weather (e.g., annual amount of precipitation), vegetation, disturbance, and threats to sage-grouse habitat. For example, the primary threats to sage-grouse habitat in Oregon versus Montana are conifer invasion (Baruch-Mordo et al. 2013) and sodbusting (Walker 2008), respectively. In addition, different studies use different monitoring techniques; thus direct comparisons among studies are difficult. The hen apparent annual survival estimates (measured

from Apr 1 – Mar 31) observed during this study (Table 1) are within the 37-78% range observed across the distribution of sage-grouse (Table 2). However, our estimates do not

Survival Estimate	Location	Reference
75 – 98%	Central Montana, our study area	Sika 2006
48 – 78%	Wyoming	Holloran 2005
48 – 75%	Idaho	Connelly et al. 1994
57%	Alberta	Aldridge and Brigham 2001
61%	Colorado	Connelly et al. 2011
37%	Utah	Connelly et al. 2011

Table 2. Summary of annual adult female greater sage-grouse survival estimates from several studies across the greater sage-grouse range.

represent formal survival analyses and might change after such analyses are completed. Our apparent annual survival estimates appear to be lower than those observed by Sika (2006) in our study area during 2004-2005. We will be better able to compare our survival rates to those of other studies when formal analyses are completed. There are fewer studies that estimate seasonal in addition to annual survival. We measured apparent seasonal survival of hens (Table 3) and delineated seasons according to biologically meaningful periods for sage-grouse following Blomberg et al. (2013): spring = Apr – May, summer = June – July, fall = Aug – Oct, winter = Nov – Mar (Table 3). Blomberg et al. (2013) monitored hen survival for 328 hens from 2003-2011. Their seasonal survival estimates were: spring = 0.93 or 93% ± 0.02 SE; summer = 0.98 ± 0.01 SE; fall = 0.92 ± 0.02 SE; and winter = 0.99 ± 0.01 SE. These seasonal hen survival rates are higher than our apparent survival estimates, but again we caution that we have not yet completed formal hen survival analyses. Blomberg et al. (2013) found very little annual variation in hen survival, allowing them to pool years and obtain one rate for each season (above). We have yet to evaluate interannual variation in seasonal survival rates and thus present our rates per year.

Year / Season	Apr-May (Spring)	Jun-July (Summer)	Aug – Oct (Fall)	Nov – Mar (Winter)	Annual
2011	88%	91%	90%	79%	57%
2012	84%	93%	89%	82%	58%
2013	92%	86%	90%	89%	64%
2014	92%	100%	79%	87%	73%
2015	96%	100%			96% Ends March 31, 2016

Table 3. Apparent seasonal and annual survival (number of hens still alive / total number of hens monitored) of our marked population of greater sage-grouse hens in Golden Valley and Mussellshell Counties, Montana during 2015 for both SGI and non-SGI areas combined. Our annual survival is measured from Apr 1 – Mar 31.

Nest Success

Data entry and proofreading for 2014 has been completed. Data entry and proofreading has not been completed for the 2015 data, but preliminary numbers show that of the 77 nests we monitored during the 2015 season, 69 were first nests and 8 were second nests (re-nesting attempts from failed first nests; Table 4). There are some hens each year that do not nest. However, 66% of the marked population did attempt to nest during 2015 (Table 5).

	2011	2012	2013	2014	2015
Overall Nest Success	30%	54%	40%	64%	52%
Total Number of Nests	102	91	85	74	77
Number of 1st Nests / Nest success	79 / 28%	82 / 52%	69 / 39%	68 / 63%	69 / 54%
Number of 2nd Nests Nests / Nest success	22 / 41%	9 / 67%	15 / 40%	6 / 67%	8 / 38%
Number of 3rd Nests / Nest success	1 / 0%	-	1 / 100%	-	-

Table 4. Apparent nest success (number of monitored nests that hatched at least one chick / total number of nests monitored) of our marked population of greater sage-grouse hens in Golden Valley and Mussellshell Counties, Montana during 2011 – 2015 (SGI and non-SGI areas combined). Total number of nests monitored are presented as well as number of nests per nest attempt.

	2011	2012	2013	2014	2015
Total number of marked hens at the start of the nesting season	101	112	93	106	100
Hens attempting to nest out of all marked hens	78% (79/101)	73% (82/112)	76% (71/93)	64% (68/106)	66% (66/100)

Table 5. Percent of our marked population of greater sage-grouse hens that attempted at least one nest in Golden Valley and Mussellshell Counties, Montana during 2011 – 2015 (SGI and non-SGI areas combined).

Apparent nest success this season was 52% (Tables 1, 4). To put these numbers in perspective, nest success varies from 14 – 86% across the entire range of sage-grouse (including studies from Oregon, Colorado, Idaho; Connelly et al. 2004), with a mean of 46% (Connelly et al. 2011). We have not yet completed formal nest success analyses for this season. Please refer to the FY14 Annual Report for preliminary analyses from the first 3 years of the study.

Chick Survival

At the time of the last annual report for FY14, our apparent chick survival estimate was not complete because we were still monitoring marked chicks. The FY14 apparent chick survival estimate was 15% (Table 1). FY15 apparent chick survival is currently 28%, but we are still monitoring chicks. These are preliminary results regarding apparent survival, not formal, statistical survival analyses. Also, this is a conservative estimate that only includes chicks that were known to survive until their batteries expired. Any chicks with unknown fates are censored from our apparent survival calculation. Previous studies have shown chick survival to be variable and range from 12-50% during the first few weeks after hatching (Aldridge and

Boyce 2007, Gregg et al. 2007, Dahlgren et al. 2010, Guttery et al. 2013). However, caution should be used when comparing estimates among studies because the duration of monitoring periods differ. For example, Gregg et al. (2007) and Dahlgren et al (2010) monitored sage-grouse chicks for 28 and 42 days, respectively, whereas we are able to monitor chicks up to 110 days. Transmitter technology is continually changing and these differences in monitoring periods represent, in part, technological advances that have created smaller, lighter radio transmitters with longer battery life. In addition, some studies measure "brood" survival (at least one chick from a brood lives) or unmarked chicks rather than monitoring individually marked chicks. Unmarked chicks are difficult to observe and monitor, and brood mixing may occur that results in broods containing chicks not parented by a particular hen. Thus there are limitations when comparing unmarked chick or brood survival estimates with telemetry survival estimates.

DELIVERABLES

In FY15, we originally planned to produce a manuscript with Dr. Hayes Goosey regarding sage-grouse chick survival and insect food availability. We have not yet created that product, partly because we have met with collaborators and modified/updated our schedule for manuscript production. Our schedule o potential manuscripts over the next 2 years are now as follows:

1. Montana State University will produce a manuscript on the influence of grazing on insect communities based on the 3 years of data collected to date.
2. The University of Montana Ph.D. Candidate working with us will attempt to finish a dissertation on the sage-grouse project in FY16. At least 3 manuscripts will be submitted for publication based on this dissertation:
    a. Impacts of sodbusting on the occurrence and abundance of males on greater sage-grouse leks---to be submitted in FY16.
    b. Impacts of grazing and food availability on sage-grouse nest success—to be submitted in the next 2 years (FY16-17).
    c. Impacts of grazing on sage-grouse habitat—to be submitted in the next 2 years (FY16-17).
3. Berkeley et al. manuscript on chick survival—within the next 2 years (FY16-17).
4. University of Montana Masters thesis from the songbird project associated with our study will be completed and a manuscript based on this thesis will be submitted for publication within the next year (FY16).

Our communication activities related to this study include written products, presentations, and sharing our research with livestock producers, landowners, NRCS and federal land management staff, and wildlife management agencies. Below is a list of our communication activities during the funding period (July 1 2014 – June 30, 2015).

Progress Reports

Activity	Description	Delivery Dates
IWJV-Pheasants Forever funding reports	Biannual progress reports on the sage-grouse project submitted to IWJV-Pheasants Forever.	31-Oct-2014; 31-Apr-2015
USFWS	Annual progress report for PR funds.	15-Aug-2014
USFWS	Annual progress report for survey and monitoring funds to do vegetation sampling on CMR satellite refuge units.	21-Nov-2014

Professional Meetings & Activities

Activity	Description	Delivery Dates
Publication Planning Meeting	Organized our sage-grouse research group and collaborators to meet at UMT and discuss a schedule for writing and submitting potential publications.	20-Nov-2014
Centennial Valley Sage Grouse Project	Helped organize and participated in a meeting with our partners at MSU to discuss project updates and future goals for both projects.	2-Dec-2014
Annual Oversight Committee Meeting	Presented updates on the sage grouse project to the committee and solicited feedback.	3-Feb-2015
Invited Presentation	Invited presentation at the BLM state-wide range meeting in Billings, MT.	13-May-2015

Landowner Appreciation

Description	Delivery Dates
Landowner appreciation dinner.	July 29, 2015
Multiple visits to landowners to maintain relationships.	Spring / Summer 2015

Education

Activity	Description	Delivery Dates
Presentation to Rocky Mountain College class	Gave an invited presentation about our sage-grouse project to an undergraduate Range Ecology class at Rocky Mountain College in Billings, MT.	30-Oct-14
Invited Presentation	Gave an invited presentation on our sage-grouse project to the Charles M Russell NWR working group.	June 11, 2015

Outreach

Description	Delivery Dates
Invited to participate in a field tour of the Roundup Sage Grouse Core and Habitat with Dylan Laslovich, Senator Jon Tester's Congressional Representative. This was hosted by BLM.	Aug 14, 2014
Hosted Tim Baker, Governor Bullock's Policy Advisor for Natural Resources, in a field excursion to mark sage-grouse chicks with radio transmitters.	June 2014
Hosted Senator John Walsh's natural resources aide and took him to view a sage-grouse lek.	May 2014

Planned FY16 Communication Activities:

- Biannual funding progress reports for IWJV-Pheasants Forever due Oct 2015, April 2016.
- Annual funding progress report for USFWS for survey & inventory funding due Nov 2016.
- Multi-state meeting of all research groups working on grazing and sage-grouse in Utah, Idaho, and Montana scheduled for Nov 4-5th at Montana Wild in Helena.
- Annual oversight committee meeting in Feb 2016.

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