Conservation Effects Assessment Project 2017
Report for the Natural Resource and Conservation Service

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EXECUTIVE SUMMARY

Goals and objectives for this project ─ This project evaluated the effectiveness of the State Acres For Wildlife Enhancement (SAFE) subprogram of the Conservation Reserve Program (CRP) in establishing vegetation that is beneficial for wildlife. This evaluation occurred over two years (e.g., 2016 and 2017) and in two study locations in southern Idaho and eastern Idaho. Funding for the data collected during 2016 came from a state NRCS Conservation Innovation Grant while data collected during 2017 came from a national NRCS Conservation Effects Assessment Project.

Columbian sharp-tailed grouse (CSTG) have been identified as an indicator species for wildlife in Idaho. Our first objective was to assess vegetation in fields enrolled in the SAFE program and determine if projects have met their objective of establishing vegetation that is beneficial to wildlife. Vegetation hypothesized to benefit include native forbs and grasses with minimal presence of annual grasses and broadleaf noxious weeds. Our second objective was to determine how seed mixture design, timing of seeding (fall vs. spring), age of seeding, seedbed preparation (mechanical vs. chemical), post-seeding clipping, and precipitation influence the eventual success of SAFE projects. Our third objective was to determine if SAFE is benefiting CSTG by measuring demographic rates of birds fitted with radio-collars. Our fourth objective was to evaluate the accuracy of aerial infrared (AIR) and ground-based lek count methodologies. Although it was not an explicit goal of this project, additional funding from the Idaho Bird Conservation Partnership allowed abundance estimation of songbirds inhabiting general sign-up CRP (hereafter CRP) and SAFE projects.

Customers that benefit from this project accomplishments ─ Any person or agency interested in establishing beneficial grasses, shrubs and forbs or creating upland wildlife habitat benefits from this grant because of the information that was collected on the differences in species composition between CRP and SAFE plantings and the establishment of SAFE plantings. This information will also be useful to agency personnel evaluating proposed CRP or SAFE conservation practices (i.e., initial seeding, mid-contract management, etc.) in landscapes inhabited by CSTG and dominated by altered grassland habitats and those interested in understanding the accuracy and limitations of various lek count methodologies.

Methods employed that demonstrate alternative technology ─ We collaborated with Owyhee Air Research to conduct AIR surveys of GSG leks and pseudo leks to evaluate accuracy of AIR and ground-based counts. AIR surveys of GSG leks were conducted simultaneously with double-observer, ground-based surveys. Using two observers for ground surveys, we were able to estimate observer error in ground counts and relate them to AIR counts. We then evaluated the bias of AIR counts by

examining the direction and magnitude of the difference between pseudo lek numbers (i.e., captive pheasants tethered to the ground in an arrangement meant to represent a grouse lek) and the number counted with AIR. These estimates of survey accuracy have implications for both GSG and CSTG management since lek counts are used to monitor both species. Furthermore, both ground and AIR methods are being employed to conduct lek counts for monitoring population trends of both species.

INTRODUCTION

A brief overview of the project — This project was collaboration between Idaho Department of Fish and Game (IDFG), FSA, Idaho State University, U.S. Geological Survey, Intermountain Aquatics, Owyhee Air Research, U.S. Fish and Wildlife Service, and 52 private landowners. The project design was to use field vegetation measurements, field preparation data, and Columbian sharp-tailed grouse (CSTG) demographic rates to evaluate the effectiveness of the State Acres For Wildlife Enhancement (SAFE) subprogram of the Conservation Reserve Program (CRP) in establishing vegetation that is beneficial to CSTG populations in Idaho.

Accomplishments — We evaluated the vegetation composition of CRP and SAFE plantings in Power and Oneida counties (e.g., hereafter, southern Idaho study area) and, Fremont, Jefferson, and Teton counties (hereafter, eastern Idaho study area); measured the demographic rates of CSTG in southern Idaho; and conducted AIR and ground counts of greater sage-grouse (GSG) leks and pseudo leks of captive pheasants in Owyhee, Clark, and Jefferson counties (Figure 1). This research occurred during 2016 and 2017 with many collaborators.
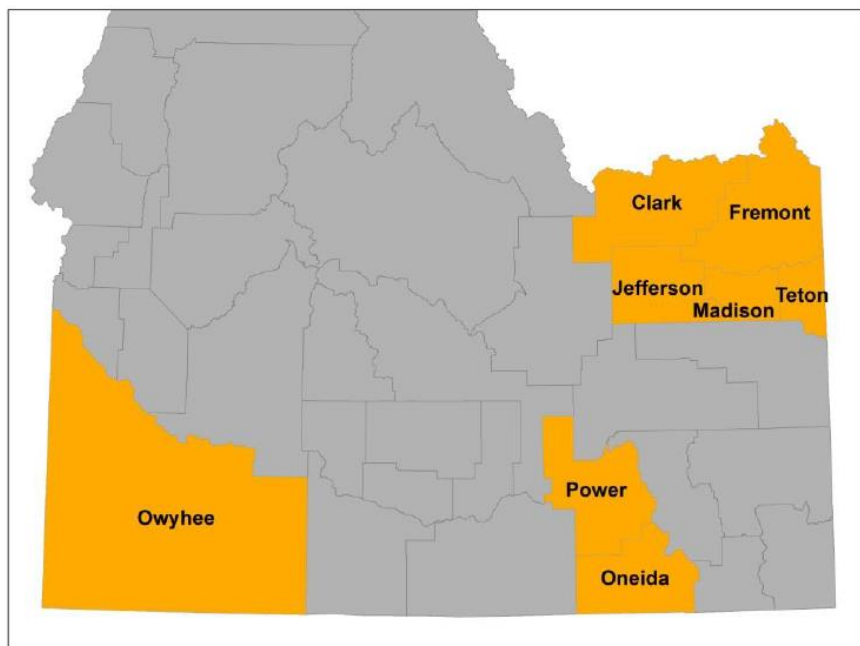
Figure 1 – Counties in eastern Idaho where the project was conducted.

How the project was funded — The project was funded by an NRCS Conservation Innovation Grant for 2016 field work (Year 1) and a Conservation Effects Assessment Project grant through the national level of NRCS for 2017 field work (Year 2). Owyhee Air Research, Intermountain Aquatics, IDFG, and Gifford Gillette combined had in-kind contributions that equaled the funding provided by the

Conservation Innovation Grant in Year 1. Additionally, the combination of Intermountain West Joint Venture and IDFG funded Gifford Gillette's salary from November 2015 through February 2017 as he directed the project in Year 1 and the project transitioned to Year 2. The Intermountain West Joint Venture also augmented funding in Year 2 for project personnel conducting field work and data analysis. Both years of the project citizens of Idaho provided camp trailer housing (Perry and Gail Gillette) and a centrally located property with access to power both of which were *pro bono* (Monte and Dixie Lind). Lastly, an award from the Idaho Bird Conservation Partnership allowed songbird surveys to be conducted in Power and Oneida counties during 2016.

Business and academic relationships that facilitated the project ─ One of the primary innovative aspects of this project was the refinement of aerial infrared (AIR) lek counts to monitor grouse populations. This technique was first developed in 2009 through the combined efforts of Peter Coates and Gifford Gillette with U.S. Geological Survey and John Romero with Owyhee Air Research. While Gifford Gillette obtained a PhD at the University of Idaho during 2011–2014, the collaboration between Peter Coates, John Romero, and Gifford Gillette continued. Some of that work was funded by a previous NRCS Conservation Innovation Grant issued in 2013. This collaboration led to publications on the use of AIR for lek counts (Gillette et al. 2013, Gillette et al. 2015). During 2015 Idaho State University (ISU) also became involved. Peter Coates, in collaboration with David Delehanty at ISU, financially supported Gifford Gillette from April to November 2015 as he developed collaborations and obtained funding for the research effort summarized in this report.

Collaboration with Intermountain Aquatics allowed vegetation surveys in eastern Idaho CRP and SAFE plantings. Intermountain Aquatics brought interest and expertise in grassland assessment and restoration that was invaluable and allowed a broader project scope. Brigham Young University-Idaho (BYU-I) professor Jericho Whiting and several BYU-I students played an important role by providing personnel to conduct vegetation surveys in eastern Idaho. The first year of data collection in a new area can be extremely difficult, but due to key collaborations with Jeff Klausmann and Jericho Whiting, field data collection was a success.

Key personnel during the study and a description of their qualifications ─ <u>Mark Hurley</u>, Wildlife Research and Data Coordinator for IDFG, oversaw the budget and monitored project payments and progress during Year 1 of this project. Dr. Hurley has been part of the IDFG wildlife research program for over 20 years, during which he has provided oversight to dozens of IDFG research projects. <u>Shane Roberts</u>, Principal Wildlife Research Biologist for IDFG, assisted with grant monitoring, acquisition of housing and equipment for field personnel during Year 1. Dr. Roberts also conducted the analysis of factors influencing establishment of forb cover for Year 1 data. <u>David Delehanty</u>, Assistant Professor for Idaho State University, supported all efforts during Year 1 including identifying key field personnel that worked both years on the project and administered the Conservation Effects Assessment Project agreement that funded Year 2 field work. He also helped to secure key additional funding from Intermountain West Joint Venture by negotiating a low overhead rate. Dr. Delehanty authorized all grant expenditures and supervised the payment of project personnel in Southern Idaho during Year 2 and helped secure necessary housing, vehicles, and field equipment for requisite field work.

<u>Gifford Gillette</u> was the project director and field coordinator for both years and was responsible for securing all grants obtained, organizing meetings with collaborators, communicating study design plans and responsibilities of collaborators on the grant. He also organized all field efforts for vegetation surveys and grouse monitoring. Dr. Gillette organized volunteers in Boise and Idaho Falls and coordinated with IDFG biologists and Owyhee Air Research to complete AIR lek counts. He has extensive experience as a grouse biologist as well as a 7-year history of collaborating with IDFG, Idaho universities, and Owyhee Air Research. Dr. Gillette is also familiar with the producer-side of the

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Farm Bill, having grown-up on a 3,200 acre farm. <u>Pamela Paasche O'Hearn</u> is a post-doc at Idaho State University that seamlessly finalized the synthesis of the large vegetation data sets that were collected in two study areas and in both years of this effort. She also contributed project oversight and troubleshooting for field personnel in Year 2. Dr. O'Hearn has a breadth of experience in study design, collection, and analysis of environmental variables and technology that enhances conservation endeavors especially the monitoring of upland game bird species and their habitats.

     <u>Jeff Klausmann</u> is the owner of Intermountain Aquatics Inc., an eastern Idaho-based company specializing in wildlife habitat restoration. Klausmann brought more than a decade of experience restoring both aquatic and terrestrial habitats in the Intermountain West to this project. He oversaw the personnel responsible for vegetation surveys in Teton, Fremont, and Jefferson counties; played a key role in identifying applied management practices potentially influencing success or failure of SAFE projects; and helped with gaining access to landowners in the Eastern Idaho region. Intermountain Aquatics Inc. had multiple employees each year that contributed greatly to the success of this project and were instrumental in the formation and completion of this project.

     <u>John Romero</u>, of western Idaho-based Owyhee Air Research, is the pilot and owner of the aircraft and thermal imaging camera used on the project. Romero has extensive experience with thermal imagery, as both a pilot in the military and through the last seven years of his own research and development of an aerial platform conducive to infrared cameras. Romero has operated multiple types of infrared cameras and gyro-stabilizing gimbals over the last three years. Owyhee Air Research had multiple employees each year that contributed greatly to the success of this project and were a key collaborator in the formation and completion of this project.

Project goals and objectives ─ Goals and objectives were a combination of interests that reflected wildlife and natural resource professionals that were interested in this work during the time research was conducted.

     Objective 1 - Determine whether SAFE projects were successful in establishing desirable forbs, shrubs and grasses beneficial to CSTG and whether those plantings were an improvement for CSTG habitat over traditional CRP plantings. We were successful at measuring vegetation composition in 125 CRP or SAFE tracts in eastern Idaho. We conducted assessments in Power and Oneida counties and our project collaborators from Intermountain Aquatics, Inc. conducted vegetation assessments in Teton, Fremont, and Jefferson counties.

     Objective 2 - Determine if field preparation (seed mixture, timing of seeding, age of seeding, varying levels of mechanical and chemical seedbed preparation, post-seeding clipping) or environmental variables (e.g., precipitation) influenced the eventual plant composition of SAFE tracts and their potential benefit to CSTG. Our aim was to inform land managers about which management practices did or did not produce successful SAFE habitat plantings. We obtained field preparation information from local USDA Farm Service Agency (FSA) offices for the majority of SAFE projects we conducted field assessments on, developed variables to evaluate based on the available data, and analyzed the effects of field preparation on the primary vegetation variable of interest (forb canopy cover). Although we completed this objective, the sample size could have been increased and the resolution of our analysis could have been improved (i.e., ask more specific questions as opposed to generic questions) if the available field preparation records would have been complete, standardized, and more detailed.

     Objective 3 - Evaluate the benefit of SAFE plantings by comparing the demographic rates (i.e., nest success, brood success, adult survival) of grouse occupying a CRP and SAFE-dominated landscape before (2011-2013) and after SAFE plantings were established circa 2016 and relate that to demographic rates of birds inhabiting sage-steppe habitats during the same time periods. We were successful at obtaining demographic rates for CSTG occupying the SAFE landscape but were

unsuccessful at capturing and collaring an adequate sample of CSTG in the sage-steppe landscape for comparison during 2016. Furthermore, all grouse captured that were occupying the sage-steppe landscape died before the nesting season had completed. Small lek sizes and numbers of attending females, coupled with personnel issues on the project during the short trapping window (i.e., peak female attendance at leks), led to an unsuccessful capture effort in the sage-steppe landscape during 2016. During 2017 we were successful at achieving this objective and capturing CSTG occupying the sage-steppe landscape.

Objective 4 - Evaluate the accuracy of AIR and ground-based methodologies for counting the number of birds attending a lek. We were successful at simultaneously counting GSG leks with AIR and double-observer ground counts to evaluate error between the methods. We were also successful at conducting AIR counts of pseudo leks (i.e., ring-necked pheasants tethered to the ground), which gave us a way to measure the accuracy of AIR using a known number of grouse-sized birds.

Although it was not an explicit goal of this project, additional funding from the Idaho Bird Conservation Partnership allowed simultaneous abundance estimation of songbirds inhabiting general CRP and SAFE projects.

The scope of project tasks ─ The evaluation of both vegetation and wildlife metrics (e.g., CSTG demographics and songbird abundance) to assess SAFE occurred in southern Idaho including within the Rockland Valley. This valley's vegetation and CSTG demographics were studied extensively during 2011–2013 (Gillette 2014), prior to the implementation of extensive SAFE plantings in the valley. With the help of our collaborators at Intermountain Aquatics, we also evaluated general CRP and SAFE in eastern Idaho. We did not attempt to collect CSTG demographic information in Fremont, Teton, and Jefferson counties.

The quantifiable physical results from this project ─ The scope of this research project was unique in our effort to evaluate the Conservation Reserve Program. We document and describe fundamental vegetation aspects of subprograms within the Conservation Reserve Program on a landscape scale level: the State Acres For Wildlife Enhancement (CP-38 and CP-2) and general CRP enrollment (CP-1; CP-10). SAFE enrolled lands have been established in the last 5-6 years with the goal of creating wildlife habitat and general CRP enrollment, in some cases, may have been established as many as 30 years ago with the goal of stabilizing soils. We also investigated seeding practices that led to success or failure of SAFE efforts to establish wildlife habitat. Simultaneous with this endeavor, we documented the use, survival, and reproduction of Columbian sharp-tailed grouse occupying SAFE-enrolled lands across two years (2016 -2017). We estimated abundance of songbirds in SAFE versus general CRP during one year (2016) ─ this was not a comparison we could make for CSTG because not enough grouse occupy general CRP to compare demographics in SAFE. We tested and quantified the difference between traditional ground-based lek count techniques and a new innovative approach, Aerial Infrared (AIR) lek counts, which are methods used to track CSTG and greater sage-grouse population trends in both CRP/SAFE and shrub-steppe landscapes in the western U.S.

We evaluated vegetation composition in 76 CRP and 87 SAFE enrolled tracts in southern and eastern Idaho. In order to evaluate CRP and SAFE tracts, we conducted 656 vegetation surveys in these areas. In total, these tracts together were a fine-scale representation of approximately 18,000 acres of wildlife habitat. The tracts we surveyed in Power and Oneida counties of southern Idaho were larger (130 ± 13.4 acres) than those we surveyed in Fremont, Teton, and Jefferson counties of eastern Idaho (88 ± 8.0 acres). We acquired enough vegetation data to evaluate the effects of field preparation on forb cover in 42 SAFE plantings during 2016 and are awaiting these data for an additional 27 SAFE plantings evaluated during 2017.

Most SAFE tracts were treated both mechanically and chemically prior to seeding and were clipped for weed control post-seeding. Twelve seed companies and 32 seed mixtures were used to seed SAFE fields.

We captured and banded 60 CSTG during spring 2016. This included 19 females and 24 males in an area dominated by SAFE lands while 3 females and 14 males were captured in an area dominated by shrub-steppe rangelands. All female CSTG were fitted with radio-transmitters. Field personnel obtained over 400 ground telemetry locations. We captured and leg-banded 94 CSTG during spring 2017. Of those captured, 22 females and 2 males were fitted with radio-transmitters in SAFE habitat and 12 females and 2 males received radio-transmitters in shrub-steppe habitat. Additionally, 40 males were banded in SAFE and 21 were banded in shrub-steppe. Field personnel again obtained over 400 ground telemetry relocations.

During April of 2016 we conducted 22 simultaneous AIR and ground-based counts of greater sage-grouse (GSG) leks. We also conducted 15 AIR counts of pseudo leks of tethered captive pheasants. This required the involvement and coordination of over 24 volunteers to conduct counts south of Boise and west of Rexburg Idaho. Through these two sets of surveys we were able to quantify average error between AIR and ground counts, average error between ground-based observers, and average error between AIR counts and known truth. This allowed us to make declarations about the accuracy and limitation of both types of methods. During 2017 we were also able to evaluate the capability of AIR to locate sage-grouse nests. Two flights were conducted east of Grasmere, Idaho during April and were coordinated by Dr. Courtney Conway. For each flight, the pilot and AIR technician were given 3 known (active) sage-grouse nests to verify the IRIS settings were appropriate for detecting heat signatures of nests. A polygon of a BLM grazing pasture was also provided as an area to search for nests where 2-5 known nests also occurred but the pilot and IRIS operator did not know about. Because of weather conditions, one flight was at night prior to dawn and one flight was at dawn.

BACKGROUND – FACTORS THAT LEAD TO THE DEVELOPMENT OF THIS PROJECT

The problem the project was intended to address ─ Perennial grassland wildlife habitat in the U.S. has declined annually since 2008, primarily due to reductions in the acres enrolled in the Farm Bill's CRP program (FSA 2014). The same trend has been occurring in Idaho, with total CRP acreage decreasing from a high of 825,000 acres to about 625,000 acres in 2014 (FSA 2014). However, Idaho maintains one of the largest allocations of SAFE acreage in the U.S., with 147,300 acres enrolled during 2016. SAFE habitat is specifically designed to benefit CSTG by providing stands of bunchgrasses and forbs. Although SAFE does not totally replace the lost CRP acreage, the hope is that the increased habitat quality of SAFE plantings will compensate for the decrease in acreage.

Monitoring the effectiveness of a conservation program is a difficult task. In the case of CRP, there have been various objectives for the program over time, and with the more recent SAFE subprogram, those objectives have shifted more toward wildlife. What has not been determined is 1) if the programmatic goals of SAFE, to establish forbs and grasses beneficial to CSTG, are being efficiently accomplished and 2) whether plantings created by SAFE are actually beneficial to CSTG population growth (i.e., increased population demographic rates).

A brief account of previous attempts to solve the problem ─ During 2011-2013, Gillette (2014) evaluated the effect of general CRP on CSTG ecology, prior to the implementation of SAFE on a landscape scale, by monitoring the demographic rates of CSTG in CRP-dominated and native sage-steppe-dominated landscapes of Power and Oneida counties. The population growth rate of CSTG occupying the CRP landscape was estimated to be declining (0.770 ± 0.284; Gillette 2014). A

statistical population reconstruction of the hunted portion of CSTG during 2000-2013, which was based on hunter harvest information and lek count data, indicated populations were stable but possibly declining during that time (Gillette 2014). There was no concurrent effort to evaluate the effectiveness of CRP plantings in establishing diverse grassland stands or providing CSTG habitat. To our knowledge, there has been no thorough evaluation of the SAFE program's effectiveness in establishing bunchgrass-forb mix habitat or of its ability to positively influence CSTG demographics. Proett (2017) collared CSTG in eastern Idaho, just east of Idaho Falls in Bonneville County, in 2014 and 2015 to examine the effects of wind energy and habitat on CSTG breeding ecology. He found that CSTG selected nests with a higher portion of grassland habitat with >30% forb content within 60 ha of the nest (i.e., average CSTG hen's recess movements during incubation) and that an increase in that high forb habitat type within the 60 ha buffer also led to increased daily nest survival. That study was not specifically designed to evaluate SAFE, but since most SAFE plantings result in grasslands with ≈30% forb cover, it does suggest SAFE plantings are likely to have a positive effect on CSTG reproduction.

How the problem is usually dealt with today — Despite the prevalence of habitat conservation programs, post-management monitoring efforts and evaluations of success are often minimal or non-existent; often due to lack of personnel resources for the agency implementing the program. The amount of effort required to effectively monitor projects can equal the effort to implement, making thorough evaluations of success even more challenging. We undertook this effort because the effectiveness of the SAFE program in Idaho in establishing beneficial, perennial vegetation and the habitat effectiveness of general CRP and SAFE have not been addressed; and therefore, the problem essentially is not being currently addressed. Furthermore, data were collected previously from 2011 to 2013 for the general CRP program instituted in 1986. This was a tremendous opportunity to evaluate recent developments in the program.

Agriculture and environmental sectors benefiting by this project — Seeded grasslands provide important habitat for wildlife in Idaho. The vast majority of seeded grasslands are currently, or formerly, enrolled in some form of CRP. However, general CRP acres have decreased every year since 2008 (FSA 2014). The U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and IDFG have a mutual interest in the restoration of grasslands. Wildlife biologists and land managers, regardless of agency affiliation, seek to conserve wildlife populations and value informative data on habitat restoration efforts. Sharp-tailed grouse are also a valuable upland game species in Idaho. Information that leads to the creation of improved CSTG habitat, and therefore, improved CSTG populations benefits the Idaho sportsmen and sportswomen who hunt them. The CRP and SAFE programs provide an economic benefit to Idaho landowners by providing income on marginally productive agricultural lands. The landowners are required to plant and maintain the vegetation on the land to remain compliant with the program. Understanding which management techniques result in the most efficient establishment and maintenance of vegetation that will fulfill program objectives is a large financial benefit to the landowners, FSA, and the U.S. taxpayers that fund the program.

The natural resources issue addressed — We used field measurement data to compare CRP and SAFE plantings in how they may provide habitat for CSTG, a simple but needed evaluation of how SAFE is an improvement over CRP for CSTG habitat. However, the functional quality of SAFE projects varies widely and some projects fail to achieve the program objectives of establishing a diversity of plants beneficial to CSTG. We also evaluated what management practices influenced the establishment and habitat quality of SAFE projects. We use the results from this evaluation to suggest ways that data acquisition could be improved for further monitoring and evaluation of the SAFE program.

The negative effects of the problem on the environment, the community, or the producer's economic welfare — Healthy wildlife populations are typically viewed as valuable resources to the community and to producers as long as crop depredation does not become an issue. With a burgeoning human population in Idaho, the value of wildlife will only increase as will the importance of protecting the habitats on which they depend. As natural habitats are impacted by human population growth, the importance of wildlife habitats that have been modified or created by humans will also likely increase. Ineffective or inefficient techniques for establishing or maintaining beneficial grassland plantings are an economic loss for both the private landowner tasked with establishing the vegetation and the agency facilitating the establishment work. Increased efficiency in establishing quality, perennial vegetation is an economic benefit for all managers involved, the wildlife benefitting from the created habitat, the people that utilize the wildlife for both consumptive and non-consumptive recreation, and the U.S. taxpayers that fund the conservation programs.

DISCUSSION OF QUALITY ASSURANCE AND REVIEW OF METHODS

Project site description: characteristics of the site, sample locations, rationale for locations —We evaluated CRP and SAFE vegetation in Power, Oneida, Fremont, Jefferson, and Teton Counties. This geographical extent represents approximately 50% of known CSTG leks in Idaho. We evaluated contracts that totaled over 10,500 acres. Lands adjacent to SAFE were predominantly dry-land farms consisting of mostly wheat crops. Counties were selected for inclusion in this project to 1) allow for comparison to previous work conducted by Gillette (2014) and 2) include representative areas of the primary CSTG strongholds in Idaho.

Sampling design — We timed vegetation surveys to be consistent with when wildlife species utilize these habitats; all surveys were conducted during the nesting and brood-rearing seasons for CSTG (May to August). We sampled vegetation across a wide range of eastern Idaho inhabited by CSTG, providing results with broad implications, and because we had radio-collared CSTG, we knew the vegetation surveys were appropriate given the presence of CSTG in those areas or the similarity of habitats where we didn't have collared grouse. Issues with sample size for CSTG demographic rate estimation are thoroughly discussed in the Conclusions and Recommendations section.

Sample analysis and quality control — Analytical procedures used in the field involve the proper identification and measurement of plants. Observers who conducted vegetation surveys were also responsible for entering data into excel spreadsheets to maximize data quality control. All heights and distances were recorded in metric units. Our sampling regime was designed to capture the average vegetation composition and structure within a given tract. A transect distance of 20 m is a common length used for landscape scale evaluations of vegetation communities. Under sampling of vegetation is not likely to be a problem because the entirety of a single CRP and/or SAFE field is planted with a single, constant seed mixture and with equipment that reduces the amount of within-field variation that might have otherwise occurred naturally. Project field personnel from IDFG and Intermountain Aquatics were trained together on vegetation measurement protocols and vegetation identification as a quality control measure. Field personnel in different counties communicated regularly to ensure consistent data collection. Project supervisors also periodically visited vegetation sampling crews to answer questions and follow up about analytical techniques used in the field, such as plant identification and measurement.

We used established techniques to ensure standardization among our sampling procedures and relationship to other studies. The Daubenmire cover class method was developed to systematically

measure vegetative and mineral cover categories (Daubenmire 1959) and has been used extensively throughout the ecological sciences. The use of cover classes helps to minimize observer bias and variation between observers. At each geographic location (Teton, Fremont, and Jefferson counties had one field crew, Power and Oneida counties had another field crew), one technician conducted the canopy cover estimates while the second technician records data to maintain consistency between vegetation surveys.

The physical and analytic activities of the project ─ We conducted vegetation sampling and evaluated field preparation efforts at tracts enrolled in CRP or SAFE within Power, Oneida, Jefferson, Teton, and Fremont counties and monitored CSTG demographics and songbird abundance in Power and Oneida counties. Within Power and Oneida counties, we attempted to monitor birds in a landscape dominated by SAFE plantings and a landscape dominated by sage-steppe rangelands, the same landscapes monitored by Gillette (2014) prior to implementation of landscape-scale SAFE plantings, to evaluate the impact of SAFE on CSTG demographics.

Plant Composition and Structure ─ We measured vegetation characteristics of CRP and SAFE projects at 2-6 random locations within each tract, depending on tract size. We used accepted techniques (Canfield 1941, Daubenmire 1959, Carlyle et al. 2010) to estimate plant composition and structure. These were the same techniques used to evaluate the quality of habitat for CSTG in Power and Oneida counties during 2011-2013 (Gillette 2014). At each random location within a tract, we oriented a 20-m transect in a random direction. We used Daubenmire frames (20 x 50 cm; Daubenmire 1959) at 2, 5, 10, 12, 15, and 20 m from the point to bin estimates of grass and forb canopy cover into one of eight bins (trace = 0.01%-1% cover, 1 = 1%-5% cover, 2 = 6%-15% cover, 3 = 16%-25% cover, 4 = 26%-50% cover, 5 = 51%-75% cover, 6 = 76%-95% cover, 7 = 96%-100% cover). We used the line-intercept method (Canfield 1941) to estimate shrub canopy cover along each transect. We estimated canopy cover by seven cover classes (grass, forb, shrub, residual cover, litter, bare ground, rock). For forbs and grasses, we used the midpoint of each bin as the cover class estimate for an individual frame and averaged measurements across the six frames within a transect for a transect-level canopy cover measurement. We also measured the height (i.e., droop height) of the tallest plant that provided cover (i.e., would provide at least some concealment cover to a nesting CSTG) within 1-m of the frame within each cover class and averaged those heights within cover class along each transect. We kept a list of all species present along the transect for species diversity comparisons. We used comparisons of means ± 95% confidence intervals (95% C.I.) to evaluate differences in species composition and grass, forb, and sagebrush canopy cover and height between CRP and SAFE plantings.

Effects of Field Preparation ─ We obtained information from local FSA offices about the seeding and field preparation characteristics of most of the SAFE tracts that we evaluated during 2016. This information included the year and season of seeding, seeding equipment used (i.e., typically drill of some type), mechanical and chemical seedbed preparation (i.e., type of mechanical and times treated), whether the stand was clipped post-seeding, previous conservation practice the tract was enrolled in (i.e., general CRP versus specific practices like CP-4D), seed mixture details, and description of soil type. Not all information was present for every tract and we minimized the soil preparation variables we examined to maximize sample size. We used data collected from rain gauges in each county (NOAA National Center for Environmental Information, www.ncdc.noaa.gov) for total, non-snow April-June precipitation each year. Information for fields surveyed during 2017 is being compiled by the FSA.

Because forb canopy cover proved to be the most important vegetation feature to CSTG nest success during the Proett CSTG study in eastern Idaho (2017), we selected forb canopy cover as our response variable of interest to evaluate the impacts of field preparation. We used Akaike's Information Criteria corrected for small sample size (AIC_c) to compare univariate linear regression models evaluating whether the number of times a field was mechanically prepared (mech_times), whether mechanical treatments were combined with chemical treatments (chem), the planting season (season), whether fields were clipped after planting (clip), years since planting (age), and precipitation during April-June of the establishing spring (precip; i.e., precipitation the following spring for fall seedings) affected forb canopy cover. Variables from supported univariate models (i.e., univariate model AIC_c lower than intercept-only model) were combined in additive models and compared to all univariate models. We also compared linear regression models built from a further subset of the data, due to limited information on the seed mixture used in all plantings, to evaluate whether the portion of the seed mixture that was forb (by weight) ultimately affected forb canopy cover in SAFE plantings.

Columbian Sharp-tailed Grouse Demographics ─ We captured grouse during February-April 2016 and 2017 using both walk-in traps on leks and a night-netting method using all-terrain vehicles described by Gillette (2014). We determined the sex of the grouse based on feathers, fitted female grouse with 15 g necklace-style VHF radio-transmitters, and released them at the point of capture. We located grouse from the ground 2–4 times per week until their death or transmitter failure. Locations involved walking a 20-m circumference around the grouse with the goal of not flushing the grouse. At each location, we used a handheld GPS to determine the UTM coordinates and recorded the vegetation cover type (e.g., CRP, SAFE, shrub-steppe). We used radio-telemetry and visual sightings aided by binoculars to locate incubating females. When a female was found within 30 m of the previous location on two consecutive visits during the nesting season, we sought visual confirmation of the nest. Upon locating a nest, we recorded the UTM coordinates and the nest site vegetation type without flushing incubating hens. Upon cessation of incubation we inspected nests to determine fate and number of eggs hatched. Nests were considered successful if at least 1 egg hatched.

We located radio-marked females with broods within 48 hrs of hatch and twice a week thereafter. Periodic checks of brood presence or absence were conducted during morning every 10 days after first location of the female with the brood. Great care was taken to minimize disturbing broods. Females with broods were slowly approached while their location was triangulated from 30–40 m, and we immediately retreated if the female feigned a broken wing (i.e., hen feigning injury to distract person from brood presence). When females either flushed long distances or made long-distance movements (> 2 km) and no chicks were detected for 3 consecutive locations, we classified broods as unsuccessful. We flushed remaining broods at 35-days post-hatch to estimate the number of offspring that survived. Broods were considered successful if at least 1 chick survived to 35 days post-hatch. We compared survival of collared females, apparent nest success, and brood success to values collected during Gillette's (2014) past study in the same habitats and published information on CSTG demographic rates.

The combination of two years of telemetry data of over 800 relocations of CSTG that were captured allowed us to estimate population growth (lambda, λ) for CSTG occupying SAFE and shrub-steppe habitat. We estimated 11 demographic characteristics for yearling and adult female CSTG: eggs per nest of initial nest attempts and renest attempts, nest success of initial and renest attempts (e.g., at least one egg hatching of a nest clutch), chicks hatched per eggs laid, brood success (e.g., at least one chick surviving to 35 days post-hatch), fledglings surviving to 50 days, survival of females during reproduction, fall and winter. These data are consolidated as survival and fecundity parameters in the matrix model. The survival parameter is the product of adult survival across three seasons of estimates.

The fecundity parameter is generally the product of the 8 remaining demographic characteristic probabilities of success mentioned above for eggs, chicks, and fledglings.

The combination of these demographic characteristics allow us to determine if populations are at risk of declining, are stable, or increasing. Furthermore, we compare our estimates of population growth with previous research that was conducted in the same area for CSTG during 2011 to 2013. An estimate of lambda (λ) that is below 1.0 is a population at risk of declining, around 1.0 is a stable population, and above 1.0 is an increasing population.

Lek Counts ─ During April of 2016 we conducted simultaneous AIR and ground-based counts of GSG leks. We used to two observers for ground-based counts to allow for the estimation of error rates between observers. The AIR technician used all zoom capabilities of an integrated infrared imaging system (IRIS)—combining a cooled infrared camera, gyro, and other technologies—to count as many GSG as possible at each lek. Counts were conducted between 0.5 hours before sunrise to 1.5 hrs after sunrise. We calculated the error rate of each observer (ground and AIR) for comparisons of error consistency and magnitude between survey types and observers. We also created pseudo leks by tethering captive ring-necked pheasants (surrogate for prairie grouse species, midway between GSG and CSTG in size) to the ground in an arrangement similar to male GSG on a lek in sage-steppe habitat typical of a GSG lek site. We then used AIR to count these leks, providing an estimate of error in AIR counts.

Songbird Surveys ─ The Idaho Bird Conservation Partnership provided funding to conduct songbird surveys in SAFE and CRP tracts in concert with our other objectives. We used double-observer point counts to monitor songbird abundance. Surveys were initiated in late May and continued until the first week in July, when singing dropped off significantly. Songbird surveys were conducted starting 30 minutes before sunrise and for 5 hours after sunrise. We used comparisons of means $\pm$ 95% C.I. to evaluate differences in the abundance of five focal species and total species abundance between CRP and SAFE plantings.

Innovative aspects of the project relative to existing practices ─ The two most innovative aspects of this project were 1) the assessment of the effectiveness of a national grassland conservation program (SAFE) and 2) the refinement of AIR techniques for counting GSG and CSTG leks. To our knowledge, there is little to no existing information that summarizes the differences in the nation-wide CRP and SAFE plantings, evaluates what techniques result in SAFE plantings that have the potential to benefit CSTG, and links SAFE to improved CSTG demographic rates. The results of this project can inform future decisions on SAFE enrollment acreage and overall Farm Bill direction while immediately informing local mid-contract management decisions and efforts to increase seeding efficiency.

The process of counting leks via AIR methods has been described (Gillette et al. 2013) and cooled infrared cameras have been the focal technology of this approach for wildlife surveys. Previously, cooled infrared cameras were mounted on gyro-stabilization units as separate, independently-powered components (Gillette et al. 2013). The system we used on this project contained a cooled infrared camera, gyro, electro-optical sensors (lasers, waveguides, etc.), high definition digital camera, and an augmented-reality computer as part of one system; which we refer to as an integrated infrared imaging system (IRIS). The gyro integrated into the IRIS system provides enhanced camera stabilization over previously described AIR techniques (Gillette et al. 2013). Improved stabilization provides better image quality and the technology allows for automatic target tracking, which keeps a target object in the field of view until it has been identified, increasing efficiency. Lasers in the IRIS allow us to determine the accurate location ($\pm$1m day or night) of objects within the camera's field of view and assist with marking locations for future video analysis,

increasing accuracy and efficiency. IRIS also has improved zoom capabilities over previously-described systems. We can switch between three levels of infrared optical zoom, two levels of digital zoom and continuous zoom for 1080 HD daylight and IR video, allowing for increased accuracy in identification of target species and enhanced detection of smaller species. All functions are located on a hand controller and a touch-screen monitor allows for easy data recording and uninterrupted view of the monitor. The monitor displays and records camera operating parameters such (e.g., azimuth, tilt, slant range distance), target information (e.g., location), and aircraft information (e.g., location, altitude, airspeed, time). The software of the augmented reality system maps the area surveyed at various scales of interest, includes camera geo-referencing in real-time, and includes information overlays of roads, watercourses, geographic features, transect lines, and waypoints.

Schedule of events, when components were built and installed, the period of time that data was collected

Objective	Task	Dates
Plant Composition and Structure	Correspond with landowners to obtain access to CRP and SAFE fields for vegetation measurement	Jan 2016 - Jul 2016
	Measure vegetation in CRP and SAFE fields	May 2015 - Aug 2016 May - Aug 2017
Effects of Field Preparation on SAFE	Get appropriate NRCS and FSA permissions to access field preparation data	Jan 2016 - Mar 2016 Aug - Dec 2017
	Work with local FSA personnel to obtain field preparation data for SAFE tracts of interest	Apr 2016 - Dec 2017
Columbian Sharp-tailed Grouse Demographics	Capture and radio-collar female CSTG	Mar - Apr 2016 Feb - Apr 2017
	Monitor radio-collared CSTG for survival, nest success, and brood success	Mar - Aug 2016 Mar - Aug 2017
Lek Counts	Conduct AIR and ground-based counts of GSG leks and pseudo leks	Mar - May 2016
Analysis	Summarize and analyze data	Aug - Dec 2016 Aug - Dec 2017
Report	Prepare final report	Aug - Dec 2017

Summary of what worked, what didn't work, and why ─ Relative to our first objective, because the methods for estimating grass and forb canopy cover (e.g., Daubenmire frame) and shrub canopy cover (e.g., line-intercept method) are well established, these processes mostly worked as expected. When estimating vegetation cover, there was one phenomenon that impacted our results and had little to do with the process of planting and establishing grassland. By the latter part of summer, forbs may lose some of their biomass due to insect foraging, which could influence the structure of SAFE fields. It is more of a complicating factor in SAFE fields than general CRP, since forbs are more common in SAFE fields. The later in the summer sampling is conducted (end of July or early August), the more likely this can become a problem. During late summer 2016, we observed that many forbs had been partly defoliated by insects and were providing less cover than they would have during nesting. This did not appear to be as acute of a problem during 2017. Therefore, it would be best for future vegetation assessments to occur in as compact of timeframe as possible prior to defoliation in late summer.

Relative to our second objective, we were successful at obtaining information about seed mixture design, equipment used, timing and age of seeding, seedbed preparation, post-seeding practices, previous conservation practices, and soil type for most SAFE seedings. Unfortunately, data on field preparation was often not detailed or complete enough for a fine-scale assessment of the impacts of field preparation. It is possible our results for this objective would have differed with more detailed and complete data. We provide suggestions in the Conclusions and Recommendations section on potential improvements for data collection and access.

Relative to our third objective, we were successful at capturing CSTG and obtaining demographic rates for CSTG occupying SAFE lands, however, our confidence intervals for estimates of population growth (lambda) for CSTG occupying shrub-steppe were large because CSTG experienced high mortality in shrub-steppe habitats (i.e., control area). Our estimates for demographic characteristics of CSTG occupying shrub-steppe are still valuable and informative. This issue is discussed more thoroughly in the Conclusions and Recommendations section.

Relative to our fourth objective, we were able to conduct simultaneous AIR and ground-based counts of GSG leks to examine error rates within and between methods. In fact, efforts were so successful during 2016, it was not necessary to collect as much AIR data during 2017 and we were able to investigate another capability of AIR technology ─ locating sage-grouse nest sites. Although the coordination of simultaneous ground and AIR counts requires substantial planning and personnel time to collect these data in many different and remote areas, future assessments will benefit from conducting counts in areas where leks are in close proximity and there is good road access to maximize efficiency.

What would be done differently in this project if it were started today? We would look to acquire additional funding to increase personnel resources for CSTG capture in the sage-steppe (control area) and SAFE habitats to improve our sample sizes, and therefore, our statistical power to detect an effect of SAFE on CSTG demographics.

FINDINGS

Plant composition and structure – On average, SAFE plantings contained more forb and native grass species, fewer shrub species, about an even number of Eurasian grass species, and had higher overall plant species diversity than CRP plantings (Figure 2). Specifically, SAFE plantings contained 1.4 more forbs, 1.3 more native grasses, and 3.1 more total species; CRP plantings contained 0.5 more shrub species; and the number of Eurasian grasses did not differ between CRP and SAFE plantings. SAFE

plantings had more forb cover and taller forbs than CRP plantings (Figure 3). Grasses and shrubs did not differ in cover or height between SAFE and CRP. In 2017, SAFE plantings contained numerically fewer grass and forb species and slightly higher shrub species than CRP, but these differences were not statistically significant.
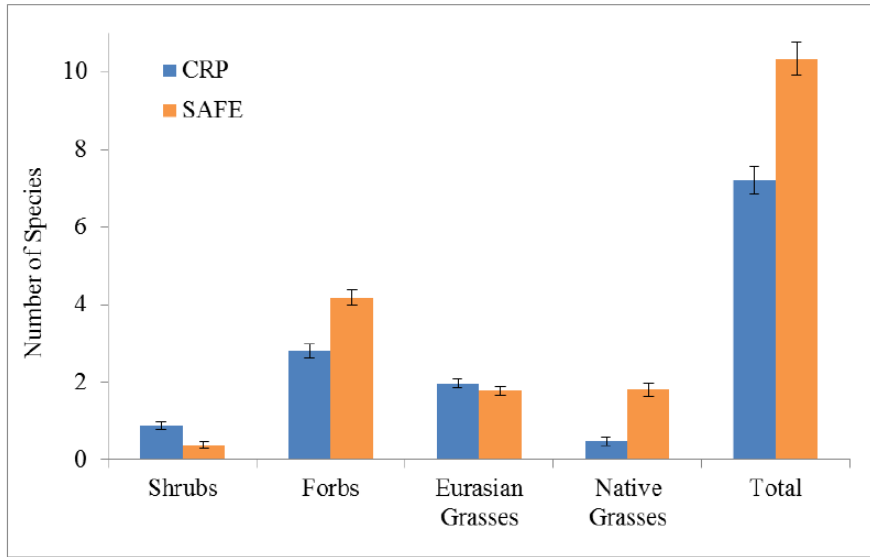
Figure 2 – Average species abundance (± 95% C.I.) in CRP and SAFE plantings surveyed in eastern Idaho, 2016.
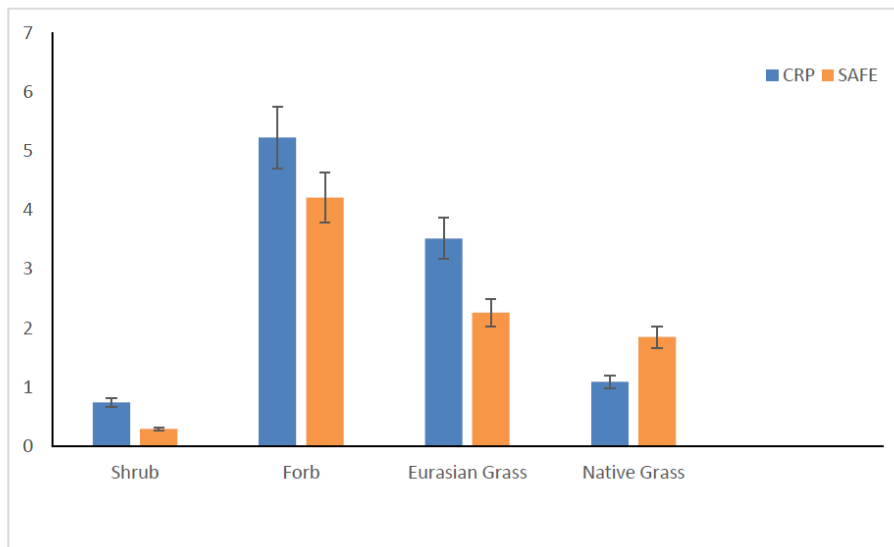
Figure 3 – Average species abundance (± 95% C.I.) in CRP and SAFE plantings surveyed in eastern Idaho, 2017.

When combining 2016 and 2017 results, SAFE plantings contained numerically more percent cover in sagebrush (*Artemesia sp.*), grasses and forbs, as well as residual shrub cover, whereas CRP had a higher percent cover in other shrub species, residual grasses, litter and rock. SAFE areas had reduced heights for shrub components, but taller grasses, residual grass, forb and residual forb heights. T-tests indicated statistically significant differences between SAFE and CRP in grass and forb cover,

fresh and residual, but not in shrub cover. We were able to conduct sufficient vegetation sampling in unenrolled sagesteppe sites in the southern Idaho region, which indicate that CRP and SAFE plantings yield significantly different vegetation communities higher in forbs and grasses, lower in shrubs, than the unenrolled sites.

Alfalfa (*Medicago sativa*) was the most common perennial forb, followed by sainfoin (*Onobrychis viciifolia*). Sweet clover (*Melilotus officinalis*), prickly lettuce (*Lactuca serriola*), salsify (*Tragopogon dubius*), and mustards (Brassicaceae family) were common annual/biennial forbs. Common grass species in SAFE tracts included bluebunch wheatgrass (*Pseudoroegneria spicata*), big bluegrass (*Poa secunda*), basin wildrye (*Leymus cinereus*), cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromus inermis*), and intermediate wheatgrass (*Thinopyrum intermedium*). Common grass species in CRP tracts included crested wheatgrass, intermediate wheatgrass, and smooth brome. When shrubs were present, big sagebrush (*Artemesia tridentata* ssp.) was the most common, followed by rabbitbrush (*Ericameria nauseosa* or *Chrysothamnus viscidiflorus*) and bitterbrush (*Purshia tridentata*).

Intermediate wheatgrass was present in about 70% of all sample plots and was the most common Eurasian grass. Smooth brome and crested wheatgrass were present in 57% and 43% of all sample plots, respectively, with smooth brome much more common in Teton, Fremont, and Jefferson counties (79% of plots in those counties) and crested wheatgrass much more common in Power and Oneida counties (75% of plots in those counties). Shrubs were present in about 50% of all sample plots and were present more often in CRP plots (57%) than in SAFE plots (38%).

SAFE plantings had higher forb canopy cover and taller forbs than CRP plantings (Figure 3). Grass and sagebrush canopy cover and height were similar between CRP and SAFE plantings.

Effects of Field Preparation on SAFE — We had enough data to evaluate the effect of field preparation on vegetation establishment for 42 SAFE plantings. Mechanical seedbed preparation occurred from one to six times for the tracts we evaluated, with 71% of tracts treated with >1 mechanical treatment. Disking was the most common mechanical practice followed by harrowing and plowing. In about 64% of tracts, the ground was also chemically treated, typically prior to disking. Post-seeding management practices only consisted of clipping tracts after seeding. Clipping was the most common practice overall, occurring in 81% of tracts. Soil type was not documented for 45% of the tracts we evaluated, 47% were silt loam, 5% were sandy loam, and 3% were loam. Twelve seed companies and 32 seed mixtures were used to seed the SAFE tracts we evaluated. Mixes contained an average of eight species in combinations of 2-6 grasses with 2-9 forbs. The most common species were big bluegrass, basin wildrye, thickspike wheatgrass (*Elymus lanceolatus*), bluebunch wheatgrass, alfalfa, sainfoin, small burnet (*Sanguisorba minor*), and yarrow (*Achillea millefolium*; Table 1).

Table 1. Common names of grasses and forbs planted in SAFE tracts in eastern Idaho that were evaluated during 2016 and 2017.

Grasses		Forbs	
Big Bluegrass	Basin Wildrye	Alfalfa	Sainfoin
Thickspike Wheatgrass	Bluebunch Wheatgrass	Small Burnet	Yarrow
Snake River Wheatgrass	Western Wheatgrass	Sweetclover	Blue Flax
Slender Wheatgrass	Sandberg Bluegrass	Milkvetch	Sunflower
Indian Ricegrass	Tall Wheatgrass	Penstemon	Forage Kochia
Bottlebrush Squirreltail	Orchardgrass	Rocky Mountain Beeplant	

April-June precipitation (precip), planting age (age), and whether the tract had been treated both mechanically and chemically prior to planting (chem) were the only variables that were related to forb canopy cover and were combined in additive linear models. When all additive and univariate models were compared, the top model suggested a positive relationship between April-June precipitation during the establishment spring (precip) and eventual forb canopy cover (Figure 4, Table 2). The second best model containing precip and age contained an uninformative parameter (chem) because the top model is nested within it (Arnold 2010), and therefore is not considered a truly competing model. The model containing the age of planting was also within 2.0 AIC_c of the top model, suggesting it has some support. That model simply suggests increased forb canopy cover as stands get older. None of the models containing variables related to field preparation (mech_times, chem, season, clip) were competitive with the top model ($\Delta AIC_c > 2.0$). A model predicting forb canopy cover with the portion of the seed mixture comprised of forb seeds performed poorer than an intercept-only model ($\Delta AIC_c = 2.2$), suggesting no relationship.
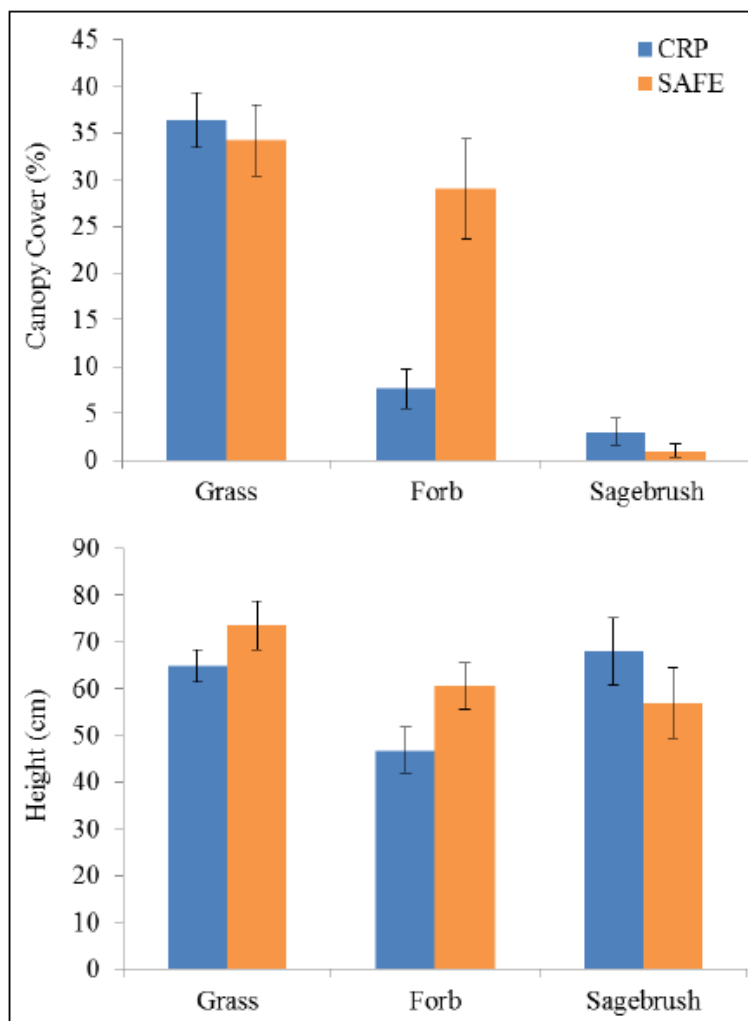
Figure 4 – Average grass, forb, and sagebrush canopy cover and height ($\pm$ 95% C.I.) measured in CRP and SAFE plantings in eastern Idaho.

Table 2. Model selection results, and parameter estimates for models within 2.0 AICc of top model, for linear regression models predicting forb canopy cover in SAFE plantings of eastern Idaho, 2016.

Model	K	Log-lik	AIC_c	ΔAIC_c	w	β_0	β_1	β_2
$\beta_0 + \beta_1 *Precip$	3	-183	372	0.0	0.34	14.0	3.9	
$\beta_0 + \beta_1 *Precip + \beta_2 *Chem$	4	-183	374	1.8	0.14	20.6	3.2	-5.5
$\beta_0 + \beta_1 *Age$	3	-184	374	2.0	0.12	15.9	4.0	
$\beta_0 + \beta_1 *Chem$	3	-184	375	2.3	0.11			
β_0	2	-186	376	3.3	0.06			
$\beta_0 + \beta_1 *Age + \beta_2 *Chem$	4	-183	376	3.6	0.05			
$\beta_0 + \beta_1 *Mech\_times$	3	-185	376	3.8	0.05			
$\beta_0 + \beta_1 *Area$	3	-185	376	3.9	0.05			
$\beta_0 + \beta_1 *Age + \beta_2 *Precip + \beta_3 *Chem$	5	-182	376	4.0	0.04			
$\beta_0 + \beta_1 *Season$	3	-185	378	5.2	0.03			
$\beta_0 + \beta_1 *Clip$	3	-186	378	5.6	0.02			

Columbian Sharp-tailed Grouse Demographics — All CSTG captured in the landscape with SAFE plantings spent at least 50% of their time in SAFE fields and 16 of 19 spent >80% of their time in SAFE fields during 2016. Survival of adult CSTG during the spring and summer months was 43%, with 50% of the birds inhabiting the SAFE landscape surviving the spring-summer. The majority of adult CSTG mortality was attributed to mammals, with avian predation also not uncommon. Overall nest success averaged 33% in 2016 (n = 21 nests). Eighteen nests were in SAFE, one was in shrub-steppe rangelands, and two were in CRP lands. As has been well documented in the past with videography work (Gillette 2014), nest failures appeared to be primarily caused by badgers and coyotes regardless of habitat type. Based on inspection of nests, we attributed five nest failures to mammalian predators (≥36%, particularly badgers), two nest failures to the adult being killed during incubation recess (14%), one failure to trampling by cattle (7%), and there was not enough evidence to determine cause for 6 nests (43%). All hatched nests occurred in the SAFE landscape (n = 7). Brood success to 35 days was 29%. Two hens lost their broods prior to the first check at 10 days. One of these females died and the other brood was considered lost after no brood was documented during several follow-up checks and the hen eventually congregated with another, unmarked CSTG. Three broods failed between the 10-day and 20-day checks, one due to the death of the hen. Two broods successfully survived to 35 days.

During 2017 we monitored the fate of 31 nest attempts in general CRP, SAFE, and shrub-steppe habitats. Nest success was 53% in SAFE habitat and 43% in shrub-steppe habitat. There were only two nest attempts documented in general CRP habitat, both of which failed. Female survival during spring and summer for CSTG females occupying SAFE habitat was 69% and 42% for CSTG females occupying shrub-steppe.

Population Growth (λ) — Columbian sharp-tailed grouse occupying SAFE landscapes during 2016-2017 were estimated to have higher population growth and closer to being categorized as a stable population compared with CSTG occupying CRP landscapes during 2011 to 2013 (Table 3). Specifically, the life history stage when CSTG benefit the most within SAFE habitats is the fecundity of yearling females. Yearling females occupying SAFE habitats were more successful at hatching eggs and rearing young in SAFE habitats compared with CRP habitats by two orders of magnitude. Survival of adults is similar between habitats.

Table 3. Estimated population growth built upon survival and fecundity parameters of adult (subscript "A") and yearling (subscript "Y") CSTG occupying a SAFE-dominated landscape, CRP-dominated landscape, and a shrub-steppe-dominated landscape with 95% C.I. surrounding lambda.

	Lambda	Fecundity $_Y$	Survival $_Y$	Fecundity $_A$	Survival $_A$
CRP (2011-2013)	$0.36 - 0.73$	0.09	0.48	0.16	0.37
Shrub-steppe (2011-2013)	$0.38 - 0.92$	0.24	0.41	0.14	0.47
SAFE (2016-2017)	$0.37 - 0.96$	0.28	0.49	0.11	0.39
Shrub-steppe (2017-2017)	$0.26 - 1.35$	0.64	0.42	0.05	0.18

Lek Counts – Of 22 simultaneous AIR and ground-based counts of GSG attending leks (Figure 5), the average error between methods was 30%. Sometimes AIR detected more GSG attending leks and sometimes ground-based observers detected more. Having two ground-based observers at each lek also allowed us to estimate error between ground-based observers, which averaged 10%. On the same mornings, we conducted 15 pseudo lek counts with a known number of pheasants tethered to the ground (Table 4). There was an average error rate of 10% when we used AIR to count pseudo leks. AIR counts were 100% accurate for 10 of 15 counts (67%), with error ranging from 7% - 67% on the other five counts. AIR counts both over- and under-counted pheasants on pseudo leks.
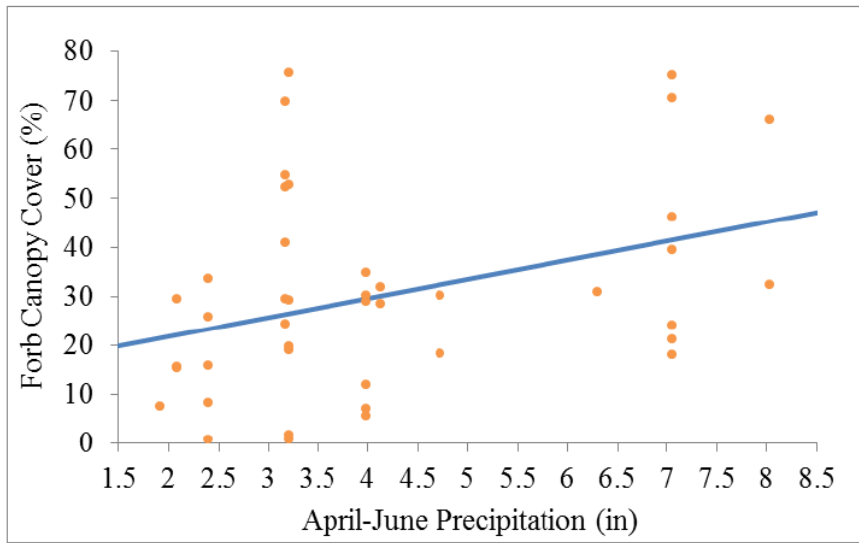
Figure 5 – Modeled relationship (and raw point data) between April-June precipitation in the first spring after planting and measured forb canopy cover for SAFE plantings in eastern Idaho, 2016.

During 2017 we tested the ability of IRIS to detect sage-grouse on nests in late May. For both flights during dawn and prior to dawn the IRIS was able to detect the nests that were provided to the pilot and AIR technician but they were unable to differentiate unknown nests within a large pasture. One nest was detected from as far away as one mile and disturbance by the AIR method was minimal

to the grouse being surveyed. The ability to detect a GSG female returning to a nest can be viewed at the following link: https://www.youtube.com/watch?v=YSydUsQPGCw.

Table 4. Results from aerial infrared (AIR) counts of pseudo leks with a known number of pheasants tethered to the ground conducted in Idaho, 2016.

Pseudo Lek	Survey Date	AIR Count	Pheasants	Error
A	4/4/2016	16	11	+45%
B	4/4/2016	13	14	-7%
C	4/4/2016	11	11	0%
D	4/4/2016	24	24	0%
E	4/4/2016	16	16	0%
1	4/6/2016	9	9	0%
2	4/6/2016	16	16	0%
3	4/6/2016	19	19	0%
4	4/6/2016	8	7	+14%
5	4/6/2016	14	14	0%
F	4/7/2016	15	15	0%
G	4/7/2016	2	2	0%
H	4/7/2016	4	4	0%
I	4/7/2016	29	25	+16%
J	4/7/2016	7	21	-67%

Songbird Surveys - We completed 53 point count and 55 transect songbird surveys in CRP and SAFE tracts. Common detections included western meadowlarks, grasshopper sparrows, brewer's blackbirds, vespers sparrows, and mourning doves. These were our focal species. Some of the least commonly detected species include a Brewer's sparrow, Bullock's oriole, western wood pewee, Townsend's solitaire, and Lazuli bunting. Abundance of the five focal species and total species abundance did not differ between the CRP and SAFE tracts we surveyed (Figure 6).
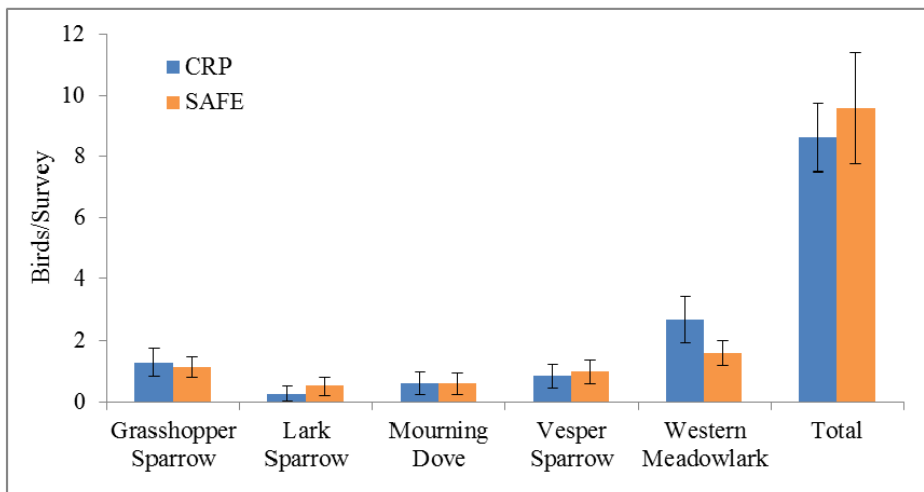
Figure 6 – Focal species and total bird abundance (birds/survey ± 95% C.I.) in CRP and SAFE tracts surveyed with double-observer point counts in Power and Oneida counties, Idaho, 2016. Total = all species of birds observed, not just the focal species listed.

CONCLUSIONS AND RECOMMENDATIONS

Plant Composition and Structure — The goal of the SAFE program in Idaho is to increase quality grassland, shrub steppe, mountain brush, and riparian habitat for Columbian sharp-tailed grouse. The majority of SAFE plantings evaluated during 2016 and 2017 were successful at establishing forbs, including legumes (alfalfa and sainfoin), and native grasses. The average SAFE tract that we evaluated established four forb species, a 49% increase in forb species over the traditional CRP tracts we evaluated. The average SAFE planting contained almost two native grasses and two Eurasian grasses while CRP plantings had less than one native grass and about two Eurasian grasses. Native bunchgrasses are likely more beneficial to reproducing CSTG, since the bunchgrass form creates interspacing between plants that provides movement corridors for newly-hatched chicks. These results suggest that, on average, SAFE plantings are more successful at establishing native grasses, forbs, and legumes beneficial to CSTG than most CRP plantings. However, with an average of two rhizomatous, Eurasian grasses remaining in SAFE plantings, vegetation composition should be measured again as the stands age to see if these highly-competitive grasses eventually outcompete the beneficial forbs and native grasses.

The starkest contrast between CRP and SAFE vegetation characteristics was differences between forb cover and structure. This is one of the greatest indicators that SAFE projects are providing better CSTG habitat than general CRP projects. Proett (2017) found that CSTG in eastern Idaho selected nest sites in grassland habitats with high forb canopy cover (≥30%) and that daily nest success improved as the portion of high forb canopy cover within an average hen's recess distance of the nest increased. Therefore, it is likely the SAFE plantings we evaluated, with an average forb canopy cover of 29% ± 5.4% in 2016 and 27% ± 4.8 in 2017, are positively affecting CSTG nest success. It is well established that plant height influences concealment cover for CSTG, with taller vegetation providing more cover. It is clear from our data that forb cover and height was significantly higher in SAFE tracts. While there was variation between years, that is likely due to differences in weather and changes in vegetation due to establishment of new plants.

A potentially negative byproduct of reseeding grasslands to SAFE specifications is the reduction of shrub cover. Both SAFE (26%) and CRP (29%) sites had lower percent shrub cover than adjacent native shrub habitats (37%). A decrease in shrub cover is a result of the seedbed preparation process that often involves chemical treatment, mowing, disking, and planting with a seed drill. It is not uncommon for farm bill coordinators to recommend that producers seed around shrub patches within fields in order to retain some shrub cover within SAFE tracts. Shrubs provide cover from predators, nesting substrate, and thermal refuge during summer months. Proett (2017) found no relationship between the presence of shrubs in seeded grasslands (CRP and SAFE) and nest site selection or nest success in a landscape of interspersed seeded grasslands, native shrub-steppe, aspen stands, and mountain shrub communities. It is possible that the importance of a shrub component in SAFE plantings depends on the amount of native shrub habitats that are interspersed or in close proximity to the SAFE planting.

It was common for the SAFE tracts we evaluated to have an increase in weedy and invasive species. This was most likely a result of disturbance during the process of reseeding SAFE projects that removed the existing competition for invasives (e.g., rhizomatous grasses). Managing invasive species during the first growing season is a common practice, where clipping (i.e., mowing) is often conducted prior to seed set. General CRP projects typically experience less soil disturbance, contain more rhizomatous grasses, and often include re-enrollment with an existing cover of sod-forming grasses. Therefore, these fields had fewer invasive species. Future evaluation of SAFE should focus on how the abundance of invasive species changes over time as the seeding matures and what methods

could be employed to minimize and treat invasive species during establishment without impacting the beneficial seeding.

Effects of Field Preparation on SAFE ─ The techniques and intensity of mechanical treatments varied widely among SAFE plantings. Although >30 different seed combinations were planted, mixes contained a fairly consistent group of species dominated by bunchgrasses and forbs that provide both forage quality and structure (e.g., alfalfa and sainfoin). In our analysis, spring precipitation in the establishment year was more important than any of the field preparation efforts in producing increased forb canopy cover. This result is logical because eastern Idaho is relatively dry and prone to drought conditions, with much of the region receiving only around 12 inches of annual precipitation that comes in sporadic weather events. Root establishment during the initial growing season, fueled by the amount of available moisture, likely determines whether a plant can withstand the sometimes extensive dry periods during the summer months.

A preliminary analysis of the first year of data collection indicates that total precipitation during the establishment spring (April-June) had the largest influence on resulting forb canopy cover. Age of the stand may also affect forb canopy cover. None of the field input variables we evaluated were adequate predictors of forb canopy cover. Our inability to detect an effect of field preparation on resulting forb cover may also be due to the resolution of the field preparation data. The field preparation characteristics for many fields were difficult to determine from the files at local FSA offices and much of the data that did exist was in note form. Approximately 75% of the fields that we evaluated contained missing or unclear information for at least one field preparation or seeding characteristic. This led us to either 1) eliminate the tract with missing data from the analysis (n = 18 tracts) or 2) utilize variables that were less refined than they could have been (e.g., "yes" or "no" on chemical treatments instead of using the number of times a tract was chemically treated). The seed mixture used was the most consistent information recorded, since the seed tags were almost always photocopied in the file. The development of standard protocols and forms for recording field preparation information could help with data collection and consistency across all offices implementing the SAFE program. If the data recording system were digital it would even further ensure data quality control and make data retrieval more efficient.

Columbian Sharp-tailed Grouse Demographics ─ Upper level demographic rates such as nest success, brood success, and adult survival can be compared to examine how CSTG perform in SAFE versus shrub-steppe habitat. For example, survival and brood success of CSTG occupying SAFE lands during 2016 was similar to those of CSTG occupying CRP but lower than those of CSTG inhabiting shrub-steppe habitats during 2011-2013. Nest success, which has a large impact on population growth (Gillette 2014), was higher than it was for CSTG inhabiting CRP and similar to what it was for CSTG inhabiting shrub-steppe habitats during 2011-2013. However, we consolidate these parameters into fecundity and survival components of population growth which also populate the matrix model and make interpretation less nuanced (Table 3).

The finding that population growth (λ) is higher for CSTG occupying SAFE is preliminary evidence that SAFE may be accomplishing its objective to benefit wildlife in a way that general CRP does not, which was initially intended to stabilize soils. This corroborates with the finding that SAFE fields had higher forb cover compared with CRP fields. Forb cover is believed to provide an environment that is beneficial for chick survival and growth of upland game birds that relates to their fecundity. It is possible that prevailing climatic conditions were more favorable overall during the 2016-2017 period compared with 2011 to 2013 since CSTG occupying shrub-steppe were also more likely to be a stable population or even increasing compared with 2011-2013 (Table 3). However, survival and fecundity rates increased in SAFE landscapes from 2016 to 2017 and it may be more

likely that as more land becomes established CSTG are more productive with increased quality habitat availability. We hypothesize that with similar climatic conditions during 2018, these parameters will be higher because of the amount of established vegetation that is part of the SAFE program. It generally takes three years for SAFE habitat to be established and although the majority of SAFE-enrolled tracts have been planted, they amount of mature habitat available will reach a critical threshold during 2018 based on the rate of tracts that are successfully established and certified.

Lek Counts ─ Annual lek counts are the primary data source for monitoring GSG and CSTG population trends. The use of AIR to count leks is becoming increasingly common, yet it is unclear how the bias of AIR counts compares with the bias of traditional lek counts. During our 2016 surveys, AIR counts averaged 10% error when compared to pseudo leks of a known number of birds. Ground counts and AIR counts differed by an average of 30%, suggesting AIR counts may be more accurate, on average, than ground counts. All estimates are bias to some degree but reliable estimators are predictably bias in direction and magnitude. AIR counts during these trails were fairly accurate on average (average error of 10%) but their bias was unpredictable in direction (i.e., both under- and overestimated) and magnitude (i.e., error at individual leks from 6% to 67%) for individual lek counts. More research is needed to understand the environmental (e.g., ambient temperature, vegetation type and cover at lek) or other (e.g., camera methodologies and equipment) variables that impact accuracy of AIR counts at individual leks, which could then be used to correct counts for visibility bias.

We demonstrated during data collection of 2017 that AIR methods using IRIS can detect known sage-grouse nests during late May. The pilot and AIR technician attributed the inability to detect nests unknown to them but known to collaborating researchers to too many heat signatures within the polygon they were searching that made it difficult to differentiate a sage-grouse hen on a nest from other heat sources. Our surveys were conducted in late Apirl and May. During these times when temperatures are higher compared with nesting that occurs earlier in the season, there are more heat signatures similar to that of a sage-grouse nest. For example, sage-grouse nests are abundant on the landscape during April and some exist in March. Because we demonstrated that sage-grouse nests can be detected using IRIS technology, it is possible that nest searches for nests unknown to the pilot and AIR technician that are conducted earlier in the year would be more successful. Prevailing ambient air temperatures have a significant impact on the efficacy of AIR methods for detecting wildlife. However, vegetation can also play a role in blocking the heat signature of a nest and the inability to differentiate heat signatures is not solely a function of prevailing ambient air temperatures.

If the approximate location of a nest is known within a 200 m radius, AIR methods with IRIS could be used to identify the exact location of a sage-grouse nest. We recommend that future efforts focus surveys during March and April and on small areas where nests are known to occur. For example, there are many on-going sage-grouse studies with nest locations from previous years. If researchers are interested in bolstering their sample sizes to quantify reproduction, then nest searches should begin in known nesting areas informed by previous year's data or biologists experience observing hens during the nesting season as opposed to searching larger landscapes to identify potential sage-grouse nests.

Songbird Surveys ─ We were unable to detect a difference in songbird abundance between CRP and SAFE plantings. The survey data reported here are raw counts with no correction for detection probability. It is possible the detection probability (i.e., probability a bird is detected on a survey given it is present) of songbirds is lower in SAFE than in CRP, due to the increased vegetation structure (i.e., more total cover and taller plants) of SAFE plantings. If that was the case, we may have detected a difference between plantings once visibility bias was accounted for. More research would be needed to

develop estimates of detection probability for different CRP/SAFE vegetation compositions and heights.

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