2013 ANNUAL REPORT

GREATER SAGE-GROUSE RESPONSE TO SEASON-LONG AND PRESCRIBED GRAZING (NRCS CONSERVATION PRACTICE 528) ON PAIRED ECOLOGICAL SITES (PHASE 1)

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Cooperators

Deseret Land and Livestock

Pheasants Forever, LLC.

Natural Resources Conservation Service Sage-grouse Initiative

Rich County Coordinated Resources Management

Rich County Commission

Utah Department of Agriculture and Food

Utah Division of Wildlife Resources

Bureau of Land Management

US Forest Service

Utah State University Extension

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Introduction

Background

The Utah Division of Wildlife Resources (UDWR) reports that sage-grouse (*Centrocercus* spp.) were historically found in all 29 Utah counties (UDWR 2009). In 2009, sage-grouse occupied habitats in 26 of Utah's counties. The UDWR estimated that 13.6% or 11,514 mi^2 (29,821 km^2) of Utah provides habitat for sage-grouse. Beck et al. (2003) reported that sage-grouse in Utah occupy 41% of historical habitats.

The complex mosaic of land ownership, competing resource uses, and administration of the sagebrush habitats compound sage-grouse management and conservation in Utah. Because of this mosaic, sage-grouse may occupy seasonal habitats administered by several different federal and state agencies and private landowners. The UDWR (2009) estimated that privately owned lands provide 40.5% of the occupied sage-grouse habitat with BLM lands second at 34%. The U.S. Forest Service (USFS) administers 10% of the currently occupied sage-grouse habitat and the State of Utah approximately 9.5%. Of this land base, Utah School and Institutional Trust Land Administration (SITLA) manages 8.0%, Utah Division of Parks and Recreation <1%, and UDWR 1.5%. Ute Tribal land comprises 5.2% and National Park Service and military reservations less than one percent each.

Declines in sage-grouse populations appear to parallel the loss and fragmentation of sagebrush (*Artemisia* spp.) habitats (UDWR 2009). The cause of this habitat loss and fragmentation include wildfire, urban expansion, development, agricultural conversion, herbicide treatments, rangeland seeding, noxious weeds/invasive species expansion, conifer encroachment, drought, and improper livestock grazing management (UDWR 2009). The primary land use in sage-grouse habitats in Utah is grazing by domestic livestock.

Reported effects of grazing on greater sage-grouse (*C. urophasianus*: sage-grouse) and their sagebrush habitats differ (Beck and Mitchell 2000). The reason for this is that no before-after-control-impact (BACI) studies have been conducted to specifically document the long-term impacts on greater sage-grouse vital rates and the effects specific grazing strategies on ecological site condition and trends. Changes to sagebrush steppe vegetation communities in response to management actions may be manifested over decades (Connelly et al. 2004). Concomitantly, the prohibitive costs of meaningfully monitoring vegetation and sage-grouse population changes over extended time periods have precluded meaningful documentation of grazing effects on greater sage-grouse (Beck and Mitchell 2000, Connelly et al. 2004).

The Utah Sage-grouse Strategic Management Plan (UDWR 2009) has identified the following research priorities regarding livestock and sage-grouse.

a) How does domestic grazing directly affect sage-grouse populations?

b) How does domestic grazing directly or indirectly affect sage-grouse habitats (all seasonal areas)?

c) How do water developments affect sage-grouse and their habitat (directly and indirectly)?

d) Does domestic grazing alter behavior in seasonal habitat areas (including meadows/riparian areas)?

The Natural Resources Conservation Service (NRCS) Sage-Grouse Initiative (SGI) seeks to engage private landowners and other partners in cooperative efforts to reduce threats to sage-grouse populations. The SGI provides targeted technical and financial assistance through Farm Bill programs to assist cooperators with implementing sage-grouse conservation.

The SGI is focused on implementing conservation practices on private and public lands as a means to: 1) improve sage-grouse habitat, 2) increase sage-grouse vital rates and population size, 3) prolong or enhance the desired effects of other land treatments, and 4) broader land management benefits to include other wildlife species and producers. By assisting land managers and livestock producers to improve range conditions in core sage-grouse population areas, SGI also seeks to improve sage-grouse habitat quality while ensuring the sustainability of working rangelands. An important component of the SGI is scientifically documenting the effectiveness of the conservation practices such as prescribed grazing on sage-grouse habitat use and populations.

Purpose

The purpose of this assessment is to scientifically document sage-grouse individual and population responses using a Before-After Control-Impact (BACI) design to vegetation changes that may occur under prescribed grazing of paired sites located in Rich County, Utah. Specific questions to be addressed include:

1). Do sage-grouse vital rates differ under prescribed and traditional season-long grazing practices implemented on BLM allotments?

2). Do sage-grouse seasonal habitat-use patterns and leks trends differ under prescribed and season-long grazing?

3). Does the quality of the seasonal habitats used by sage-grouse under prescribed and season-long grazing differ based on structure, composition, and nutrient analysis?

Study Area

The study area is located in Rich County, Utah, in the western United States. Rich County is located in northeastern Utah and constitutes the southwestern portion of the Wyoming Basin Sage-grouse Management Zone II (Knick and Connelly 2011). The research is being conducted on 2 study sites within the Rich County. The first study site is located on Deseret Land and Livestock (DLL), an 86,900 ha privately-owned ranch comprised of roughly 80,600 ha of private lands and 6,300 ha of BLM managed lands at lower elevations. The DLL is managed as a cohesive unit and land managers there have used rotational prescribed grazing practices since 1979. The second site, Three Creeks, is a 56,900 ha collection of private lands and 27 BLM and USFS grazing allotments managed under season-long grazing practices.

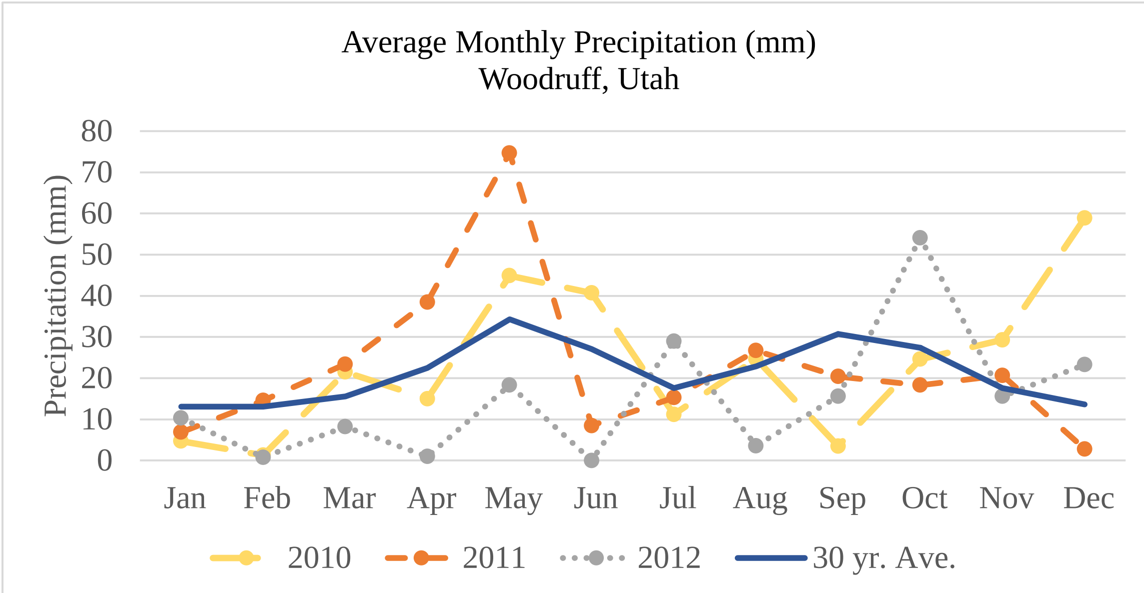

Figure 1. Average monthly precipitation (mm) for Woodruff, Utah. Data is for 2010-12.

Both sites exhibit characteristic sagebrush steppe habitats dominated by Wyoming big sagebrush (*A. tridentata wyomingensis*) and an understory of bunchgrass species. Stands of aspen (*Populus tremuloides*), fir (*Abies* spp.), and pine (*Pinus* spp.) are found at higher elevations. Elevation ranges from 1900 to 2600 m. Mean annual precipitation ranges from 250 mm in the lower elevations to 457 mm at higher elevation. Roughly half of this precipitation occurs from December to March (Johnson 1989; Figure 1). Mean temperatures ranged from 28.7° C in July to -6° C in January (Western Regional Climate Center 2012).

Methods

Study Concepts

The research project consists of paired site studies and constitutes 2 distinct phases that will be implemented from 2012-2016. During Phase 1, treatment data on sage-grouse habitat use and vital rates is being collected on the two study sites under current grazing management practices. During Phase 2, scheduled to begin in 2014, the grazing management on the Three Creeks study sites will be change from season-long to rotational prescribed grazing practice that will result in 20% of the area being rested from livestock grazing annually. This second phase accomplishes a BACI study design where two years of pre-treatment data for Three Creeks and two-three years of post-treatment data will be compared.

Lek Trends

The lek routes have been used as an alternative method for obtaining reliable indices to breeding sage-grouse males. We have surveyed lek routes and counted the number of males strutting on leks during the spring lekking season and will continue each spring throughout the study. These indices will be used to track sage-grouse population trends on each study site. Lek surveys followed Utah Department of Wildlife Resources (UDWR 2009) protocols and were conducted from late March through early May. Leks were visited a minimum of 4 times during the breeding season. All lek counts were conducted within 0.5 hour before to 1.5 hours after sunrise. Designated leks routes were counted on the same mornings. Counts were conducted on days when the weather conditions were favorable for lekking (i.e. no precipitation or strong winds). Observers used binoculars from >50 m and counted individuals observed at the lek. Observing from this distance prevented observers from disturbing lekking activities. Peak attendance for each site was calculated using the largest count of males from that lek. However, these counts only provide an index to breeding population size, and have been referred to as "convenient sampling."

Radio-telemetry

The desired study population was set at 60 juvenile and adult male and female sage-grouse at each site (approx. 40♀ and 20♂, n =120). Captured birds were fitted with a 19 g necklace style very high frequency (VHF) radio transmitter. Transmitters were equipped with a mortality sensor to document mortality. Mortality data was analyzed using known fate modeling in Program MARK to compare seasonal and annual differences in survival between treatments.

All captured birds were aged, sexed, weighed, and wing and tarsus measurements taken. All birds were released at the point of capture. Birds were aged and sexed based on feather characteristics and molt patterns (Eng 1955, Crunden 1963). All birds captured, including those not radio-collared, were marked with an aluminum leg-band (size 14 females, size 16 males) engraved with a unique identification number. These bands will provide rudimentary information on movements in the event that birds are recaptured or reported by hunters if harvested.

To maintain desired sample size, new radio-collars will be placed on sage-grouse annually to replace those that are missing or lost to mortality. Radio-marked birds were tracked to determine habitat use, home range and vital rates. Nests and broods were monitored from nest initiation until 42 days after hatch to quantify nest and brood-rearing success for each site. Movement and home range estimates will be derived using Spatial Analyst tools in ArcGIS Desktop (Environmental Systems Research Institute, Inc., Redlands, CA).

To estimate sage-grouse vital rates across the entirety of each study site, we attempted to radio-mark and track individuals from each lek (n=32) within the 2 sites. Capture techniques included night spotlighting and long-handled hoop nets as described by Giesen et al. (1982) and Wakkinen et al. (1992). We used an All-Terrain Vehicle (ATV) to capture birds.

Data obtained by tracking radio-collared grouse were used to assess vital rates and habitat use. Radio-marked females were located 2x weekly during the spring until time of nest initiation. Telemetry software (LOAS) was used to estimate female locations at the start of the nesting season. Calculated locations allowed us to monitor females that are in the process of initiating nests without disturbing them. We assumed a female was nesting after remaining in the same spot as indicated by the VHF signal for a period > 4 days. After determining that a female was on a nest we verified her presence by homing in on the female and her nest without disturbing it.

Because of the predation risk to sage-grouse and their nests from multiple predators, nest verification occurred after the area has been visually checked for predators. A GPS point was recorded for all nests and nesting female's presence was remotely monitored weekly.

Once a female moved from the nest, it was checked to determine nest fate. Eggshell fragments with separated membranes and typical hatching pattern on the shell (Rearden 1951) were used to indicate a successful hatch. All unhatched and depredated eggs were recorded.

Nesting effort or initiation was estimated as the proportion of hens that attempted to nest / the total hens alive at the onset of nesting period. Re-nesting effort was estimated from the proportion of hens that re-nest / total hens that survive an initial nest failure. We considered a nest successful if at least one egg in the nest hatches successfully.

Nest success was calculated at each study site as the proportion of nests in which at least one egg hatches. Hatching success was determined for each nest, as the proportion of all eggs laid in successful nests that hatch. Hen success was calculated for each study site as the proportion of hens that hatch at least one egg, regardless of the number of nesting attempts. Clutch size was represented by the number of hatched eggs in the nest. Nest site fidelity will be calculated as the mean distance moved from an initial nest site from one year to the next, using only females that survive and nest in consecutive years.

When broods are approximately 42 days of age, we located, flushed and counted chicks to determine brood success. Brood size was calculated as the mean number of chicks per hen at 42 days of age, using all hens alive at the onset of nesting. At each site, chick survival was calculated as the number of chicks that survive to 42 days of age from all eggs that hatched in successful nests. Dahlgren et al. (2010) documented a high rate of brood-hopping (chicks are adopted by females that are not their mother) in some populations. If brood-hopping occurs, this may bias estimates of chick survival and brood success if the chicks that brood-hopped are presumed mortalities.

Distances from lek of capture to initial nest and re-nest sites will be calculated for all hens that attempt to nest. Spring and summer movements will be estimated for individual grouse by calculating a mean distance from lek of capture to all subsequent locations. A median distance moved will be calculated for the entire study population and compared between study sites. Movement and home range estimates will be derived using Spatial Analyst tools in ArcGIS Desktop. Using these techniques, a 95% fixed kernel (FK) home range will be estimated.

After hatching, females with broods were located ≥1 week and brood size determined every 2-3 weeks with night spotlight counts (Dahlgren et al. 2010). Broods will be followed until independence in September/October. From October to March female sage-grouse will be located monthly. Male sage-grouse and females without broods will be located weekly from March to September and then monthly thereafter. Seasonal and annual movements will be described temporally and spatially using GIS and home ranges estimators.

Sage-grouse populations often engage in seasonal movements over large annual ranges composed of differing seasonal habitats. To determine the extent that these two populations will engage in such activity, we will: 1) define the second-order selection of habitat based on home ranges of individuals or subpopulations (e.g., birds associated with a lek or lek complex), 2) assess the condition of various seasonal habitat components (e.g., breeding and winter habitats), within the home range (third-order selection), and 3) describe the quality and quantity of food or cover at particular use sites (fourth-order selection) (Johnson 1980). To accomplish these objectives, sage-grouse seasonal movements/migrations will be spatially plotted to identify important seasonal habitats. Aerial photos, satellite imagery, and digitized maps will be used to measure the size and juxtaposition of these habitats. The term 'condition' referred to above relates to landscape characteristics such as habitat patch sizes, measures of habitat quality (structure, percent cover), connectivity (availability of corridors connecting patches), amount of edge and distance between habitat patches.

Vegetation and Habitat Monitoring

Habitat quality and vegetation responses to grazing treatment will be assessed with vegetation surveys in each study site. Because the research focus is hens and their reproductive success, vegetation surveys were based on the location of nesting sites and subsequent brood locations of collared hens. Each vegetation survey location was paired with a random site generated using the 'gencondrandompnts' command builder in Geospatial Modeling Environment (GME; Beyer 2012). Each paired random site was between 50 m to 1000 m of the actual nest or brood location. These distances will ensure that random sites occur within habitat readily available for selection by the hen but far enough to avoid overlap with the actual bird location. To avoid sampling habitat known to be undesirable to sage-grouse, final paired random point selection was stratified using the actual nest or brood location habitat. Random sites were located in the same grazing pasture as the actual site. This will ensure both sites were equally exposed to the same potential levels of livestock grazing in any given year.

Vegetation surveys were conducted along 4 transects laid out in the cardinal directions. Transect length varied by location type. Nest location transects were 15 m and transects at brood sites were 25 m. The longer transect length at brood sites reflected the larger area of use by broods.

To assess vegetation characteristics at each survey location, several methods were employed. Because visual obstructive cover helps to limit nest predation risk, Robel pole measurements (Robel et al. 1970) were recorded at each nest and random nest site. The pole was centered in the nest bowl and measurements were taken from a height of 1 m and a distance of 4 m. At random nest site the pole was centered where shrub canopy cover appeared greatest.

To determine canopy cover for all shrub species at each site we used measurement techniques based on the canopy line intercept method described by Canfield (1941). The ability of the line intercept method to converge on the actual shrub cover at lower sample sizes when compared to Daubenmire plots makes it a better choice for our sites (Hanley 1978). Measurements included both length of vegetation intercept and height. Because of the open nature of shrub canopies in sagebrush steppe, gaps in foliage that are <5 cm were considered continuous. On transects where 2 species intersect at the same position, only the taller of the 2 species was recorded to avoid overestimation of shrub canopy cover.

High food forb cover was associated with both early- and late-season brood habitat in Wyoming (Holloran 1999). Feeding trials of sage-grouse chicks conducted by Johnson and Boyce (1990) found insects to be an essential component of their diet for both survival and development. The abundance of insects is influenced to a degree by the amount of forb cover. Brood locations occur in areas with less sagebrush cover when compared to nest sites (Holloran 1999). A reduction in brush cover might be mitigated by increased forb cover in these locations June to September.

Forb cover was estimated using methods outlined by Daubenmire (1959). Plots were read at 3, 6, 9, 12, and 15 m along each transect at nest sites (n=20/site). Longer transect lengths for brood sites included additional plots at 18 and 21 m (n=28/site). When possible all forbs and grasses within the plot were identified to species level. Specimens that are unidentifiable to species level in the field were recorded as A=annual or P=perennial, G=grass or F=forb and assigned a number based on the sample order (e.g., PF1, PF2). Samples of unidentified species were collected for later identification. The percent cover for each species was assigned using Daubenmire's class system. The use of classes in cover estimations reduces bias and error between observers to a point lower than the normal variation within the site (Daubenmire 1959). Height for each species in the plot was measured using the individual of that species closest to the bottom right corner of the plot. Bare ground, rock, and litter cover was also estimated for each plot.

The mean percentage of cover for species in each plot was calculated using the cover class midpoint (Daubenmire 1959). Percentages for each species was summed for all plots at each site then divided by total number of plots. The resulting value will be used as the estimation of total percentage of cover for each species at that site. Species mean height will also be calculated for each site.

Viewsheds for nest and brooding locations (Aspbury and Gibson 2004) will be calculated to determine long-range visibility at these sites. We will use the viewshed tool in the Spatial Analyst tools of ArcGIS to generate each viewshed. Viewsheds will be calculated from 10 m Digital Elevation Models (DEM) layers available from the State of Utah's Automated Geographic Reference Center (AGRS 2012).

Nutritional Analysis

Sage-grouse habitat has historically been evaluated in terms of structure (e.g., vegetation cover, height, density, etc.). By describing vegetation characteristics associated with sage-grouse use and random sites, inferences can be drawn regarding relationships of habitat quality and selection to productivity (Connelly et al. 2003). It's possible that vital rates may differ even though no observable difference in vegetation structure of habitat-use areas exists at either site. Thus, there still would be biological costs to different grazing regimes, but they may be underestimated by relying solely on vegetation structural measurements. Expanding the traditional definitions of sage-grouse habitat quality to include the nutritional make-up of sagebrush and other important forage plants may provide greater insights into the biological costs of displacing birds from traditional seasonal habitats.

We will assess nutritional and chemical components of plants preferred by sage-grouse in both treatment and control to determine if dietary constituents can be used to predict diet selection and how diet impacts productivity. We will monitor dietary selection of individually radio-marked sage-grouse and collect samples from plants eaten by that individual. For example, in the case of sagebrush, samples collected February to March from browsed and random non-browsed shrubs (within 1 m) of the same subspecies will be analyzed for nitrogen (protein) digestibility, amino acids, and chemical composition following techniques outlined by Remington and Braun (1985). These results may be used to develop alternative metrics to identify, map, and conserve high quality sage-grouse habitat. A map of the most palatable sagebrush plants could identify key foraging sites across landscapes and predict important winter and early spring use areas for sage-grouse (J. Connelly, IDFG, personal communication).

Predator surveys

Increased predation of sage-grouse is perceived as a major threat to the species by private land owners (Belton et al. 2009). Connelly et al. (2000) found predation to be the leading cause of mortality for a sage-grouse population in SE Idaho. Hunting was the second leading cause of mortality. Hagen (2011) reported that range wide sage-grouse nest success rates and adult survival are relatively high and that few studies have demonstrated a link between habitat quality, predation, and mortality rates. However, in fragmented native habitats or areas where anthropogenic activities sustain higher levels of native or invasive predator populations, predation may limit population growth (Bui et al. 2010).

Coates and Delehanty (2010) hypothesized that the potential risk for increased raptor and corvid predation on sage-grouse could be mitigated by maintaining and restoring sagebrush canopy cover. Additional threats to sage-grouse and their young include ground squirrels (*Spermophilus* spp.), badgers (*Taxidea taxus*), coyotes (*Canis latrans*), red fox (*Vuples vulpes*), weasels (*Mustela* spp.), and skunks (*Mephitis* spp.) (Coates et al. 2008).

Because predator populations may change in response to changing grazing practices, continuous monitoring is important to explain any observed differences in sage-grouse vital rates. If sage-grouse nest and adult predation rates are lower in areas under prescribed grazing, this practice may constitute a best management practice to mitigate the effects of other anthropogenic disturbances (e.g., power lines and roads). Because the dynamics of a predator population and its primary food source can also impact sage-grouse populations (Schroeder and Baydack 2001), data regarding the relative abundance of potential sage-grouse predators and possibly their common prey will be incorporated into the evaluation.

By incorporating site-specific variation (distance from roads, power lines, etc.) along with landscape variables (e.g., vegetation, topography) directly into models of nest and brood success we can determine functional relationships between the direct or indirect impacts of treatments on sage-grouse vital rates while controlling for variation in environmental or habitat factors such as predation.

In the case of adult sage-grouse we will examine the condition of the remains to determine if death was caused by a mammalian or avian predator or from other causes (e.g., power lines, human interaction, capture myopathy, sickness, etc.). In the event that bones and feathers are broken or matted (i.e., chewed), death will be attributed to a mammalian predator. If a mammalian predator is implicated, the surrounding area will be searched for sign of hair, scat, tracks or evidence of a den to identify the specific predator. If the remains consist of the entire carcass with feathers intact, partially plucked, or if only the breast is consumed, the cause of death will likely be an avian predator. In the case of avian predators, known raptor nests and perches will be searched for the remains of sage-grouse. Pellet analysis can provide additional insights into the diets of raptors that use tall structures for perching or nesting (Prather and Messmer 2010), however inclusion of this technique in the methods is still under review. If there is an insufficient amount of evidence or information at the mortality site, the cause of death will be designated unknown.

Our objective for the predator aspect of this study is to document the relative effect of prescribed and season-long grazing on sage-grouse predation rates. This may be more important than documenting the specific predator. Changes in abundance of avian, mammalian, and primary prey will be monitored using standardized transects in the treatment and control areas using methods outlined by Garton et al. (2005). The prey base for these predators will also be measured to account for any prey shifting that may take place. Monitoring trends of potential sage-grouse predators in concert with changes in vital rates in the study areas will provide data to corroborate any observed differences in vital rates between treatment and control sites.

Coates and Delehanty (2010) compared a priori models of sage-grouse nest survival (microhabitat variables) to models of sage-grouse nest survival that included raven abundance as covariates. They focused on ravens, because the species has been identified as a major synanthropic predator (Boarman and Heinrich 1999). They conducted strip transect surveys (Garton et al. 2005) of ravens at sage-grouse lek complexes every 3–7 days during morning (0600–1200 hr) from March to June to investigate the impact of raven abundance on sage-grouse nest success in Wyoming. Their best model at predicting nesting success included day of incubation and raven abundance. Luginbuhl et al. (2001) took a slightly different approach to look at the effects of corvid abundance on sage-grouse. They assessed the relationship between predation on artificial nests and corvid abundance using a variety of techniques including point-count surveys, transect surveys, and the broadcast of corvid territorial and predator attraction calls. Point counts of corvid abundance had the strongest correlation with predation of artificial nests.

We monitored avian predator abundance annually between April and July from specific points along transects in the treatment and control sites. Counts were restricted to days with light winds (<19 kph) and little or no precipitation (Luginbuhl et al. 2001). At each survey point, birds were counted by visually searching the area with the aid of binoculars and listening for bird calls. Counts included ravens, other corvids, and raptors, either flying or perched, during a 10 minute period. The species code and count was recorded along with the time, weather, behavior, and distance at time of first detection. To mitigate double counting survey points are separated by >2 km distance and previously recorded birds will be tracked prior to moving to the next survey point. The survey routes are located along unimproved or gravel roads within each study area.

The same surveys route will be conducted annually using the same methodology. Somershoe et al. (2006) combined point count data and distance sampling to estimate the density of 14 bird species. Combining these two techniques was beneficial because density and relative abundance could be estimated. This is advantageous compared to relative abundance indices that cannot be compared among species due to differences in detectability (Norvell et al. 2003). Using Somershoe's (2006) technique we used distance annuli of 0-50 m, >50-100 m, >100-250 m, >250-500 m, >500-1000 m, and >1000 m. These distance annuli are larger than those used by Somershoe (2006). We increased distances to reflect the open sagebrush habitat of this project and the ease of detection for our species of interest due to larger body sizes. In accordance with the recommendations from program DISTANCE, we will record a minimum of 60-100 detections for calculating detection probabilities. If detections at the species levels do not meet this requirement, we will bin species into guilds to increase the number of detections (J. Dinkins, Utah State University personal communication, April 2012).

Spotlight surveys are considered a practical method for assessing relative abundance of nocturnal animals. We will use spotlight surveys to determine the relative abundance of mammalian predators of sage-grouse; and to obtain indices of lagomorph populations. The surveys will follow protocols outlined by Gese (2001) where two observers will each use a 3 million candle power spotlight to scan the area while the vehicle is driven at (16-24 km/hr). Observers will typically locate animals by eye shine. When an animal is detected the vehicle is stopped and individuals are identified with binoculars. The mileage and time of detection is recorded for each sighting. An index of animals/km can then be calculated (Gese 2001). Spotlight counts will be used to estimate population size with line-transect methodology by recording the perpendicular distance to the sighted animal. Transects will be > 10 km and conducted in similar habitats. It is recommended to repeat surveys over several nights (repeated counts) to obtain a measure of sampling error (Gese 2001).

Scat transects are a practical method for determining coyote abundance (Henke and Knowlton 1995). No special equipment is necessary and technicians can be easily trained in proper protocol. Schauster et al. (2002) found scat transects more effective than scent station surveys and second only to mark recapture estimates when determining abundances of swift fox (*Vulpes velox*). Knowlton (1984) reported a high correlation ($r^2 = 0.97$) between scat deposition rates and coyote density estimates when compared to mark-recapture methods using radioisotope detection of feces.

For this study 20 one km scat transects are distributed across each study site. When estimating the coyote population for the state of Wyoming, Gese (2009) conducted scat transects at a rate of 1 transect per 471 km^2.

Transects will begin in July each year and be initially cleared of all scats. We will read transects at 14 days for a single sampling occasion. All scats will be removed from transects 14 days before reading. Transects will be read the same time each year. Knowlton and Gese (1995) identified potential biases associated with scat transects. These biases include an estimated 0.7 detection probability for transects walked once and destruction of scats on heavily travelled roads. Efforts to reduce this bias will include walking transects both directions to increase detection probability. Transects will be located along infrequently accessed two-track roads to reduce the potential destruction of scats by vehicles.

To calculate the coyote density for each site we will use the same equation Gese (2009) used in Wyoming: coyotes/km^2 = 4.9052* scats/km/day.

Data Analysis

Annual survival of radio-marked sage-grouse for this report was calculated using the known fate model within Program MARK (White and Burnham 1999). The sage-grouse included in survival estimates survived for at least one week after being radio-collared to ensure that mortalities are not related to capture myopathy (Spraker et al. 1987). Radio-collared sage-grouse harvested during upland game bird hunting seasons, or found to be illegally taken, will be included in the survival estimates.

Site-specific (including distance from anthropogenic features) and landscape vegetation will be incorporated into the survival analyses as temporal variables. Nest survival will subsequently be modeled using Nest Survival models described by Dinsmore et al. (2002) within Program MARK. Recruitment and λ will be estimated for each study site.

Population vital rates (i.e., survival, recruitment and λ) will be compared for the study sites and other areas in Utah using various landscape and environmental parameters (e.g., vegetation, cover type, patches size, relative to distance from tall structures). Identification of unique relationships between vital rates and environmental parameters such as distances from roads, transmissions lines, and residences can provide insights regarding potential effects of land uses on sage-grouse local populations.

Gradient analysis will be used to assess if relationships exist between distance from landscape features and sage-grouse abundance (via lek surveys) and seasonal habitat-use patterns. The relationship between sage-grouse habitat use patterns (i.e., time of, duration, and frequency of movements and distance moved), and distance from anthropogenic activities will also be calculated. The averages of these differences by distance gradient can be compared against the null hypothesis (H_o=0) using *t*-tests and confidence intervals to test whether a reduction in sage-grouse density different from what would be expected under normal distribution (P=0.05) and to identify the distance at which it occurred.

Results and Discussion

Lek Surveys

We surveyed 32 leks from 18 March to 26 April 2013. Twenty-four leks were located within or adjacent to DLL and the other 8 were within or adjacent to the Three Creeks Study Area. No new leks were located in either study area in 2013. The number of males counted on leks surveyed was lower in 2013 than 2012 for both study areas. On DLL, we recorded a 17% decline in the number of males counted compared to 2012. The 2013 counts were 14% lower than 2012 and

75% of the previous 10-year average. The number of males counted on Three Creeks leks also declined (Figure 2).

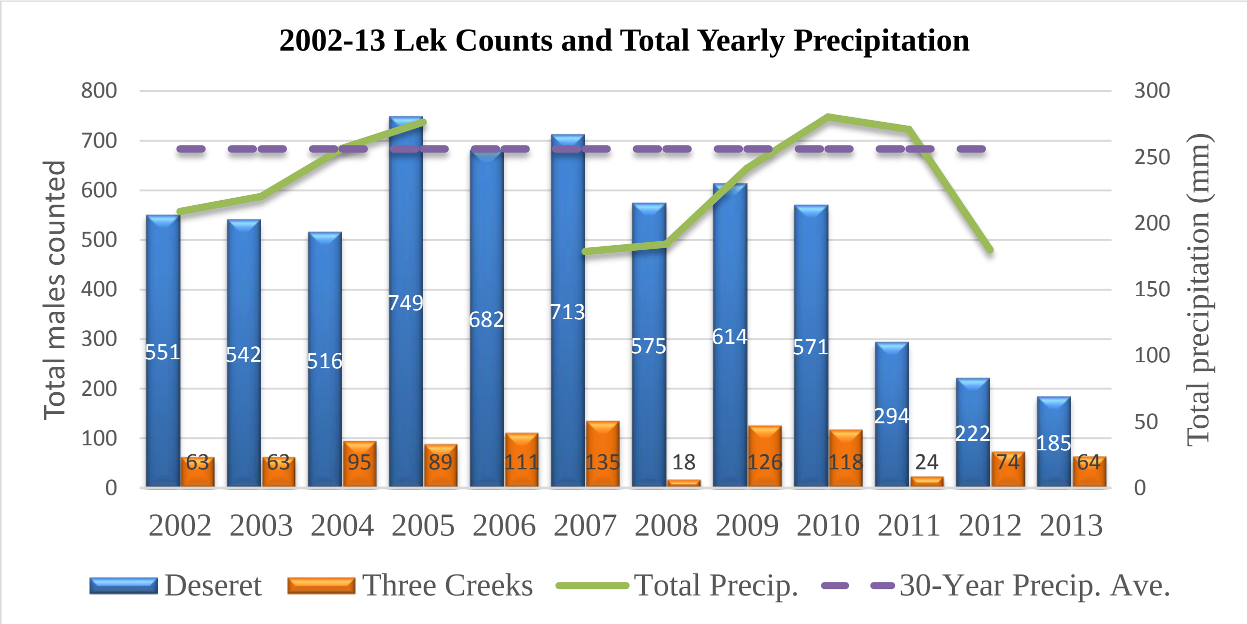

Figure 2. Project area lek counts for 2002-2013 combined with yearly precipitation data. Counts were conducted on 24 and 8 leks on the Deseret LL and Three Creeks Study Areas. Annual precipitation data for 2006 was lacking. Historic lek count data were provided by the Utah Division of Wildlife Resources.

Radio-telemetry Monitoring

In 2013, we began trapping sage-grouse on the DLL and Three Creeks study areas in early March and continued to mid-April. A full-time crew consisting of 2 technicians were stationed at DLL and involved in trapping efforts during March. A second crew of 2 technicians began in April to assist with the increased trapping demands as we approached peak hen attendance at the leks. The second crew of technicians made it possible to have a crew trapping on each study area every night. These intense trapping efforts were critical to achieving study sample size goals (Figure 3). Trapping efforts ended mid-April when hens had dispersed from the lekking areas.

Crews trapped every night of favorable weather and moonlight conditions, resulting in 29 crew nights of trapping efforts for the 2013 season. To address the low 2013 nest and brood sample sizes, which were the result of using hens captured in 2011, we focused all our capturing efforts in 2013 on hens roosting near leks. All of the birds captured in 2013 were fitted with leg bands including any males that were released without radio-collars. We concentrated trapping efforts around lekking areas where we observed the largest number of roosting hens. The only exception to this was a wintering area in the northern portion of DLL where 8 hens were collared. In an effort to distribute collars equally across each study area, we trapped all accessible leks at least once during the season. Capture success in 2013 varied by study site, lek, and night. The highest number of birds captured during one night was eight.

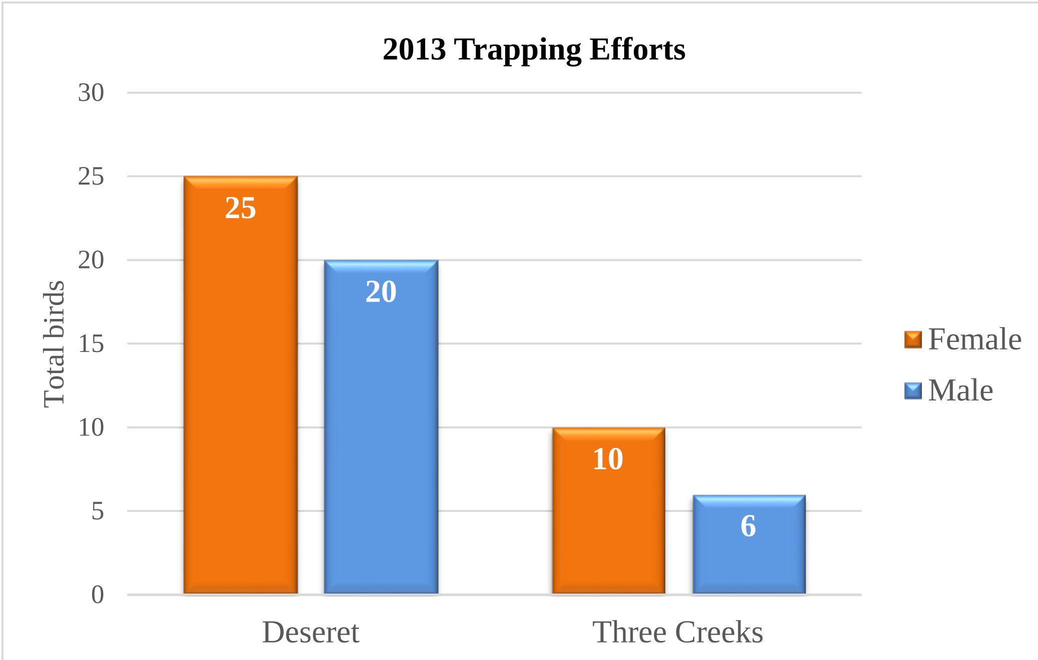

Figure 3. Total number of sage-grouse trapped in 2013 by study area.

On April 15, 2013, we had exceeded annual project goals for the number of hens radio-marked (Figure 4). At this time we had 51 hens radio-marked on DLL (36 adult, 5 juvenile, 10 yearling). The Three Creeks sample size was 43 collared hens (36 adult, 3 juvenile, 4 yearling).

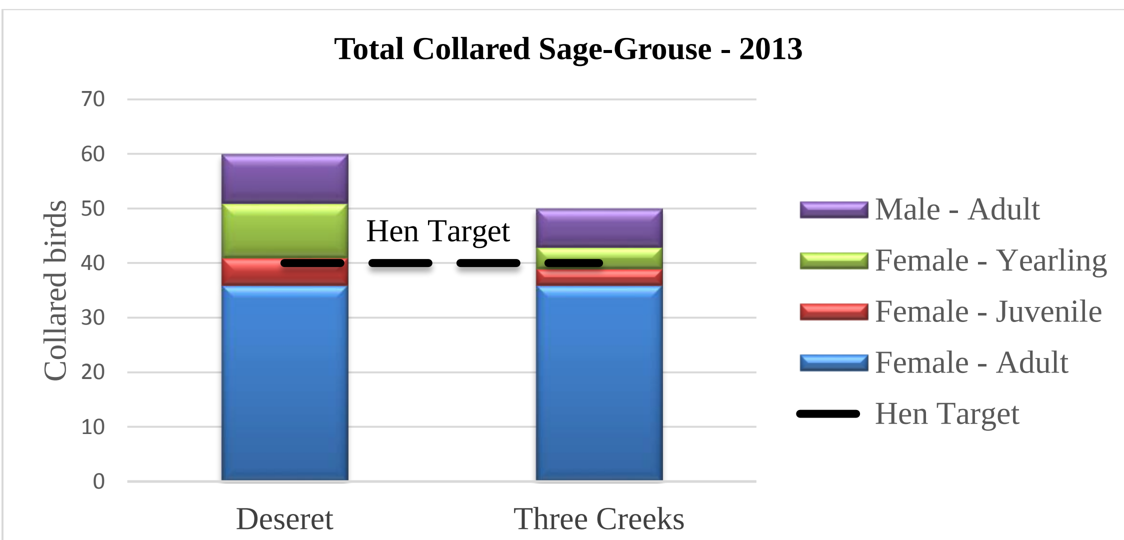

Figure 4. Greater sage-grouse radio-marked on each study area as of 15 April 2013. These totals also include birds and/or mortalities that were previously undetected.

Of the 2013 initial sample size of 51 radio-collared hens from DLL, only 31 (60.8%) were detected within the study area during the nesting season. Sample size difference resulted from 16 missing hens that had either left the study area and/or were undetected mortalities. An additional 4 more hens were observed nesting just north of the DLL boundary (Figure 5).

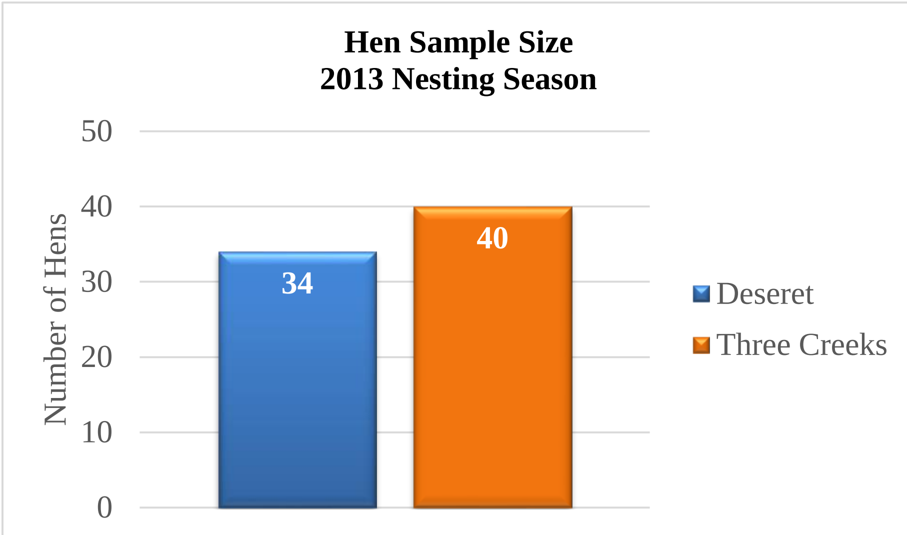

Figure 5. Greater sage-grouse radio-marked hens monitered in 2013 on the DLL and Three Creeks Study Areas.

Of the initial sample size of 43 collared hens from Three Creeks, only 36 (83.7%) were detected within the study area during the nesting season. Sample size differences resulted from 4 missing hens that either left the study area and/or were undetected mortalities. An additional 3 hens were observed nesting outside of the Three Creeks boundary.

Nest Initiation and Nest Success

The start of the nesting season was determined by the date of the first verified nest for that year. In 2012 and 2013 the start of the nesting season occurred on 18 April and 28 April, respectively. The percent of hens initiating a nest during 2012-2013 was below 50% overall for both study areas (Figure 6).

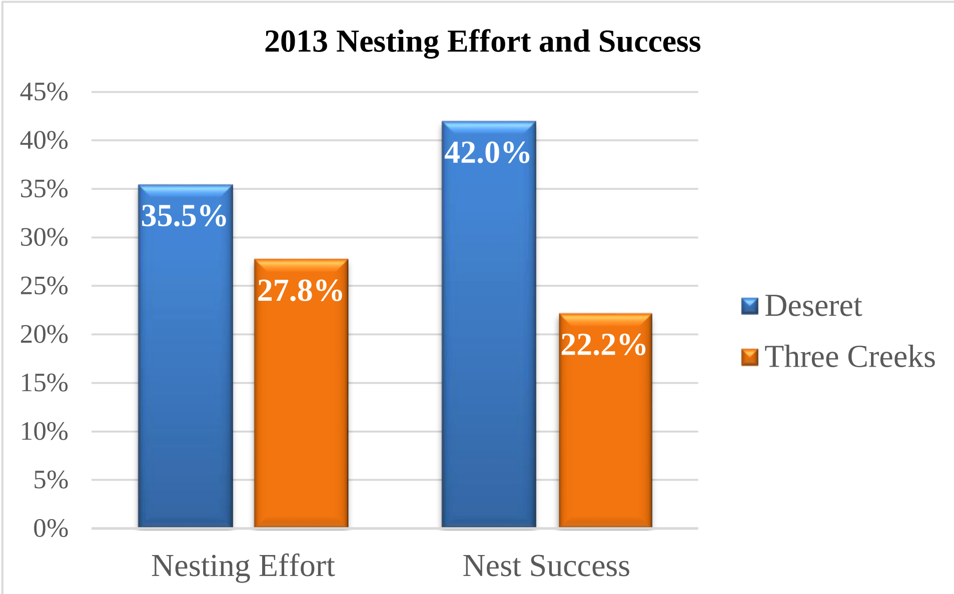

Figure 6. Nesting effort and nest survival results for the DLL and Three Creeks study areas, 2012-2013.

In 2013, eleven of the 31 radio-collared hens (42%) on DLL initiated nests, of which 4 were successful. On the Three Creeks Study Area, ten of 36 radio-collared hens (22.2%) initiated nests in 2013, of which 4 were successful. One hen on Three Creeks re-nested with both attempts resulting in depredation. No hens were observed re-nesting in either study area in 2012.

We used the Nest Survival model in Program MARK to calculate both daily nest survival and total nest survival for each study area. Nest survival in 2013 was higher on DLL compared to Three Creeks. Overall, nest survival decreased on both study areas compared to the previous year. In 2013, DLL had 42% nest survival compared to 58% in 2012. In Three Creeks, we calculated a nest survival of 22% this year compared to 31% for 2012.

Greater Sage-grouse Movement Distances from Capture Leks

In both 2012 and 2013, we recorded radio-collared birds making relatively large movements from the leks where they were captured. Hen dispersal distances from capture leks ranged from less than 1 km to 68 km (Figure 7). To locate missing birds we conducted extensive searches during three aerial telemetry flights. These flights covered roughly 250,000 ha but were only successful at locating 8 missing birds. Search efforts outside of the study area involving telemetry by ground crews were limited because of fieldwork demands for data collection within the study areas.

Notable movements included a juvenile hen collared on DLL that we recorded nesting 50 km from the lek she was captured near the western shore of Bear Lake. In 2012, we recorded a hen dispersing from the southern portion of Three Creeks beyond Bear Lake in the north for a distance of 68 km. In March 2013, this same hen was observed in northern Deseret. The distance between the hen's 2012 summering area and that used in the spring of 2013 totaled 83 km.

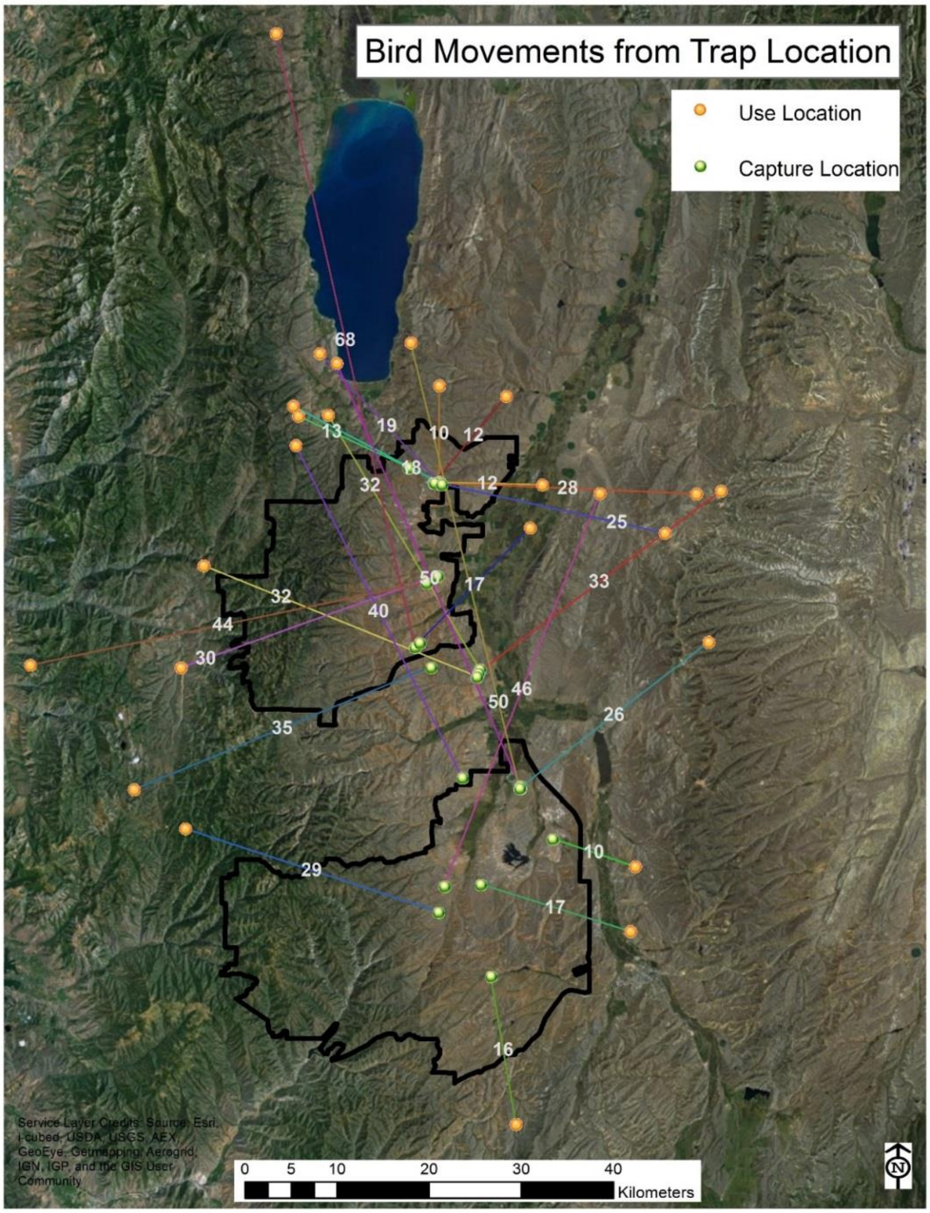

Figure 7. Dispersal of sage-grouse from trap location. Movements shown are for birds that were subsequently located outside the study areas. Birds remaining within the study areas are not displayed. Each point marks the farthest location where each bird was subsequently located. Each line represents an individual bird. Distances provided in kilometers.

Brood Success

In 2013, only eight successful nests were observed across both study areas (DLL n=4, Three Creeks n=4). Of these, 8 successful nests, only one brood in DLL survived to 42 days. The low nest and brood sample sizes resulted from low nest initiation and success in 2013. This occurred despite exceeding sample size goals for 2013.

Survival

We calculated sage-grouse survival rates for each study area for the period including 1 September 2012 to 31 May 2013. In our initial analysis, we combined both sexes and all age classes. Calculated overall survival rates for Deseret LL were 83% during the analysis period. This is down slightly from 87% in 2012. Three Creeks had a higher survival rate near 90%. This is a similar survival rate to the observed survival rates in 2012 (see Figure 8).

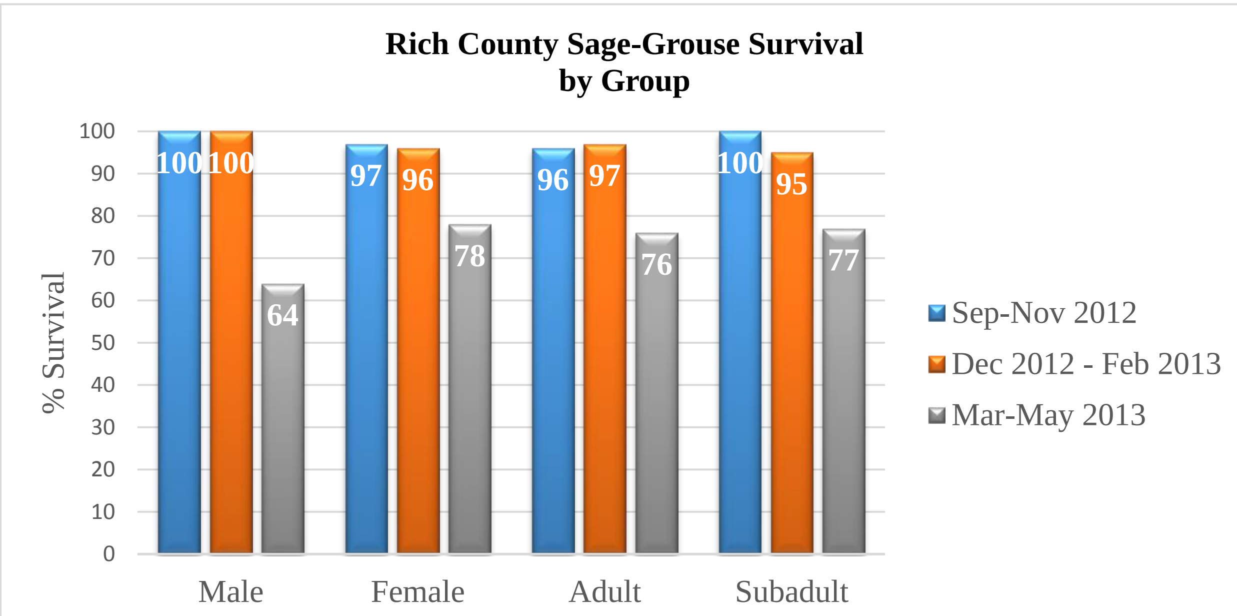

Figure 8. Greater sage-grouse rates by age, sex, and season for the DLL and Three Creeks Study Area, 2012-2013.

Vegetation Habitat Metrics

In 2013, we monitored 23 nest sites across both study areas (DLL n=12, Three Creeks n=11). We completed vegetation surveys at all nest sites to determine site structural habitat characteristics. We paired each nest site with a randomly generated site occurring within the same pasture. We assume that since each paired nest and random site are located in the same pasture, they are subject to the same level of grazing pressure. We will use the data collected on random sites in determining differences in hen selected nest sites and randomly generated sites.

We also conducted vegetation surveys at 25 brood sites for each study area. Methods to survey brood sites were similar to those of nests. Each brood site was paired with a randomly generated survey site within the same pasture. Broods were located 3-5 times a week. The time that was required to survey a particular brood site was highly variable. Brood sites in open or grassy habitat were surveyed relatively quickly. In 2013, we located many of our brood sites at higher elevations in sites dominated by thick stands of brush and aspen. These sites were difficult to access and time consuming to read. Given the difficulty that we experienced surveying these sites, it was not possible to conduct vegetation sampling for every known brood location. Technicians were also tasked with predator surveys, brood counts, and continual monitoring of other birds throughout the season. This further limited the time available for vegetation surveys. Despite these other responsibilities and demands, our crew completed 146 vegetation surveys.

Predator Surveys

In 2012, to estimate coyote abundance we surveyed 5 scat transects in each study area. This initial sampling effort was based on transect densities for the study area. In 2013, we increased the number of scat transects to 20 for each study area (Figure 9).

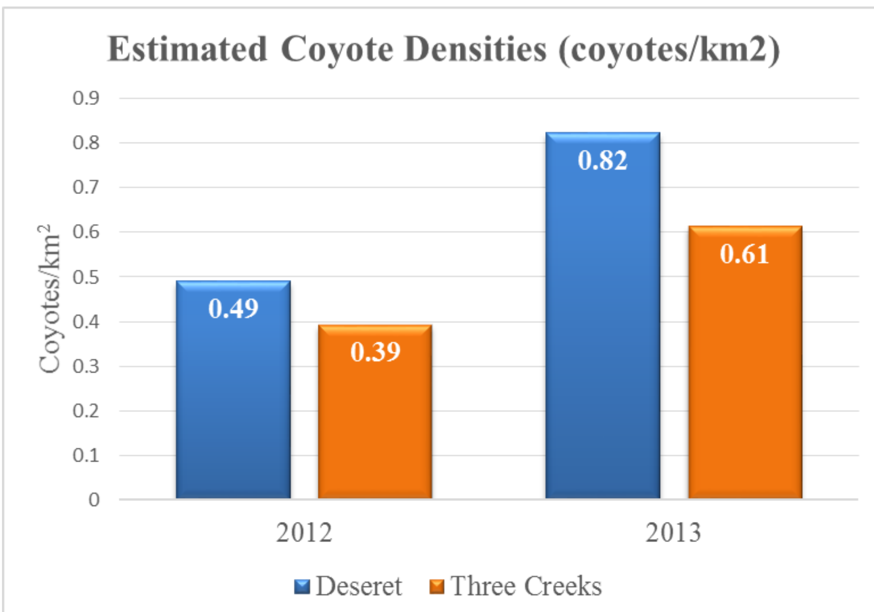

Figure 9. Estimated calculated coyote densities based on transect counts. Counts in 2012 were based on 5 transects in each study area. In 2013, 20 transects were counted in each study area.

Corvid surveys were conducted using protocols outlined in the methods section. In 2012, 7 sampling periods were completed with 5 sampling periods in 2013. Yearly corvid counts were compared by combining these species and then calculating an average number of corvids per transect (Figure 10). We observed the largest difference in Three Creeks with a seven-fold difference between sampling years. Much of this difference can be accounted for by several

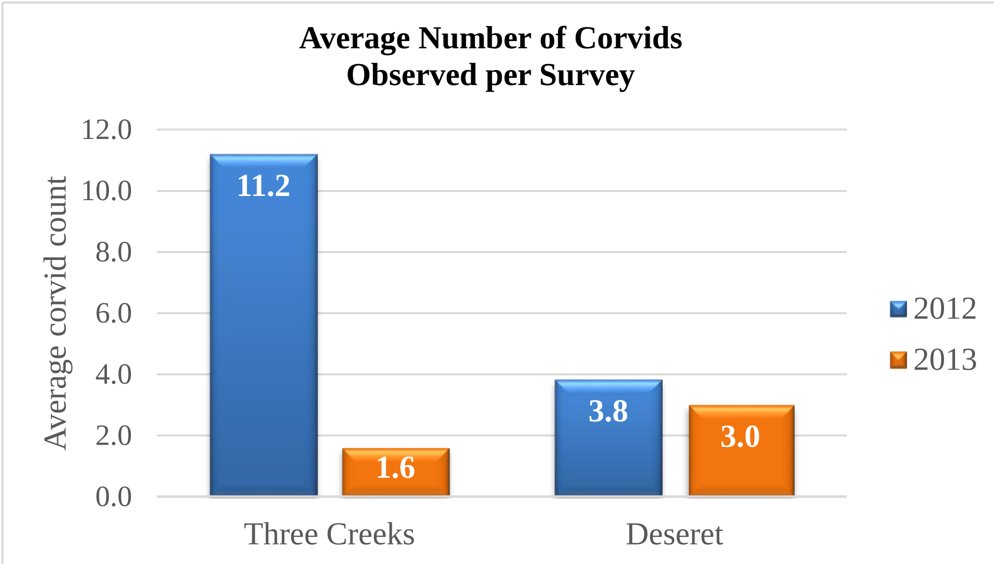

Figure 10. The average number of corvids counted for each transect by study area, 2012-2013.

groups of >10 corvids observed in 2012. There were no observations of groups of >2 corvids made in Three Creeks in 2013. Groups of >4 corvids were never detected in DLL regardless of sampling year.

Preliminary Conclusions

In 2013, although we increased the number of radio-marked hens beyond project goals, the observed low nesting propensity (~32%) and low brood survival on both study areas affected our final sample size of both nests and broods. Hen dispersal in both years increased the difficulty of locating birds and the likelihood that hens would nest outside of the study area. In 2013, 6 hens were observed nesting outside of the study area. Nests occurring outside the study area boundaries were excluded from our analyses.

To address issues with missing birds we conducted 3 telemetry flights throughout the season. The total area covered by these flights was roughly 250,000 ha. Although this effort provided important information about seasonal bird movements, it did not result in recovery of all the missing birds. In 2013, we also focused exclusively on trapping hens on lekking areas (with a single exception). We believe that this can increase the number of potentially resident hens when compared with trapping large wintering grounds. Despite our effort, a large number of radio-collared hens still dispersed from the study areas.

To better understand dispersal and long distance movements of sage-grouse in Rich County, we intend to increase the sample size goals of radio-marked hens and number of flights in 2014. We also recommend replacing 5-10 necklace-style collars with GPS transmitters on hens known to make large seasonal movements. We have observed birds captured in Rich County travelling between Utah, Idaho, and Wyoming. Location information provided by GPS transmitters would help us understand the interstate movements of this population and provide decision makers with better sage-grouse home size and range information in this tri-state area.

Lower lek counts in 2013 may be in part due to poor chick production and survival in 2012. It is also possible that continuing drought conditions affected lek counts in 2013. Precipitation levels in 2012 for Rich County were below the 30-year average. The very dry spring could have led to low forb production and the resulting poor chick survival that we observed that year. The exception to the low precipitation year was a very wet July. The cause of poor chick survival in 2012 might have been the combination of initial low forb production and high precipitation levels, which can lead to greater chick mortality from exposure (Guttery et al. 2013). To analyze the strength of these relationships, we will include weather data and NDVIs indices to determine the potential effects on vital rates.

Our overall observed chick survival was lower in 2013 compared to 2012. However, 77 random broods were located across both study areas. These broods contained from one to 8 chicks. Because these were un-collared hens, the actual number of unique random broods is unknown. We mapped these brood locations in ArcGIS and overlayed them with the SWReGAP data layer. We found 70% of these brood locations were occurring in areas classified as Montane Sagebrush Steppe. These locations are composed mostly of mountain sagebrush (*A. t. vaseyana*) mixed with bitterbrush (*Purshia tridentata*), mountain snowberry (*Symphoricarpos oreophilus*), Utah serviceberry (*Amelanchier utahensis*), and rabbitbrushes (*Chrysothamnus spp.* and *Ericameria spp.*).

We assume there are likely a number of successful broods in both study areas that are surviving to independence. However, because they are from unmarked hens we do not capture them in our data.

2013-2014 Work Plan

A more detailed analysis of habitat characteristics will begin fall 2013. Using the programs outlined in the methods section, we will estimate vital rates for each study area and explore any potential correlations between these rates and habitat characteristics.

We will examine habitat use and home range sizes using Geospatial Tools in ArcGIS. Seasonal patterns and dispersal from trap locations and wintering grounds will be determined and used as a guide in future trapping efforts.

Based on the lower than expected nest and brood sample sizes this season, we plan to increase the number of collared and available hens next year. We will accomplish this using several methods. First, we plan to trap additional hens during fall 2013. This should increase the likelihood that collared hens are likely to be resident hens. Trapping will also take place in spring of 2014 to replace any over-winter mortalities, lost birds, or failed transmitters. If the number of available collars allows, we will attempt to increase 2014 initial sample size to a minimum of 50 hens for each study area. Preliminary results will be presented at local and regional conferences and at future local Rich County CRM meetings.

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