2014 ANNUAL REPORT

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

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Cooperators

Bureau of Land Management

Deseret Land and Livestock

Intermountain West Joint Venture

Natural Resources Conservation Service Sage-grouse Initiative

Pheasants Forever, LLC.

Rich County Commission

Rich County Coordinated Resources Management

US Fish & Wildlife Service

US Forest Service

Utah Department of Agriculture and Food

Utah Division of Wildlife Resources

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 mi² (29,821 km²) 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 livestock 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 research is to scientifically document sage-grouse individual and population responses to habitat and vegetation differences that may occur under prescribed grazing and season-long grazing practices on paired study sites in Rich County, Utah. Specific questions to be addressed in our research objectives include:

1) Do sage-grouse vital rates differ between areas managed under prescribed and traditional season-long grazing practices?

2) Does sage-grouse habitat composition and quality differ based on prescribed rotational or season-long grazing practices?

3) Do sage-grouse seasonal habitat-use patterns differ under prescribed rotational and season-long grazing practices?

4) 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 Rich County. The first study site is 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 federal BLM lands located in the lower elevations. The DLL study area 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 BLM and USFS grazing allotments and private lands that are generally managed under season-long grazing practices.

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 (Banner et. al 2009; 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 was originally designed as a paired site study with 2 distinct phases implemented over 4 years (2012-2015). Phase 1 was scheduled for 2012 through 2013 and evaluates the impact on sage-grouse populations between the 2 grazing treatments under a paired site study design. In this phase DLL is the treatment and Three Creeks the control. Phase 2 was to begin in January 2014 when Three Creeks would implement a grazing management change from season-long to rotational prescribed grazing practices. This second phase would have applied a Before-After Control-Impact (BACI) study design where two years of pre-treatment data for Three Creeks to two years of post-treatment data will be compared. Unfortunately the anticipated grazing management change in Three Creeks and the corresponding shift to Phase 2 of the study has been delayed. This study will instead continue as a paired site study through 2015 comparing DLL and Three Creeks grazing practices.

Lek Trends

Lek routes have been used as an alternative method for obtaining indices of breeding sage-grouse males. We survey lek routes and count the number of males strutting on leks during the spring lekking season and will continue each spring through 2015. The resulting indices will be used to track sage-grouse population trends for each study site. Lek surveys follow the Utah Department of Wildlife Resources (UDWR 2009) protocols and were conducted from late March through early May. Leks were visited a minimum of 3 times during the breeding season. All lek counts were conducted within 0.5 hour before to 1.5 hours after sunrise. Designated lek routes were counted on the same mornings. All 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 all individuals observed at the lek. Observing from this distance prevented observers from disturbing lekking activities. Peak attendance for each lek was calculated using the highest male count during the season.

Radio-telemetry

The initial sample size objectives for radio-collared sage-grouse was 60 juvenile and adult, male and female sage-grouse at each site (approx. 40♀ and 20♂, n =120). This initial goal was achieved for 2012. Because we are interested in comparing sage-grouse vital rates between the treatments, we increased our nesting and brooding sample size by focusing exclusively on radio-collaring hens. 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.

All captured birds were aged, sexed, and weighed, with wing and tarsus measurements taken. Age and sex were determined based on feather characteristics and molt patterns (Eng 1955, Crunden 1963). All captured birds, 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. All birds were released at their point of capture.

To maintain desired sample size, new radio-collars were deployed on additional birds 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 50 days after hatch to quantify nest and brood-rearing success. Movement and home range estimates will be calculated using Spatial Analyst tools in ArcGIS Desktop (Environmental Systems Research Institute, Inc., Redlands, CA).

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

Data obtained by tracking radio-collared grouse were used to assess vital rates and habitat use. Radio-marked females were located twice weekly during the spring until time of nest initiation. We also used telemetry software (LOAS) to estimate hen 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 transmitter to locate 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 passed a visual check for predators. A GPS point was recorded for all nests with the nest remotely monitored several times a week until hatch or failure of the nest.

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 within that study site at the onset of the 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 survival was calculated using the Nest Survival model with Program MARK. This model takes into account both the time of first detection and number of days a nest was monitored.

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. We calculate nest site fidelity 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 were approximately 50 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 50 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 50 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. Broods were followed until independence in July/August. From October 2014 to March 2015 we will conduct a series of aerial telemetry flights to locate radio-collared sage-grouse. We attempted to locate male and female sage-grouse without broods biweekly from March to August 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 composition responses to grazing treatment will be assessed with vegetation surveys in each study site. Because the research is focused on hens and their reproductive success, vegetation surveys were based on the location of nesting sites and subsequent brood locations of radio-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 generated within the same pasture as the actual nest or brood location. This will ensure that random sites occur within areas that are subject to the same potential grazing pressure of the actual nest or brood location. To avoid sampling inappropriate random sites (roads, bodies of water, cliffs, etc.) all generated paired random points were overlaid on satellite imagery with those points determined not appropriate for sampling censored.

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 used 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, AF2). Samples of all 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 might impact productivity. Where possible, we will attempt to monitor dietary selection of individually radio-marked sage-grouse and collect samples of sagebrush eaten by that individual. We will collect samples from February to March from browsed and random non-browsed shrubs (within 1 m) of the same subspecies and analyze 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, Idaho Department of Fish and Game, 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 our analysis.

In the case of adult sage-grouse mortalities we examined 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, disease, etc.). In the event that bones and feathers are broken or matted (i.e., chewed), cause of death was attributed to a mammalian predator. If a mammalian predator is implicated, the surrounding area was searched for sign of hair, scat, tracks or evidence of a den to help 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 was attributed to an avian predator. In cases of avian predation, known raptor nests and perches were 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). If the evidence or information at the mortality site was insufficient to determine the cause of death, the event was designated as 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 information may be more important than documenting the specific predator. Changes in abundance of avian, mammalian, and primary prey are being monitored using standardized transects in the treatment and control areas using methods outlined by Garton et al. (2005). Monitoring trends of potential sage-grouse predators in concert with changes in vital rates in the study areas may 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 while also 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. These routes are surveyed 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, 51-100 m, 101-250 m, 251-500 m, 501-1000 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 the study areas 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, species may be binned 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 conducted spotlight surveys to determine the relative abundance of mammalian predators of sage-grouse; and to obtain indices of lagomorph populations. The surveys followed protocols outlined by Gese (2001) where two observers used a 3 million candle power spotlight to scan the area while the vehicle is driven at (16-24 km/hr). Observers located animals by eye shine. When an animal was detected the vehicle was stopped and a visual identification was obtained using binoculars. The mileage and time of detection was recorded for each sighting. This information will be used to calculate an index of animals/km (Gese 2001).

Spotlight counts were used to estimate population size with line-transect methodology by recording the perpendicular distance to the sighted animal. Transects were > 10 km in length and conducted in similar habitats. These surveys were repeated 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 were distributed across each study site. The transects were read each July and initially cleared of all scats. The transects were read again at 14 days for one sampling occasion. Knowlton and Gese (1995) identified potential biases associated with scat transects. These biases included an estimated 0.7 detection probability for transects walked once and destruction of scats on heavily travelled roads. Efforts to reduce this bias included walking transects both directions increasing the detection probability. Transects were located along two-track roads to reduce the potential destruction of scats by vehicle traffic.

To calculate the coyote density for each site we used 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 were 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, were included in the survival estimates. Nest survival was modeled using the Nest Survival models described by Dinsmore et al. (2002) within Program MARK.

At the conclusion of the study in fall 2015, 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, electric transmission and distribution power 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 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.

Preliminary Results and Discussion

Lek Surveys

We surveyed 9 leks within the Three Creeks Study Area from 29 March to 01 May 2014. Counts for an additional 16 leks within DLL were conducted by DLL staff. The NRCS also provided assistance collecting additional counts in the Three Creeks Study Area. This year we discovered a previously unknown lek within the Grey Hills area of Three Creeks. We are working with the DWR to coordinate information regarding this lek.

The average number of males counted per lek was higher in 2014 DLL compared to the previous 2 years. These counts represent an approximate 25% increase from 2013. Average counts for Three Creeks were lower compared to the previous 2 years. Despite the increase in lekking males counted in DLL, the overall counts in 2014 for both study sites were below 10-year averages (28 DLL, 18 Three Creeks).

In sagebrush-steppe ecosystems, precipitation plays a large role as a driver of plant species abundance and composition. This affects sage-grouse habitat quality and ultimately sage-grouse population vital rates. Thus, we have included local precipitation data for each of our study areas in this report (Figure 1). These data suggest a trend between lek counts and yearly precipitation.

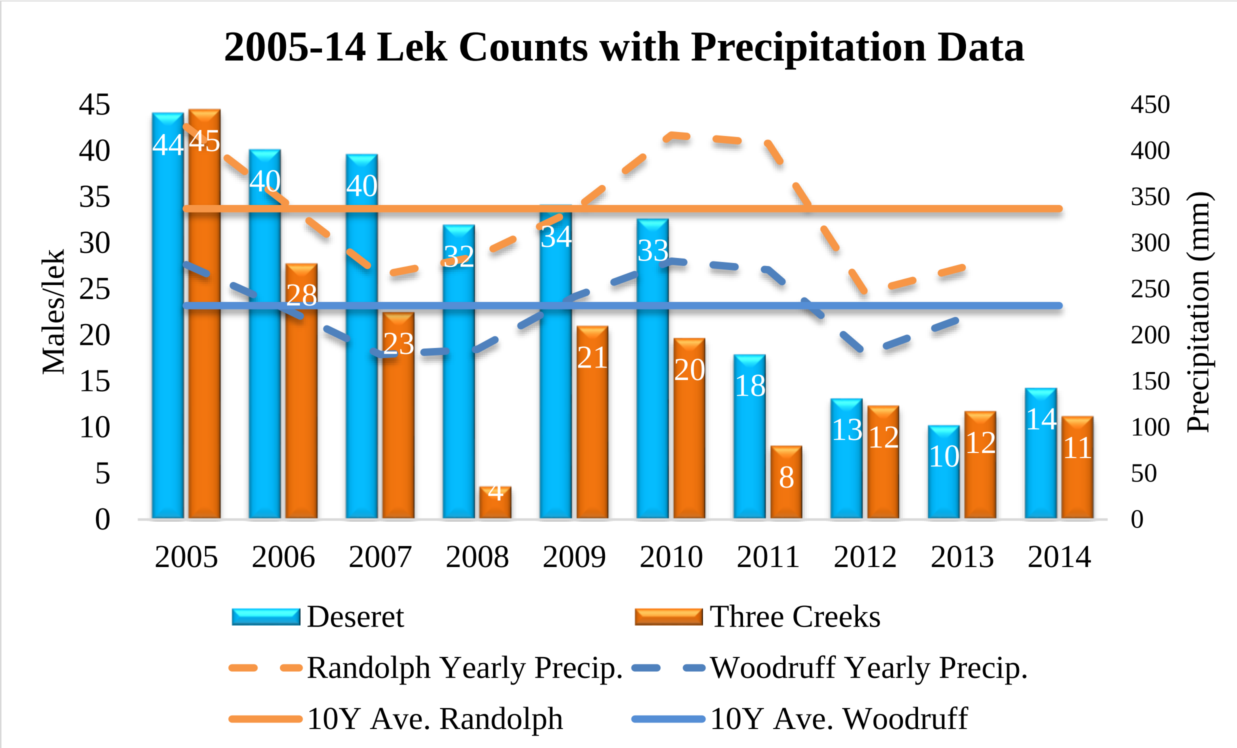

Figure 1. Project area lek counts from 2005-2014 combined with the yearly and 10-year average precipitation data for each study area. In 2014 counts were conducted for 16 and 10 leks within the DLL and Three Creeks study areas. Lek count data was provided by the UDWR. Climatic data was collected at GHCN stations in Woodruff and Randolph, Utah, and accessed through the Utah Climate Center website (https://climate.usurf.usu.edu/).

Trapping and Radio-Collaring Efforts

In 2014, we trapped sage-grouse across both study sites from late February until mid-April. A full-time crew consisting of 2 technicians were stationed at DLL for the trapping efforts starting in February. A second crew of 2 technicians began in late March and continued until mid-April to assist with the increased trapping demands as we approached peak hen attendance at area leks. The second crew of technicians made it possible for us to have a crew trapping on each study area each 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 34 crew nights of trapping efforts for the 2014 season. To maximize nest and brood sample sizes we focused all our capturing efforts in 2014 to hens roosting near project area leks. All birds captured in 2014 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 2 hens were collared. In an effort to distribute collars equally across each study area, we trapped on all accessible leks at least once during the season. Capture success in

2014 varied by study site, lek, and night. The highest number of birds radio-collared in a single night was fourteen.

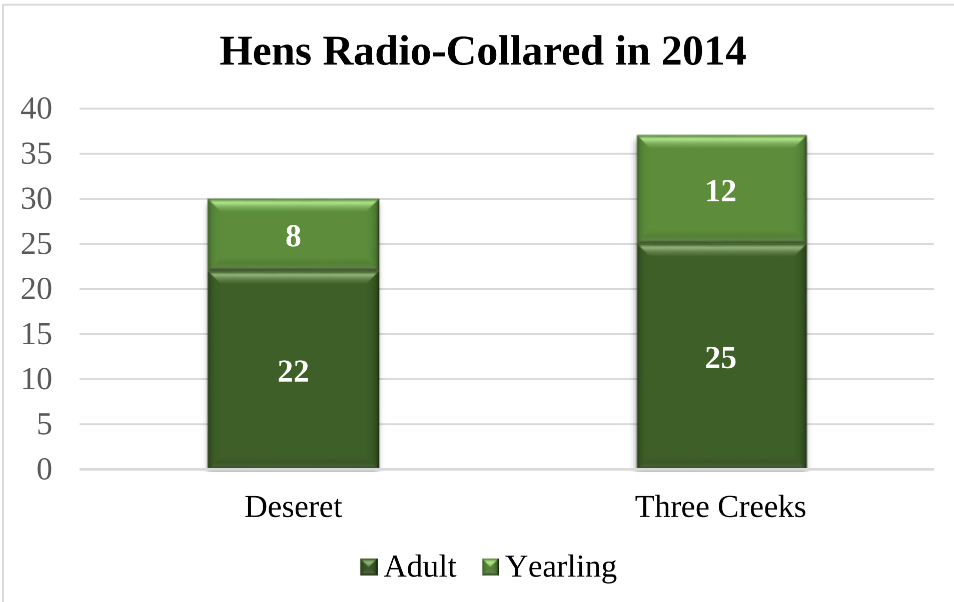

Figure 2. Sage-grouse females radio-collared in each study site for spring 2014.

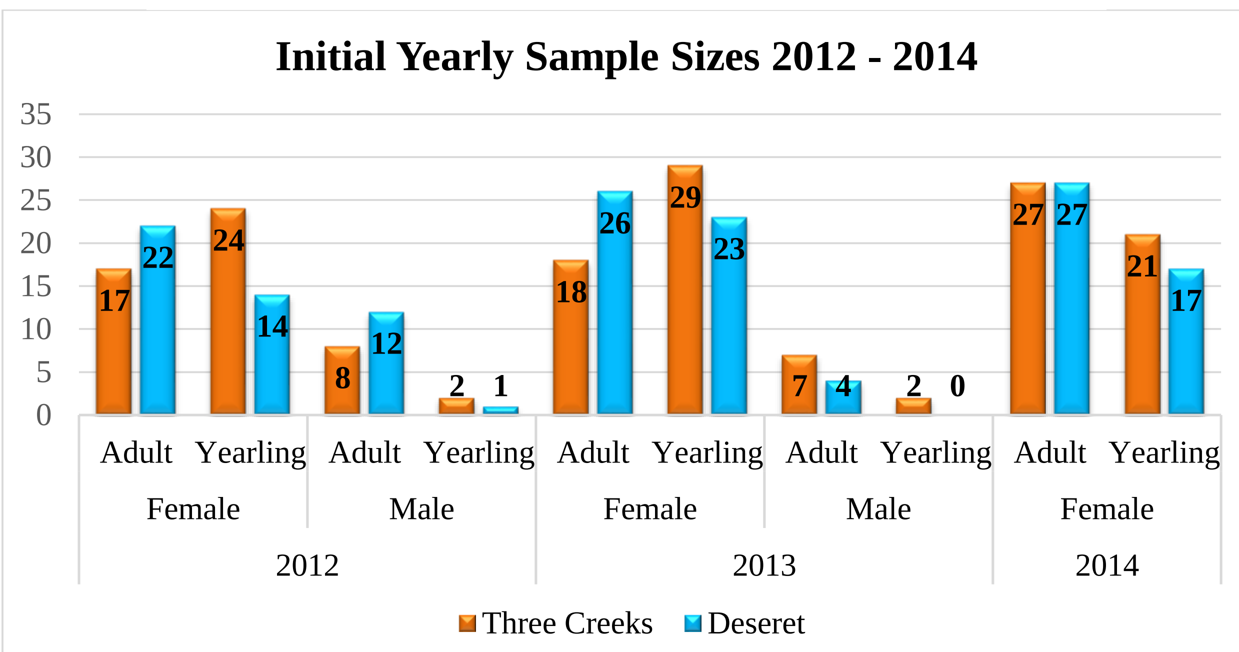

Figure 3. Initial yearly sample sizes by sex and age class for 2012-2014. Totals may also include birds that were missing and/or mortalities previously undetected.

Nest Initiation and Nest Survival

The start of each nesting season is determined as the date of the first verified nest that year. In 2012, 2013, and 2014 the start of the nesting season occurred on 18 April, 28 April, and 12 April respectively. This is the earliest nesting season that we have seen to date.

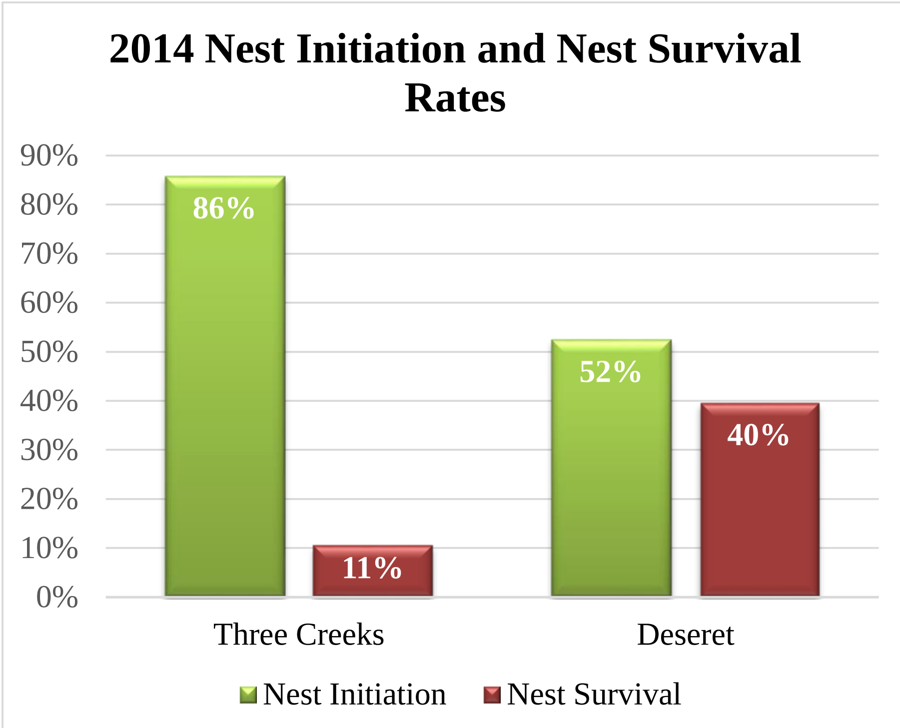

Figure 4. Nest initiation and nest survival results for Three Creeks and DLL study sites, 2014.

In 2014, twenty-four of 28 radio-collared hens (86%) in the Three Creeks study site initiated nests. Three of these hens attempted to re-nest for a total of 27 nests, seven of which were successful at hatching at least one egg. In DLL eleven of 21 (52%) radio-collared hens closely monitored in the study area initiated nests this year. Of these nests 6 hatched successfully. No hens were detected re-nesting in DLL.

We used the Nest Survival model in Program MARK to calculate daily nest survival. The estimated daily survival rate was then raised to the power of 34 to account for a 7 day laying cycle and 27 day incubation time. Despite a lower initiation rate, nest survival in DLL (39.5%) was nearly 4x that of Three Creeks (10.6%).

Brood Success

In 2014, we monitored 13 radio-collared hens with broods across both study areas. Of these broods, 7 were located in Three Creeks and 6 in DLL. Each study site also had one brood that could not be relocated at the 50 day brood check despite multiple attempts. Both of these broods were observed alive during the week prior to the final 50 day count. It is possible that these broods survived to day 50 but were censored from our analysis because we could not verify success. We observed 4 successful broods surviving to independence (≥50d) in Three Creeks

(67%) and 4 successful broods in DLL (80%). This was a significant increase from the previous 2 years where the highest brood success rate was 25% for DLL.

Survival

We calculated sage-grouse survival rates in each study area for the spring (01 March – 31 May)

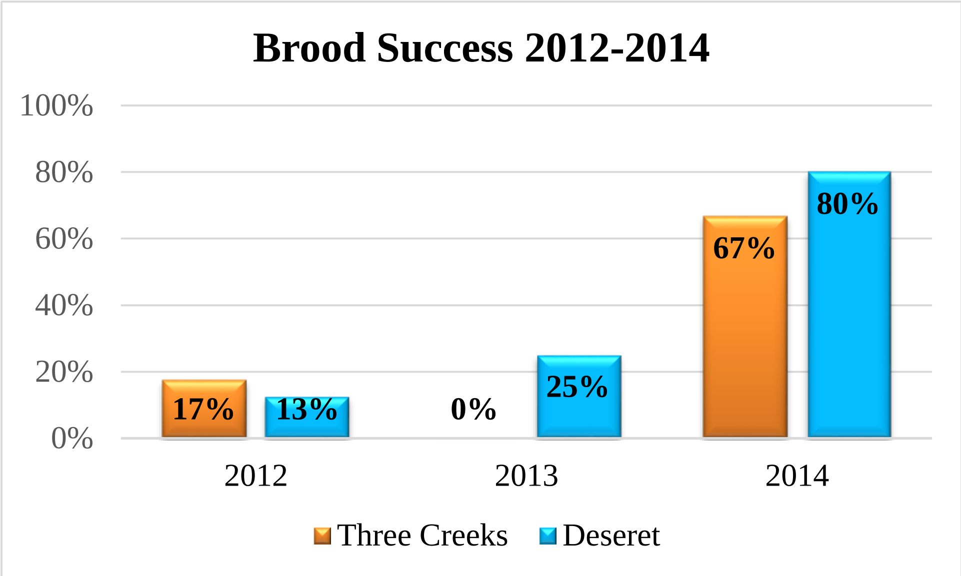

Figure 5. Brood success by study site for 2012-2014. One brood from each study site was censored from the 2014 estimates because brood fate could not be verified at day 50.

and summer (01 June – 31 August) time periods for 2012 – 2014. Limited field access and monitoring efforts in winter prevented us from reporting accurate survival rates for the winter period. In our analysis, we combined both sexes and all age classes. We plan to conduct a more complex analysis using RMark in September-October of this year, which will investigate a multitude of covariates.

We calculated an overall survival rates for DLL near 97% for spring and summer 2014. This is up from an estimated 87.5% in 2013. Three Creeks had a slightly lower survival rate compared to DLL at 95% for the same period in 2014. This is also an increase from our 2013 estimated 89% survival rate (see Figure 6).

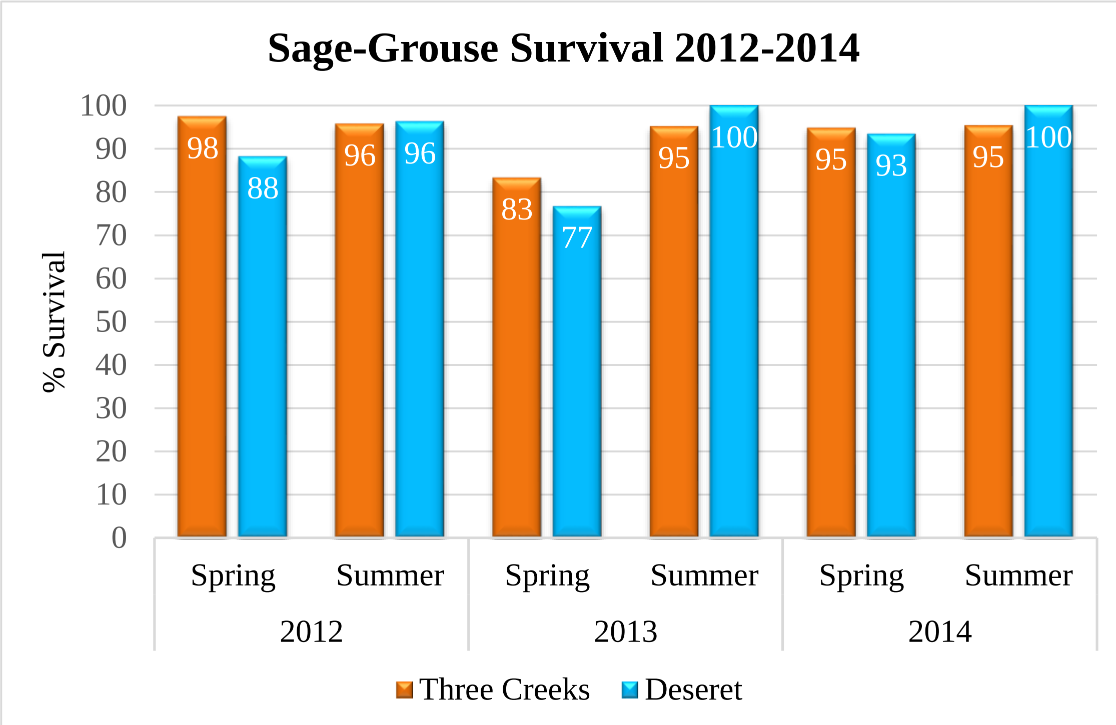

Figure 6. Sage-grouse spring and summer survival rates for Three Creeks and DLL 2012-2014.

Vegetation Habitat Metrics

In 2014, we monitored 37 nest sites for radio-collared hens across both study areas (DLL n=11, Three Creeks n=26). We completed vegetation surveys at all nest sites to determine site structural habitat characteristics. Each nest site was paired with a randomly generated site occurring within the same pasture. We assume since each paired nest and random site are located in the same pasture, they are theoretically subject to the same potential 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 in DLL and 23 in Three Creeks. Methods for surveying 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 amount time required to survey a particular brood site was highly variable. Brood sites in more open and grassy habitat could be surveyed relatively quickly. In the later brood-rearing season we located many of our broods at higher elevations in sites dominated by thick stands of brush and aspen. These sites were both difficult to access and time consuming to read. Given the difficulty experienced surveying many of 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.

Predator Surveys

In 2012, to estimate coyote abundance we established 5 scat transects in each study area and surveyed each transect on 2 occasions. This initial sampling was based on an effort to achieve transect densities greater than those used by Gese in his estimation of coyote densities in Wyoming (2009). In a subsequent discussion with Gese regarding sampling design we concluded that a more accurate coyote density estimation could be achieved by increasing transect density and reducing sampling occasions to once per season. Starting in 2013 we implemented this change by increasing the number of scat transects in each study area to 20.

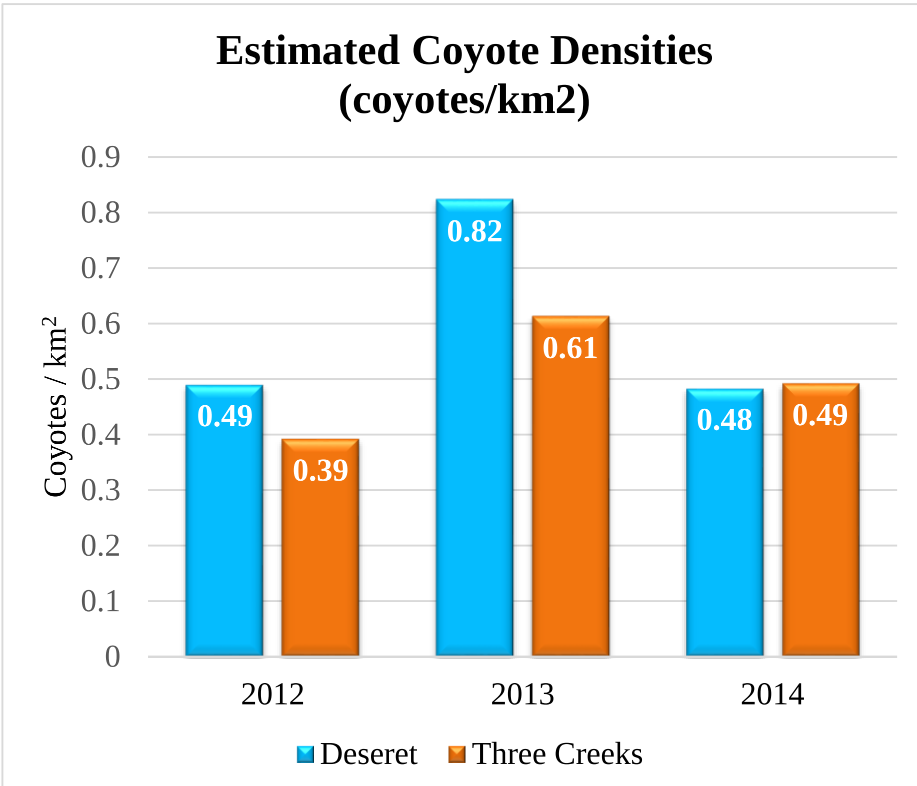

Figure 7. Comparison of estimated coyote densities between study sites for 2012-14. In 2012 5 transects within each study site were surveyed. For 2013 and 2014 estimates, we increased the number of transects for each study site to 20 transects.

Avian predator surveys were conducted following protocols outlined in the methods section. In 2012, 7 sampling periods were completed within each study area. In 2013-14 Three Creeks was sampled on 7 occasions and DLL on 5. Yearly raven averages were calculated by summing the number of raven observations for each study area and dividing by the total number of sampling days for that year (Figure 10). We observed the greatest difference in yearly averages in the Three Creeks study area with an eleven-fold difference between 2013 and 2014. Potential explanations for this difference might include raven control efforts conducted by USDA Wildlife Services within the county. We will be looking at this possibility in more depth in a later analysis. DLL has maintained raven averages across all years despite control efforts deployed there in spring 2014.

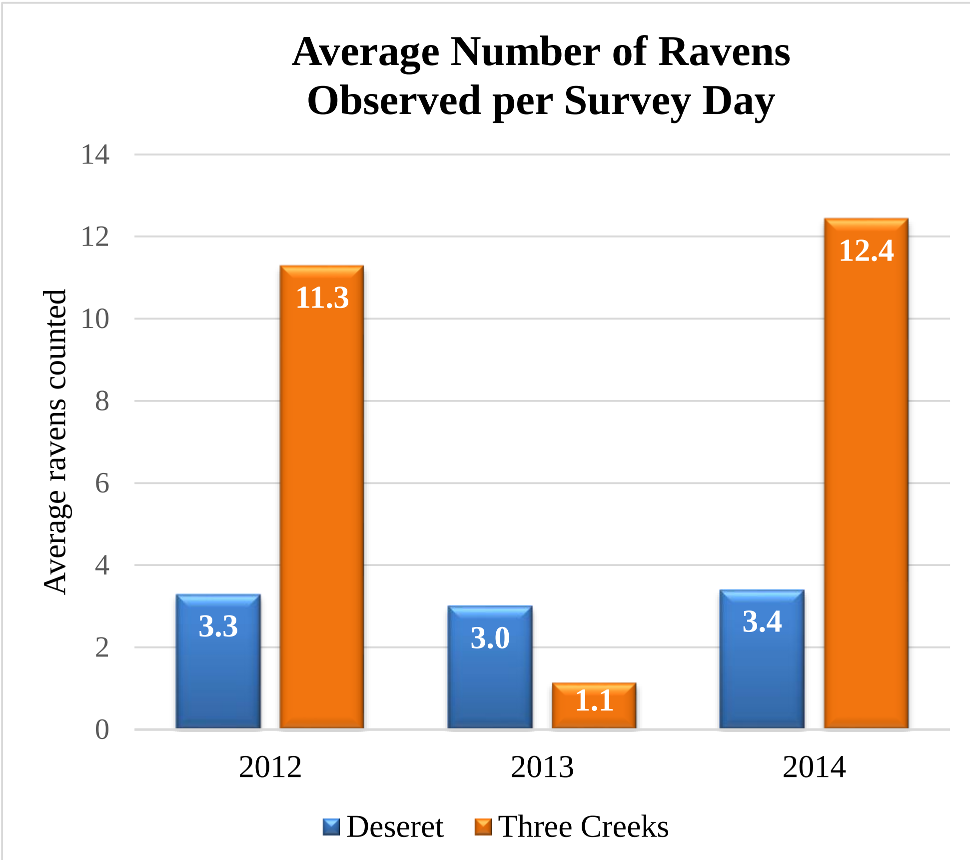

Figure 8. Average number of ravens observed per survey day compared by study area for 2012-14.

Preliminary Conclusions

Despite the slight decrease from the previous year in lek counts for Three Creeks, overall lek counts within the entire project area increased compared to 2013. Annual precipitation has also been slowly increasing in the area following 2012, one of the lowest annual precipitation years in the past decade.

Radio-collaring efforts in spring 2014 were successful with 30 hens radio-collared on DLL and 37 on Three Creeks. The high number of newly radio-collared hens helped us to exceed project sample size goals of 40 radio-collared hens on each study site. At the start of the 2014 season, we had 48 radio-collared hens from Three Creeks and 44 radio-collared hens from DLL. To increase the time each transmitter is on air and the length of time each bird could be tracked, we switched from ATS brand transmitters to Holohil Systems Ltd. Based on manufacturer's specifications this provides an increase of 441 days to the nominal life. We anticipate these transmitters will continue to function beyond the projected end date of the project in 2015 and therefore allowing radio-collared hens to remain on air and available for other potential follow-up research.

Nest initiation rates for both areas were up from the previous 2 years at 86% in Three Creeks and 52% in DLL. There are several potential reasons for the observed differences between study areas including nesting hen age class. We will be looking into this and other possible reasons in winter 2014.

Estimated nest survival rates also varied between study sites. While our hypothesis is that DLL exhibits higher rates of nest survival, the observed 3.5 fold difference was unexpected. When combined with nesting initiation rates, these results suggest that sage-grouse on Three Creeks were 39% more likely to initiate nesting but nearly 72% less likely that those nests would survive compared to nesting hens in DLL.

Observed brood success was also at the highest levels since 2012 for both study sites. Three Creeks saw brood success rates near 70% and DLL slightly higher around 80%. The highest calculated brood success rates in previous years were 17% and 25% respectively. The higher rates of nest initiation, nest success, and brood success are promising for sage-grouse populations in Rich County.

Sage-grouse survival rates were similar between study sites. Estimated rates for spring 2014 were 93%-95% and summer survival ranged from 95%-100%. Similar to the other vital rates, we saw higher rates of survival in 2014 compared to previous years.

In 2014, we conducted vegetation surveys at 37 nests and 48 brood use sites across both study sites. We paired each actual use site with a random control site. In total, we completed 170 vegetation surveys in the project area for 2014. We anticipate that the large sample size will enable a robust analysis of the habitat data. However, the data is time consuming to convert from field data forms into digital format. We are currently working on this conversion and will start our vegetation/habitat analysis this winter.

Coyote densities decreased to 2012 levels (~0.49/km^2) after an observed spike across both study sites in 2013 (~0.7/km^2). Respective calculated densities did not differ between study areas in 2014. That contrasts with differences in detected raven numbers observed during each of the 3 study years. In 2014, the number of ravens observed during avian surveys was nearly 4x higher in Three Creeks compared to DLL. This is consistent with 2012 estimates but reversed when compared to 2013 estimates when more ravens were observed on DLL. Raven numbers are influenced by a multitude of factors including the density and proximity of anthropogenic features and local control efforts. We are making efforts to obtain more data regarding each of these in order to analyze the potential causes of these differences.

To address issues with missing birds this spring we conducted a telemetry flight on 28 May. DWR provided assistance in field checking birds that were located outside of the study area. One of these detected hens was discovered nesting in North Eden canyon on the east side of Bear Lake. This hen was trapped in early March on DLL and travelled 62 km from the area of capture to her selected nesting area by May. DWR also verified a mortality northeast of Woodruff Narrows roughly 4 miles into Wyoming. Another mortality was reported near Hardware Ranch in Blacksmith Fork Canyon but turned out to be an old mule deer collar when DWR attempted to recover it. The flight provided important information about seasonal bird movements, but did not result in recovery of all the missing birds. An increase in aerial telemetry flights in the spring could help locate more dispersing hens and provide for better home range estimations.

To better understand dispersal and long distance movements of sage-grouse in Rich County, we again intend to exceed the original sample size goals of 40 radio-marked hens and increase the number of flights in 2014-15. 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 for this tri-state population.

2014-2015 Work Plan

In the fall of 2014 we will begin a detailed analysis of the vegetation and habitat data that was collected this year. Currently this field data is still in the process of being entered into digital format. Using the programs outlined in the methods section, we will estimate vital rates for each study area and explore potential correlations between these rates and the corresponding habitat characteristics of each area.

Collecting winter locations to aid in the estimation of winter habitat use and range have proven difficult throughout both study areas. This is due to limited vehicle access during the winter months and personnel time limitations. In an effort to address this challenge and increase our understanding of winter movements of our radio-marked hens, we will conduct several aerial telemetry flights over the winter of 2014-15. The location data collected on these flights will help close the gaps in our understanding of season habitat use for our study population. We will also use this data to examine and map seasonal habitat use and home range sizes using Geospatial Tools in ArcGIS. These maps will then be presented in our 2015 annual report.

In response to lower than expected nest and brood sample sizes in 2013, we made efforts in 2014 to increase the number of collared and available hens for this season. We will continue these same efforts into 2015. Trapping will start in February 2015 to replace any over-winter mortalities, lost birds, or failed transmitters. If the number of available transmitters allows, we will attempt to increase the initial 2015 sample size to a minimum of 50 hens for each study area.

In 2014 we had the opportunity to present the study and our preliminary results to several groups and agencies. We plan to continue to take advantage of these opportunities and will present at local and regional conferences and at local Rich County CRM meetings in the coming year.

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