

**GREATER SAGE-GROUSE RESPONSES TO PINYON - JUNIPER REMOVAL:
MITIGATING RESISTANCE IN AN ANTHROPOGENIC ALTERED LANDSCAPE**

2017 ANNUAL REPORT



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Introduction

Conifer woodlands are expanding from their historical distributions across Intermountain West Rangelands (Bradley and Fleishman 2008, Knick et al. 2014). Crawford et al. (2004) estimated a 10-fold expansion in conifer woodlands, particularly juniper (*Juniperus* spp.) and pinyon-pine (*Pinus* spp.; conifers) in the past 130 years, which has impacted 18.9 million hectares of sagebrush (*Artemisia* spp.) ecosystems inhabited by the greater sage-grouse (*Centrocercus urophasianus*; sage-grouse).

Stiver et al. (2006) estimated that 60,000-90,000 ha of sagebrush habitat across the range of sage-grouse is lost annually to conifer encroachment. Sage-grouse population declines have also been attributed to conifer expansion (Beck et al. 2003, Schroeder et al. 2004). Mitigating conifer expansion into occupied sage-grouse habitat in core conservation areas was identified as a potentially important species conservation strategy by the U.S. Fish and Wildlife Service (USFWS) in the Conservation Objectives Team Report (USFWS 2013).

In Utah alone, conifers been removed from > 200,000 hectares of sagebrush landscapes since 2006 under the Utah Department of Natural Resources (UDNR) Watershed Restoration Initiative (WRI; UDNR 2014). The Natural Resources Conservation Service (NRCS), through its Sage-grouse Initiative (www.sagegrouseinitiative.com), provide cost-share to landowners to mechanically remove or reduce conifers on private lands in the western U.S. Similar projects have been implemented range wide on Bureau of Land Management (BLM) and U.S. Forest Service (USFS) administered lands.

Large-scale mechanical conifer reduction projects are relatively low cost on a per hectare basis, and may have potential for increasing usable habitat for sage-grouse and other sagebrush obligate species (Baruch-Mordo et al. 2013, Dahlgren et al. 2016, Cook et al. 2017). This potential increase in suitable habitat could reduce the seasonal movements for impacted sage-grouse populations due to more continuous useable habitat; distances for an individual bird or population often directly reflect the availability of suitable habitat (Dahlgren et al. 2016, Cook et al. 2017).

For sage-grouse, there are many factors that influence reproductive success and survival; however, habitat is the only factor that has remained consistently manageable (Crawford et al. 2004). Furthermore, assessing the effectiveness and benefits of management actions on sage-grouse populations has been difficult due to sage-grouse having low fecundity rates, low densities and large home ranges when compared to other gallinaceous birds (Knick et al. 2014). The effect of anthropogenic modified landscapes on species movements, gene flow, and reproductions may be quantified by resistance models. Few studies have assessed the performance of resistance models in terms of spatial and thematic resolution as well as their focus on the ecology of a particular species, or more generally on the degree of human modification of the landscape (Shirk et al. 2015). This study will focus on determining the role

of mechanical conifer removal on sage-grouse habitat utilization and seasonal movement patterns in a landscape that exhibits a high level of anthropogenic disturbance (Gifford et al. 2014). This research will provide land managers with additional information regarding the role of mechanical conifer treatments in mitigating the potential effects of anthropogenic disturbances on sage-grouse populations in the Box Elder Sage-grouse Management Area (SGMA) in northeastern Utah (Utah Governor's Office 2013).

Study Purpose

Several gaps in knowledge still exist on how sage-grouse select for, utilize, move, and migrate through conifer treatment areas and existing conifer habitat. In this report, we provide preliminary results of on-going research that is being conducted to evaluate the effects of the scale and placement of mechanical conifer removal treatments on sage-grouse habitat utilization, seasonal movement patterns, and vital rates at the landscape scale in the Box Elder SGMA. This research is being conducted by Justin Small, a PhD graduate student working under the guidance of Dr. Terry A. Messmer (Principal Investigator). Completion of this research will provide land managers with new information regarding the scale and placement of mechanical treatments to mitigate the potential effects of anthropogenic disturbances on sage-grouse populations in conifer-encroached areas. Land managers will be able to identify and implement conifer removal and habitat improvement areas more accurately that are critical to one of Utah's largest sage-grouse populations' conservation and sustainability, as well as other sagebrush obligates found in the area.

We are seeking to develop and validate models that evaluate the effects of conifer removal treatments on mitigating resistance to sage-grouse movements and habitat-use in anthropogenic-altered landscapes that are managed by multiple jurisdictions. We are also seeking to validate the effect of mechanical conifer treatments of sage-grouse population stability and growth. Ultimately, completion of this work will provide information regarding the type and amount of potential mitigation credits that could be accrued by a landowner or agency for mechanical conifer removal treatments to offset anthropogenic disturbances in SGMAs.

Objectives

- What effects have the scale and placement of mechanical conifer removal treatments completed in the Box Elder SGMA had on sage-grouse vital rates and population trends?
- What effects have scale and placement of mechanical conifer removal treatments completed in the Box Elder SGMA has had on mitigating resistance to sage-grouse movements and habitat-use in an anthropogenic-altered landscape?

- What scale of mechanical conifer removal treatments is desired to mitigate resistance to sage-grouse movements and habitat-use in an anthropogenic-altered landscape?

Study Area

The study area encompasses the Raft River subunit found in Box Elder County Adaptive Resource Management (BARM) Local Working Group (BARM 2002). The study area was based on the Box Elder Management Area outlined in the 2002 state plan, and is embedded in the Box Elder Sage-grouse Management Area defined in the Utah Plan (Utah Governor's Office 2013). The Raft River subunit is located in the northwestern portion of Utah (Figure 1).

Geographically, the core of the study area is flanked by the Raft River Range Mountains to the north, the Grouse Creek and Pilot Mountains to the west, by the Great Salt Lake to the southeast and areas of salt flats to the south (Cook et al. 2013). The study area is primarily located in the Northern Great Salt Lake Desert HUC 8 Watershed (HUC#16020308), and exists in parts of the Curlew Valley HUC 8 Watershed (HUC#16020309) on the eastern edge. Approximately 440,750 ha are encompassed within the study area. Land ownership within the Raft River subunit is a mixture of public and private lands consisting of: Bureau of Land Management, U.S. Forest Service, Utah School and Institutional Trust Lands Administration and private (Cook et al. 2013; Sanford and Messmer 2015).

Vegetation structure and composition are correlational with changes in elevation gradients. Low elevations are made up of salt desert shrub, through multiple sagebrush (*Artemisia* spp.) communities, transitioning into juniper and mountain mahogany (*Cercocarpus ledifolius*) woodlands, and lastly to sub-alpine and alpine coniferous forest (*Picea* spp., *Pinus* spp., and *Pseudotsuga* spp.) at higher elevations.

Climatic data from Park Valley, Utah, from 1990 to 2015 shows annual precipitation of 11.52 inches (29.26 cm) in Park Valley (elevation 5,548 ft), with 5.6 inches (14.2 cm) falling as snow between November and April. Temperatures range from a monthly average high of 87° F (31° C) in July to a monthly average low of 15° F (-9.4° C) in December and January (Western Regional Climate Center, 2014). Snow can remain at high elevations over 8000 ft. (2438 m) into late summer but does not usually persist through spring at lower elevations. Greater levels of snowfall and colder temperatures exist at higher elevations.

Methods

Sage-grouse radio-marking

Beginning in early fall 2015, five female sage-grouse were captured and fitted with geographic positioning system (GPS) radio-marked transmitters. In the spring of 2016, ten more GPS

transmitters were deployed on eight female sage-grouse and two male sage-grouse. The GPS transmitters were distributed evenly across the study area to ensure that a total representation of the bird population is obtained. We also deployed 20 very high frequency (VHF) necklace-style radio-collars on an additional female sage-grouse across the study area. The combination of GPS and VHF radio-transmitters will allow us to evaluate if the type of transmitter deployed may affect vital rates. Caudill et al. (2014) reported sage-grouse fitted with back-mounted radio-transmitters had lower survival rates than birds fitted with necklace-style radio-transmitters. Every sage-grouse is weighed, sexed, aged, evaluated for general health, and receives a numbered leg band. Every capture site was recorded (UTM, 12N, NAD 1983). Birds were fitted with a backpack style GPS transmitter (Microwave Telemetry, Inc. 22g PTT-100 Solar Argos GPS Transmitter). Birds were processed and released at their capture site.

GPS and VHF Radio Telemetry

The GPS and VHF radio-marked birds were relocated a minimum of twice a week during nesting and brood rearing season. Nests were visually confirmed, and then monitored 2-3 times per week from the farthest distance that observer can confirm the female's location without risk of disturbance. After hatching, females with broods were located 2-3 times per week. Broods were flushed 50 days post-hatch to determine brood success and approximate brood size. The presence of a minimum of one chick per hen is classified as brood success. In fall and winter months, GPS collared birds are being located weekly via Movebank (Movebank Animal Tracking Data 2015) to estimate survival and habitat use. Research protocols were approved by the Utah State University Institutional Animal Care and Use Committee permit #2322. A UDWR Certificate of Registration has been obtained (2BAND8743).

A UTM location was also recorded every time we relocated a VHF radio-marked female. All locations were overlaid on a remotely sensed conifer cover map to determine thresholds of use based on conifer cover. The GPS and VHF data collected from radio-marked sage-grouse will be used to illustrate and determine the magnitude of sage-grouse utilization within available habitat types (Dahlgren et al. 2006).

Nesting Monitoring

For VHF radio-collared female sage-grouse, nest initiation was determined when a female was observed in the same location for two consecutive visits during or following breeding season. For GPS marked females, nesting was determined when UTM coordinates were recorded in the same location over several consecutive days during or following breeding season. Once nesting was suspected, a UHF receiver and Yagi antenna was used to pick up the UHF radio frequency(s) emitted by the GPS transmitter(s) to confirm nesting. To mitigate nest abandonment, caution was taken not to disturb nesting females. Nest locations were marked using a handheld GPS unit and a discreet physical landmark to aid researchers in returning to the point of initial observation. All nesting females were observed twice weekly. Nests were

discretely monitored from 5-30 m until the 50 day flush. A successful hatch was determined when egg halves were found intact in or near the nest bowl, and/or the inner membrane of the egg was separated from the shell (Wallestad and Pyrah 1974). Determination of a failed nest was when no eggs or egg halves were found at the nest site, if egg halves were not intact, or if only egg fragments remained at or near the nest site.

Brooding Monitoring

Once hatched, broods were monitored twice weekly until 50 days of age, or brood was determined to fail. Each brood was flushed at 50 days and the number of chicks was recorded to determine brood success (Schroeder 1997). Broods were re-flushed if any doubt of brood success occurred during initial flushing. Due to the big sagebrush (*A. tridentate* ssp.) and tall mixed mountain brush vegetation plant communities that broods were predominantly found in, all flush counts were conducted in daylight hours to reduce the risk of missing birds that otherwise may not be visible while using a spotlight count method.

Vegetation Surveys

Vegetation surveys were conducted at all nest sites, every other brood site, and one random site for every other measured brood site. These vegetation surveys provided information about cover and forage plant preferences in utilized areas. Each survey consists of four transects placed in cardinal directions from the used site; transects are 15 m and 10 m at nest and brood sites, respectively. The Daubenmire frame technique was used to measure and evaluate the height and species composition of grasses and forbs according to recommendations by Connelly et al. (2000). Five frames were placed on each nest survey transect at 3 m intervals, and four frames were placed at 2.5 m intervals on all other surveys. The Robel pole method was used to measure the visual obstructions that could be encountered at nest sites, brood sites and random sites (Robel et al. 1970). Vegetation data will be compared at the end of this study to evaluate and determine the differences in vegetation structure and composition that exist between preferred and random sites.

Preliminary Results

Data analysis

Due to this study involving how sage-grouse select, move through, and utilize habitat at the population level, we will use a resource selection function and resistance models for analysis (Gillies et al. 2006). Using a resource selection function, we will assess and determine whether sage-grouse are utilizing one habitat type (sagebrush, phase I, II, III juniper invaded areas, or type of juniper removal areas) over another and then investigate whether these behaviors are resulting in different survival rates and seasonal movement patterns (Sandford et al. 2016). The

location data obtained from GPS/VHF radio marked female sage-grouse will also be used to conduct a landscape scale analysis and logistic regression. This analysis will evaluate a range of prioritization models (Figure 2) in terms of their ability to illustrate and predict empirical patterns of lek occupancy and individual sage-grouse habitat used based on type, scale, age, and location of mechanical conifer removal treatments (Shirk et al. 2015). Other univariate and multivariate statistics could be used throughout the duration of the study period as well. This analysis will be completed at the end of the fourth field season. For this annual report, we have provided only descriptive statistics.

Vital Rates

For the 2017 field season, 20 of the 28 females' monitored (6 GPS and 13 VHF birds) initiated nests (71%) (Tables 2 and 3). Ten females out of 20 females hatched successfully (50%). Nine nests were predated across the study area and one was abandoned. The predator type could not be determined, but evidence suggest ravens (*Corvus corax*; common raven) were responsible for seven and mammals for two nest depredations. In all nine cases, none of the females were killed. One female whose nest was predated re-initiated another nest.

Of the 10 females with broods (four GPS and six VHF females), two collars malfunctioned (one VHF and one GPS), which eliminated tracking those females, unfortunately. Five of the remaining eight broods were successful at the 50 day flush (two GPS and three VHF), for an overall brood success of 63%. The VHF female that re-initiated a nest was regrettably one of the females that wore a malfunctioning collar. Observation and documentation of this re-nesting behavior is important, as was in 2016, due to nest re-initiations being uncommon throughout the West Box Elder SGMA.

Unique Nesting Observations

This field season we observed two GPS marked females that selected nesting sites in older P-J treatments. One female picked a nest site in the Pine Creek area east of Grouse Creek (Figure 5), but unfortunately she abandoned her nest. However, the other female picked a nest site just southeast of Rosette which she hatched and successfully reared a brood to the 50 day flush (Figure 6). These documentations of females selecting older treatment areas is valuable in identifying how sage-grouse are responding to habitat manipulation at the landscape scale across the SGMA.

Mortalities

For the 2017 field season, seven GPS and four VHF females were killed. All four VHF mortalities and five GPS mortalities were females radio-marked in April 2017 (Tables 1 and 3). Of the mortalities, two females showed signs of avian predation and four mammalian predation. Two females (both GPS) were killed on Highway 30, one in Park Valley and the other near

Kelton. Mortality causes remain unknown for the other three females. We suspect a badger (*Taxidea taxus*; American badger) could have killed one of the last three females; we noticed an increase in badger activity during the 2017 field season.

Survival Estimates

We are currently completing data quality checks on location and vegetation data and importing into our database for analysis purposes. To date, summary statistics and analysis of preferred habitat are not available. However, our study population shows similar preferences as reported for other populations in the literature. The radio-marked females are selecting for taller stands of sagebrush for nesting cover and mesic areas imbedded in contiguous sagebrush habitat for late brood rearing and summer habitats.

Sage-grouse Movements

Throughout July and early August, radio-marked females were widely dispersed over the landscape, with brooding females moving into wet meadow areas and higher/cooler summer pastures (Figure 4). By the end of July, all brooding females were in close proximity to water sources. To provide some examples of the types of seasonal movements observed we offer the following: During July, a VHF female that was brooding on the north side of Dennis Hill ended up moving over to Lynn Valley just south of the Reservoir; this area was significantly wetter towards the end of the summer than her initial brooding sites. Furthermore, this female was successful with three chicks at the 50 day flush, and she brooded in the most heavy raven occupied areas recorded within the SGMA. Two other successful females that brooded around Rosette this season stayed local and in close proximity to wet pastures and spring sources within the area. These females' more consolidated movement patterns could be due to a noticeable increase in surface water resulting from the above average 2016-2017 winter.

Plan of Work

To date, the 2017 breeding season has been completed. However, we are remotely monitoring GPS marked birds through Movebank interactive online mapping and location website (Movebank Animal Tracking Data 2015). This allows us to continue monitoring survival rates, seasonal movement patterns, and overall population viability. For the remainder of the fall and winter of 2017-2018, we will continue trapping to redeploy any mortality recovered GPS transmitters and to augment the current GPS and VHF radio-marked birds. The protocols previously used will be followed during all capture attempts.

For the 2018 field season, we will be capturing and radio-marking chicks with small VHF backpacks to better understand actual brood response to treatments and areas of resistance.

Furthermore, this will allow us to harness data for the entire life cycle of radio marked sage-grouse within the West Box Elder SGMA (Figure 3). For the 2018 trapping season, if the weather permits, we are hoping to start trapping in early February. Last year's early trapping efforts were impeded by snow depth, hopefully we will get a break this season.

Additionally, during late season, I was offered the opportunity by Dr. Terry Messmer to move up to a PhD level graduate position, which I accepted. One of the main reasons for accepting this position is that I was not content with only completing two years of research while so many questions remained unanswered. I have more than enjoyed conducting research within the West Box Elder SGMA. Therefore, I could not imagine a better area, group of people, or context to conduct research while completing my graduate work. I am greatly anticipating two more years of fieldwork and interactions with the ranchers and landowners of the West Box Elder SGMA. All data collected during the 2016-2019 field seasons will be analyzed and included in a final report and defended in a PhD dissertation. Additional data may be included from past studies where it is applicable.

Acknowledgements

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Tables and Figures

Figure 1. Greater sage-grouse (*Centrocercus urophasianus*) Management Area and Subunits, Utah Box Elder Sage-grouse Management Area.

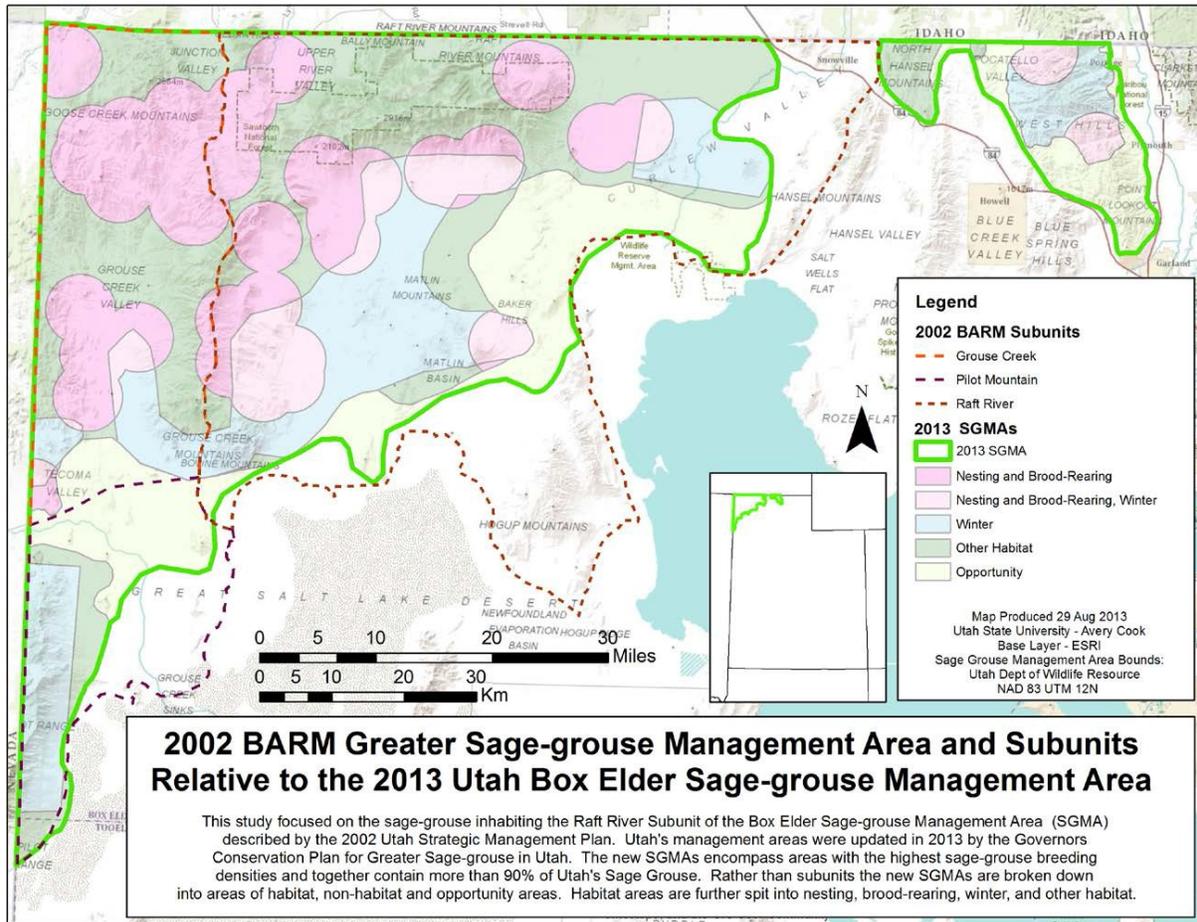


Figure 2. Resource Selection Function and Prioritization tool model of greater sage-grouse (*Centrocercus urophasianus*) relative change in use areas within the Box Elder Sage-grouse Management Area, 2017.

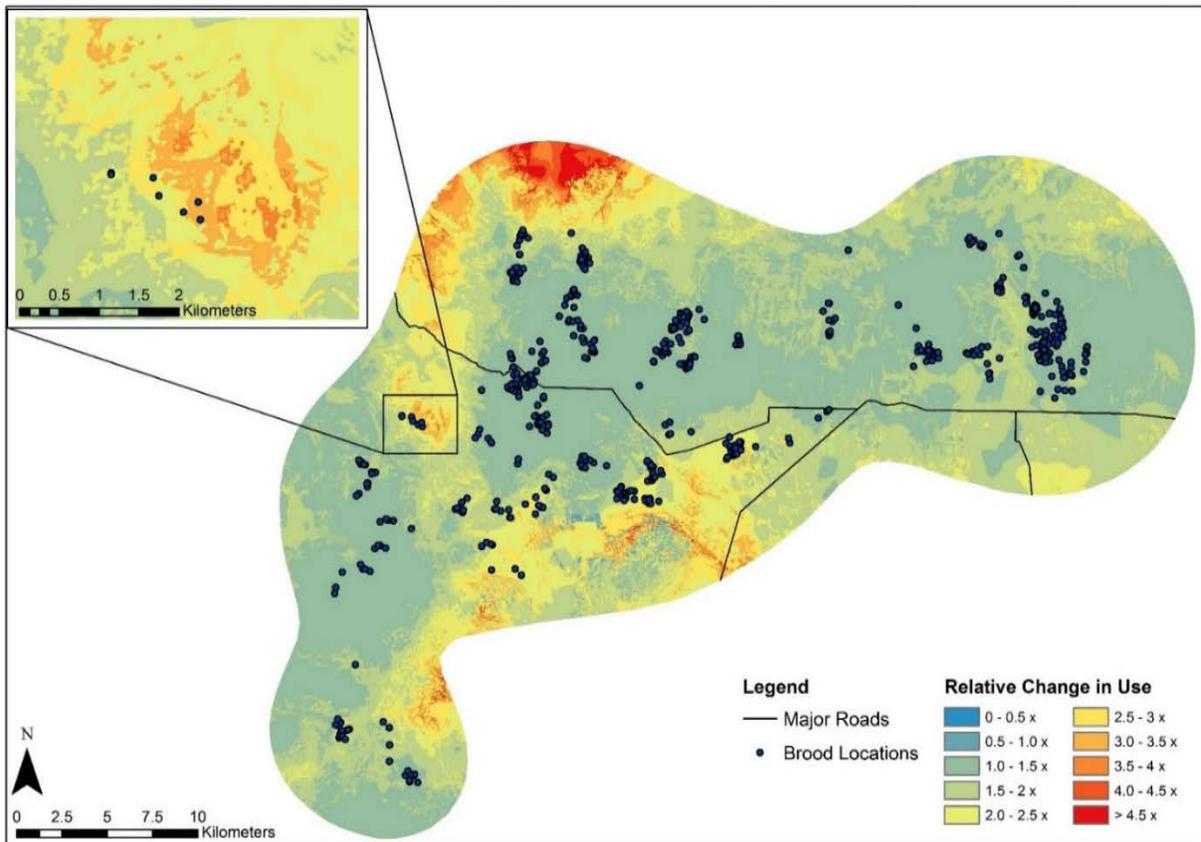


Figure 3. Life cycle of the greater sage-grouse (*Centrocercus urophasianus*).

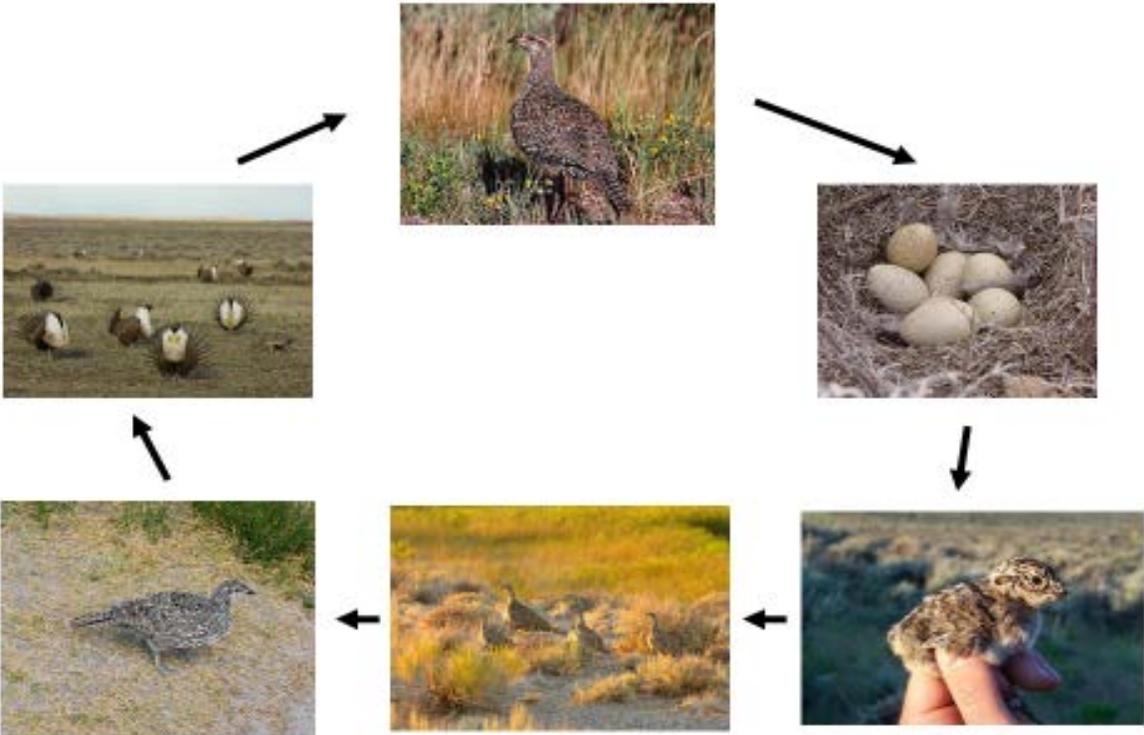


Figure 4. Locations and densities of female greater sage-grouse (*Centrocercus urophasianus*) marked with global positioning system rump-mounted transmitters, Utah Box Elder Sage-Grouse Management Area, 2017.

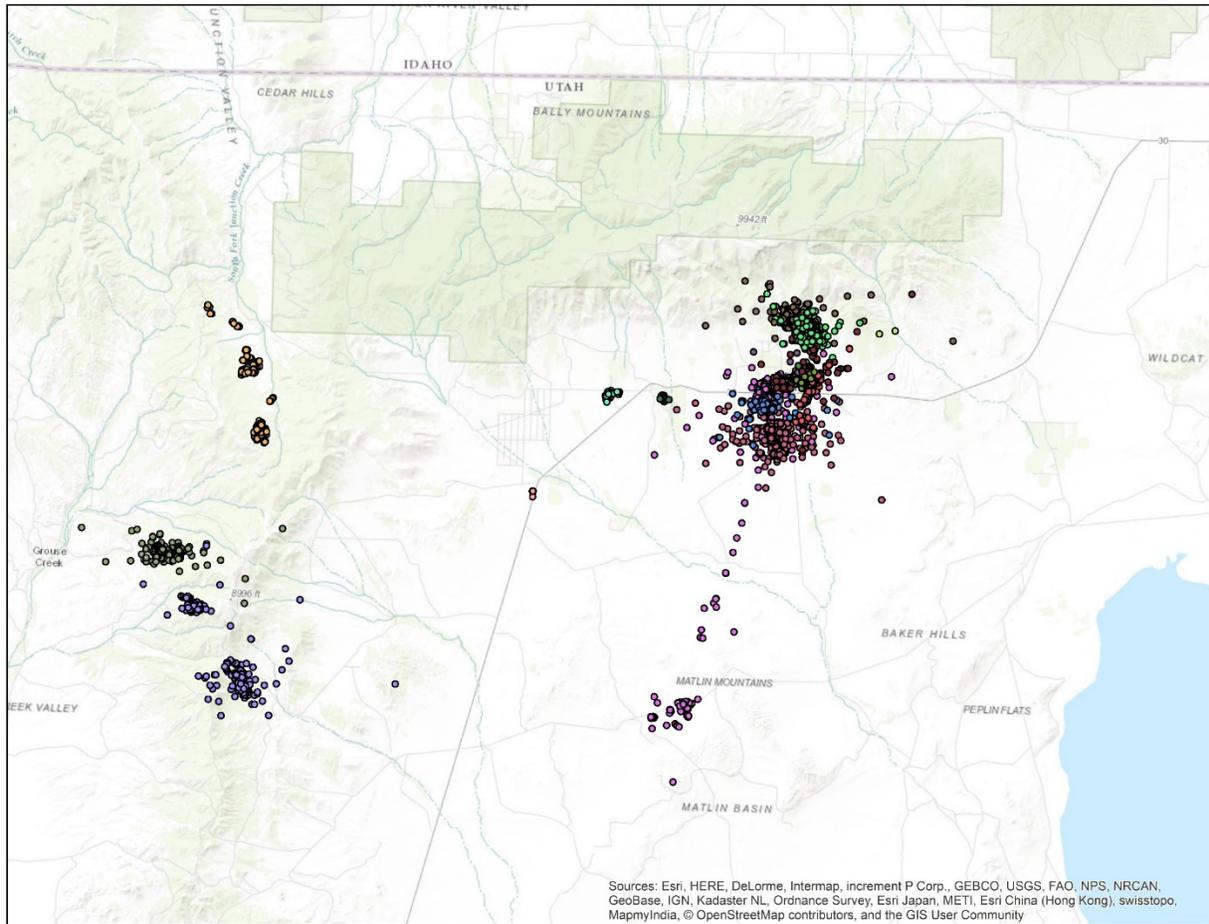


Figure 5. Nest site of female sage-grouse (*Centrocercus urophasianus*) marked with a global positioning system rump-mounted transmitter within mechanical conifer removals treatment, Pine Creek, Utah, Box Elder Sage-grouse Management Area, 2017.



Figure 6. Nest site of female sage-grouse (*Centrocercus urophasianus*) marked with a global positioning system rump-mounted transmitter within mechanical conifer removals treatment, southeast of Hwy 30, Rosette, Utah, Box Elder Sage-grouse Management Area, 2017.



Table 1. Greater sage-grouse (*Centrocercus urophasianus*) survival rate estimate: Raft River Subunit, West Box Elder County, Utah, 2017.

	Sage-Grouse Radio Marked	Total Mortalities	Percent Mortality
Adult Male	1	1	100
Adult Female	21	7	33.3
Juvenile Male	1	0	0
Juvenile Female	8	3	38
Total	31	11	35.4

Table 2. Overall nest and brood success estimates for female greater sage-grouse (*Centrocercus urophasianus*), Raft River Subunit, West Box Elder County, Utah, Box Elder Sage-grouse Management Area, 2017.

		Marked Females	Accessible Marked Females	Females Nested	Re-nest Attempts	Mean Clutch Size	Nests Hatched	Successful Broods	Mean Brood Size
2017	Adult	21	21	15 (71%)	1	6.3	10 (67%)	5 (50%)	2.6
	Yearling	8	8	5 (63%)	0	0	0 (0%)	0 (0%)	0
	Total	29	29	20 (69%)	1	6.3	10 (53%)	5 (50%)	2.6

Table 3. Nest and brood success estimates for female greater sage-grouse (*Centrocercus urophasianus*) for global positioning system (GPS) transmitters and very high frequency (VHF) radio-collars, Raft River Subunit, West Box Elder County, Utah, Box Elder Sage-grouse Management Area, 2017.

2017						
Sex	Radio Type	# Marked	Mortalities	Nests Initiated	First Initiation	Last Initiation
Male	VHF	1				
Male	GPS	1				
Female	VHF	14	3	10	4/19/2017	6/14/2017
Female	GPS	15	8	10		
Sex	Radio Type	Nests Hatched	First Hatch	Last Hatch	Successful Broods	Failed Broods
Female	VHF	6	5/19/2017	6/28/2017	3	3
Female	GPS	4			2	2

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