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

2018 ANNUAL REPORT

Cooperators:

Jack H. Berryman Institute

Utah Division of Wildlife

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West Box Elder Coordinated Resources Management

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Executive Summary

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 ha 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 ha 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), provided 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 reproduction may be quantified by priority 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 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 Public Lands Policy Coordination Office [PLPCO] 2019).

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 on 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 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 (PLPCO 2019). 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: BLM, USFS, 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 (Figures 4 and 5). We also deployed 20 very-high frequency (VHF) necklace-style radio-collars on 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 ultra-high frequency (UHF) receiver and Yagi antenna were used to pick up the UHF radio frequency(s) emitted by the GPS transmitter(s) to confirm nesting. To mitigate nest abandonment, caution was taking 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). We determined a nest failed 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.

New for the 2018 field season, we radio-marked broods with small VHF backspacks (Figures 7 and 8). The VHF backpacks were sutured onto the chick's backs and remained until around the 70 day mark if mortality did not occur. This allowed us to track the complete life cycle of sage-grouse within the West Box Elder SGMA (Figure 3) and obtain the finest scale data possible to observe how individual sage-grouse chicks are responding to pinyon-juniper treatments across the SGMA. We will continue marking chicks for the 2019 field season as well.

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

Because the study involves sage-grouse select, move through, and utilize habitat at the population level, we will use a resource selection function and priority models for data 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 2018 field season, 14 of the 30 females monitored (6 GPS and 8 VHF birds) initiated nests (47%) (Table 2 and 3). Six females out of 14 females hatched successfully (43%). Seven nests were predated across the study area and one was abandoned. The predator type could not be determined, but evidence suggests that ravens (*Corvus corax*; common raven) were responsible for the nest depredations. In all seven cases, none of the females were killed. One of the seven female's nest that was predated re-initiated another nest.

Of the 6 females with broods (3 GPS and 3 VHF females), one GPS transmitter malfunctioned, which eliminated tracking that female and prevented us from marking her brood, unfortunately. Four of the six broods were successful at the 50 day flush (two GPS and 2 VHF), for an overall brood success of 67%. Twelve of the 25 chicks marked survived to 50 days (48%). One brooding female was a re-nest and she had 6 chicks and her first nest predated had 9 eggs! I would say she is productive. This was our only re-nest this season, but still very important to document with re-nests being extremely rare in the West Box Elder SGMA. I have been fortunate enough to document at least one re-nest over the past three field seasons.

Unique Nesting Observations

This field season we observed females moving much sooner to higher elevation habitat(s) than they usually occupy during the mid-summer brood-rearing period. Of the four successful brooding females, all moved early and kept their movement patterns consolidated to higher elevation habitat. With the lack of spring run-off for the spring of 2019, female sage-grouse might have anticipated the dryer conditions coming earlier than normal and circumvented the transitional stage between lower nesting habitat and higher brooding habitat.

Mortalities

For the 2018 field season, six GPS and eight VHF females were killed. All six GPS mortalities and eight VHF mortalities were females radio-marked in Spring 2018 (Tables 1 and 3). This is a 27% increase from last year's mortalities at this point. Of the mortalities, five of the GPS females showed signs of mammalian predation and one is undetermined. Five of the VHF mortalities showed signs of avian predation, 2 mammalian predation and 1 was undetermined.

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

With having decreased wet areas and runoff for the 2018 field season, females had begun spreading-out over the landscape by early May in search of quality habitat and sufficient green groceries to meet their nutritional requirements for nesting and brooding (Figure 6). By June, all marked birds were either occupying higher elevation habitat or lower irrigated agriculture fields; no birds were utilizing any dryer transitional areas within the SGMA. Throughout July and early August, radio-marked females with broods moved increasing closer to wet meadow areas and higher/cooler summer pastures.

To provide some examples of the types of seasonal movements observed we offer the following: Starting in May, 2 GPS females and 2 VHF females moved within a week on top of the Grouse Creeks to seek out quality nesting habitat; all 4 females chose nest sites in habitat that is usually reserved for brooding habitat in July and August. Three of these females were successful at the 50 day flush. These females' more expansion movement patterns earlier in the season could be due to a noticeable decrease in surface water resulting from the below average 2017-2018 winter, the exact opposite of the 2016-2017 winter. The other successful female made a similar movement up Dunn Canyon just north of Park Valley.

2019 Plan of Work

Although the 2018 field season has been completed, 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 2018-2019, we will continue trapping to redeploy any mortality recovered GPS transmitters and to augment the current GPS and VHF radio-marked birds. For the 2019 trapping season, we will begin trapping and monitoring birds in mid-March. The protocols previously used will be followed during all capture attempts.

For the 2019 field season, we will continue 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 2019 field season only, Justin will be conducting a case study of the West Box Elder CRM to gain a better understanding on what was the catalyst for its beginning and the momentum that keeps it moving forward. This will include interviewing WBE landowners of CRM and likely a survey send by mail. The West Box Elder CRM is one of the most successful local working groups in Utah— and the Intermountain West— and we believe it can be used as a template for other local working groups to help them become self-sustainable.

Lastly, 2019 will be our fourth and final field season. We have more than enjoyed conducting research within the Box Elder SGMA. We could not imagined a better area, group of people, or context to conduct research for Justin while completing his PhD graduate work. After completion of the 2019 field season, all of the data collected during the 2016-2019 field seasons will be analyzed and included in a final report then defended in a PhD dissertation. Additional data may be included from past studies where it is applicable.

Acknowledgements

This project was made possible by the support of landowners throughout the study area in addition to the following agencies and organizations:

Tables and Figures

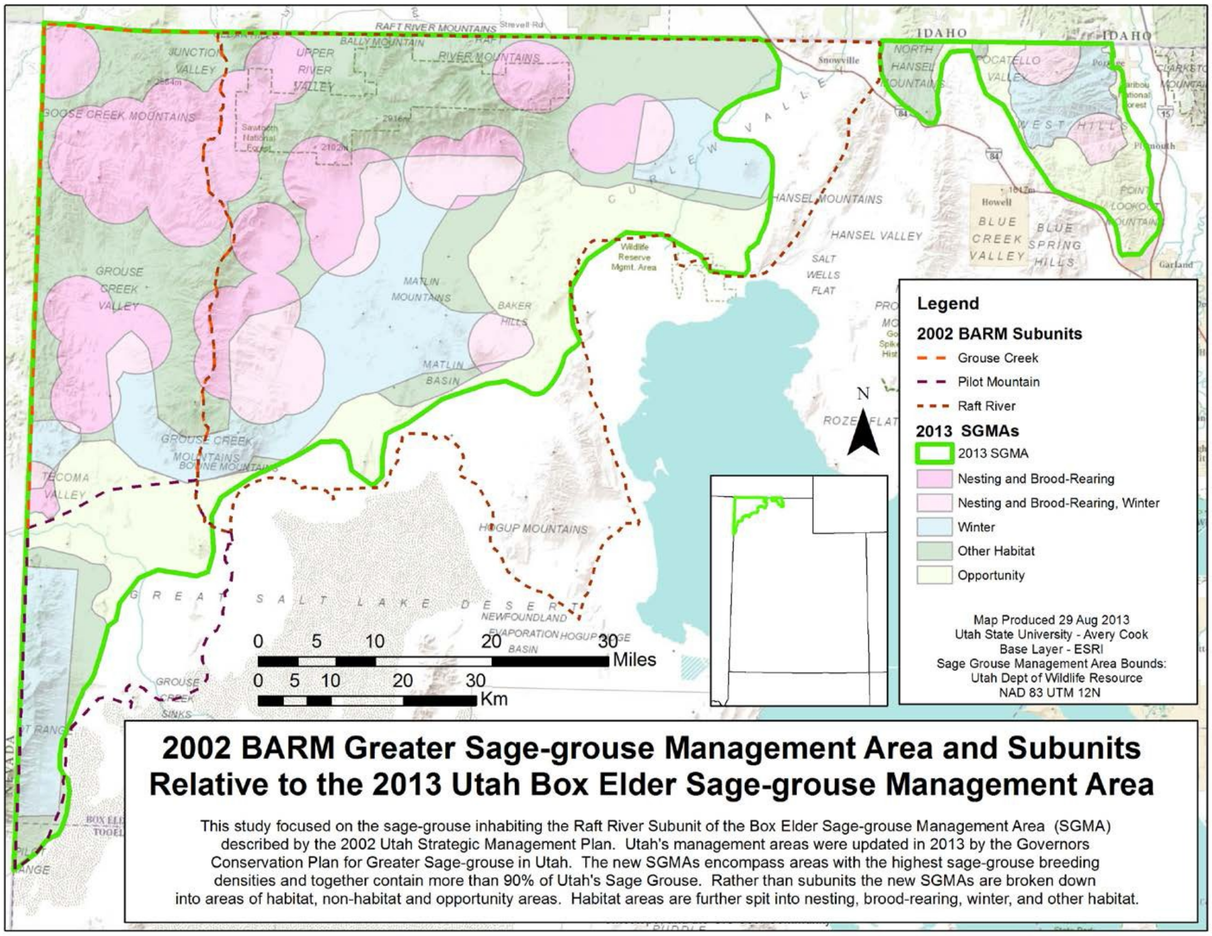

Figure 1. Greater sage-grouse (*Centrocercus urophasianus*) Management Area and Subunits, Utah Box Elder Sage-grouse Management Area.

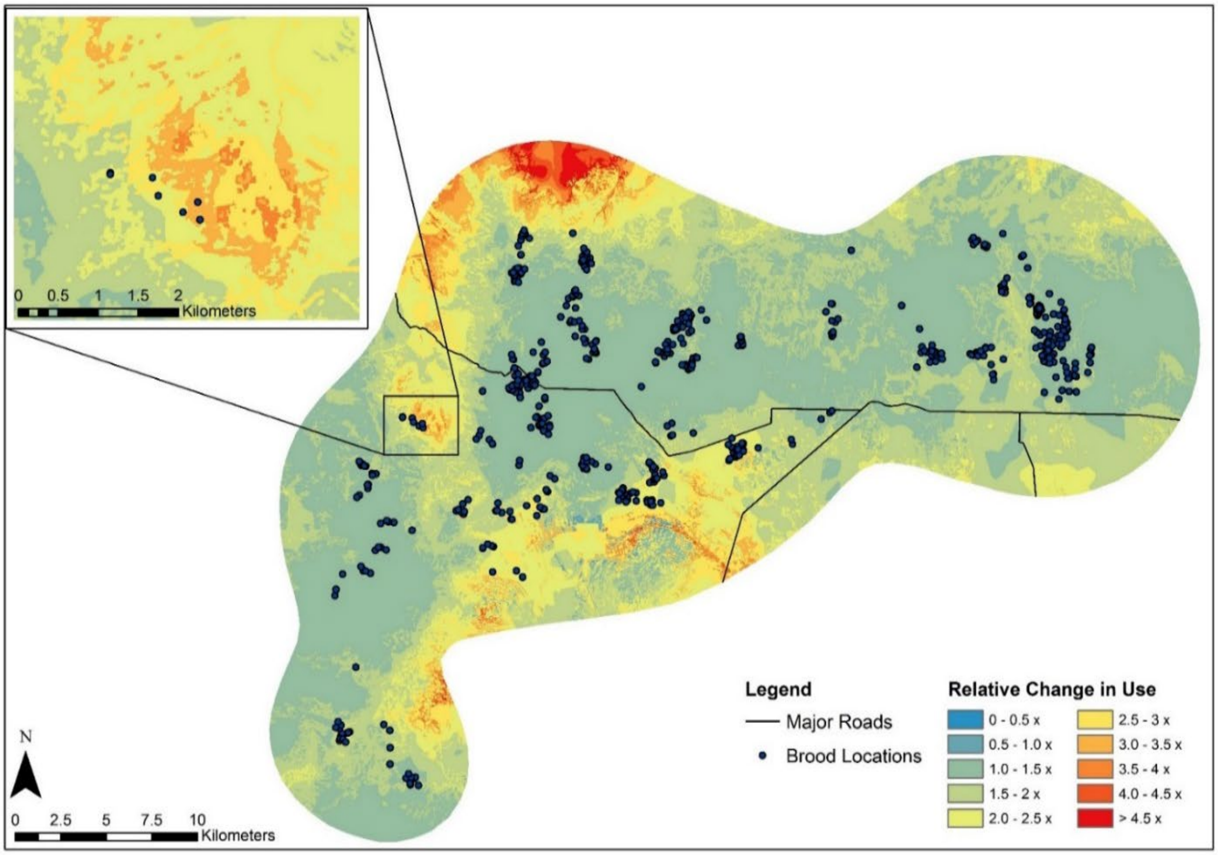

Figure 2. Resource Selection Function and Prioritization tool model of greater sage-grouse *(Centrocercus urophasianus)* relative change in use areas within the Box Elder Sage-grouse Management Area**,** 2017.

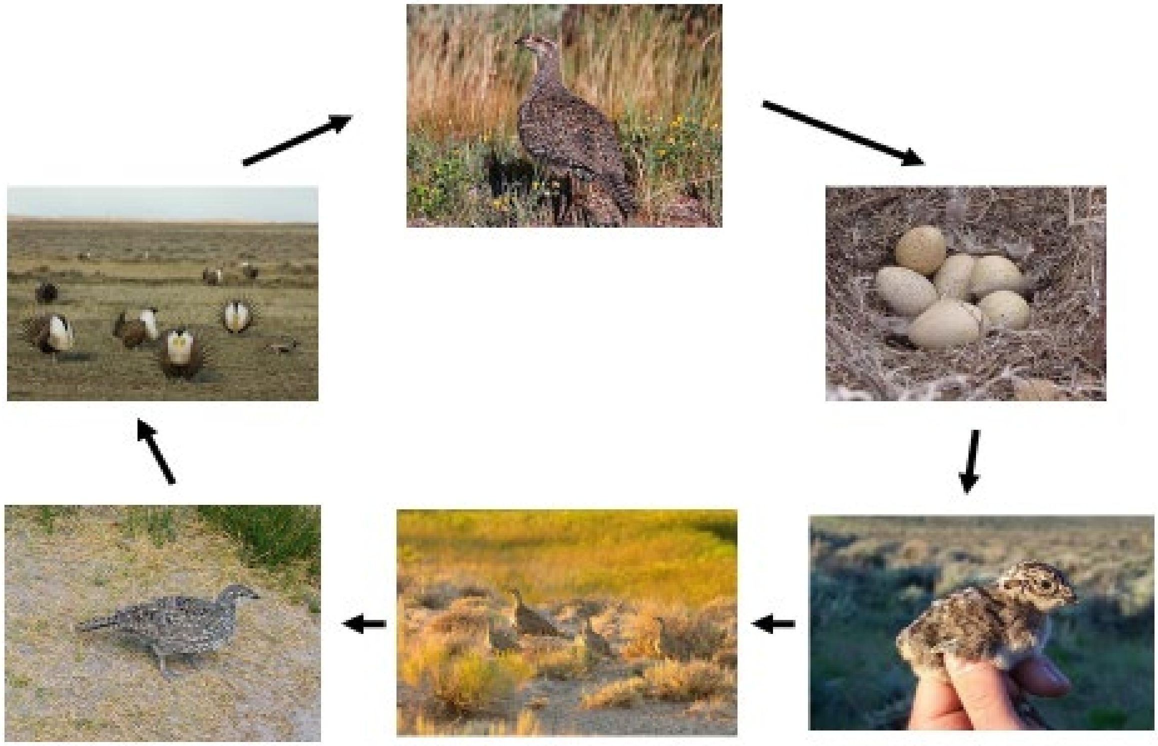

Figure 3. Life cycle of the greater sage-grouse (*Centrocercus urophasianus*).

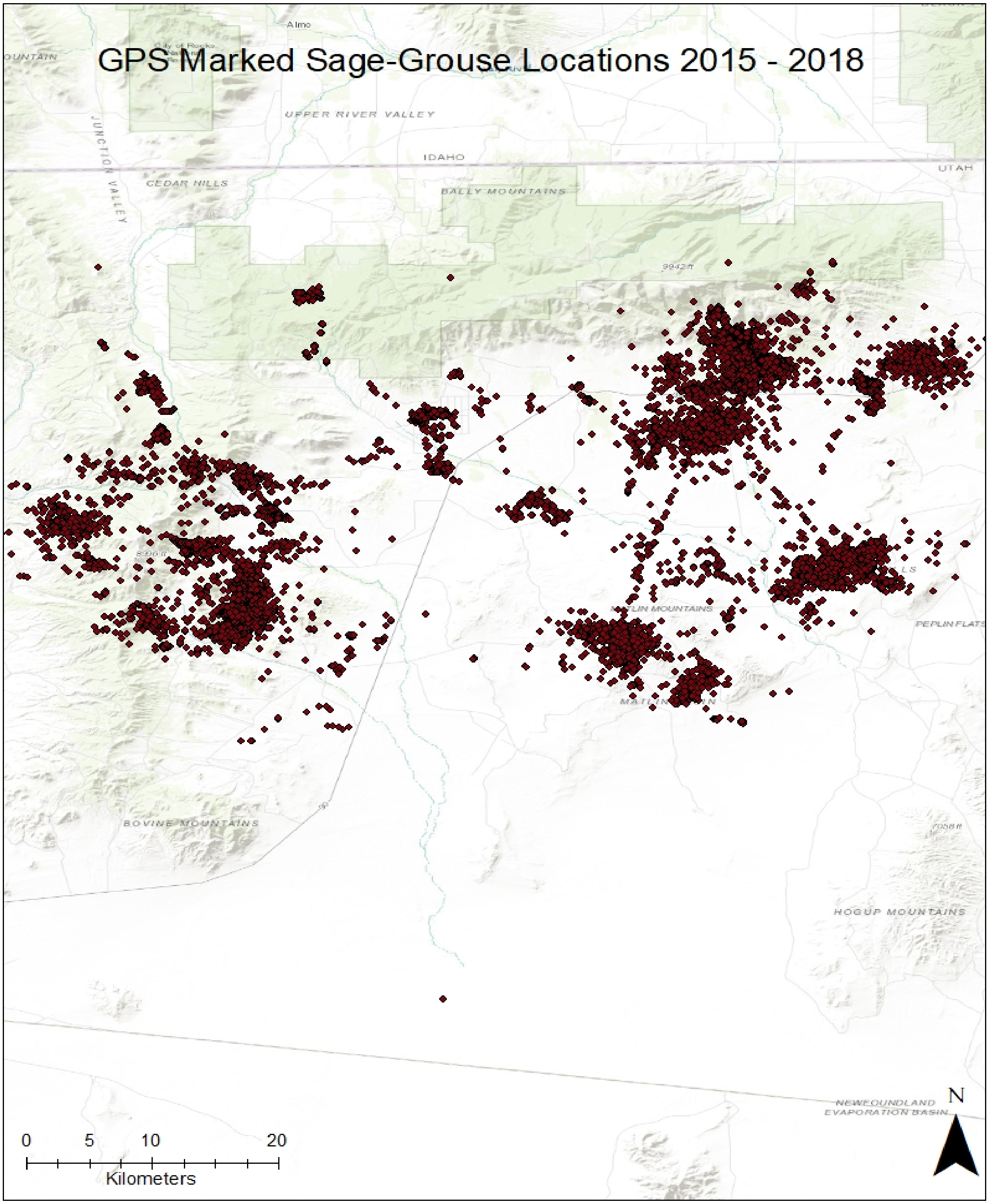

Figure 4. Locations and densities of female greater sage-grouse (*Centrocercus urophasianus*) marked with global positioning system (GPS) rump-mounted transmitters, Utah Box Elder Sage-Grouse Management Area, 2015 - 2018.

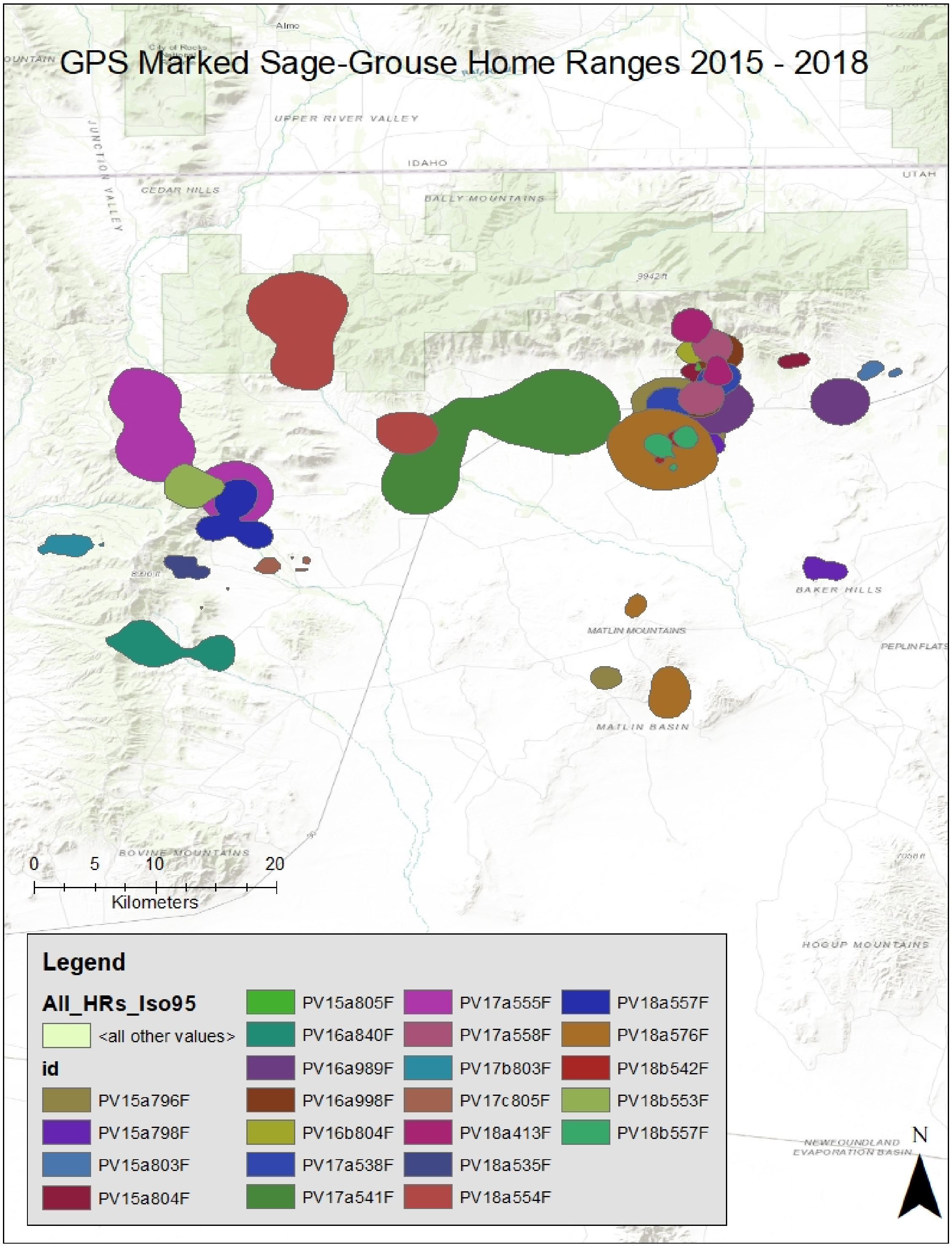

Figure 5. Home ranges of female sage-grouse (*Centrocercus urophasianus*) marked with a global positioning system rump-mounted transmitter within the Box Elder Sage-grouse Management Area, Utah, 2015 - 2018.

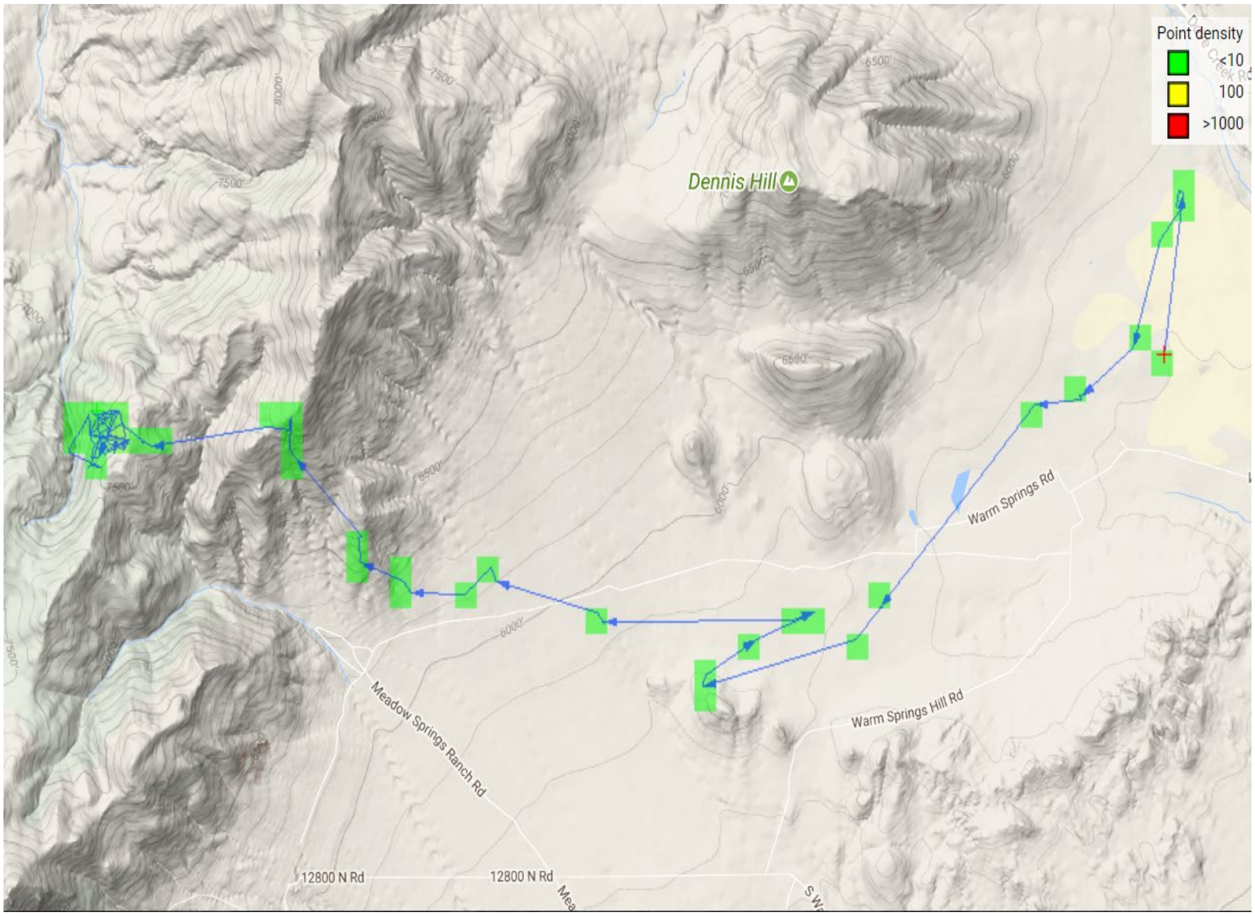

Figure 6. Movements of female sage-grouse (Centrocercus urophasianus) marked global positioning system (GPS) rump-mounted transmitters with from Warm Springs Lek capture point in early April 2018.

Figure 7. Attaching very-high frequency backpack radio-transmitters to sage-grouse (*Centrocercus urophasianus*) chicks, Grouse Creek Mountains, Utah, West Box Elder Sage-grouse Management Area, Spring 2018.

Figure 8. Sage-grouse chicks (*Centrocercus urophasianus*) marked with VHF backpack radio-transmitters thermoregulating before release, Raft River Mountains, Utah, Box Elder Sage-grouse Management Area, spring 2018.

Table 1. Greater sage-grouse (*Centrocercus urophasianus*) survival rate estimate: Raft River Subunit, West Box Elder County, Utah 2018.

	Sage-Grouse Radio Marked	Total Mortalities	Percent Mortality
Adult Male	4	2	50
Adult Female	23	9	39
Juvenile Male	0	0	0
Juvenile Female	7	3	43
Total	34	14	41

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, 2018.

		Marked Females	Accessible Marked Females	Females Nested	Re-nest Attempts	Mean Clutch Size	Nests Hatched	Successful Broods	Mean Brood Size
2017	Adult	23	23	10 (43%)	1	5.6	6 (60%)	4 (67%)	3.3
	Yearling	7	7	4 (57%)	0	0	0 (0%)	0 (0%)	0
	Total	30	30	14 (47%)	1	6.3	6 (43%)	4 (67%)	3.3

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, 2016.

2017						
Sex	Radio Type	# Marked	Mortalities	Nests Initiated	First Initiation	Last Initiation
Male	VHF	4				
Male	GPS					
Female	VHF	16	8	8	4/23/2018	6/11/2018
Female	GPS	14	6	6		
Sex	Radio Type	Nests Hatched	First Hatch	Last Hatch	Successful Broods	Failed Broods
Female	VHF	3	5/24/2018	7/6/2018	2	1
Female	GPS	3			2	1

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