2016 Annual Report

POPULATION DYNAMICS AND SEASONAL MOVEMENTS OF TRANSLOCATED AND RESIDENT GREATER SAGE-GROUSE (*CENTROCERCUS UROPHASIANUS*), SHEEPROCK SAGE-GROUSE MANAGEMENT AREA

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Cooperators

Utah Public Lands Policy Coordination Office

Utah Division of Wildlife Resources

Bureau of Land Management

US Forest Service

US Geological Survey

USDA/APHIS Wildlife Services

West Desert Adaptive Resources Management Local Working Group

Utah Cooperative Fish and Wildlife Research Unit

Utah State University Extension

Jack H. Berryman Institute

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Executive Summary

Sheeprock Sage-grouse Management Area (SGMA) greater sage-grouse (*Centrocercus urophasianus*) population declines in the past decade triggered additional management actions by the State of Utah, the Bureau of Land Management, US Forest Service, and the West Desert Adaptive Resource Management Local Working Group. To stabilize the population, multiple sage-grouse translocations of up to 40 birds per year during the 2016-2018 breeding seasons from two distinct, genetically-compatible populations located in Box Elder and on Parker Mountain have been proposed. The translocations will be conducted in-conjunction with a comprehensive habitat restoration and predation management program.

In 2016, 40 sage-grouse were radio-marked and translocated and 7 resident birds were captured and radio-marked in the SGMA. Radio-marked birds were monitored throughout the breeding season. Females initiated 5 nests - 4 translocated females and 1 resident female. Of those 5 nests, 3 hatched—2 translocated and 1 resident—with 16 chicks. Only two broods with 4 chicks successfully made it to the 50-day brood surveys. We recorded 15 translocated and 1 resident radio-marked sage-grouse mortalities. In 2017, we will be conducting standard surveys to obtain better estimates of mammalian and avian predator abundance during the breeding season in response to land use changes and predation management.

Based on preliminary sage-grouse movement and habitat-use data, we identified potential sites for management projects in three lek areas. Additionally, because of the low nest initiation rates for translocated females, we are exploring changes in translocation dates for 2017 and the use of artificial insemination for some translocated females to increase nest initiation rates.

Introduction

Historically, greater sage-grouse (*Centrocercus urophasianus*; sage-grouse) occupied sagebrush (*Artemisia* spp.) habitats in 5 western states and 3 provinces in North America totaling an estimated area of 1,200,483km^2 (Schroeder et al. 2004). Currently, estimated distribution has declined to 11 states and 2 provinces 688,412km^2, only 57% of the species' pre-settlement range (Schroeder et al 2004). One of the primary factors contributing to the decline has been the loss and fragmentation of sagebrush habitat associated with the life history of sage-grouse (Aldridge et al 2008). Despite the reduction to the current distribution, populations have demonstrated more stable trends overall; however, some populations have continued to decline (Connelly et al. 2004). The current distribution has fragmented, increasingly isolated populations that require translocations for support (Connelly and Reese 1997).

In 2013 the State of Utah published a conservation strategy for sage-grouse. The strategy identified eleven sage-grouse management areas (SGMAs) within the state which represented the highest sage-grouse breeding density areas and supported more than 90% of the combined Utah population of sage-grouse (Utah Governor's Office 2013, Dahlgren et al. 2016). The strategy incorporated five objectives:

1) Population: Sustaining an average male lek count of 4100 males (based on a ten-year rolling average on a minimum of 200 monitored leks) in the SGMAs, and increase the population of males to an average of 5000 (based on the same ten-year rolling average on a minimum of 200 monitored leks) within the SGMA's.
2) Habitat: Protect 10,000 acres of sage-grouse habitat on private and School and Institutional Trust Lands Administration (SITLA) lands annually through conservation covenants, leases, easements or other legal tools, with emphasis on best-of-the-best population areas
3) Habitat: enhance an average of 25,000 acres of sage-grouse habitat within SGMAs annually
4) Habitat: increase the total amount of sage-grouse habitat acreage within the SGMA's by an average of 50,000 acres per year, through management actions targeting opportunity areas—areas which offer the best potential for creating new habitat for greater sage-grouse
5) Distribution: maintain viable populations within each SGMA.

The Bureau of Land Management (BLM) currently manages 50% of the sage-grouse habitat located within the SGMAs. In 2015, the BLM and the U.S. Forest Service (USFS) published amendments to existing resource management (RMP) and land use plans (LUP) that placed increased emphasis on the monitoring of sage-grouse populations and their habitat (BLM 2015). In Appendix B of the Utah RMP amendment, the BLM identified a series of hard and soft triggers to guide sage-grouse conservation efforts. The soft triggers represent thresholds in the population and habitat that are needed to be addressed before they become severe (BLM 2015). The hard triggers are a threshold that require immediate action necessary to prevent large deviations from their objectives, which are illustrated in the following criteria (BLM 2015):

Short-term Decline:

a) 4 consecutive years of 20% or greater annual decline in average males per lek each year
b) average males per lek, based on lek trends, drops 75% below the 10-year rolling average males per lek in any single year

Long- term Decline

c) Lambda < 1 in 6 consecutive years
d) Lambda < 1 in 8 years of a 10-year window

The West Desert Adaptive Resource Management (WDARM) Local Working Group was formed in 2002 to identify voluntary conservation actions that could be implemented to manage sage-grouse. In 2007 the group published a conservation plan to guide management action in the area (WDARM 2007). The WDARM plan encompasses the Sheeprock SGMA. The strategy goals developed by the WDARM included:

1. Incorporate management strategies from state and federal agency partners, local governments, and established range wide conservation and management guidelines (Connelly et al. 2000, Connelly et al. 2004)
2. Increase effective communication with all potential stakeholders in the West Desert and the State of Utah, through outreach, information distribution, and education
3. Address and prioritize threats to aid in prioritizing management solutions
4. Identify and pursue funding sources, or support partners in their pursuance of funding for projects that will help achieve specific strategies and actions.

Sheeprock SGMA

Of the eleven SGMAs outlined in the Utah sage-grouse conservation strategy, ten have shown positive lek trends consistently for the past decade. The one exception is the Sheeprock SGMA populations. In 2006, the active male lek counts for the Sheeprocks were 190 observed males (Robinson 2007). In 2015, the number of active males counted on leks was 23 (Utah Division of Wildlife Resources [DWR], unpublished data). Given these trends, sage-grouse population hard triggers published by BLM were triggered (BLM 2015). During the Summer of 2015, the WDARM met and discussed avenues for immediate action required to prevent extirpation of the Sheeprock population. As part of this effort, the WDARM recommended initiating a translocation program.

Translocations have been used as an avenue to establish, reestablish, or prevent extirpation of species populations with the ultimate goal being to create a self-sustaining population (Griffin et al. 1989, Dickens et al. 2009). Success of translocations is contingent on the methods and protocol of capture. The species that have the highest success of translocations are wild, native gamebirds into areas that contain individuals of the species (Griffin et al. 1989). The quality of habitat will also influence the success, with higher habitats leading to higher success; however, in areas with lower quality habitat, on-going habitat restoration projects aid in success (Dickens et al. 2009). In areas with higher predation, predator control was shown to have increased

success as well (Baxter et al. 2008). The protocol that provides the highest probability of success is having the birds translocated overnight during the breeding season and released on the lek the morning of capture (Reese and Connelly 1997, Baxter et al. 2008).

Study Purpose

The purpose of this project is to augment the population of sage-grouse located within the Sheeprock SGMA in efforts to aid in population increase and its eventual stabilization. In this regard, the specific objectives of this study include:

1. Determine vital rates (nesting and brood success, annual survival) for radio-marked birds and if they differ between translocated sage-grouse and resident sage-grouse.

2. Determine habitat-use (breeding, winter), responses to management actions, and seasonal movements for marked birds and if they differ between radio-marked translocated sage-grouse and resident sage-grouse.

3. Determine travel corridors used by marked birds and if translocated and resident birds are similar.

4. Determine the effect of the translocations on lambda. (Note: because all translocated males will be radio-marked we will be able to censor them from lek count lambda calculations).

5. To develop specific disturbance and habitat management recommendations for the USFS, BLM, and other partners based on marked sage-grouse vital rates and habitat-use patterns. These recommendations will include the prioritization and placement of projects to increase mesic habitats, usable space, development and placement of migration corridors, and actions to mitigate the potential effects of dispersed recreation on sage-grouse seasonal habitats.

Study Area

The Sheeprock SGMA is located near Vernon in central Utah. It is an area comprised of 611,129 acres located in both Tooele and Juab counties. Of the total area, approximately 535,233 acres has been estimated to provide adequate sage-grouse habitat. The BLM and the USFS manage 325,280 and 92,328 acres of the SGMA, respectively. The remaining acres are divided as follows: private ownership (82,740 acres), SITLA (34,131acres), and the Utah Department of Natural Resources (684 acres).

The 50-year average maximum summer temperature is 32.4 ˚C in July, and the minimum winter temperature is -10.4 ˚C in January. This area is characterized by warm, dry summers and cool winters. The average annual precipitation is 10.24 inches, with the highest amount being in the Spring and Fall months. Average snowfall is 36.2 inches (Wester Regional Climate Center 2016).

Elevation ranges from 1500m in the lower valleys to 2950m with the tallest peaks. The lower elevation vegetation is comprised of Wyoming big sagebrush (*A. tridentata* spp *wyomingensis*), crested wheatgrass (*Agropyron cristatum*), and bulbous bluegrass (*Poa bulbosa;* Robinson

2007). Invasive vegetation located in the lower elevation includes cheatgrass (*Bromus tectorum*) and knapweed (*Centaurea* spp.; Robinson 2007). As elevation increases, shrubs such as the following become more prevalent: serviceberry (*Amelanchier alnifolia*), common snowberry (*Symphoricarpos albus*), antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*A. tridentate vaseyana*) and juniper (*Juniperus* spp) stands (Robinson 2007). Higher elevations, along ridgelines, are dominated by black (*A. nova*) and low sagebrush (*A. arbuscula*; Robinson 2007). Rubber rabbitbrush (*Ericameria nauseosa*) and Douglas rabbitbrush (*Chrysothamnus viscidiflorus*) are also prevalent in lower and mid elevations (Robinson 2007). Other grasses and forbs include: oniongrass (*Melica bulbosa*), sandberg bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), bottlebrush squirreltail (*Elymus elymoides*), great basin wildrye (*Leymus cinereus*), indian ricegrass (*Achnatherum hymenoides*), foxtail barley (*Hordeum jubatum*), little barley (*Hordeum pusillum*), western wheatgrass (*Pascopyrum smithii*), arrowleaf basalmroot (*Balsamorhiza sagittata*), blue-eyed mary (*Collinsia parviflora*), tailcup lupine (*Lupinus caudatus*), tapertip hawksbeard (*Crepis acuminate*), and clover (*Trifolium* spp.; Robinson 2007).

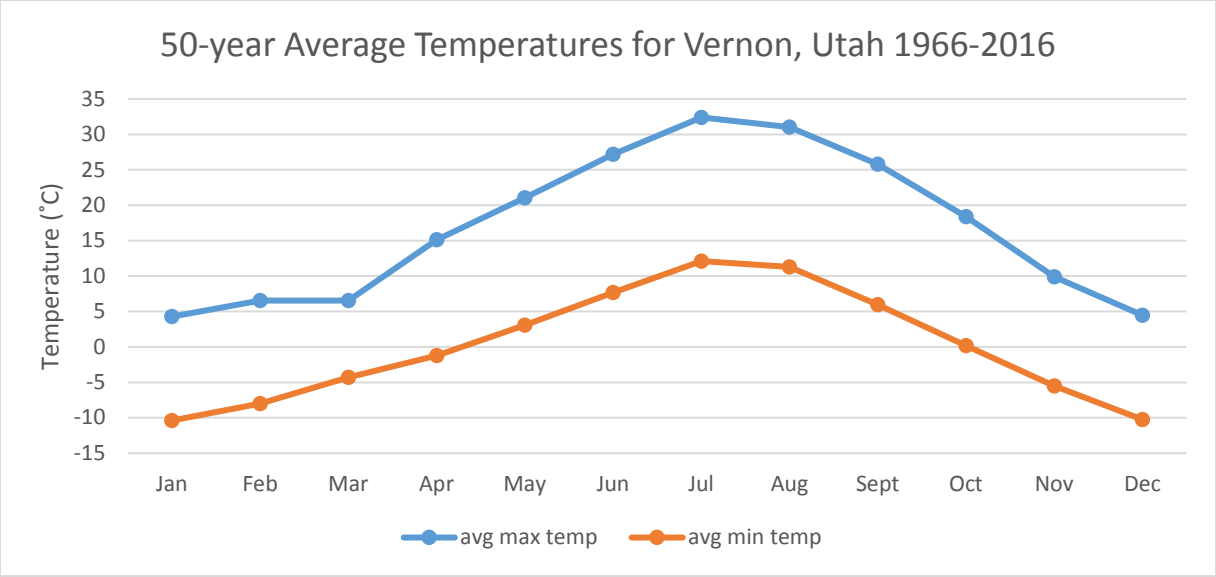

Figure 1. Average minimum and maximum temperature data collected by Western Regional Climate Center in Vernon, Utah, from January 1966 to June 2016 (Western Regional Climate Center 2016).

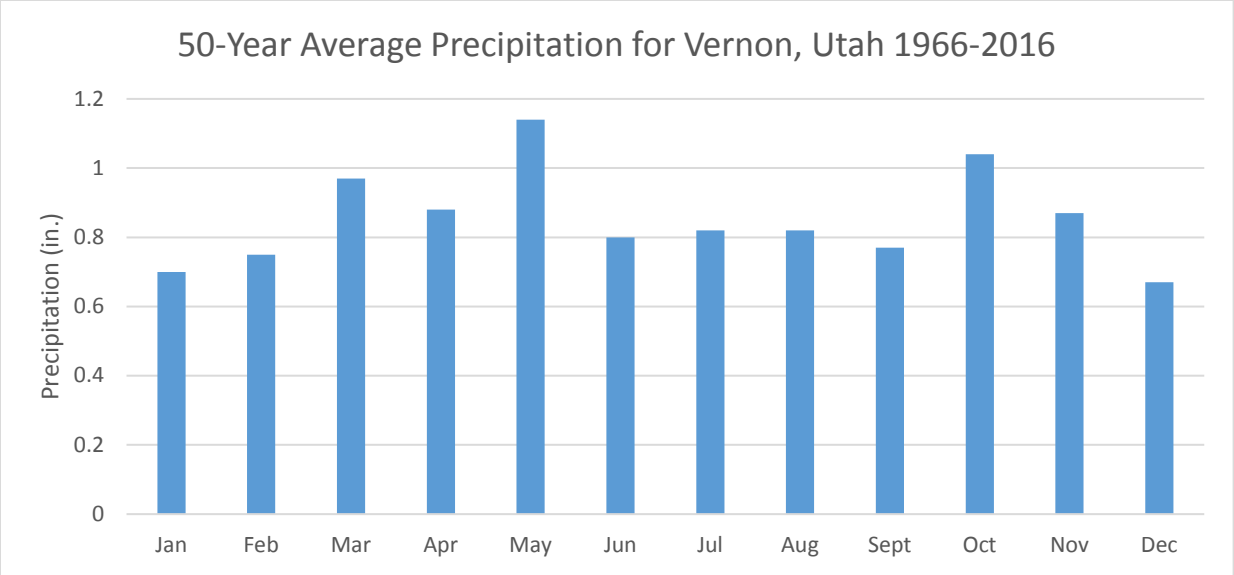

Figure 2. Average annual precipitation in inches, illustrating a bimodal distribution with peaks occurring during the Spring and Fall months from January 1966 to June 2016 (Western Regional Climate Center 2016).

According to WDARM (2007) one of the greatest threats posed to sage-grouse are fires on the landscape and the introduction invasive plants that fill those gaps. Wildfires occur periodically throughout the SGMA. Since 1986, 13 fires have occurred periodically, the last one occurring in late summer of 2016. In some areas of these wildfires, cheatgrass and rabbitbrush have replaced existing sagebrush stands (WDARM 2007). The WDARM cited two altered fire regimes being incompatible with sagebrush habitat in their 2007 plan. First, cheatgrass invading has increased the frequency of fires and potentially changes the sagebrush community into grasslands (Miller and Eddleman 2000, Connelly et al. 2000). Second, fire suppression has encouraged the expansion of pinyon-juniper stands into the sagebrush community, altering the ecosystem (Miller et al. 2000).

Predation has also been identified as a major threat in the Sheeprock SGMA, primarily due to increased populations of corvids and red fox, which did not co-evolve with sage-grouse (WDARM 2007, Robinson 2007, Robinson and Messmer 2013, Utah Governor's Office 2013). Predators of the sage-grouse at different life stages and/or nests include weasel (*Mustela* spp.), badger (*Taxidea taxus*), coyote (*Canis latrans*), common raven, *(Corvus corax*), American crow (*Corvus brachyrhynchos*), red fox (*Vulpes vulpes*), golden eagle (*Aquila chrysaetos*), ferruginous hawks (*Buteo regalis*), red-tailed hawks (*Buteo jamaicensis*), and Northern harrier (*Circus cyaneus*; Robinson 2007, WDARM 2007). However, no one predator specializes or targets sage-grouse exclusively; predators mostly focus on rodents and lagomorphs (Schroeder et al. 1999).

Principal land uses include ranching, off highway vehicle (OHV) recreation, and big game hunting. For the private landowners, ranching constitutes their primary income and therefore is an important industry for the area. Sheep and cattle grazing are the two major livestock that are grazed on the study area. The BLM and the USFS manage seasonal grazing allotments that they allow the ranchers to graze for certain times of the year, and some landowners graze cattle on

their own land for grazing periods throughout the year as well. The OHV recreation has been identified from the WDARM group to have a potentially large impact on the survival of sage-grouse, due to its high activity along several key areas used by the grouse. The impacts of the OHV recreation are likely two main factors: disturbance of individuals and alteration of habitat (WDARM 2007).

Methods

Sage-grouse Translocations

The 2016 translocations followed guidelines outlined by Connelly et al. (1997) and Baxter et al. (2008). During the breeding season of 2 to 3 consecutive years beginning in 2016, 30 females and 10 males were translocated from genetically compatible populations of sage-grouse located in Box Elder County and in Wayne County on Parker Mountain (Reese and Connelly 1997, Oyler-McCance et al. 2005). These populations are greater than 50km away from the Sheeprock SGMA, where the birds were released (Reese and Connelly 1997, Oyler-McCance et al. 2005). The source populations were approved by the Regional Advisory Councils, the Wildlife Board, the Resource Development Coordination Council (RDCC), and the West Desert, Parker Mountain, and West Box Elder SGMA local working groups.

The sage-grouse to be translocated and resident birds that were radio-marked were captured at night using all-terrain vehicles, spotlights, and long handled nets at night near active leks (2100hr to 200hr; Connelly et al. 2003). The sage-grouse translocated were processed upon capture or brought to the trucks and processed there before leaving the capture site. Most of the females were fitted with an 18-gram necklace style very high frequency (VHF) radio transmitter (Advanced Telemetry Systems, Insanti, MN, and American Wildlife Enterprises, Monticello, FL). Some females were fitted with camouflaged and solar-powered GPS satellite transmitters following capture protocols mentioned previously (Connelly et al. 2003). Eight of the translocated males were fitted with the VHF radio collars, and two with GPS satellite transmitters. The GPS transmitters contain Ultra High Frequency (UHF) capabilities to allow for relocating marked birds in the field and contain a ground-track window for several hours per day to transmit the UHF signal. Processing included mounting the transmitter, ageing, sexing, weighing, marking with a 14-16 leg band for females and males, respectively, and the capture location was recorded (UTM, 12N, NAD 83).

After the sage-grouse to be translocated were processed, they were placed in individual cardboard boxes (30cm x 23cm x 30cm) with ventilation and transported overnight in a pickup truck to the study site (0200hr to 0700hr). The radio-marked sage-grouse were released the morning following capture, within 200m, adjacent to the lek site. The boxes were lined up with the opening facing the lek and each grouse was released after the immediate area was scanned for predators.

In the Sheeprock SGMA, we attempted to capture up to 10 resident sage-grouse (8 females and 2 males) in the spring of 2016. Our plan was to deploy two GPS transmitters on females and two GPS transmitters on males of the resident population, with the remaining six resident females being fitted with the VHF radio-collars. All captured sage-grouse were weighed and aged by the

plumage characteristics indicated by the P9 and P10 wing feathers. They were immediately released following processing after capture. With the population being so low in the Sheeprock SGMA, capturing 10 grouse represented a realistic goal (Robinson and Messmer 2013). Data gathered from the resident population will provide WDARM with current information on the habitat use, seasonal movements, and habitat corridors of the resident population.

Lek Counts

Lek counts were conducted according to the procedures outlined in the Utah DNR's protocol. A minimum of three counts were conducted in weekly intervals beginning in mid-March and ending May 7. The counts begin 30 minutes before sunrise and end 1 hour and 30 minutes after sunrise, counting 3 to 5 times during that time period and recording the maximum number of males that visited the lek. To record whether translocated males visit the lek, the observer used radio telemetry equipment to listen for the translocated males' frequencies. Radio-marked translocated males will be excluded from 2017 lambda calculations based on lek counts.

Radio-telemetry

To monitor sage-grouse vital rates and habitat-use, locations were recorded for all radio-marked grouse using UTM's in NAD83. For the VHF transmitters, birds were located with VHF receivers and VHF antennas. The data for the GPS-marked birds has a duty cycle of 5 days, so data are uploaded at the end of each duty cycle. Five locations were recorded each day for the GPS transmitters. For each location, the date, time, observer, UTM, group size, flocking with resident birds, nearest lek, habitat type, visible wells, nearest disturbance and mortality was recorded. Mortality for the VHF radio-collared birds was determined by a mortality signal (faster pulse), which turns on after 8 hours when the collar has been in the same place. Mortality for the GPS transmitters was determined using the data, which detects a mortality mode after several fixes at the same location. After a mortality signal was detected, we attempted to locate the transmitter and determine the cause of death.

During the nesting season, all radio-marked females were located 2 to 3 times per week to determine the date of nest initiation. Once a nest was confirmed, we observed it 2 to 3 times a week from 30 to 50 meters away to determine the fate of the nest. Once the eggs hatch after 26-28 days of incubation, the clutch size was estimated by counting the number of egg shells after the female leaves the nest. If a nest failed, we attempted to identify the cause and monitored the female 2 to 3 times a week to document re-nesting attempts. Broods were visually radio-tracked 3 times a week until the brood reached 50 days old. Females that did not have broods were tracked 1 to 2 times per week.

For each nest and one brood location per week (up to 50 days of age for the brood), we recorded vegetation measurements using a line intercept method to determine shrub cover, height and species (Connelly et al. 2003). Each location consisted of four, 15 meter transects for nest sites and four, 10 meter transects for brood sites. A random compass bearing was taken to determine the direction of the initial transect. Daubenmire frames, 20 x 50 cm every 3 meters for nests and 2.5 meters for broods were used along each transect to determine the percent cover of forbs and grasses at each site (Daubenmire 1959). A Robel pole was used at each vegetation plot to assess

visual obstruction at 4 meters along each transect at 100 cm high, looking both into and out from the Robel pole (Robel 1970).

During the fall and winter, the sage-grouse are being located bi-monthly using ground telemetry. Periodic flights in a fixed wing aircraft will be used to locate the grouse that are undetectable from the ground. Locations of the GPS birds will continue to be downloaded after each 5-day duty cycle to determine movement corridors and fall and winter ranges. All research activities will be executed in accordance with Utah State University IACUC approved protocol.

Preliminary Results

Translocations

On March 9-10, 2016, teams in Box Elder were distributed among four lek areas: Dry Basin, Chicken Ridge, Meadow Springs, and Warm Springs. In total, there were 19 birds captured from the two nights of trapping: 11 females and 8 males. Of the 11 females, 9 were fitted with VHF collars and 2 with GPS transmitters. Of the 8 males, 5 were fitted with VHF collars and 3 with GPS transmitters (2 of which fell off upon release). These birds were translocated into Government Creek lek area.

On April 8, 2016, the translocation effort on Parker Mountain yielded 21 birds: 19 females and 2 males. Because we wanted to augment two separate leks on the Sheeprock SGMA - McIntyre and Benmore - the radio-marked birds were released as follows: 7 birds (1 male and 6 females) were released on the Benmore lek, and 14 birds (1 male and 13 females) were released McIntyre. Of the 19 females captured, 6 were fitted with GPS PTT transmitters and 13 were fitted with VHF transmitters. Of the males, 1 was fitted with a GPS PTT transmitter and the other was fitted with a VHF transmitter. There were two females released into McIntyre without VHF collars. This completed the translocation efforts with 40 total translocated birds, reaching the goal for 2016.

Seven resident birds were captured and radio-marked: 5 females and 2 males. Of the females, 2 were fitted with a GPS PTT transmitter, and 3 have been fitted with VHF radio collars. Both of the males were fitted with GPS PTT transmitters.

Lek Surveys

Three leks—Government Creek, Benmore, and McIntyre— were surveyed from early April to May 5 in the Sheeprocks SGMA. In lek counts gathered from the DWR biologists and those that we conducted, there were 25 males observed at the peak of lekking season.

Radio-Telemetry

In March and April, translocation efforts combined with trapping efforts in the Sheeprock SGMA yielded a total of 46 birds: 40 translocated and 6 resident birds (10 translocated males, 30 translocated females, 2 resident males, 4 resident females). Of the 40 birds translocated, 8 (20%) of them were not detected during the study area throughout the whole season. Of the 34 females during nesting season, only 25 (73.5%) were detected within the study area. In July, we captured and marked a resident female, giving us a total of 47 marked birds.

Because of the number of habitat restoration projects being conducted in the SGMA, we mapped these projects relative to known sage-grouse locations. Below are figures depicting radio-marked sage-grouse use of completed and proposed Watershed Restoration Initiative (WRI) treatments.

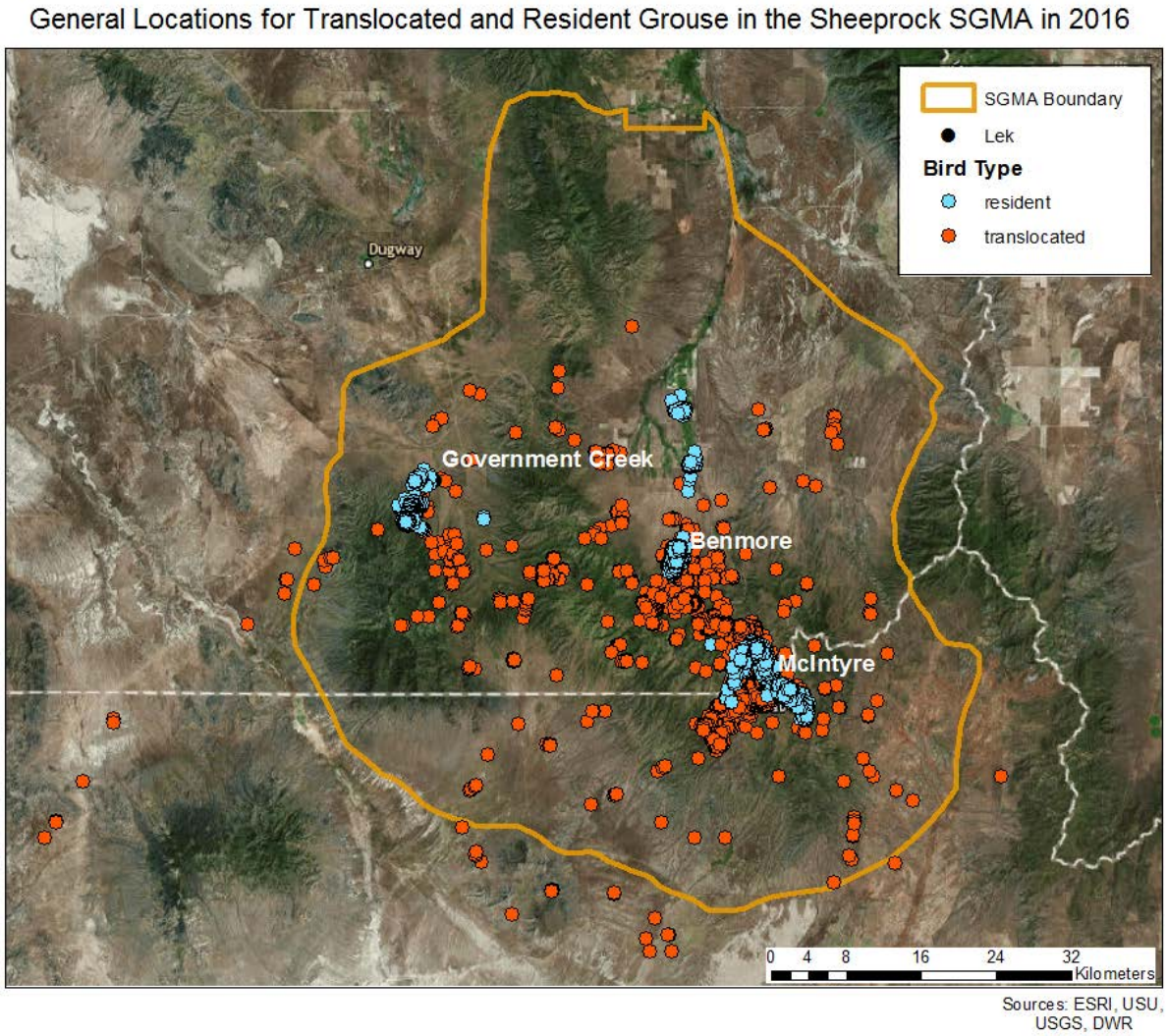

Figure 3. General location map of the resident and translocated greater sage-grouse (*Centrocercus urophasianus*) radio-marked with very high frequency (VHF) radio-collars and global positioning system (GPS) rump-mounted radio-transmitters, Sheeprock Sage-grouse Management Area, 2016.

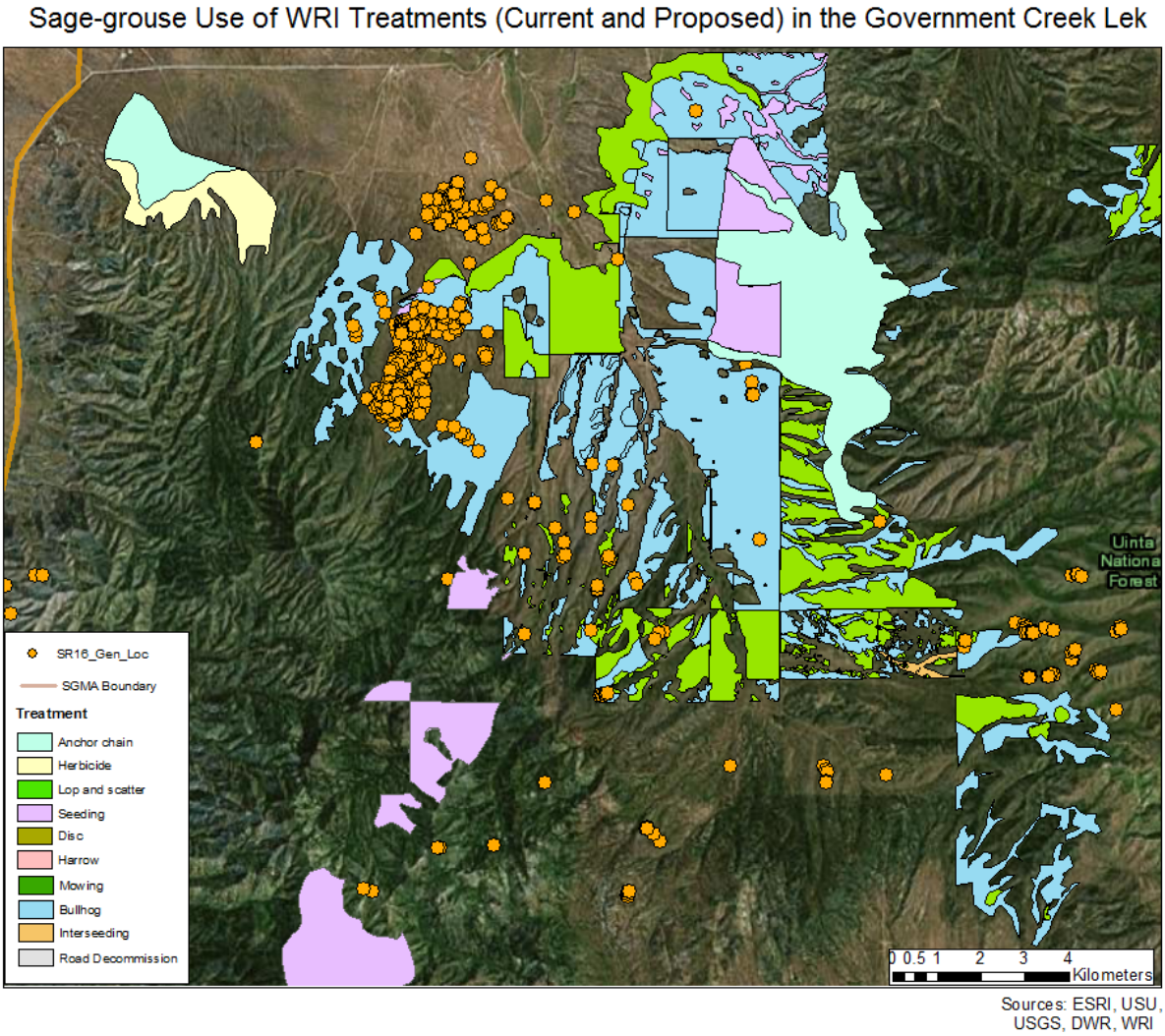

Figure 4. Radio-marked greater sage-grouse (*Centrocercus urophasianus*) locations relative to completed and proposed Watershed Restoration Initiative Projects in the Government Creek lek area, Sheeprock Sage-grouse Management Area, 2016.

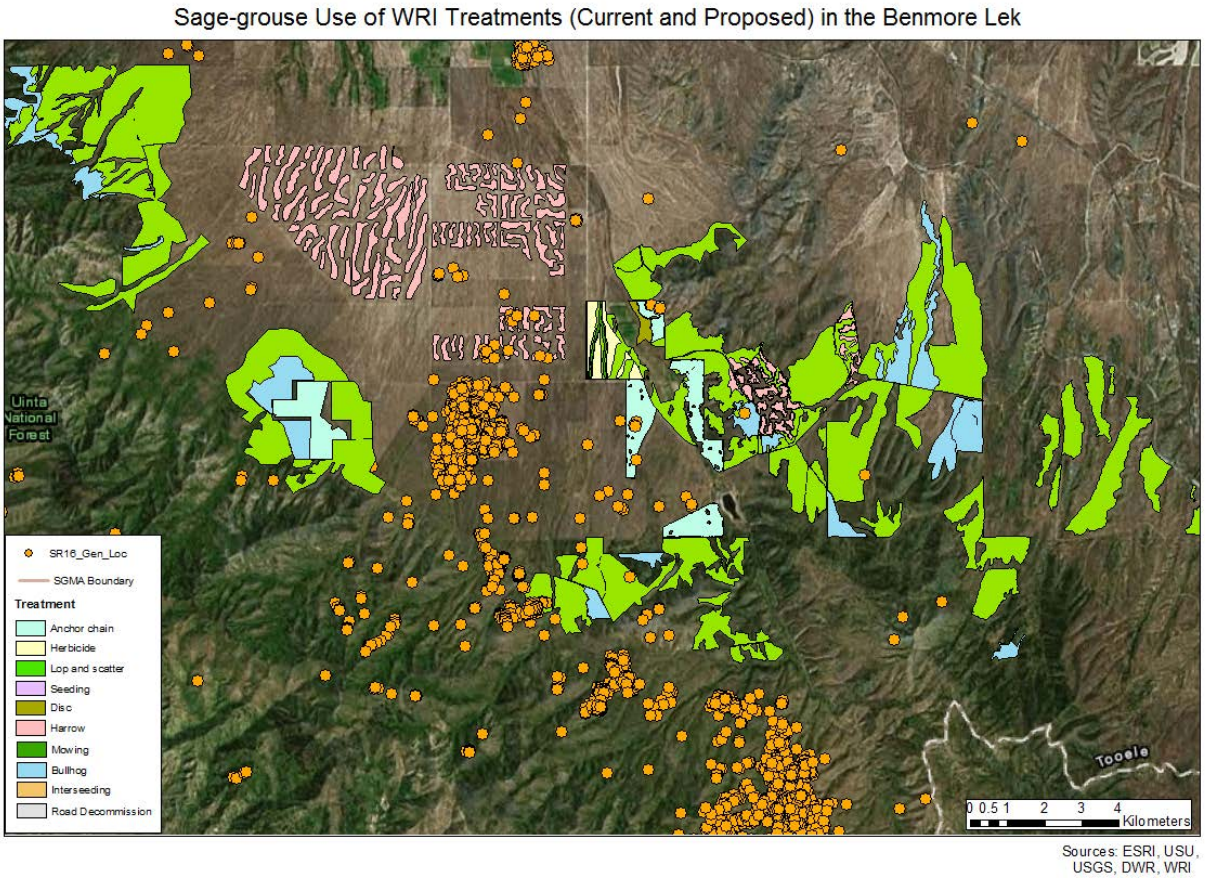

Figure 5. Radio-marked greater sage-grouse (*Centrocercus urophasianus*) locations use of completed and proposed Watershed Restoration Initiative Projects in the Benmore lek area, Sheeprock Sage-grouse Management Area, 2016.

Nest Initiation and Success

In 2016, we located 5 nests from both the translocated and resident females, all located within the McIntyre lek. Of the 33 translocated females detected during the nesting season, 4 initiated nests, yielding a 12% nest initiation rate. Of the 4 resident females marked during the nesting season, only 2 were detected, yielding a 50% nest initiation rate. Nest initiation dates began April 15 and the last nest hatched on June 10, 2016.

Of the 4 translocated female nest initiations, 3 initiations were from Parker Mountain (translocated in early April) and 1 was from Box Elder (translocated in early March). Two of the four nests hatched, which was a 50% success rate. The two nests yielded 11 eggs that hatched. The first translocated female initiated on April 15 and the last initiation was on May 22. The first successful nest hatched on May 30 and the last successful nest hatched on June 10.

The resident female successfully hatched her nest with 5 eggs, which, combined with the translocated females' chicks, gave a total of 16 chicks. The resident female initiated her nest on April 23 and hatched on May 24 (Table 1).

Table 1. Nest initiation and hatch dates for translocated and resident female greater sage-grouse (*Centrocercus urophasianus*) with information on which source population females were translocated from, Sheeprock Sage-grouse Management Area, 2016.

Bird ID	Res/Trans	Source Population	Nest Initiation	Nest Hatch Nest Fail	# Chicks
SR-16-8054	Trans	Parker Mt.	4/15/16	Fail	-
SR-16-2350	Res.	-	4/23/16	5/24/16	5
SR-16-8032	Trans	Box Elder	5/2/16	5/30/16	5
SR-16-9151	Trans	Parker Mt	5/17/16	6/10/16	6
SR-16-2475	Trans	Parker Mt.	5/22/16	Fail	-

Brood success

The 2 translocated broods had 50% success, with one brood successfully reaching the 50-day brood survey with 3 chicks. The resident female successfully reached the 50-day brood survey with 1 chick. In total, that yields 4 chicks, which is a 25% survival rate for the chicks.

Because the radio-marked females were only in the McIntyre lek, we also documented any unmarked broods that we came across in the field, which gives us more data on habitat use for broods. Figure 6 shows the brood locations.

Vegetation measurements

Data were collected for the 5 nests and the 3 broods for each week they had chicks. At this time, these data have not been analyzed.

Survival

We recorded 16 mortalities between March to November: 4 males and 12 females. Of these 15 were translocated birds had 15 mortalities (46.8% mortality rates with censoring the translocated birds not detected). Most of the mortalities occurred in early and mid-August (Figures 7 and 8).

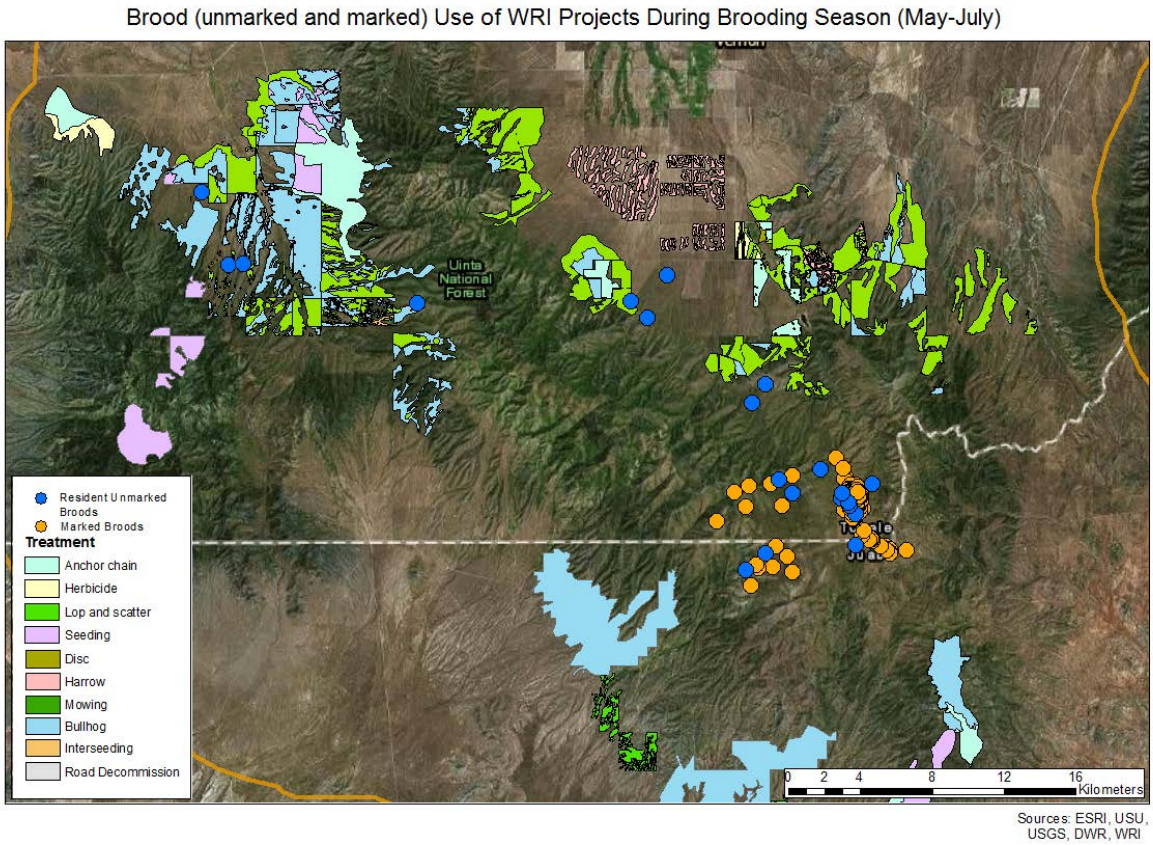

Figure 6. Greater sage-grouse (*Centrocercus urophasianus*) brood locations of unmarked broods (blue) and marked (orange) broods and their use of completed and proposed Watershed Restoration Initiative Projects in the Benmore lek area, Sheeprock Sage-grouse Management Area, 2016.

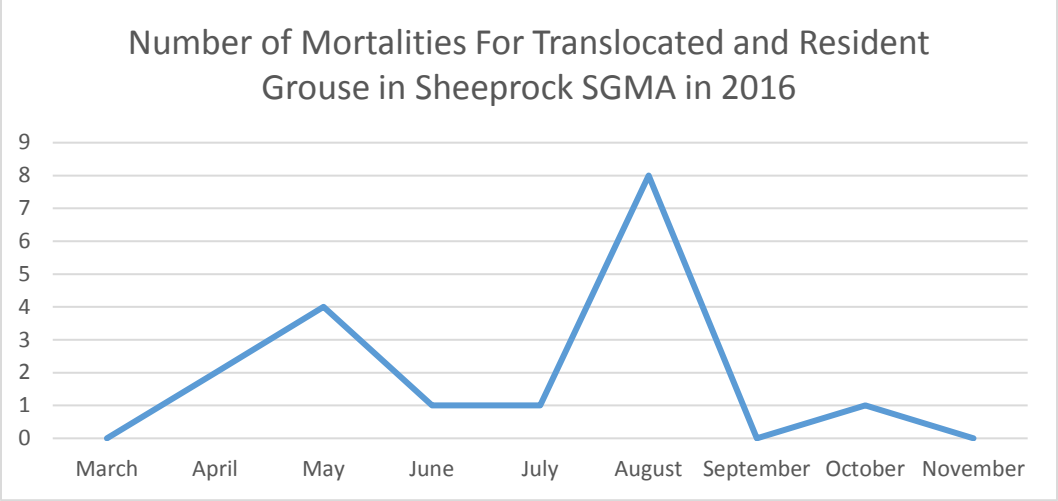

Figure 7. Greater sage-grouse (*Centrocercus urophasianus*) monthly mortalities, Sheeprock Sage-grouse Management Area, 2016.

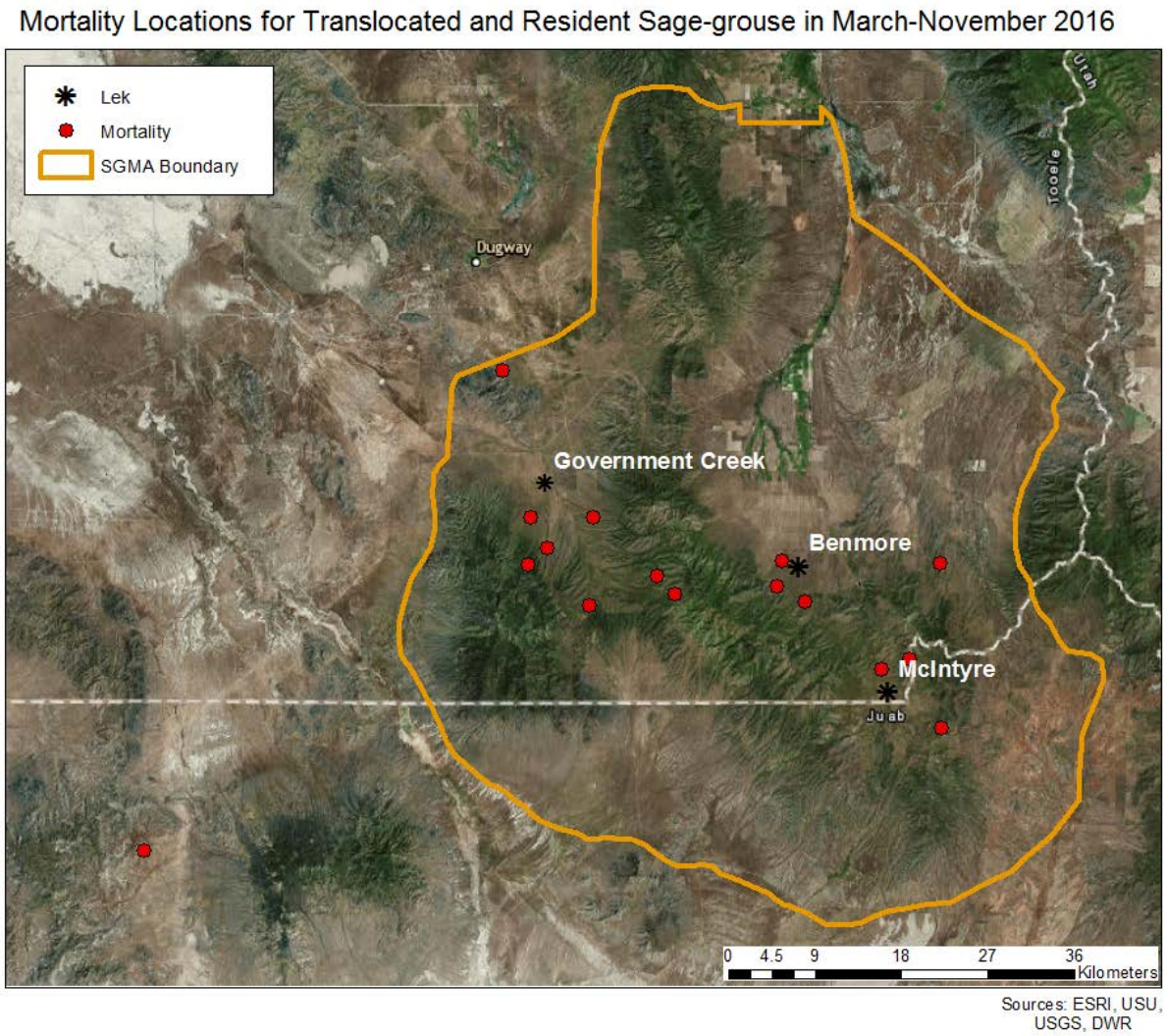

Figure 8. Greater sage-grouse (*Centrocercus urophasianus*) mortality locations, Sheeprock Sage-grouse Management Area, 2016.

Preliminary Recommendations

Given the extensive seasonal movements made by several of the birds translocated from Box Elder SGMA, and the higher nest initiation rates for the Parker Mountain SGMA birds, it appears as though translocations in Box Elder may have been conducted too early in the season and the females may not have been ready to breed or were bred. Thus, upon release of the Box Elder birds, instead of visiting the leks and initiating nests, the females appeared to attempt to return to their source population or tried to find adequate habitat. For the 2017 field season, we are investigation the possibility of synchronizing the translocations and incorporating artificial insemination techniques which have proven successful in other gamebird translocation. If we receive approval for use of this technique, a portion of the translocated females from both populations will be inseminated with semen collected from resident males to see if it will increase their nest initiation rates.

The high mortality rates recorded for the translocated birds later in the season are of particular concern. We will be initiating corvid/raptor and canid surveys in 2017 to develop better estimates of the abundance of predators in the area in response to predator control efforts. From the map above, it appears that most of the mortalities occurred within the Government lek, which exhibits lower habitat quality relative to Benmore and McIntyre lek areas. With the conifer removal projects currently under way, we would expect to see increased nest and brood success in 2017 (Sandford 2016).

We will be conducting detailed habitat analyses to identify potential sites for projects relative to sage-grouse travel corridors, recorded mortalities, and habitat-use areas. Habitat fragmentation appears to be limiting the birds' survival and movements. We have provided a preliminary analysis for potential sites for conifer removal projects (Figs. 9-12).

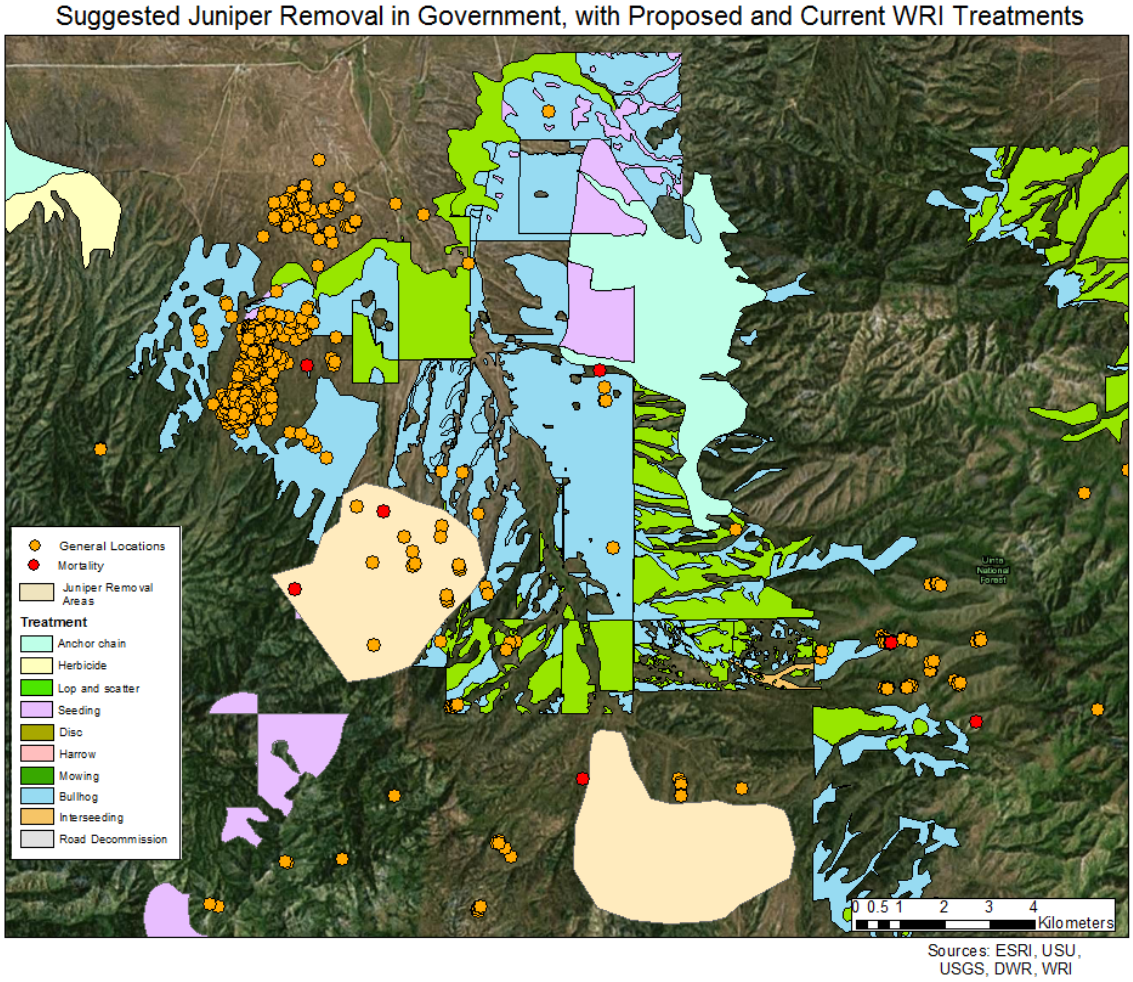

Figure 9. Potential sites for management projects in the Government Creek lek area to benefit greater sage-grouse (*Centrocercus urophasianus*) during the breeding season, Sheeprock Sage-grouse Management Area, 2016.

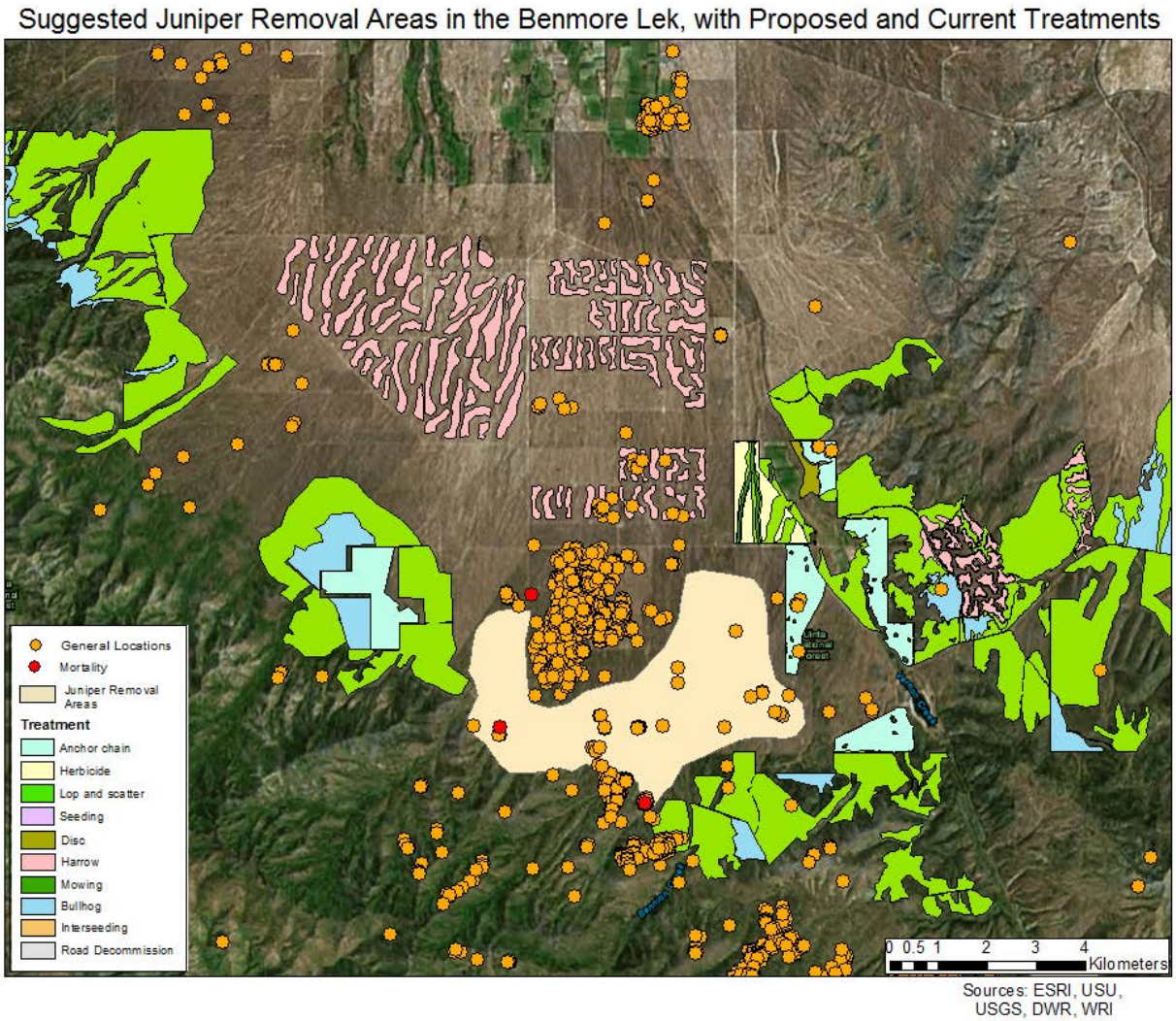

Figure 10. Potential sites for management projects in the Benmore lek area to benefit greater sage-grouse (*Centrocercus urophasianus*) during the breeding season, Sheeprock Sage-grouse Management Area, 2016

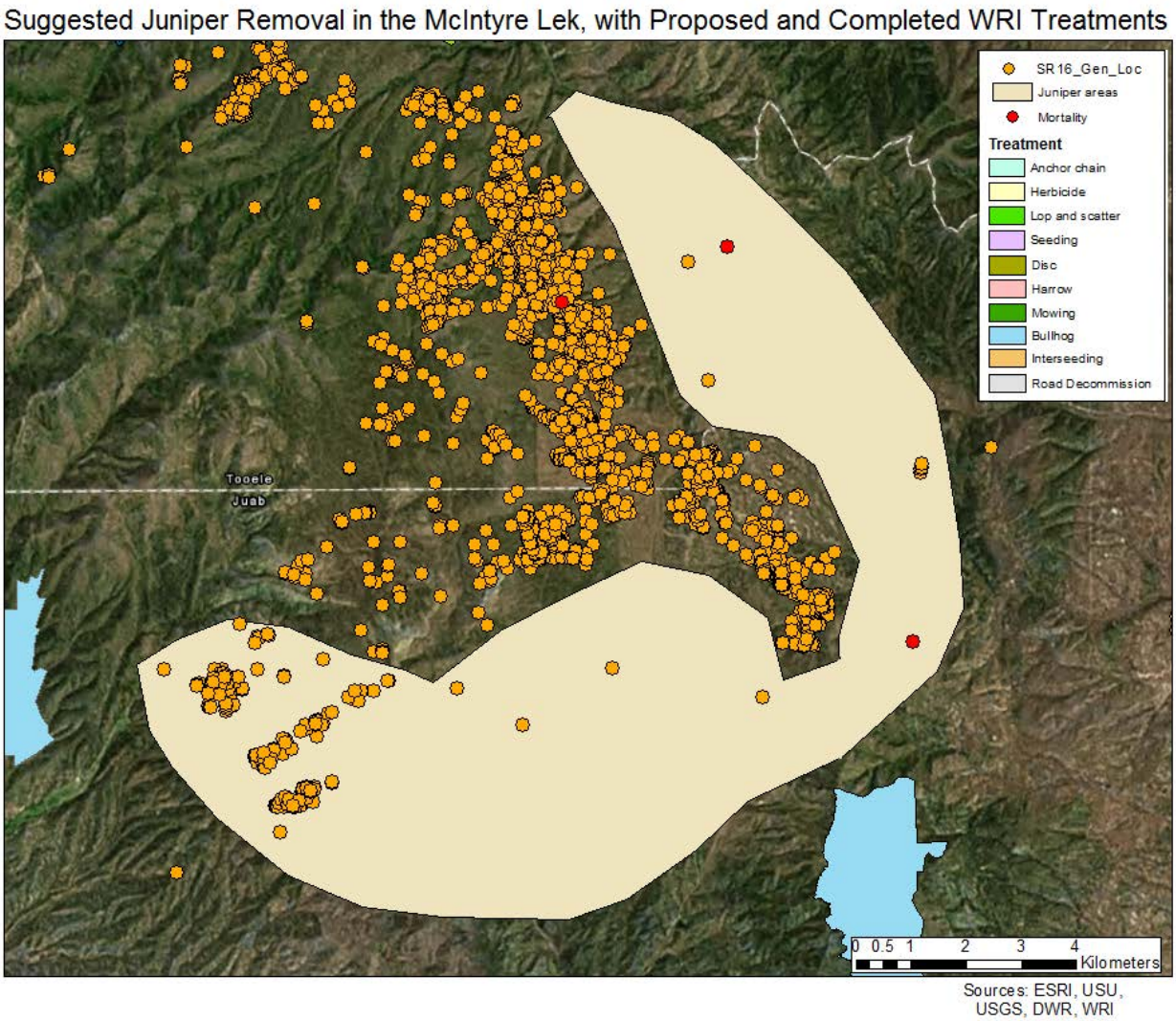

Figure 11. Potential sites for management projects in the McIntyre lek area to benefit greater sage-grouse (*Centrocercus urophasianus*) during the breeding season, Sheeprock Sage-grouse Management Area, 2016

Reduced moisture during the summer months can be a limiting factor for sage-grouse. We completed a normalized difference vegetation index (NDVI) using July 2015 data to depict moisture availability to the sage-grouse during the brood-rearing period. Our analysis suggests the radio-marked sage-grouse are selecting more mesic areas near the leks from June-August (Figs. 12-14).

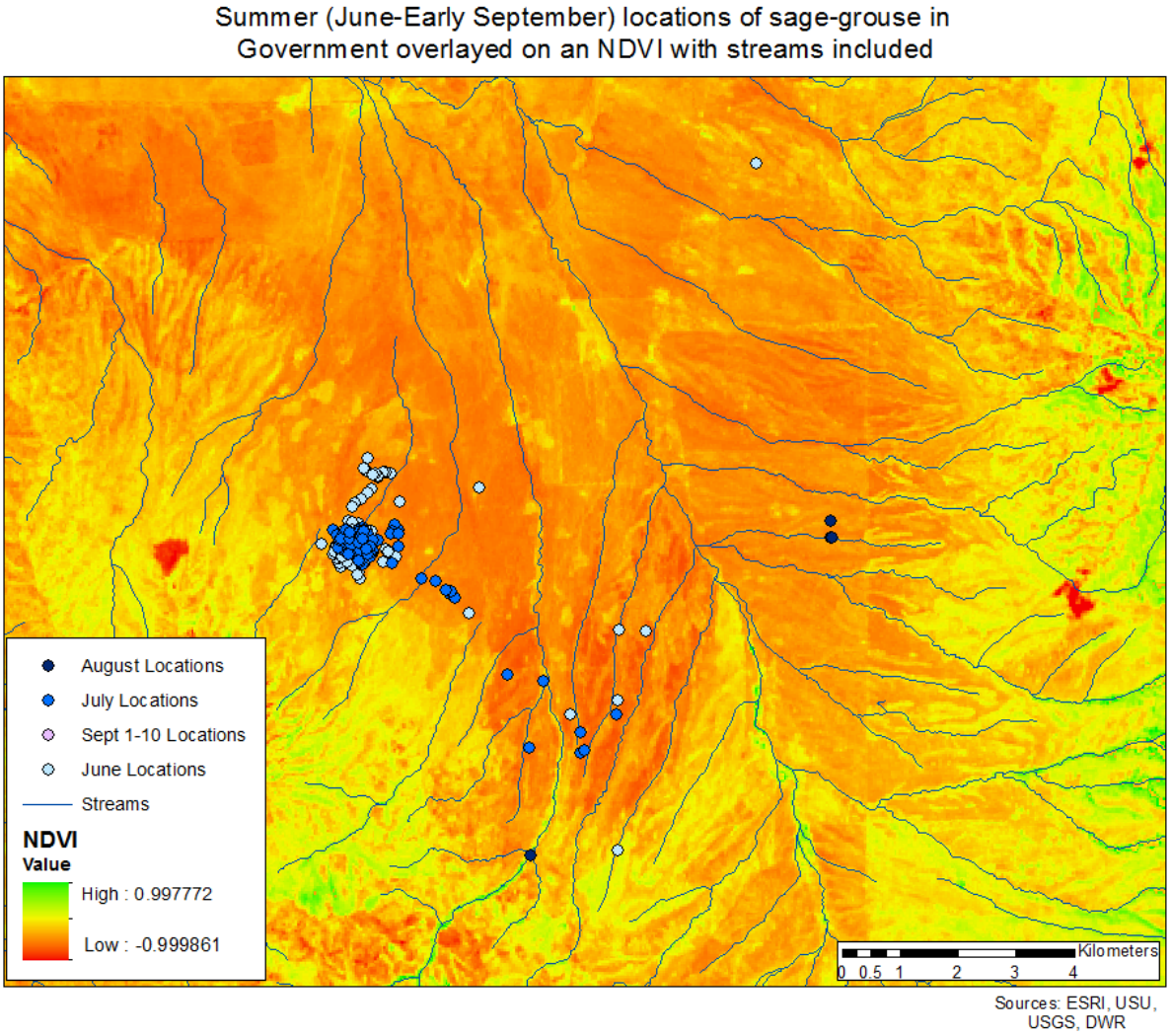

Figure 12. A normalized difference vegetation index (NDVI) using July 2015 data depicting mesic areas and greater sage-grouse (*Centrocercus urophasianus*) use in the Government Creek lek area, June-August 2016, Sheeprock Sage-grouse Management Area.

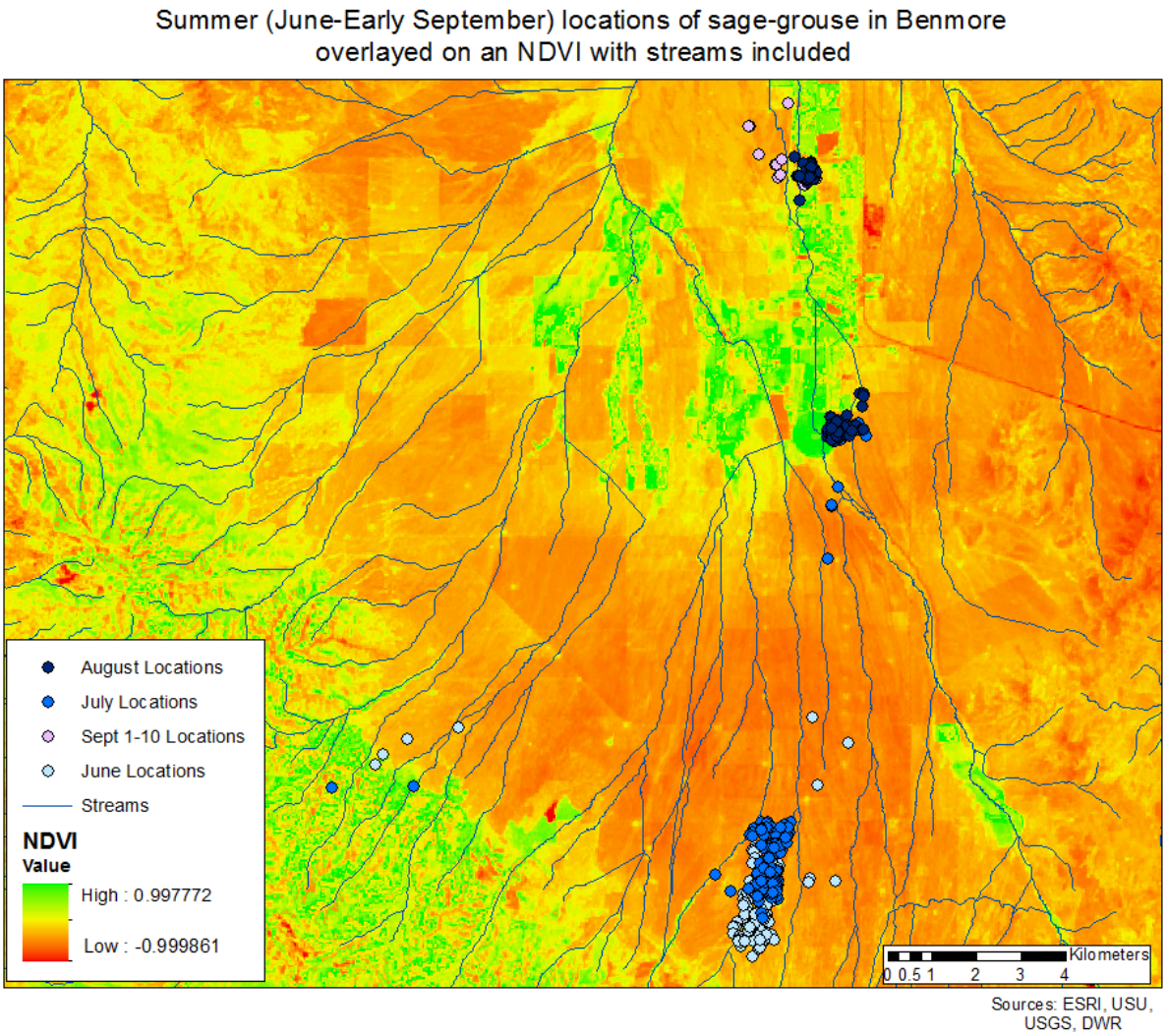

Figure 13. A normalized difference vegetation index (NDVI) using July 2015 data depicting mesic areas and greater sage-grouse (*Centrocercus urophasianus*) use in the Benmore lek area, June-August 2016, Sheeprock Sage-grouse Management Area

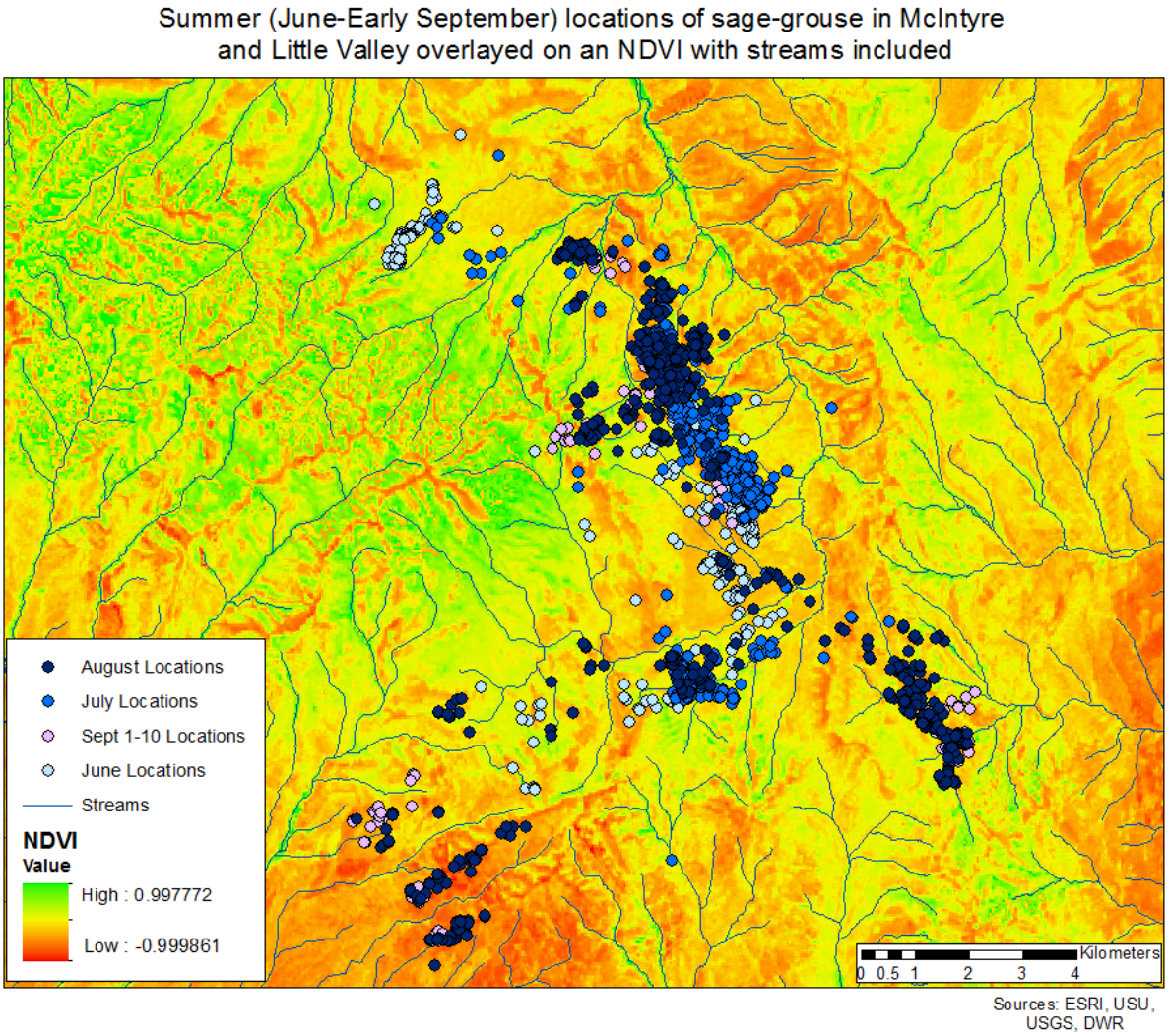

Figure 14. A normalized difference vegetation index (NDVI) using July 2015 data depicting mesic areas and greater sage-grouse (*Centrocercus urophasianus*) use in the McIntyre lek area June-August 2016, Sheeprock Sage-grouse Management Area.

2017 Work Plan

Jan-March: Field preparations to include finalizing research funding plan, a flight in January/February to see birds' winter range location, hiring technicians, purchasing radio-transmitters and field equipment, and participation in local working group and related meetings.

March-April: Sage-grouse capturing, radio-marking, translocations with artificial insemination of half of females and participation in local working group and related meetings. We will be hiring 4 technicians this field season. More effort will be put into trapping in Government Creek and Benmore to acquire better data of resident birds' movements. Predator surveys will also be conducted during the field season to estimate predator abundance.

April-August: Monitoring radio-marked sage-grouse vital rates and habitat-use, and participation in local working group and related meetings.

August- December: Bi-weekly monitoring of population, data analysis and reporting, and participation in local working group and related meetings. A flight in later season to document the birds' late fall/early winter locations.

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