GREATER SAGE-GROUSE (CENTROCERCUS UROPHASIANUS) HABITAT USE PATTERNS AND VITAL RATES IN THE MORGAN-SUMMIT SAGE-GROUSE MANAGEMENT AREA: CONSERVATION IMPLICATIONS FOR MANAGERS

2015 ANNUAL REPORT

Cooperators:

Kern River Gas Transmission Company

Utah Division of Wildlife Resources

Summit County

Morgan County

Deseret Land and Livestock

East Canyon State Park

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Morgan-Summit Adaptive Resource Management Sage-grouse Local Working Group

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Introduction

Populations of greater sage-grouse (*Centrocercus urophasianus*; sage-grouse) have declined range-wide over the last century (Connelly et al. 2004). The potential habitat of sage-grouse has declined from an estimated pre-settlement distribution of 1.2 million km^2 to 668,000 km^2 as of 2000 (Schroeder et al. 2004). These declines have been largely attributed to the degradation, alteration, and fragmentation of the sagebrush (*Artemisia* spp.) habitats which sage-grouse depend on (Schroeder et al. 2004, Connelly et al. 2011). In Utah, it has been estimated that sage-grouse occupy 41% of possible historic habitats, with the largest populations inhabiting sagebrush areas in western Box Elder, western Garfield, Rich, Uintah, and Wayne Counties (Beck et al. 2003).

In response to population declines and the potential for the species to be designated for protection under the Endangered Species Act (ESA), the Utah Division of Wildlife Resources (UDWR) developed a strategic statewide management plan (Plan) in 2002 (UDWR 2002, 2009). In April 2013, Utah Governor Gary Herbert signed Utah's Conservation Plan for Greater Sage-Grouse (http://wildlife.utah.gov/uplandgame/sage-grouse/pdf/greater_sage_grouse_plan.pdf). The Utah Plan is a scientific-based strategy that establishes goals and measurable objectives for sage-grouse in Utah, and identifies how Utah will manage their habitat and populations to meet these objectives (Utah Governor's Office 2013). Over the past 19 years researchers from Utah State University and Brigham Young University have completed studies which have mapped the ecology of most of Utah's sage-grouse populations. These studies were paramount to the development of the scientific basis and strategies of the Utah Plan. Based on this research, the state of Utah established 11 sage-grouse management areas (SGMAs). These SGMAs afforded the greatest potential to conserve the species in Utah. The Rich-Morgan-Summit SGMA, located in northeastern Utah near the Wyoming border is inhabited by one of the state's largest sage-grouse populations (Utah Governor's Office 2013).

Less research has been conducted on Utah's smaller sage-grouse populations. Thus information regarding the ecology of these smaller populations that could be used to guide and refine conservation recommendations contained in the Utah Plan (2013) is lacking. One such area includes sage-grouse populations that occupy private lands in Morgan and Summit Counties in northern Utah. Very little is known about sage-grouse habitat use (nesting, brooding and winter use), migration patterns, or connectivity to larger populations within these areas.

The Morgan-Summit Adaptive Resource Management (MSARM) sage-grouse local working group (LWG) has developed a conservation plan with the goal of maintaining, and where possible, increasing sage-grouse populations and improving habitat conditions in Morgan and Summit Counties (MSARM 2006). The conservation plan identifies several strategies including, but not limited to: monitoring of leks, identification of important sage-grouse habitat use areas,

and potential habitat conservation actions to improve sage brush quality. Because Morgan and Summit Counties are made up primarily of private lands, conservation of sage-grouse depends on the voluntary cooperation of private landowners. The willingness of private landowners to collaborate with state and federal agencies to improve habitat and conserve species like the sage-grouse provides evidence that community-based conservation programs can be effective.
The decision in September 2015 by the U.S. Fish and Wildlife Service to not protect the greater sage-grouse under the ESA (USFWS 2015) provides additional time for the states to demonstrate their conservation plans are working.

Study Purpose

Completion of this study will provide better information about sage-grouse habitat-use patterns and vital rates in Morgan and Summit Counties, Utah for application to management. It will also identify potential migratory corridors or habitat fragmentation by tracking and documenting inter-seasonal movements of sage-grouse in these population complexes. Acquiring these data is critical to identify management actions that will achieve the goals of the conservation plan in Morgan and Summit Counties.

Objectives

1. To determine seasonal migration patterns and associated vital rates (seasonal survival, nest success, and brood success) of sage-grouse populations in the southern portion of the Rich-Morgan-Summit SGMA.

2. To determine nesting, brood rearing, and winter use habitat areas that are preferred by these sage-grouse populations and determine if they differ from random sites in vegetation structure and composition.

3. To determine if different radio-marking techniques influence vital rates of sage-grouse?
   -Do vital rates of sage-grouse marked with rump-mounted global positioning system (GPS) transmitters differ from those marked with necklace style very high frequency (VHF) radio-collars?

Study Area

This research focuses on sage-grouse populations located in the southern portion of the Rich-Morgan-Summit SGMA in northern Utah (Figure 1). The Rich-Morgan-Summit SGMA was defined in the Utah Plan (2013). Geographically, the core of the study area is located within 5 miles of East Canyon State Park in the Wasatch mountain range in Morgan County. It is generally bounded by the Morgan-Weber County line to the north, the Utah-Wyoming border to

the east, the Summit-Wasatch County line to the south, and the Morgan County and Summit County lines to the west. The study area encompasses approximately 215,000 ha (800 mi^2). Land ownership in the study area is mostly private with some public lands which consist of US Forest Service, state owned Wildlife Management Areas, and Utah State Parks.

Vegetation composition in the study area varies with elevation from mostly big sagebrush communities at low elevations into Gambel oak (*Quercus* spp.), maple (*Acer* spp.) and mountain brush woodlands, to aspen (*Populous tremuloides*) and mixed coniferous (*Picea* spp. and *Pseudotsuga menziesii*) forests at higher elevations. Elevation ranges from 5052-9304 ft. (1540-2836 m) above sea level.

Climate data from 1903 to 2013 for Morgan County show annual precipitation averages of 17.53 in. (44.53 cm). Average monthly temperatures range from a high of 89.5° F (31.9° C) in July to a low of 35.5° F (1.9° C) in January (Western Regional Climate Center (WRCC) 2015). The winter of 2014-2015 was mild with lower than normal snow accumulations which led to an early spring. Monsoon-like rain fell in May helping the area catch up to average precipitation.

Methods

Capture and Marking

Beginning in March 20l5 we captured and radio marked sage-grouse with VHF radio collars and camouflaged and solar-powered GPS satellite transmitters that are also equipped with ultra high frequency (UHF) radio signals. In addition, each of the birds was fitted with a numbered leg band. All sage-grouse were captured at night near leks (mating grounds) within the study area during the breeding season using an ATV, spotlight, and long handled net following protocols described by Connelly et al. (2003). Captured birds were sexed, aged, weighed, and examined to determine general physical condition (Eng 1955). A few feathers were collected for DNA analysis and the capture location was recorded (UTM, l2N, NAD 83). Birds were handled with care to mitigate capture related mortality and they were released on site.

Radio Telemetry

Following release, VHF radio-collared sage-grouse were located using radio telemetry to determine habitat use patterns, seasonal movements, nesting and brood success, and survival rates. Marked males were located 1-3 times per week from March until the end of July. Marked females were located twice weekly until nesting began or weekly upon nest or brood failure. We have attempted to locate all radio-collared birds monthly during the winter season (November to February) to determine winter range using a small fixed-wing aircraft outfitted with radio-telemetry equipment.

GPS Transmitters

Hens with GPS transmitters were tracked primarily through non-invasive monitoring by downloading location data from the Argos system (CLS America 2015) and visualizing the data using ESRI Arcmap 10.2.2 and Movebank (Wikelski and Kays 2015). Each GPS transmitter is programmed to collect up to 9 locations per day. Each GPS transmitter also emits a UHF radio signal that I used to locate nesting birds, to get accurate brood locations, and to verify that a hen was still raising a brood. From fall to early spring, GPS marked birds will continue to be tracked and monitored non-invasively through the Argos system.

So far, from October through December 2015, location information from some of the GPS transmitters has been spotty due to low batteries and the inability to properly charge. There are many factors that could prevent the GPS transmitters from recharging properly during this time including clouds, snow, and rain that block the sun, or birds roosting under bushes or in the shadows of hills, mountains, rocks, or taller brush.

Nest Monitoring

For radio-collared birds, nest initiation was determined when a female was found in the same location on two consecutive visits during or following the breeding season. For GPS marked birds, nesting was suspected when a location was broadcast in the same UTM coordinates over several consecutive days during or following the breeding season. Once nesting was suspected, I located the nesting hen manually using a UHF yagi antenna and receiver to pick up the UHF radio frequency emitted by the GPS transmitter. Care was taken not to disturb nesting females to mitigate nest abandonment. Nest observation locations were marked using a hand-held global positioning system (GPS) unit and a discreet physical marker to aid researchers in returning to the observation location. Actively nesting females were observed from a distance of 5 to 30 m 3-5 times per week until the nest hatched or failed. A successful hatch was determined when egg halves were found intact or near the nest bowl, and/or the inner membrane of the eggs was separated from the shell (Wallestad and Pyrah 1974). A failed nest was determined 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. Egg halves that were not intact were examined for holes in the sides of the eggs that would indicate a corvid predation. No eggs or only egg fragments remaining at the nest site would indicate a mammal predation. Every effort was made to verify nest success by locating the marked hen as quickly as possible to observe her behavior and/or by visually observing chicks with the hen.

Brood Monitoring

After hatching, females with broods were located twice weekly until the brood reached 50 days of age or until the brood failed. A failed brood was determined if the hen flushed with one or more hens and no chicks were seen on two consecutive location attempts. Each brood was flushed and counted 50 days after hatching to determine brood success (Schroeder 1997). Brood flush counts for all marked hens with broods were performed during daylight hours. Radio telemetry equipment was used to locate the marked hen. Once her exact location was determined, a thorough search of the area was performed by walking an outward spiral pattern for 20 minutes and all chicks were counted. Brood hopping can occur with sage-grouse and would bias our results so we observed the number and relative size of chicks in each brood throughout the season to determine if this was occurring.

Vegetation Surveys

Upon locating a marked sage-grouse, a vegetation survey was conducted at the location to determine the characteristics of the preferred cover and forage plants. Surveys were performed at nest sites, brood sites, and paired random sites. Random sites were selected using random distances and directions from nest and brood sites. Each survey consisted of four transects, each in a cardinal direction. Nest site transects were 15 m in length while brood site transects were 12 m in length. The line intercept method was used to determine shrub canopy cover and height, and the Daubenmire frame technique was used to evaluate species composition of forbs and grasses (Connelly et al. 2003). Five frames were placed on each nest survey transect at 3 m intervals while four frames were placed on each brood survey transect, also at 3 m intervals. Robel poles were used to determine visual obstructions that would be encountered at nest sites, brood sites, and random sites (Robel et al. 1970). Comparisons of these data will be made at the end of the study in order to determine if differences in vegetation structure and composition exist between preferred and random locations.

Survival Estimates

If a marked bird's radio-collar or GPS transmitter emits a mortality signal, every effort is made to locate the marked bird as quickly as possible to try and determine the cause of death and to recover the transmitter for later use. Simple survival estimates are calculated by dividing the total number of living birds by the total number of marked birds. These estimates can be calculated monthly and seasonally to provide monthly and seasonal survival rate estimates.

Preliminary Results

Captures

From March 12 to April 14, 2015, we captured 31 female and 5 male sage-grouse. 21 females and all 5 males were marked with VHF radio-collars while 10 females were marked with GPS transmitters. One male and two females marked with VHF radio-collars died during the field season. The male died during the mating season shortly after he was captured and marked. One VHF radio-collar was redeployed on a female on July 17, 2015. Two additional GPS transmitters were deployed on July 27, 2015 on females near the Utah-Wyoming border. One of those females died and the GPS transmitter was recovered and redeployed on another female in the same general area on September 17, 2015. That female also died and the GPS transmitter was recovered again but determined to be unusable due to a puncture in the hermetic seal that was caused by the bite of a carnivore, either during predation or scavenging. At the time of this report, 31 females and 4 males are marked with either VHF radio-collars or GPS transmitters.

Vital Rates

The following vital rate estimates are based on descriptive statistics for the 2015 field season and are subject to change following the 2016 field season when all data can be compiled and analyzed statistically.

Of the 31 females marked during March and April 2015, none died before the nesting season. All 31 females were actively monitored and 90% (n=28) initiated a nest. We were unable to determine if an additional hen initiated a nest because she was marked with a VHF radio-collar and was on a property that we did not have permission to access. However, a female marked with a GPS transmitter was on the same property and I was able to determine that she did initiate a nest based on repeated exact locations gathered and reported by the GPS transmitter. Of the 28 verified nest initiations, eight were predated or abandoned leaving 68% (n=19) that hatched successfully. The mean clutch size was 5.7 eggs.

We were not able to determine if the GPS hen mentioned above had a successful nest but we re-located her manually once she left that property and verified that she did not have a brood. Of nests that hatched, 72% (n=13) of broods had at least one chick that survived to 50 days of age. Mean brood size was 1.7 chicks per hen at 50 days post-hatch (Table 1).

Survival Estimates

Survival estimates are based on the 40 sage-grouse that were marked from March to September 2015. The population survival estimate during that time period is 88% (n=35). The male survival

estimate is 80% (n=4), while the female survival estimate is 89% (n=31). The survival estimate for birds marked with VHF radio-collars is 89% (n=24) and for birds marked with GPS transmitters is 85% (n=11). We were not able to positively identify the cause of most mortalities, however, it appears that one female was likely killed by a car on state highway 65. An explanation of these and other survival estimates can be found in Table 2.

We are currently compiling vegetation data for analysis. Currently, summary statistics and analysis of preferred habitat are not available. However, based on personal observations, marked birds seem to demonstrate habitat preferences exhibited by other studied populations; they prefer taller stands of sagebrush for nesting and early brood rearing cover and mesic areas for late brood rearing and summer habitats.

Movement Patterns

To date, movement patterns of VHF radio-collared birds have been mostly restricted to summer range. However, thanks to the GPS transmitters, two birds have been observed migrating as far as 30 miles to possible winter-use areas in Summit and Wasatch Counties (Figure 5). Both of these individuals have migrated to areas outside the Rich-Morgan-Summit SGMA boundary.

Continual monitoring of all marked birds from March to October shows a strong preference for habitat surrounding leks during the nesting and brood rearing seasons and into fall. The average distance from leks to nest sites is 934 m while the average distance from nest sites to associated brood rearing locations is 325 m (Table 3, Figure 3). We performed a Kernel Density Estimate (KDE) using sage-grouse location data and found that the preferred habitat area around East Canyon State Park is only about 1800 ha (7 mi^2) for the entire population in that area (Figure 4). Interestingly, the large majority of locations collected through VHF and GPS tracking are in Morgan County even though the Morgan-Summit County line is nearby and the habitat in Summit County appears suitable for sage-grouse. At the start of this study, we expected sage-grouse to disperse from the Henefer Divide lek after mating and use the area in both counties equally. It is possible that vegetation structure and composition differences exist on the private properties that are adjacent to the county line.

Plan of Work

We will continue to monitor marked birds to determine survival rates and seasonal movements. Should any birds die during the winter months, we will redeploy any recovered transmitters in March 2016 on new birds. We will follow capture protocols set forth previously. From March through July 2016, we will monitor all marked birds, locate nesting hens, monitor broods, and perform vegetation surveys as outlined in the methods section above.

Because we observed a bias toward habitat selection on the Morgan County side of the Henefer Divide, we will also perform random vegetation surveys on the Summit County side of the Henefer Divide. In addition, we will collect vegetation samples from both sides of the Henefer Divide that will be analyzed for nutrient content. All surveys and vegetation samples will be analyzed and compared to determine if there are structural, compositional, or nutritional differences in vegetation that might explain the bias is habitat selection. All data gathered during the 2015-2016 field seasons will be analyzed and included in the final report.

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

Table 1. Greater sage-grouse (*Centrocercus urophasianus*) nest and brood success estimates, Morgan and Summit Counties, Utah. 2015.

	Marked Hens	Nests Initiated	Re-nest Attempts	Mean Clutch Size	Nests Hatched	Successful Broods	Mean Successful Brood Size
Adult	**19**	**19 (100%)**	**0**	**6.2**	**13 (68%)**	**9 (69%)**	**2**
VHF	13	13	0	6.3	10 (77%)	6 (60%)	1.8
GPS	6	6	0	5.7	3 (50%)	3 (100%)	2.3
Juvenile	**12**	**9 (75%)**	**0**	**4.8**	**6 (67%)**	**4 (67%)**	**1**
VHF	8	6	0	5	3 (50%)	1 (67%)	1
GPS	4	3	0	4.7	3 (100%)	3 (100%)	1
Total	**31**	**28 (90%)**	**0**	**5.7**	**19 (68%)**	**13 (72%)**	**1.7**

Table 2. Greater sage-grouse (*Centrocercus urophasianus*) survival rate estimates, Morgan and Summit Counties, Utah. 2015.

			# Marked	# of Mortalities	% Survival
Adult	Male	VHF	5	1	80
	Female	VHF	14	1	93
		GPS	9	2	78
Juvenile	Male	VHF	0	NA	NA
	Female	VHF	8	1	88
		GPS	4	0	100
		TOTAL	40	5	88

Table 3. Distances from leks to greater sage-grouse (*Centrocercus urophasianus*) nests and from nests to brood rearing locations in Morgan and Summit Counties, Utah. 2015.

Number of Nests	28
Range of distance from lek to nest (m)	272 to 2,578
Mean distance from lek to nest (m)	934
# of Brood Locations	101
Range of distance from brood locations to nest (m)	43 to 716
Mean distance from brood locations to nest (m)	325

Figure 1. Study area in the southern portion of the Rich-Morgan-Summit SGMA in northern Utah.

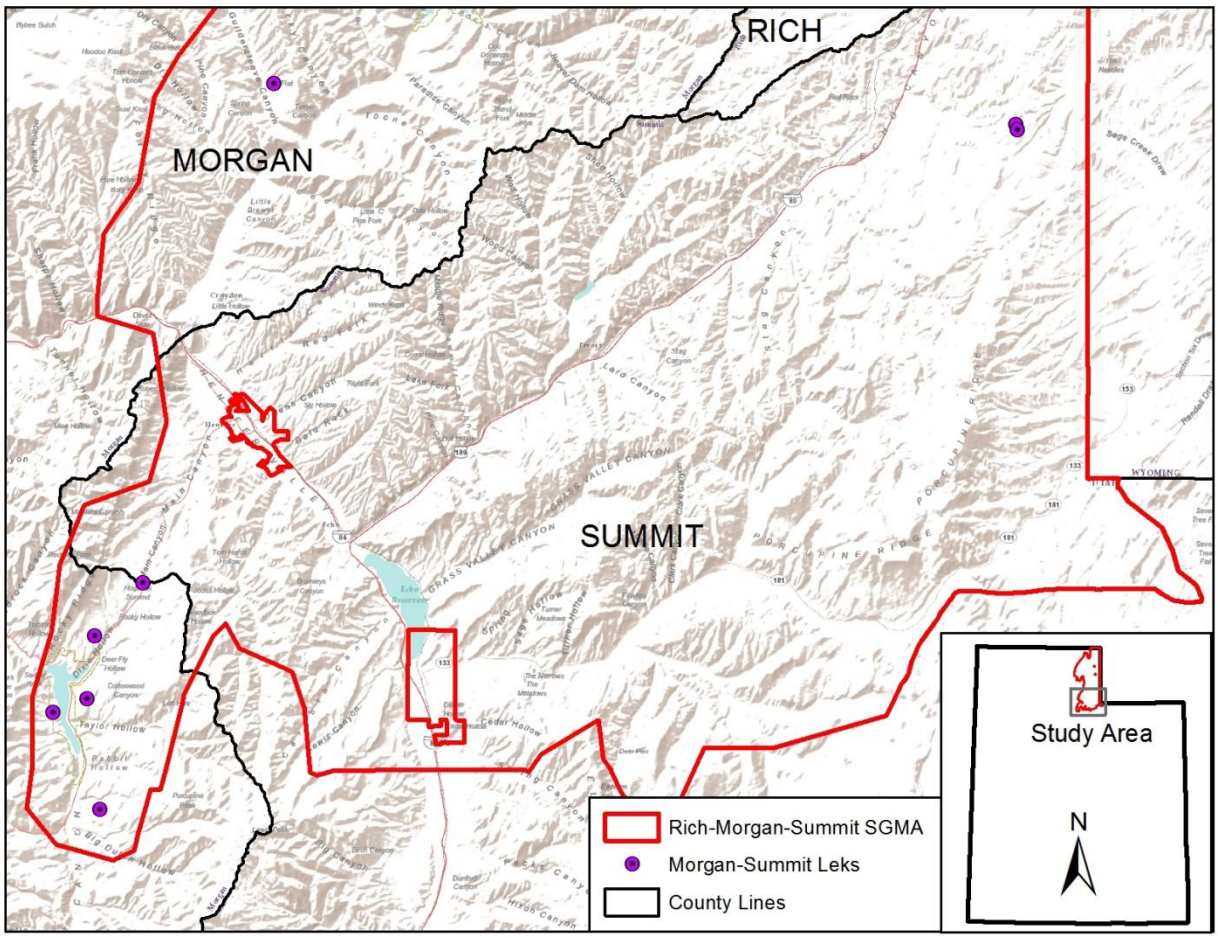


Figure 2. General use locations of greater sage-grouse (*Centrocercus urophasianus*) in Morgan and Summit Counties, Utah. 2015. Locations were acquired from March through October and only the area around East Canyon State Park is shown because this represents 36 of the 40 marked sage-grouse in the study area. The 4 other marked birds exhibited similar site fidelity near leks.

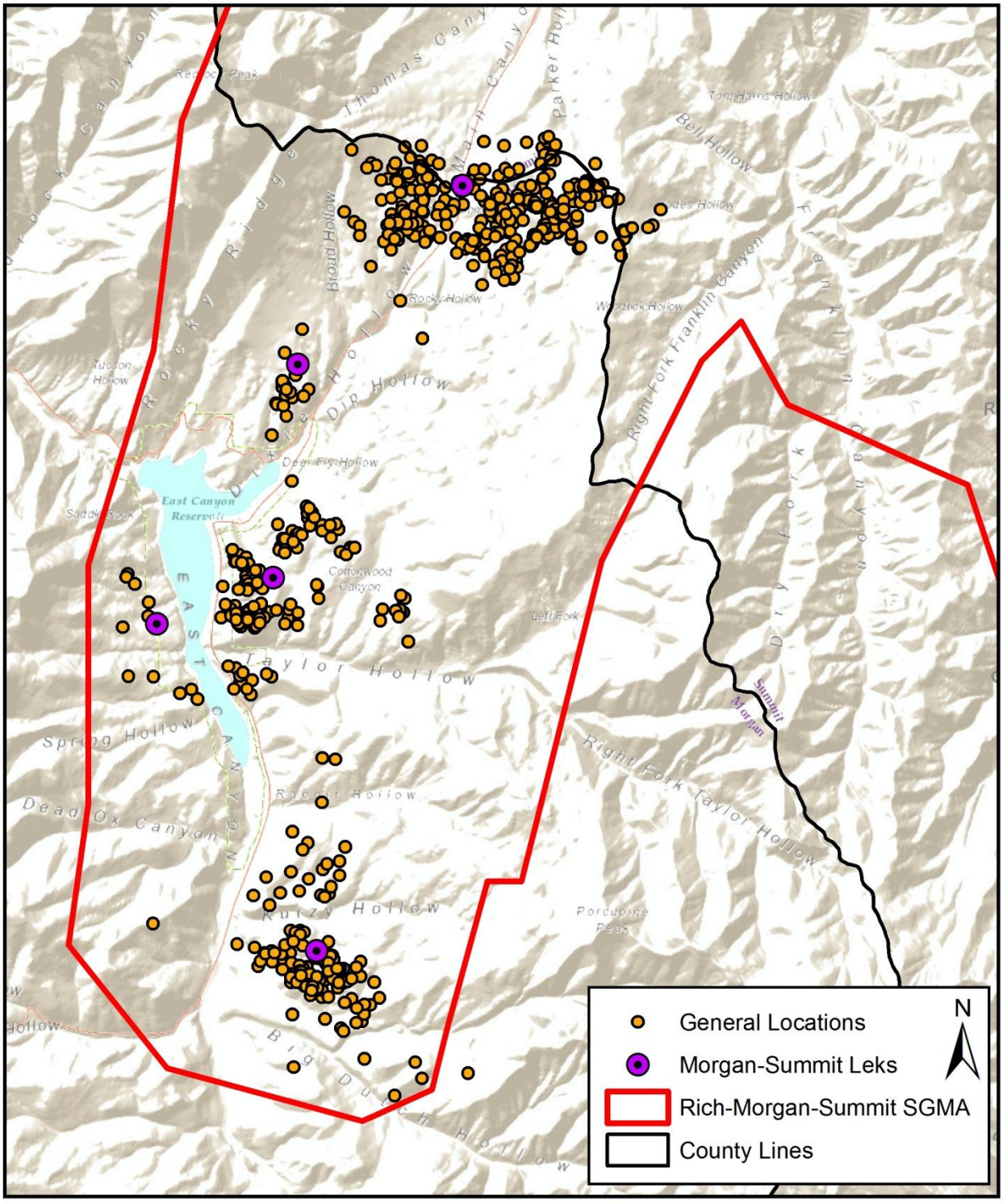


Figure 3. Greater sage-grouse (*Centrocercus urophasianus*) nest and brood rearing sites in proximity to lek locations, Morgan and Summit Counties, Utah. 2015. The image on the left shows lek and nest locations. The image on the right shows lek, nest, and brood rearing locations.

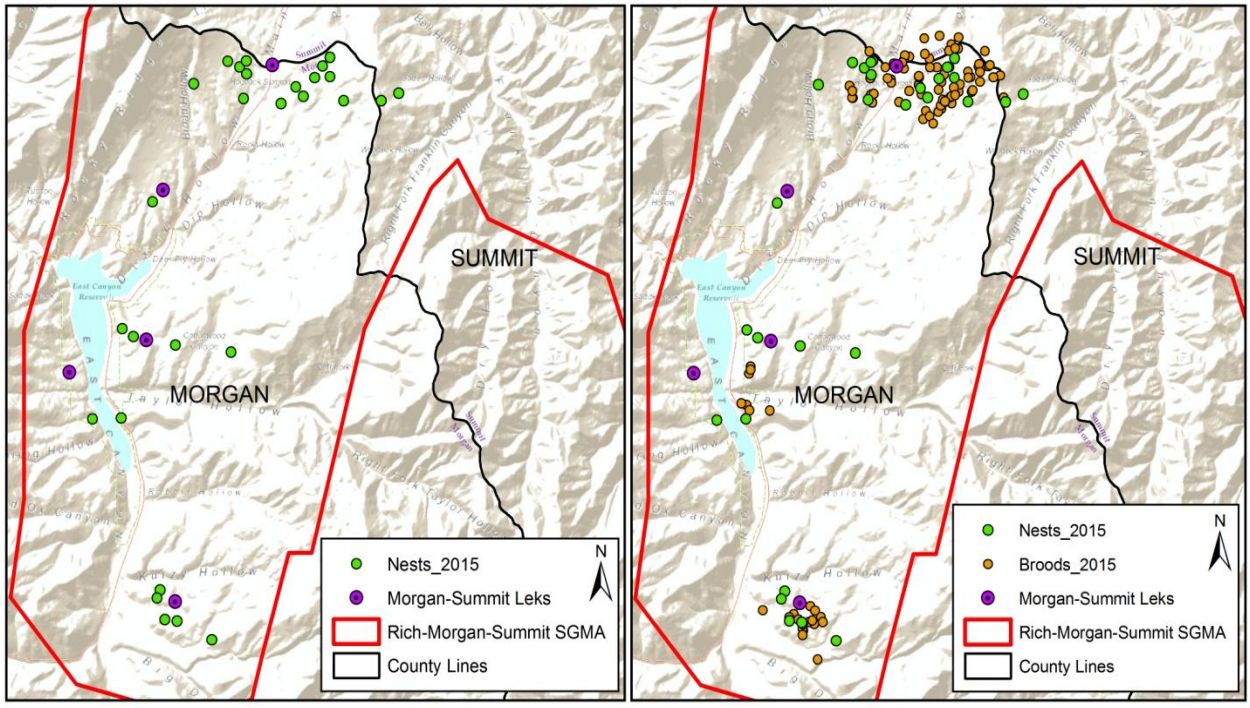


Figure 4. Comparison of the study area to a 95% kernel density estimates for greater sage-grouse (*Centrocercus urophasianus*) locations, Morgan and Summit Counties, Utah. 2015. The study area is represented by the entire image.

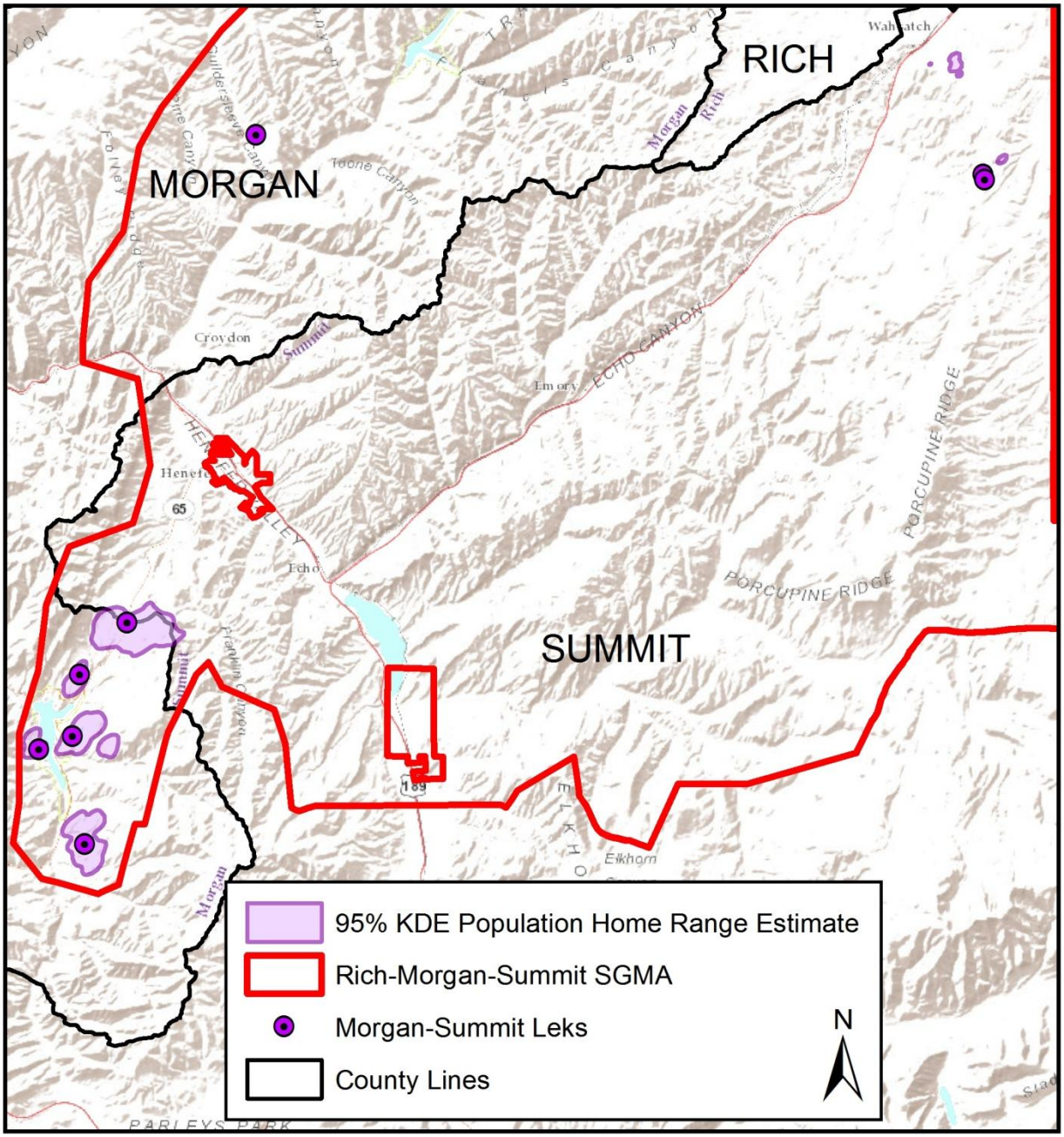
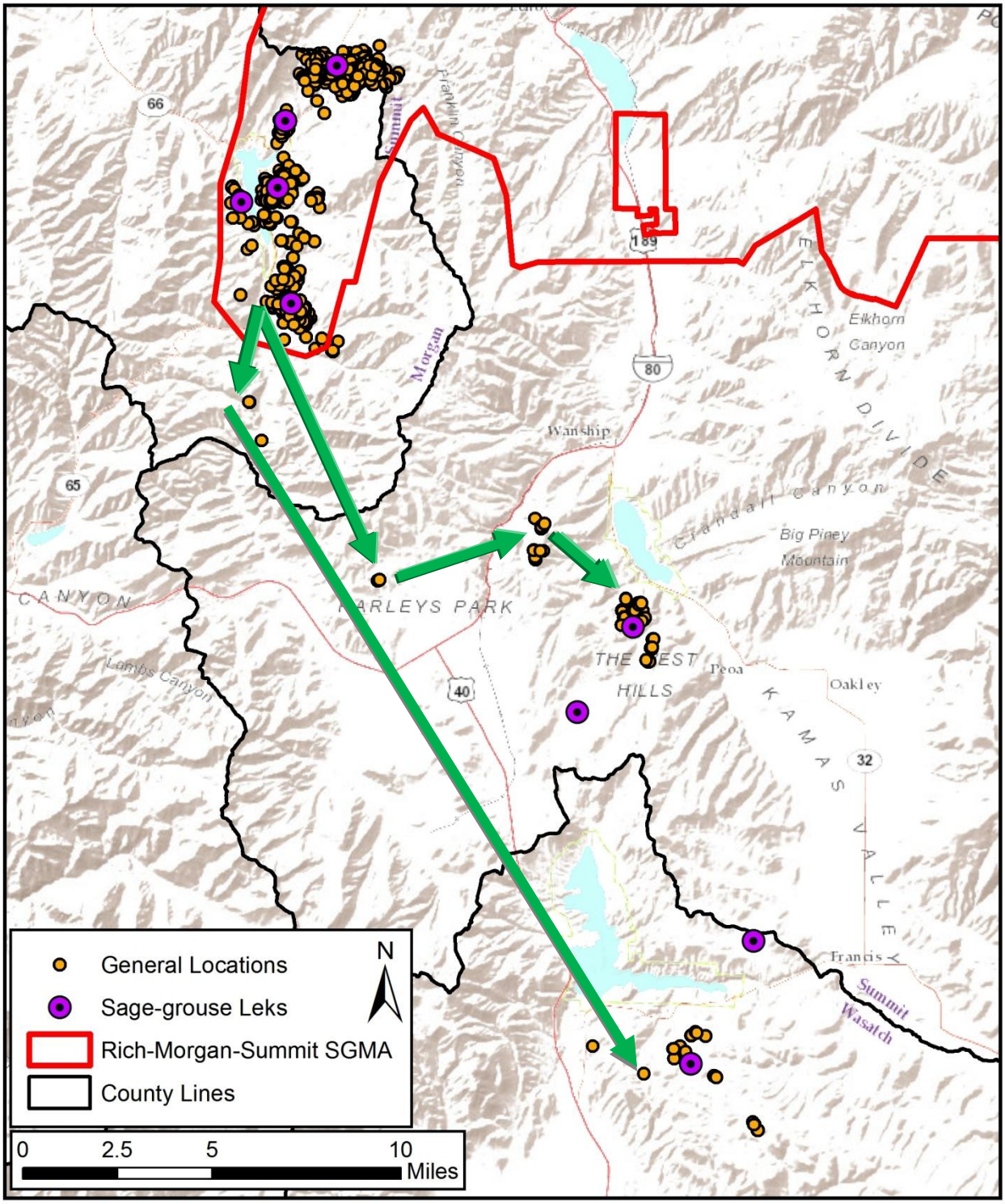


Figure 5. Migrations of 2 female greater sage-grouse (*Centrocercus urophasianus*) marked with global positioning system satellite transmitters, Morgan and Summit Counties, Utah. 2015. Note these 2 females have moved out of the SGMA to winter areas near Rockport Reservoir and Jordanelle Reservoir.



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