

## **2012 Annual Report**

### **Greater sage-grouse (*Centrocercus urophasianus*) habitat selection and use patterns in response to vegetation management practices in Western Box Elder County, Utah**



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## Introduction

Greater sage-grouse (*Centrocercus urophasianus*, hereafter sage-grouse) populations in North America have been declining in recent decades (Connelly et al. 2004). Sage-grouse populations occupy an estimated 56% of the potential habitat of pre-European settlement (Schroeder et al. 2004). These declines in population are a concern to land and wildlife managers throughout the species' range (Schroeder et al. 1999). The declines have been largely attributed to loss and fragmentation of sagebrush (*Artemisia* spp.) habitats caused by anthropogenic disturbances (Connelly et al. 2011). These disturbances have contributed to the spread of invasive plant species and increased wild fire frequency and intensity, which can reduce sage-grouse brood-rearing, wintering, and nesting habitat (Young and Evans 1978).

State and federal agencies, such as the Bureau of Land Management (BLM), have responded to the decline through implementing sage-grouse conservation and management plans that contain strategies designed to protect and restore sagebrush habitats. Habitat restoration strategies include mechanical methods such as chain harrowing, re-seeding forbs and grasses, establishing green strips using species such as forage kochia (*Kochia prostrata*), and mastication of junipers (*Juniper osteosperman*) in combination with chemical treatments to mitigate the wild fire threats posed by invasive species. However, further research is needed to evaluate the effects of these treatments on sage-grouse and sagebrush habitats.

## Project Purpose and Objectives

The purpose of this research is to evaluate the effects of chain harrowing, seeding of forage kochia in green strips, and mastication of juniper in concert with chemical treatments on vegetation composition and sage-grouse use among sagebrush habitats in northwestern Utah. The intent of both chemical and mechanical methods is to restore quality habitat conditions for sage-grouse and reduce the risk of wild fires.

The objectives of this study are:

1. To evaluate the effects of the treatment on vegetation composition. The treatment includes chain harrowing, juniper mastication, seeding forage kochia, and applying Plateau herbicide.
2. To determine the effect of the treatment and any observed changes in vegetation on sage-grouse habitat use patterns.
3. To evaluate herbivory of forage kochia by sage-grouse.
4. To assess sage-grouse ecology, including nesting and brood-rearing habit selection, survival, annual movement patterns, and habitat-use across the landscape relative to vegetation manipulations.

## Study Area

The treatments studied were implemented on Badger Flat, just south of the town of Grouse Creek, West Box Elder County, UT. The primary study site on Badger Flat consists of 6,000 ha (14,826 ac.), of which 360 ha (900 ac.) were treated. Approximately 6% of the primary study site was treated. The green strips are 300 ft. (91 m.) wide (Figure 1). The study site for determining sage-grouse response included the 6,000 hectares on Badger Flat, as well as surrounding land that is bounded by Idaho as the northern border, Nevada as the western border, Toms Cabin Road as the southern border, and the Grouse Creek Mountains as the eastern border. Land ownership in this area is a mosaic of public and private blocks. The public land is managed by the U.S. Bureau of Land Management (BLM). The primary land use is alfalfa (*Medicago sativa*) production (primarily on private land) and grazing by domestic cattle on both BLM managed and private lands.

Most of the study site is categorized by a shrub-steppe ecosystem with surrounding woodlands and interspersed meadows. Elevations range from 1500-2300 m (4900-7500 ft). Primary shrub species include Wyoming big sagebrush (*A. tridentata*), black sagebrush (*A. nova*), shadscale (*A. confertifolia*), rabbitbrush (*Chrysothamnus* spp.), snowberry (*Symphoricarpos albus*), juniper (*Juniperus osteoperma*). Common grasses include sandberg bluegrass (*Poa secunda*), Kentucky bluegrass (*Poa pratensis*), cheatgrass (*Bromus tectorum*), and wheatgrasses (*Agropyron* spp.). Common forbs include blue-eyed mary (*Collinsia* Nutt.), wild onion (*Allium acuminatum*), phlox (*Phlox* spp.), astragalus (*Astragalus* spp.), arrowleaf balsamroot (*Balsamorhiza sagittata*), tansymustard (*Descurainia pinnata*), bur buttercup (*Ceratocephala testiculata*), halogeton (*Halogeton glomeratus*), and blue mustard (*Chorispora tenella*).

## Methods

### *Treatments*

Pretreatment measurements were collected during late winter until the summer of 2010. Post treatment measurements were conducted from winter through summer in 2011 and 2012.

The chronology for treatments implemented in the fall of 2010 were:

1. August 1 - 15: mastication of juniper within greenstrip area
2. August 16 – mid September: chain harrow greenstrip (seedbed prep/removal of shrubs)
3. September 2-12: spray Plateau herbicide-5 oz Plateau/0.4046 hectares (5oz/1acre), 1 qt MSO/0.4046 hectares (1qt/1acre), Applied in 10 gal water/0.4046 hectares (10gal/1acre)
4. December 13: aerially apply forage kochia seed 4.5 bulk/lbs/0.4046 hectares

### *Sage-grouse Trapping and Radio-telemetry in 2012*

A polygon of the Badger Flat region was constructed using previous sage-grouse locations and BLM treatment sites. Using an all-terrain vehicle and spotlight, birds were captured February-April 2012 with a long-handled hoop net. A small bag and scale were used to determine the weight of each individual. The age class and sex of each bird were documented based on primary

feather characteristics (Dalke et al. 1963). Battery-powered ATS radio transmitters (Advanced Telemetry Systems, Isanti, MN) were placed on adult and juvenile sage-grouse allowing relocation. Radio transmitters weigh 16 grams each. Birds were relocated throughout the breeding season and winter to determine use or avoidance of treatment areas. A Global Positioning System (GPS) location within 5 meters accuracy was recorded at each capture location.

Birds were relocated using Communications Specialist receivers and Telonics hand-held Yagi antennae. All birds were monitored weekly from January until July 2012 within the primary study site. All hens and broods were monitored throughout the area from breeding season until fifty days post hatching for nesting and brood-rearing data.

### ***Sage-grouse Habitat Use Patterns***

Sage-grouse habitat use was monitored to document the change over time in response to treatments. From January-August 2012, radio-collared sage-grouse that were present on Badger Flat were monitored. A minimum of 20 use locations were recorded per month and plotted using a GPS in NAD 83 and accuracy of less than 5 m (16 ft.) (Figure 2). These locations were used to determine habitat use and seasonal movement patterns. ArcGIS was used to select 20 random locations per month to compare habitat vegetation attributes between use and random sites.

Vegetation measurements were collected along 2 perpendicular 20 m (64 ft.) line transects for each of these 40 locations per month. During the winter, GPS location, shrub and snow density, slope, aspect, and overall vegetation type were documented. During the summer months, GPS location, slope, aspect, shrub cover, ground cover, and overall vegetation type were documented. Shrub canopy cover was documented utilizing a line intercept method (Canfield 1941). From a central point, a 10-m (32 ft.) measuring tape was placed in 4 directions, all 90 degrees apart. Live shrub canopy was measured along the tape; gaps in shrub cover less than 5 cm (2 in.) were counted as continuous and gaps greater than 5 cm (2 in.) were excluded. Percentage of ground cover, including grass, forbs, bare ground, litter, and rock were measured using a 20cm (8 in.) x50 (20 in.) cm Daubenmire frame (Daubenmire 1959). The Daubenmire frame was placed every 2.5m (8 ft.) along each 10 m (32 ft.) transect. Comparison of measurements taken at use and random location points will allow us to determine sage-grouse selection for vegetation species and structure as well as use of treatment or non-treatment areas.

### ***Vegetation Trends and Pellet Counts***

Eight paired plots (treatment-green stripping, tree mastication, spraying Plateau, and seeding forage kochia vs. control-no treatment) were selected at random from within the Badger Flat polygon (Figure 3). During the last week in May, sixteen 100-m (328 ft.) line intercept and point intercept transects (one in each paired plot) were established to determine species composition and shrub composition. Sixteen 500-m (1640 ft.) pellet transects, eight in control and eight in treatments plots, were surveyed using distance sampling to determine use. Pellets were collected each year to assure that there is no recounting. The 100-m (328 ft.) vegetation transects and the 500-m (1640 ft.) pellet surveys were randomly located. The pellet counts will be used to evaluate bird use of treatment and non-treatment sites. The vegetation surveys will document effects of

the treatment and changes in vegetation structure over time.

During the first week of August, eight 100-m (328 ft.) transects were placed at random locations within the treatment. A 1x1 m (3x3 ft) frame was placed on the ground every 5 m (16 ft.) of each 100-m (328 ft.) transect. All forage kochia plants within the 1x1 m (3x3 ft.) frame were recorded. These measurements will be used to determine seeding effectiveness and change in cover over time.

### ***Sage-grouse Nesting and Brood-Rearing Ecology***

Sage-grouse hens were located bi-weekly throughout the breeding season. At each nest site, vegetation was measured along 2 perpendicular 30-m (98 ft.) transects. GPS location, slope, aspect, shrub cover, ground cover, and overall vegetation type were documented (Figure 2). Shrub canopy cover was documented utilizing a line intercept method (Canfield 1941). From a central point, a 15-m (49 ft.) measuring tape was placed in 4 directions, all 90 degrees apart. Live shrub canopy was measured along the tape; gaps in shrub cover less than 5 cm (2 in.) were counted as continuous and gaps greater than 5 cm (2 in.) were excluded. Percentage of ground cover, including grass, forbs, bare ground, litter, and rock were measured using a 20cm (8 in.) x 50 cm (20 in.) Daubenmire frame (Daubenmire 1959). The Daubenmire frame was placed every 3m (10ft.) along each 15-m (50 ft.) transect. Random sites 80 m (262 ft.) away in a random cardinal direction were designated and measurements of vegetation with replicated techniques were taken. A Robel pole was used to measure vegetation vertical obstruction (Robel et al. 1970). This information will be used to determine if nesting habitat used may differ in terms of vegetation structure and composition from adjacent randomly-selected areas.

Broods were located bi-weekly for 50 days post-hatching. Brood-rearing habitat was measured along 2 perpendicular 20 m (64 ft.) transects (Figure 2). GPS location, slope, aspect, shrub cover, ground cover, and overall vegetation type were documented. Shrub canopy cover was documented utilizing a line intercept method (Canfield 1941). From a central point, a 10 m (32 ft.) measuring tape was placed in 4 directions, all 90 degrees apart. Live shrub canopy was measured along the tape; gaps in shrub cover less than 5 cm (2in.) were counted as continuous and gaps greater than 5 cm (2in.) were excluded. Percentage of ground cover, including grass, forbs, bare ground, litter, and rock were measured using a 20 cm (8 in.) x 50 cm (20 in.) Daubenmire frame (Daubenmire 1959). The Daubenmire frame was placed every 2 m (6 ft.) along each 10-m (32 ft.) transect. Random sites 80 m (262 ft.) away in a random cardinal direction were designated and measurements of vegetation were taken with the same techniques as the brood-use sites. These data will provide information about brood-rearing habitats.

Analysis of these data will provide information about effectiveness of the implemented management strategies on restoring the sage-grouse habitat potentials in Western Box Elder County.

## ***Liquid Chromatography and Gas Chromatography***

### ***Terpene Analysis by Gas Chromatography***

Pellets and forage kochia samples that were collected from Duchesne and Box Elder counties were transported to the USDA-ARS Poisonous Plant Lab in Logan Utah where they were placed in a freezer awaiting chemical analysis. The pellets were removed from the freezer and allowed to thaw at room temperature. Each pellet cluster sample was crushed and 100 mg was placed into a 10 ml screw cap test tube. Dichloromethane (5 ml) was added to each sample and the sample was mixed by mechanical rotation (inverting the tubes) for 15 minutes to extract the terpenes from the pellet material. A 1 ml aliquot was removed with a glass pipette and filtered through an anhydrous sodium sulfate filter into a 2 ml auto sample vial. The samples were then analyzed using gas chromatography (GC) with flame ionization detection (FID) using a Shimadzu GC-2010 gas chromatograph and a Shimadzu AOC 20 auto sampler. Samples (1.5  $\mu$ l) were injected in a split mode (30:1 split ratio) with an injection port temperature of 250°C. The GC column was a DB-5 capillary column (30 m x 0.32 mm, 0.25  $\mu$ m) using helium as the carrier gas at a flow rate of 2 ml/min. Detector (FID) temperature was 325°C. Column temperature was set to 60°C for 1 min, increased to 160°C at 5°/min and then held at 160°C for 1 min for a total analysis time of 22 min. The profile or fingerprint of the samples was characterized by the GC retention time and relative peak intensities of the resulting GC chromatogram.

### ***Liquid Chromatography-mass spectrometry and chemical profile of non-volatile polar compounds***

Pellets and forage kochia samples that were collected from Duchesne and Box Elder counties were transported to the USDA-ARS Poisonous Plant Lab in Logan Utah where they were placed in a freezer awaiting chemical analysis. The pellets were removed from the freezer and allowed to thaw at room temperature. Samples of pellets (1 g) were extracted with 10mL of methanol. A 0.50 mL aliquot was added to 1.0 mL of 50% acetonitrile and analyzed by liquid chromatography-mass spectrometry (LC-MS) method using a Betasil C18 column 20mM ammonium acetate/acetonitrile solvents were used at a flow rate of 0.300 mL/min. A gradient of 10% acetonitrile (0-1 min) and 10%-100% (1-20 min) was used with detector (esi-100-1000 m/z). The profile or fingerprint of the samples was characterized by the LC-MS retention time and relative peak intensities of the resulting LC-MS chromatogram.

### ***High Temperature Gas Chromatography of high molecular weight volatile components***

Pellets and forage kochia samples that were collected from Duchesne and Box Elder counties were transported to the USDA-ARS Poisonous Plant Lab in Logan Utah where they were placed in a freezer awaiting chemical analysis. The pellets were removed from the freezer and allowed to thaw at room temperature. Forage kochia samples (0.24 g) were extracted with 10mL of methylene chloride. Fecal pellets (1.0 g) were extracted with 10mL of methylene chloride. Samples were extracted for greater than 16 hours. A 1.0 mL aliquot was taken and evaporated to dryness and then derivatized by the addition of 0.2 mL pyridine and 0.05 mL of BSTFA reagent. Samples were then diluted to 1.0 mL with methylene chloride. Samples were analyzed by gas chromatography-mass spectrometry (GC/MS) using the following oven program: 70°C (1 min.);

70-200°C@10°C/min; 200-320°C@5°C/; 320°C (4 min.). The profile or fingerprint of the samples was characterized by the GC-MS retention time and relative peak intensities of the resulting GC-MS chromatogram.

## Preliminary Results

### *Sage-grouse Captures, Survival, and Nesting*

Between February 2012 and April 2012, 8 additional sage-grouse were captured and radio collared. Of these 8 birds, 2 were juvenile females, 1 was a juvenile male, 1 was an adult female, and 4 were adult males. All birds were trapped on the Badger Flat study site. There were a total of 8 mortalities throughout the past year. Of these 8 mortalities, 1 was a bird that was collared in 2010, 6 were birds that were collared in 2011, and 1 was a bird that was collared in 2012.

In 2012, 8 hens initiated nests, of which 3 were successful (37.5%). Clutch size ranged from 2 to 7. The primary cause of nest failure was predation. Two broods survived to 50 days (66.6%).

In 2012, preliminary data shows that nest sites had slightly higher percent shrub, taller shrub height, higher percent grass, taller grass height, higher percent rock, high percentage of bare ground, and less litter compared to random sites (Table 1). In 2012, brood sites had slightly higher percentage of shrubs, taller shrub height, less rock percentage, and more litter than at random sites (Table 1).

Table 1. Descriptive statistics for greater sage-grouse nesting and brood-rearing habitat use, Grouse Creek Watershed, West Box Elder County. Average vegetation percentages for \*2012 Brood Sites \*\*2012 Nest Sites.

Use(1) Rndm(0)	% Shrub	ShbHt	% Forb	Forb Ht	% Grass	Grass Ht	% Rock	% Bare	% Litter
*1	29.22	34.36	16.92	9.85	14.90	21.79	12.88	13.91	41.37
*0	23.53	30.52	16.38	10.34	15.51	21.02	16.39	13.99	37.73
**1	24.08	43.94	12.77	7.33	12.84	18.24	13.24	16.83	44.33
**0	21.80	36.20	13.05	7.25	10.38	14.39	14.58	15.05	46.90

### *Habitat Selection and Changes in Vegetation*

Sage-grouse were present on the Badger Flat region both pre- and post-treatment. In 2011 and 2012, sage-grouse expanded their lek region to encompass more of the treated area. The range expansion suggested a sage-grouse preference for the treatments. We are currently analyzing location data to confirm. Based on preliminary data from summer 2012, sage-grouse selected areas exhibiting higher percentage of shrubs, taller shrub height, less grass percentage, more rock cover, more bare ground cover, and less litter cover (Table 2). In winter 2012, sage-grouse selected for slightly higher percentage shrub cover and shorter shrub height (Table 2). Average snow depth at use sites was 3.55 cm (1.3 in) and 2.95 cm (1.1 in) at random sites.

Table 2. Descriptive statistics for greater sage-grouse habitat use across the primary study site, Grouse Creek, West Box Elder County. Average vegetation percentages for \*Summer 2012 data  
\*\*Winter 2012 data

Use(1) Rndm(0)	% shrub cover	shrub ht	% forb	forb ht	% grass	grass ht	% rock	% bare	% litter
*1	14.80	39.76	1.91	3.43	9.44	8.98	25.57	27.16	35.93
*0	8.22	35.79	2.61	3.56	12.38	9.58	20.34	24.70	39.96
**1	15.22	30.26							
**0	11.54	34.13							

Based on preliminary data, treatment sites had less average shrub width, less shrub composition, and shorter shrub height (Table 3). Control plots had a greater average number of pellets. Pellets were present in all 500 m (1640 ft.) paired plots; however, quantity of pellets among each plot varied greatly.

Table 3. Vegetation measurements recorded along line-intercept and point-intercept 100-meter paired plots and pellet counts along 500-meter paired plots, Badger Flat Study Area, 2012.

Trtmt(1)Control(0)	AvgShrubWidth	%ShrubComp	AvgShrubHt	NumPellets
1	8.71	14.80	13.00	135
0	13.41	38.90	28.31	95
1	8.76	32.40	18.35	24
0	12.75	61.20	24.65	10
1	17.46	68.10	32.13	11
0	13.46	75.40	38.14	40
1	9.58	23.00	18.54	11
0	10.46	84.70	21.69	50
1	10.47	15.70	19.47	8
0	17.10	68.40	48.20	26
1	10.63	25.50	12.08	28
0	11.72	95.50	25.79	188
1	11.50	13.80	22.17	4
0	15.77	96.20	38.93	5
1	10.56	52.80	16.22	19
0	12.65	90.57	28.82	15
Total Average Trtmt	10.96	30.76	18.99	30
Total Average Control	13.42	76.36	31.82	53.63

Forage kochia plants were measured every 5 m (16 ft. ) along eight 100-m (328 ft.) transects with a 1m (3 ft.) x 1m (3 ft.) frame (Table 4). Of these frames, 42.5% (68 frames) contained forage kochia plants. There were 570 forage kochia plants within all frames. These extrapolates to 356 potential plants per 100 m (328 ft.) x 1m (3 ft.) transect in the treatments.

Table 4. Forage kochia plants across eight 100m x 1m transects. Measurements were taken every 5m with a 1m x 1m frame, Badger Flat Study Area 2012.

Total frames with forage kochia	68
Total forage kochia plants within 1m x 1m frame across all plots	570
% of frames with forage kochia	42.5
Calculated potential plants per 100m x 1m plot	356.25

### *Gas Chromatography and Liquid Chromatography*

We used gas chromatography to detect terpene content in the forage kochia samples. We learned the plants lacked significant terpene content and thus would not provide a marker that could be used to detect forage kochia in sage-grouse fecal pellets. Working with scientists at the USDA-ARS Poisonous Plant Lab, we identified other possible markers using the LC-MS and chemical profile of non-volatile polar compounds. These compounds eluted around 10 min and were characterized by base ions of 944, 974 and 812 m/z. We subsequently analyzed 15 sage-grouse fecal pellets specifically for the three marker compounds. The samples were found to be negative for these forage kochia compounds.

Based on this analysis, we tentatively concluded that the absence of the marker compounds in the fecal pellets indicated either the sage-grouse did not eat the forage kochia or these compounds were absorbed and/or metabolized and were not present in the fecal pellets. Using the high temperature GC of high molecular weight volatile components, no distinct forage kochia compounds were identified. Analysis indicated typical general plant compounds that included long and short chain fatty acids, polyhydroxy acids, phenolic acids and steroidal type compounds. Some of these compounds were also found in the grouse fecal pellets, but could be derived from almost any plant source.

### **Future 2012 and 2013 Plan of Work**

More detailed statistical analysis will be completed to determine sage-grouse habitat use, effects of treatment, and impact from anthropogenic structures. Future analysis will also involve distance-sampling analysis to determine use of treated area by sage-grouse and changes in vegetation over time. This approach will enable us to evaluate the strength of sage-grouse observed preference for the green-strips.

A micro-histological method, using Hertwig's Solution and Hoyer's Solution, will be used to analyze the presence of forage kochia in recently collected sage- grouse pellets. This method will use epidermal characteristics of forage kochia leaves to determine the presence of the plant in

pellets. We are optimistic this approach will provide us with an alternative approach to detecting forage kochia in sage-grouse fecal pellets.

A final report summarizing these efforts will be published in May 2013.



Figure 1. Aerial view of part of the treatment on Badger Flat, West Box Elder County, Utah (taken November 2010).

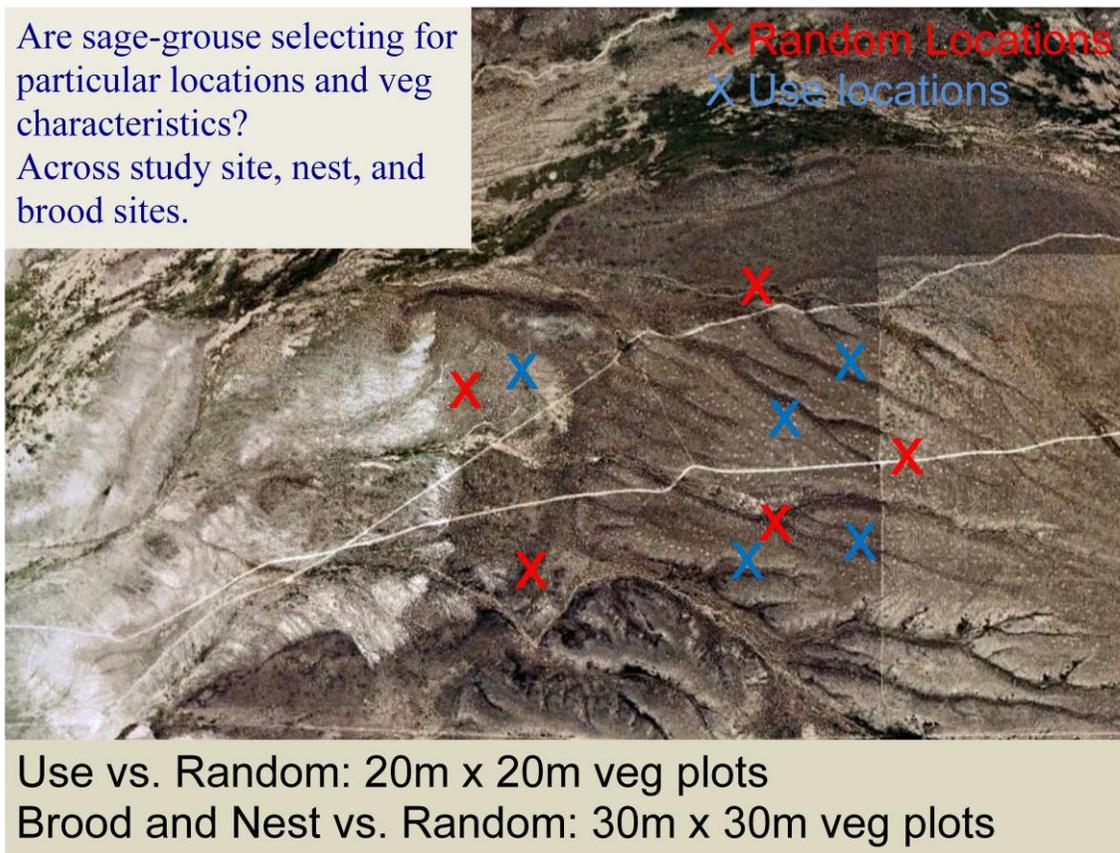


Figure 2. The relative placement of 20m x 20m habitat plots throughout Badger Flat and 30m x 30m habitat plots throughout the Grouse Creek Watershed. Through telemetry, we gathered locations of sage-grouse on the primary study site. At 20 random locations that were collected through ArcGIS and 20 use locations per month, measurements were taken using line intercept for shrub cover and daubenmire method evaluated ground cover. This information demonstrates selection for specific habitat characteristics and presence or absence of birds on treatment sites. Vegetation characteristics were also measured at nesting and brood-rearing sites and random sites to determine habitat characteristic preferences.

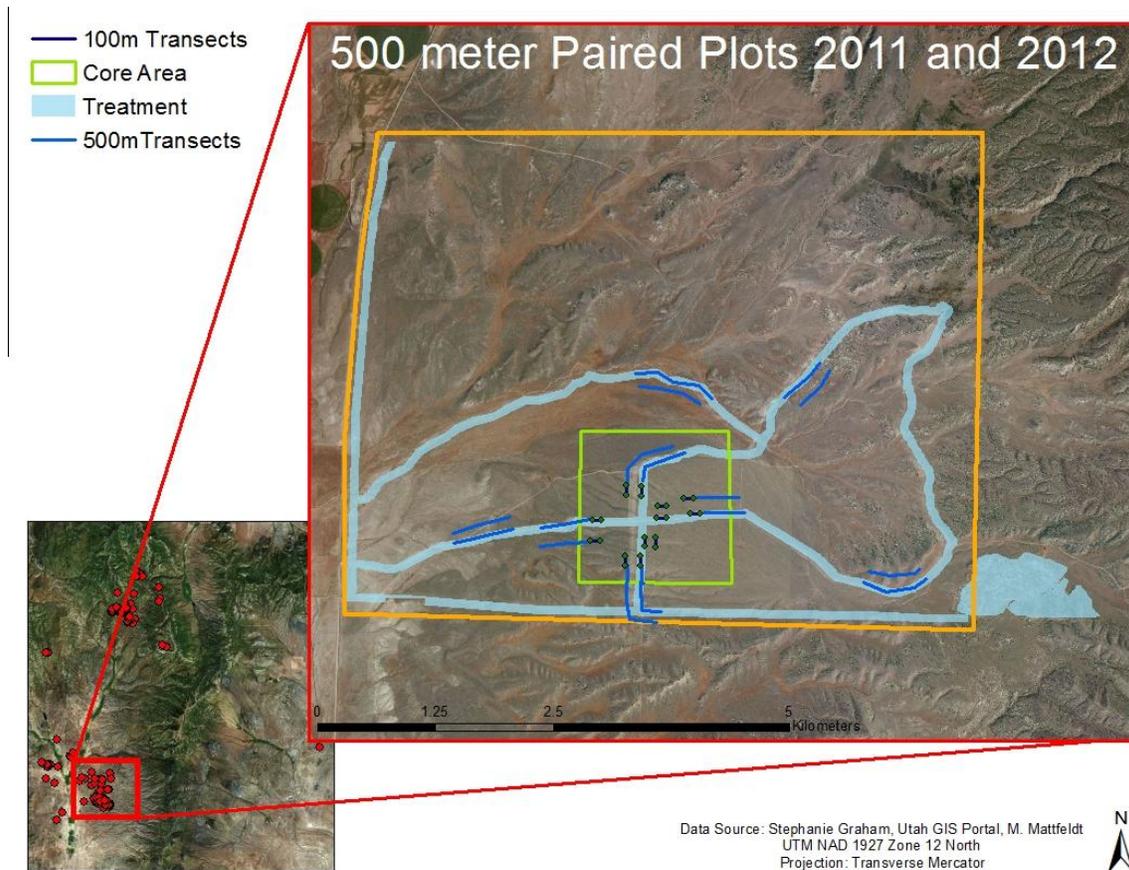


Figure 3. Total treatment of 360 ha (900 ac.) is shown in light blue. Six 100-meter paired plots are shown. In 2011, we added two more paired plots, to have a total of sixteen plots, 8 in treatment and 8 in control. We repeated measurements in these paired plots in 2012. Along these paired plots, line intercept and point intercept were used to determine changes in vegetation. In 2011 and 2012 the pellet transects were extended to 500 meters, 100 meters of which is along each vegetation transect. This data collected from distance sampling will show effect of treatment on sage-grouse use and interactions with changes in vegetation.

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