

**UTAH WATERSHED RESTORATION  
INITIATIVE STUDIES  
2007 Post-treatment Report**

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TABLE OF CONTENTS

	<u>Page</u>
RANGE TREND STUDY METHODS .....	iii
<b>2007 Post-treatment Studies</b> .....	<b>1</b>
1R-2 Rattlesnake Fire Seeded .....	1
1R-3 Rattlesnake Fire Unseeded .....	9
Summary and Comparison of Rattlesnake Fire Seeded (1R-2) and Rattlesnake Fire Unseeded (1R-3) .....	15
2R-9 Rabbit Creek Burn .....	17
2R-10 Rabbit Creek Burn Seeded .....	24
Summary and Comparison of Rabbit Creek Burn (2R-9) and Rabbit Creek Burn Seeded (2R-10) .....	32
6R-1 Cache Cave 1 .....	35
6R-2 Cache Cave 2 .....	42
9R-3 Deadman Greenstrip .....	49
9R-4 Diamond Mountain Bullhog .....	56
9R-5 Little Donkey .....	64
9R-6 North Little Donkey .....	71
9R-7 Red Fleet Lop and Scatter .....	78
10-3 Lower McCook Ridge Chaining .....	85
14R-7 Adams CE Harrow .....	97
14R-8 Adams CE Control .....	104
Summary and Comparison of Adams CE Harrow (14R-7) and Adams CE Control (14R-8) .....	111
16R-11 Lower Cedar Bench .....	114
16R-12 Upper Cedar Bench .....	121
16R-13 Upper Porphyry Bench .....	129
16R-20 Howerton's .....	138
17R-11 Santaquin Greasewood .....	145
17R-12 Santaquin Chaining .....	152
19R-1 West Lee's Creek .....	161
22R-5 Black Mountain Forb Seeding .....	169
22R-6 Greenville Bench Bullhog .....	176
23R-7 South Narrows .....	184
23R-8 Brown's Canyon Drill .....	190
24R-6 Panguitch East Bench Harrow .....	196
25R-5 Lamp Stand .....	203
30R-1 Newcastle Bullhog .....	210
<b>References</b> .....	<b>217</b>

## RANGE TREND STUDY METHODS

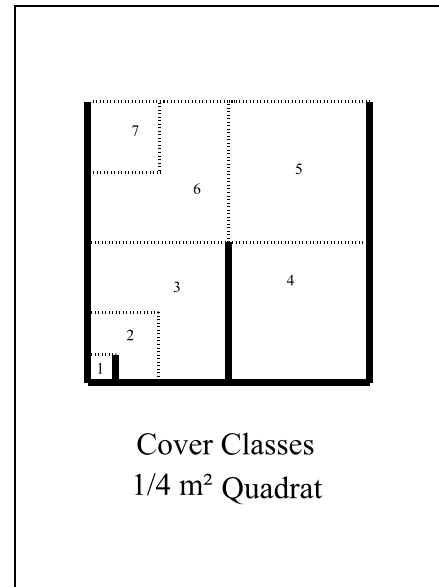
Studies monitoring range trend depend greatly on site selection, especially when dealing with large geographic areas such as wildlife management units. Since it is impossible to intensively monitor all vegetative or habitat types within a unit, it is necessary to concentrate on specific sites and/or “key” areas within distinct plant communities on big game ranges. These “key” areas should be places where big game have demonstrated a definite pattern of use during normal climatic conditions over a long period of time. Trend studies are located within these areas of high use and/or critical habitat as agreed upon by DWR, BLM, and USFS personnel. Often, range trend studies are established in conjunction with permanently marked pellet group transects. Once a “key” area has been selected, specific placement for sampling is determined. The sampling grid is carefully placed in order to adequately represent the surrounding area. All sampling baselines are permanently marked by half-high steel fence posts. The first, or beginning baseline stake, is marked with a metal tag for proper identification of the transect.

### Vegetative composition

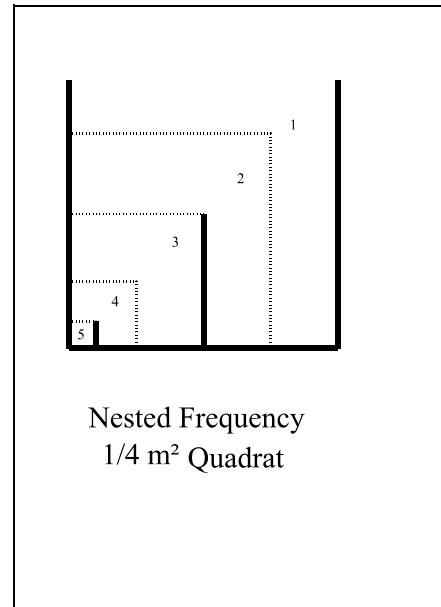
Determining vegetational characteristics for each “key” area is determined by setting up 5 consecutive 100 foot baseline transects in the area of interest. This 500 foot line is the baseline and one, 100 foot belt is placed perpendicular to each 100 foot section of the baseline at random foot marks and centered on the 50 foot mark. The beginning of each belt is marked by a rebar stake to ensure a more precise alignment of the originally sampled belt. A 1/4 m<sup>2</sup> quadrat is centered every 5 feet along the same side of the belt, starting at the 5 foot mark. Cover and nested frequency values are determined for vegetation, litter, rock, pavement, cryptogams, and bare ground. Cover and nested frequency values are also estimated for all plant species occurring within a quadrat, including annual species.

Cover is determined using a modified Daubenmire cover estimation procedure using 7 cover classes (Bailey and Poulton, 1968, Daubenmire 1969). The seven cover classes are: 1) .01-1%, 2) 1.1-5%, 3) 5.1-25%, 4) 25.1-50%, 5) 50.1-75%, 6) 75.1-95%, and 7) 95.1-100%. For example, to estimate vegetative cover with this method, an observer would visualize which cover class all the vegetation would fit into if the plants were moved together until they were touching. To quantify percent cover for bare ground, litter, rock, pavement, and cryptogams, the observer would visually estimate which cover class could accommodate all of the specified cover type within the quadrat. These numbers are then recorded. To determine percent cover for each belt, the midpoint for each cover class value observed is summed and divided by the number of sampling quadrats (20). The mean for the five belts is the average for a given site.

Total canopy cover of shrubs or trees is estimated using the line-intercept method. The distance along each belt covered by a particular species of tree or shrub is divided by the total length of the line to give percent canopy cover. Prior to 2002, only canopy cover above eye level was estimated.



Nested frequency values for the quadrat range from 1-5 according to which area or sub-quadrat the plant species or cover type is rooted in. The notation for each sub-quadrat is as follows: 5 = 1% of the area, 4 = 5% of the area, 3 = 25% of the area, 2 = 50% of the area, and 1 = the remainder of the quadrat. Each time a particular plant species or cover type occurs within the quadrat, it is scored relative to which of the smallest nested quadrats it is rooted in (in the case of vegetation) or where it first occurs (for all other cover types). The highest possible score is 5 for each quadrat occurrence and 100 per belt, for a possible score of 500 for each species or cover type at a given site. Sites read before 1992 have a maximum possible score of 400 because they have only 4 sub-quadrats. To compare data collected before and after 1992, sub-quadrats 4 and 5 are merged and a maximum possible score of 400 is used for all years.



Higher nested frequency scores represent a higher abundance for that plant species or cover type. These summed values are used to help determine changes in trend through time. Nested frequency has been found to be a more sensitive measurement for changes taking place within plant communities than quadrat frequency (Smith et al. 1987, Smith et al. 1986, Mosley et al. 1986). Plant cover values for herbaceous species are not reliable indicators of trend and can fluctuate greatly with precipitation and time of season sampled. Therefore, plant cover and density values can be misleading if used by themselves and do not necessarily indicate changes in composition and/or distribution of key plant species.

Nested frequency and average percent cover data for individual grass and forb species are summarized in the “Herbaceous Trends” table. Nested frequency and average cover of vegetation, rock, pavement, litter, cryptogams, and bare ground are summarized in the “Basic Cover” table.

Shrub densities are estimated using five, 1/100th acre strips centered over the length of each 100 foot belt. All shrubs rooted within each strip are counted and placed in the following five classes. (U.S. Department of Interior Bureau of Land Management 1996).

Seedling: Plants up to three years old which have become firmly established, usually less than 1/8-inch diameter.

Young: Larger with more complex branching. Does not show signs of maturity. Usually between 1/8 and 1/4-inch diameter.

Mature: Complex branching, rounded growth form, larger size, seed is produced on healthy plants. Generally larger than 1/4-inch diameter.

Decadent: Plant, regardless of age, that is in a state of decline, usually evidenced by 25% or more dead branches.

Dead: A plant which is no longer living.

Shrubs are also rated according to their availability and the amount of use they display, and placed in one of 9 form classes.

1. All available, lightly hedged.
2. All available, moderately hedged.
3. All available, heavily hedged.
4. Largely available, lightly hedged.
5. Largely available, moderately hedged.
6. Largely available, heavily hedged.
7. Mostly unavailable.
8. Unavailable due to height.
9. Unavailable due to hedging.

Lightly hedged: 0 to 40 percent of twigs browsed.

Moderately hedged: 41 to 60 percent of twigs browsed.

Heavily hedged: Over 60 percent of twigs browsed. Degree of hedging is based on leader use over the past three years: current annual growth is not included.

Largely available: One-third to two-thirds of plant available to animal.

Mostly unavailable: Less than one-third of plant available to animal.

In classifying browse to a form class, unavailability may be the result of height, location, or density.

Shrubs are also rated on their health and placed into one of 4 vigor classes.

1. Normal and vigorous.
2. Insect infested or diseased.
3. Poor vigor - chlorotic or discolored leaves, smaller than normal stems or leaves, flowering restricted, partially trampled, pulled up, or otherwise damaged. Stunted growth, partial crown death.
4. Dying - substantial portion of crown dead (more than 50%), more extreme than 3 above. Probably an irreversible condition.

In addition, each mature shrub species closest to every 10 foot mark along a sampling belt is measured to determine average height and crown. This allows a maximum sample of 50 plants per species to be measured at a given site depending on their respective densities. Annual leader growth is estimated for key browse species at each study site. This is done by measuring five leaders on the closest mature shrub in each quarter

(similar to point-center quarter method) from 3 stakes along the study site baseline (0', 200' and 400' stakes). These numbers are then averaged. Tree density is determined using the point-center quarter method at two hundred foot intervals along the baseline. Three hundred feet are added to the end of the transect so that five, 200 foot point-quarter centers can be read. This allows sampling trees on a much larger scale. The strip method that is used to estimate shrub density, can in most cases, effectively inventory seedling and young tree densities. However, the strip method is less effective at estimating densities of mature trees that are often widely disbursed.

Prior to 1992, shrub frequency was determined using the nested frequency method that was previously described. It was found that nested frequency of shrubs did not usually reflect accurate trends in shrub populations which had particularly low densities. Therefore, beginning in mid-1992, each 1/100th acre shrub strip is divided into 20, five foot segments. To give a more accurate measure of shrub frequency, presence or absence of shrub species is determined within these strip segments, and this measurement is termed strip frequency. For example, if a species was rooted in 25 of the 100 shrub strips, strip frequency for this species would be 25%. This larger sample will better reflect changing trends in shrub populations, especially those at moderately low densities. This data along with shrub cover is recorded in the "Browse Trends" table.

#### Trend Determination

The methods described above rely on relative and absolute measurements of plant composition as determined from the frequency, cover, and density data. In addition, estimates of plant vigor, form class, and age class are utilized to characterize shrub populations, as well as average height and crown diameter measurements. Particular attention is given to woody plants and their important role as indicators on critical winter ranges. A variety of parameters are used to help determine trend for key browse species through time. These include:

- 1) changes in density or number of plants/acre
- 2) proportion of decadent plants, and the percentage of decadent plants that are classified as dying
- 3) biotic potential or proportion of seedlings to the population
- 4) proportion of young plants in population
- 5) proportion of individuals moderately or heavily browsed
- 6) proportion of plants in poor vigor
- 7) changes in height and crown diameter measurements for mature age class
- 8) changes in browse species composition
- 9) strip frequency values
- 10) proportion of cover contributed by key species

Trends in herbaceous plants as a group or as a single "key" species can be determined by comparing the sum of nested frequency values between readings. Attention is also given to changes in species composition of grasses and forbs through time. A non-parametric statistical test (Friedman test which is analogous to analysis of variance) (Conover 1980) is conducted on nested frequencies of each species to determine significant changes at  $\alpha = .10$ . Ground cover parameters are analyzed and compared in the discussions of the reread studies. Trends for soil are determined by comparing basic ground cover measurements and cover composition (herbs vs shrubs) between years as well as comparing photos and observer observations between readings. A ratio of the nested frequency values of protective cover types (vegetation, litter, and cryptogams) to bare soil can also be used to help determine changes in soil trend. Beginning in 2002, an erosion condition class assessment adapted from the Bureau of Land Management is also completed on each study site to provide additional qualitative information on soil condition. On newly established studies, a more subjective or apparent assessment is made from qualitative comparisons.

The following tables and partial tables are taken from study number 23-1 to help illustrate some basic comparisons that can be made with the data. The "Herbaceous Trends" table summarizes average cover and nested frequency data for individual grass and forb species. The table contains all the grass and forb species

that have been sampled on study 23-1. Readings prior to mid-1992 include only nested frequency data for *perennial* species. Beginning in mid-1992, all trend studies have data for perennial and annual species as well as cover estimates for individual species.

In the following example, grasses had a combined total cover value of 11.39% in 1998 and 7.08% in 2003. In 1985 and 1991, bluebunch wheatgrass (*Agropyron spicatum*) had a nested frequency value of 227 out of a possible nested frequency score of 400. By 1998, nested frequency declined to 183. The subscript letters indicate that the nested frequency value for *A. spicatum* between 1991 and 1998 declined significantly. Nested frequency declined to 160 in 2003, but the subscript letters indicate that this was not a significant change. Cover was estimated at 7.78% for *A. spicatum* in 1998 declining to 5.59% in 2003. Trend for this grass is down over the life of the transect due to a significant decline in sum of nested frequency since 1991.

HERBACEOUS TRENDS --

Management unit 23 , Study no: 1

T y p e	Species	Nested Frequency				Average Cover %	
		'85	'91	'98	'03	'98	'03
G	<i>Agropyron spicatum</i>	<sub>b</sub> 227	<sub>b</sub> 227	<sub>a</sub> 183	<sub>a</sub> 160	7.78	5.59
G	<i>Bromus tectorum</i> (a)	-	-	<sub>b</sub> 42	<sub>a</sub> 15	.43	.03
G	<i>Oryzopsis hymenoides</i>	4	12	12	5	.17	.04
G	<i>Poa fendleriana</i>	<sub>a</sub> 6	<sub>bc</sub> 36	<sub>c</sub> 49	<sub>ab</sub> 24	.98	.46
G	<i>Poa secunda</i>	<sub>a</sub> 3	<sub>a</sub> 18	<sub>b</sub> 94	<sub>b</sub> 80	2.00	.94
G	<i>Sitanion hystrix</i>	<sub>c</sub> 25	<sub>bc</sub> 20	<sub>ab</sub> 6	<sub>a</sub> 2	.01	.01
<b>Total for Annual Grasses</b>		<b>0</b>	<b>0</b>	<b>42</b>	<b>15</b>	<b>0.43</b>	<b>0.03</b>
<b>Total for Perennial Grasses</b>		<b>265</b>	<b>313</b>	<b>344</b>	<b>271</b>	<b>10.95</b>	<b>7.05</b>
<b>Total for Grasses</b>		<b>265</b>	<b>313</b>	<b>386</b>	<b>286</b>	<b>11.39</b>	<b>7.08</b>
F	<i>Agoseris glauca</i>	<sub>a</sub> -	<sub>a</sub> 10	<sub>ab</sub> 1	<sub>a</sub> -	.00	-
F	<i>Arabis</i> spp.	<sub>a</sub> -	<sub>b</sub> 18	<sub>a</sub> 1	<sub>a</sub> 1	.00	.00
F	<i>Astragalus convallarius</i>	2	4	6	6	.15	.10
F	<i>Calochortus nuttallii</i>	4	8	-	-	-	-
F	<i>Crepis acuminata</i>	-	6	7	-	.06	-
F	<i>Eriogonum racemosum</i>	-	-	4	-	.03	-
F	<i>Eriogonum umbellatum</i>	<sub>a</sub> -	<sub>a</sub> 1	<sub>b</sub> 9	<sub>ab</sub> 5	.16	.07
F	<i>Phlox austromontana</i>	-	6	4	6	.16	.15
F	<i>Physaria chambersii</i>	1	4	-	-	-	-
F	<i>Phlox longifolia</i>	<sub>a</sub> 8	<sub>b</sub> 27	<sub>a</sub> 16	<sub>a</sub> 6	.20	.02
<b>Total for Annual Forbs</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0.00</b>	<b>0</b>
<b>Total for Perennial Forbs</b>		<b>15</b>	<b>84</b>	<b>48</b>	<b>24</b>	<b>0.83</b>	<b>0.35</b>
<b>Total for Forbs</b>		<b>15</b>	<b>84</b>	<b>48</b>	<b>24</b>	<b>0.83</b>	<b>0.35</b>

Values with different subscript letters are significantly different at alpha = .10 (annuals excluded)

In 1985, perennial grasses had a sum of nested frequency value of 265. This value steadily increased to 313 in 1991 and 344 in 1998 before declining to 271 in 2003. These changes would indicate a slightly upward perennial grass trend from 1985 to 1998 and a stable trend overall for the life of the transect. The forb trend can be determined in a similar manner. The herbaceous understory trend is determined using both the grass and forb sum of nested frequency values. For example, total herbaceous cover was 12.23% in 1998 with grasses providing the bulk of the cover. Therefore, when determining herbaceous trend, the grass proportion should be weighted more heavily than the forb proportion in this example.

The following “Browse Trends” table summarizes strip frequency and cover for all shrub species occurring on this site. All of the shrubs encountered at study number 23-1 are listed. For example, mountain big sagebrush (*Artemisia tridentata vaseyana*) had a strip frequency of 40 out of a possible 100 in 1998, declining to 26 in 2003. Average cover is determined using cover classes in conjunction with the 1/4m<sup>2</sup> quadrat and estimating the percent of the quadrat covered. In this case, mountain big sagebrush cover was estimated to be 2.54% in 1998, declining to only 0.76% in 2003.

**BROWSE TRENDS --**

Management unit 23 , Study no: 1

Type	Species	Strip Frequency		Average Cover %	
		'98	'03	'98	'03
B	<i>Artemisia nova</i>	35	26	2.24	2.41
B	<i>Artemisia tridentata vaseyana</i>	40	26	2.54	.76
B	<i>Gutierrezia sarothrae</i>	2	0	-	-
B	<i>Juniperus osteosperma</i>	4	5	5.51	9.29
B	<i>Opuntia spp.</i>	1	2	.15	-
B	<i>Pinus edulis</i>	4	6	5.99	8.81
B	<i>Purshia tridentata</i>	18	15	3.20	4.31
<b>Total for Browse</b>		<b>104</b>	<b>80</b>	<b>19.63</b>	<b>25.58</b>

To estimate canopy cover of trees and shrubs, the line-intercept method is used along each 100 foot belt. This data is reported in the “Canopy Cover, Line Intercept” table. For example, Utah juniper (*Juniperus osteosperma*) had an estimated average cover of 23.31% in 2003. Prior to 2002, only trees species were sampled in the line-intercept transect. Beginning in 2002, all woody species are included in the line-intercept transect and a canopy cover value for each is determined. Live browse cover is measured along the belt transects and converted to percent cover. Gaps of six inches or more lacking live browse cover are excluded.

**CANOPY COVER, LINE INTERCEPT --**

Management unit 23 , Study no: 1

Species	Percent Cover	
	'98	'03
<i>Artemisia nova</i>	-	1.85
<i>Artemisia tridentata vaseyana</i>	-	.55
<i>Juniperus osteosperma</i>	7.19	23.31



Beginning in 2002, annual leader growth of the key browse species is measured to get an idea of shrub production and vigor. This data is displayed in the “Key Browse Annual Leader Growth” table. For example, annual leaders on bitterbrush (*Purshia tridentata*) averaged 4 inches in length while mountain big sagebrush leaders averaged only 1.1 inches in 2003.

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 23 , Study no: 1

Species	Average leader growth (in)
	'03
<i>Artemisia tridentata vaseyana</i>	1.1
<i>Purshia tridentata</i>	4.0

The following “Point-Quarter Tree Data” table displays tree density estimates using the point-center quarter method which better estimates density of widely disbursed trees than the shrub density strips. Average basal diameter is also listed in inches. Data from 2003 estimated 197 juniper and 119 pinyon trees/acre with average basal diameters of 7.0 inches and 5.3 inches respectively.

POINT-QUARTER TREE DATA --

Management unit 23 , Study no: 1

Species	Trees per Acre		Average diameter (in)	
	'98	'03	'98	'03
<i>Juniperus osteosperma</i>	213	197	8.8	7.0
<i>Pinus edulis</i>	115	119	4.8	5.3

The “Basic Cover” table summarizes average cover of vegetation, rock, pavement, litter, cryptogams, and bare ground. Average cover prior to mid-1992 adds up to only 100%, while cover with the current method (post mid-1992) estimates several layers of plant and ground cover and will usually exceed 100%. For vegetation cover, the previous method only determined basal vegetative cover (2.0 and 5.75), while the new method estimates the vertical projection of the crown, or aerial cover (30.04 and 32.5%). Therefore, comparisons can be made for all cover measurements except for general vegetation cover.

BASIC COVER --

Management unit 23 , Study no: 1

Cover Type	Average Cover %			
	'85	'91	'98	'03
Vegetation	2.00	5.75	30.04	32.50
Rock	6.00	5.25	11.18	13.20
Pavement	30.50	24.25	26.32	19.74
Litter	46.50	46.50	42.49	37.44
Cryptogams	5.00	3.00	.93	3.45
Bare Ground	10.00	15.25	21.42	13.10

A summary of the soil data is found in the “Soil Analysis Data” table. Effective rooting depth is an average of 25 soil penetrometer readings, 5 of the deepest probes possible near each of the 5 baseline starting stakes. The effective rooting depth is a relative index that can be used for site comparisons with regard to individual species differences, site preferences, relative site potential, and abundance. Average soil temperature is taken from the deepest probe, one at each of the 5 baseline starting stakes. The temperature is listed in the table as the top measurement (e.g., 62.3°F), with the average depth (in inches) as the lower measurement (12.7). Average soil temperature is re-measured with each reading and the most current soil temperature and depth is listed in the soil analysis table. Chemical and textural characteristics are also listed and were determined by laboratory analysis of a composite soil sample taken near each of the 5 baseline starting stakes.

SOIL ANALYSIS DATA --

Management unit 23, Study # 01, Study Name: Bear Ridge

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.2	62.3 (12.7)	7.3	40.0	33.4	26.6	3.4	9.0	57.6	0.5

The descriptive terms used for ranges in pH are as follows:

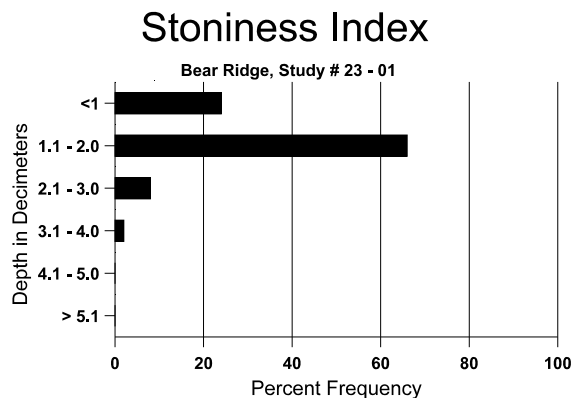
Ultra acid	< 3.5
Extremely acid	3.5-4.4
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Moderately acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	> 9.1

Percent organic matter (% OM) refers to the amount of organic matter in the top 12 inches of the soil profile. Parts per million (ppm) of phosphorus (P) and potassium (K) are also included. Values for phosphorus and potassium less than 10 ppm and 70 ppm respectively may be limiting to plant growth and development (Tiedemann and Lopez 2004).

The electrical conductivity of the soil is reported in decisiemens per meter (dS/m). Electrical conductivity is related to the amount of salts more soluble than gypsum in the soil. The following classes can be used as a reference.

Non saline	0-2
Very slightly saline	2-4
Slightly saline	4-8
Moderately saline	8-16
Strongly saline	>16

To determine how rock is distributed throughout the upper soil profile, a stoniness index is determined for each study site. Depth to the nearest rock is estimated on the first 10 feet (at one-foot intervals) along each of the 5 baselines, which allows 50 measurements. These data are then analyzed for each of the 5 incremental decimeter measurements, making it possible to visually determine the proportion (relative percent of rock at each depth) of rock from <1 decimeter to >5 decimeters. In the following example, most of the rock in the soil profile (~65%) was encountered in the 1 to 2 decimeter (4 to 8 inch) depth range. The distribution of rock in the soil profile can be an important factor for what is growing on the site, relative to site potential and soil temperature.



The “Pellet Group Data” table summarizes the frequency of animal pellets sampled within the 100 quadrats placed along the sampling belts as well as data from a pellet group transect read parallel to the study site baseline. Quadrat frequency of wildlife and livestock droppings is included in reports done prior to mid-1992. For example in 1998, rabbit pellets were found in 25% of the quadrats placed on study 23-1, increasing to 32% in 2003. Quadrat frequency of rabbit or big game pellets indicate a relative amount of use by that particular animal. This data can help characterize changes in wildlife use patterns on the site.

PELLET GROUP DATA --  
Management unit 23 , Study no: 1

Type	Quadrat Frequency		Days use/acre (ha)	
	'98	'03	'98	'03
Rabbit	25	32	-	-
Elk	4	-	7 (17)	1 (3)
Deer	36	20	51 (125)	54 (134)

It was determined that additional information on pellet groups was necessary. Therefore, a pellet group transect is now sampled in conjunction with the vegetative transects. The pellet group transect utilizes 50, 100ft<sup>2</sup> circular plots which are placed through the study area. These are usually two parallel transects of 25 plots on each side of the vegetative transect which runs 500 feet in length. The number of recent pellet groups for wildlife (usually deer and elk) and pats for cattle are recorded. That number is then converted to days use per acre. In the above example, deer days use/acre was estimated at 51 in 1998 increasing slightly to 54 in 2003. If a trend study needs to be read annually and more precision is required, the pellet group transect is marked permanently (rebar) and the pellet groups within the circular plots are removed or marked after being counted.

The “Browse Characteristics” table summarizes characteristics of the shrub community on study 23-1. Only mountain big sagebrush is included in this example. The sagebrush population is characterized by age class,

vigor, utilization, and average height and crown for mature plants. Total density in plants/acre for mountain big sagebrush, excluding seedlings, was 1,400 in 1985, 1,065 in 1991, 1,100 in 1998, and 840 plants/acre in 2003. Seedlings are excluded from the population estimate because with summer drought, many will die by late fall causing great fluctuations in population estimates between sampling dates. Since mid-1992, a larger shrub sample (more than three times larger) is used to better characterize the shrub populations. Therefore, changes in density (before and after 1992) may not necessarily indicate changes in trend, especially shrub populations that characteristically are clumped and/or have discontinuous distributions. The earlier smaller sample could easily either overestimate or underestimate shrub populations. Other characteristics like percent of the population classified as dying, percent decadence, percent of the population displaying poor vigor, percent heavy hedging, young recruitment, etc. should be given more weight in determining shrub trend when comparing survey years where sample sizes are different.

**BROWSE CHARACTERISTICS --**  
Management unit 23 , Study no: 1

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Artemisia tridentata vaseyana												
85	<b>1400</b>	266	200	400	800	-	67	24	57	-	14	13/15
91	<b>1065</b>	333	333	66	666	-	19	6	63	11	38	12/13
98	<b>1100</b>	-	100	260	740	2300	56	2	67	27	40	15/23
03	<b>840</b>	-	120	140	580	1740	29	0	69	40	40	14/21

The data on mountain big sagebrush shows the proportion of decadent shrubs in the population has steadily increased from 57% in 1985 to 69% by 2003. Plants classified as dying had also increased to 40% by 2003. More seedlings were encountered in 1985 and 1991, with slight fluctuations in the number of young plants. Dead plants, included in sampling after 1992, are abundant at 2,300 plants/acre in 1998 and 1,740 in 2003, and outnumber live plants by a ratio of 2:1 in both years. The percentage of plants displaying poor vigor has increased from 14% in 1985 to 40% in 1998 and 2003. The proportion of shrubs displaying heavy hedging declined from 24% in 1985, to 6% in 1991, and 0% by 2003. The proportion of shrubs displaying moderate use has ranged from 67% in 1985 to 19% in 1991. The average height of mature sagebrush has remained similar in all readings and averaged 14 inches in 2003. Average crown diameter has fluctuated from 13 inches in 1991 to 23 inches in 1998.

Considering all these factors, trend for sagebrush in 2003 is slightly downward due to a decline in density, increased decadence, and an higher proportion of plants classified as dying. No seedlings were encountered in 1998 or 2003 and young plants are only moderately abundant.

Management background information, photographs, and knowledgeable plant identification add to the database for each site. Management and background information for each site is obtained from the administering agency. Permanently located photographs are taken including a general view down and back up the baseline. A close-up of each half-high baseline post further characterizes individual sites. Correct plant identification is critical for a complete and accurate site analysis. Species identification mostly follows "A Utah Flora" (Welsh et al. 2003). In some cases, most notably *Agropyron* and *Purshia*, the species names used by the Range Trend Study Plant Species List (Giunta 1983) and the Intermountain Flora (Cronquist et al. 1977) are retained to maintain continuity and alleviate confusion with earlier published reports.

Range trend data have been collected throughout Utah since 1982. In addition to determining trends on winter ranges, a system to determine the condition of these areas was needed. The desirable components index (DCI) was created by Range Trend Project personnel as a tool to address condition and/or value of winter ranges for mule deer. This subjective index is used primarily to determine if a particular site has the vegetation components necessary to be a good winter range for mule deer. Winter range condition is scored based upon several important vegetation components such as, preferred browse cover, shrub decadence and young recruitment, cover of perennial grasses, perennial forbs, and annual grasses (Clements and Young 1997; Olson 1992; Plummer et al. 1968; Stevens 2004; Wasley 2004). This index is used as one of many factors in big game herd management. It can also be used to identify areas where habitat restoration projects may be needed and assist land managers in determining possible rehabilitation options.

Ideal mule deer winter range provides 12-20% of preferred browse cover, shrub decadence is 20% or less, and has 10% or more of the shrub population that is young. The herbaceous understory contains 8-15% perennial grass cover, 5% perennial forb cover, and less than 5% annual grass cover. The DCI ratings are divided into three categories of winter range based different ecological potential, these include: Lower potential sites (Wyoming big sagebrush and desert shrubs), Mid-level potential (mountain big sagebrush), and High potential (mountain brush communities).

Desirable Components Index Ratings

Lower potential sites (Wyoming Big Sagebrush and Desert Shrub Communities)

> 65 points =	Excellent
45 – 64	Good
25 – 44	Fair
10 – 24	Poor
< 10	Very poor

Mid level potential sites (Mountain Big Sagebrush)

> 80 points =	Excellent
79 – 65	Good
64 – 50	Fair
49 – 35	Poor
< 35	Very poor

Higher potential sites (Mountain Brush Communities)

> 90 points =	Excellent
89 – 70	Good
69 – 55	Fair
54 – 40	Poor
< 39	Very poor

(Black sagebrush and Basin big sagebrush will be placed in Wyoming or Mountain big sagebrush scales based on precipitation and elevation).

Desirable Components Index Scoring

Preferred Browse (60 points)

(Preferred Browse species are favorable or critical to deer)

Preferred Browse Cover (30 pts. possible)  
1.5 points for each 1% of preferred browse cover (maximum is 20% or 30 points)

Percent Decadence\* (15 points possible)  
-0.3 points for each 1% decadence (do not exceed 15 points)

Percent Young\* (15 points possible)  
0.5 points for each 1% of young

Herbaceous Understory (40 points)

Perennial Grass Cover (30 points possible)  
2 points for each 1% cover

Perennial Forb Cover (10 points possible)  
2 points for each 1% cover

Annual Grass Cover (-20 points possible)  
-0.75 points for each 1% cover

Noxious Weeds (State List)

-2 points for each species present

\*If the total preferred browse cover for the year is below 5%, then no points are awarded for percent young in population and percent decadence.

Trend Study 1R-2-07

Study site name: Rattlesnake Fire Seeded .

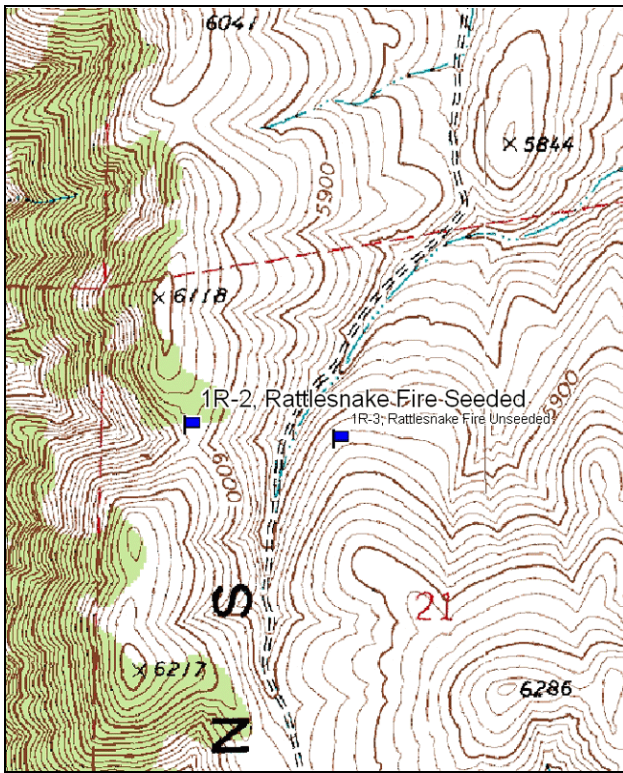
Vegetation type: Burn/Perennial Grass .

Compass bearing: frequency baseline 180 degrees magnetic.

Frequency belt placement: line 1 (11 & 95ft), line 2 (34ft), line 3 (59ft), line 4 (71ft).

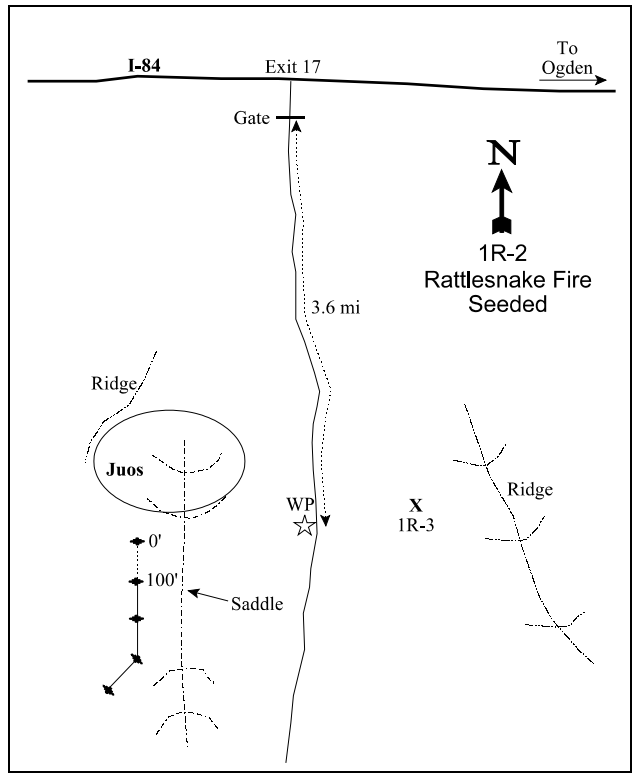
LOCATION DESCRIPTION

Take Exit 17 off of I-84 and pass through a gate. Travel south for 3.6 miles to a witness post on the right hand side of the road. The baseline is to the right (west) of the witness post and is on top of the saddle right outside of a clump of juniper trees. The 0-foot post is marked with browse tag #30.



Map Name: Bulls Pass

Township 13N , Range 6W , Section 21



Diagrammatic Sketch

GPS: NAD 83, UTM 12T 371288 E 4633943

## DISCUSSION

### Rattlesnake Fire Seeded - Trend Study No. 1R-02

#### Study Information

This study was established in 2004 to monitor the effectiveness of a seeding on a pinyon-juniper burn that occurred in 2003 on the north end of the Promontory Mountains, 3.5 miles (5.6 km) south of I-15 [elevation: 6,000 feet (1,830 m), slope: 20%-30%, aspect: west]. This study site was established on a portion of the burn that was seeded, likely aerially, in the fall of 2003. The comparison study site, Rattlesnake Fire Unseeded (1R-03), was established on an untreated ridge 1,000 feet (300 m) to the east. Both studies were sampled again in 2007. The seeded study is located in a 16-18 inch (406-457 mm) precipitation zone (USDA et al. 1999). Local precipitation data were incomplete, however, annual precipitation for wildlife management unit 1 was above normal in 2004 and 2005 and 95% of normal in 2006. Spring precipitation was above normal in 2005 and 2006 and 37% of normal in 2007 (Utah Climate Summaries 2007). Deer use estimates were 15 days use/acre (38 ddu/ha) in 2004 and 1 day use/acre (2 ddu/ha) in 2007, most of which was from previous years.

#### Soil

The soil is classified as a Sandall-Promo complex. This complex consists of shallow to moderately deep, well-drained soils that formed from limestone colluvium and residuum (USDA-NRCS 2007). It is a sandy clay loam texture with a neutral pH (7.0). Phosphorus and potassium concentrations were high following the burn in 2004 (13.5 ppm; Tiedemann and Lopez 2004). Rock and pavement are prevalent in the upper 4 inches (10.2 cm) and on the surface of the soil. Relative pavement cover was moderately high at 17% in 2004, likely a product of the 2003 fire, but had decreased to 10% by 2007. Relative bare ground cover decreased from 40% in 2004 to 21% in 2007, and relative vegetation cover increased from 27% to 40%. Relative litter cover increased from 10% to 23%. The seeding treatment was successful in preventing erosion. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Previous to the fire, mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) was the dominant browse species. In 2004, sagebrush provided 0.01% quadrat cover, and by 2007, it had increased to 0.3% cover. From 2004 to 2007, sagebrush density increased from 80 plants/acre (198 plants/ha) to 240 plants/acre (593 plants/ha), 75% of which were young plants both years. There were 360 seedlings/acre (889 seedlings/ha) sampled in 2004, but none were sampled in 2007. Decadence decreased from 25% of the population in 2004 to 0% in 2007. Browse use decreased slightly from 25% heavy use in 2004 to 17% moderate use in 2007. Black sagebrush (*Artemisia nova*) was sampled in 2007 at 20 plants/acre (49 plants/ha).

Stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) was the dominant browse species in 2004 with 3,740 plants/acre (9,238 plants/ha) and 2% quadrat cover. In 2007, stickyleaf low rabbitbrush density decreased to 2,700 plants/acre (6,669 plants/ha), but quadrat cover remained 2%. Snowberry (*Symphoricarpos oreophilus*) and gray horsebrush (*Tetradymia canescens*) were also present, but in low densities. Whitestem rubber rabbitbrush (*Chrysothamnus nauseosus*) was sampled first in 2007.

#### Herbaceous Understory

Bluebunch wheatgrass (*Agropyron spicatum*) and Sandberg bluegrass (*Poa secunda*) were the dominant grass species sampled in 2004 and 2007. Perennial grasses provided 13% cover in 2004 and 32% in 2007. Bluebunch wheatgrass was included in the seed mix, but from photos, it appeared to exist in the area before the fire. It provided 8% cover in 2004 and increased to 21% in 2007, although the nested frequency did not change significantly. Orchardgrass (*Dactylis glomerata*) was also seeded on the treatment, but provided only 0.03% cover in 2004 and was not sampled in 2007. Crested wheatgrass (*Agropyron cristatum*), the only other seeded grass sampled on the study, was sampled in a single quadrat in 2007. Sandberg bluegrass provided 4% cover in 2004

and 10% in 2007. Cheatgrass (*Bromus tectorum*) provided less than 1% cover with a quadrat frequency of 35% in 2004, but had increased to 4% cover with a quadrat frequency of 49% in 2007.

The forb diversity is high. Ten annual and 20 perennial forb species were sampled in 2004. In 2007, 11 annual and 18 perennial forbs were sampled. Perennial species provided nearly 5% cover in 2004 and 2007. Annuals provided nearly 8% cover in 2004 and 5% in 2007. None of the perennial species provided more than 1% cover individually in 2004, but in 2007 silvery lupine (*Lupinus argenteus*) provided nearly 2% cover. The only seeded forbs sampled were western yarrow (*Achillea millefolium*) and small burnet (*Sanguisorba minor*). Small burnet was only sampled in two quadrats in 2004 and was not sampled in 2007. Yarrow cover provided a fraction of a percent cover both years.

#### 2004 Post-treatment Assessment

After the first growing season following the fire and seeding, only four of the 13 species seeded on the treatment established (bluebunch wheatgrass, orchardgrass, western yarrow, and small burnet; see seeding table below). Vegetation cover was low and bare ground cover was high. Perennial grasses, mainly bluebunch wheatgrass and Sandberg bluegrass, dominated the herbaceous understory. Cheatgrass provided little cover. Forb cover was predominantly that of annuals. Very little mountain big sagebrush survived the burn, although some natural seeding took place. Stickyleaf low rabbitbrush was the dominant browse species, most of which were mature individuals. The soil, despite the fire, showed little erosion. The Desirable Components Index (DCI) score was very poor-poor due to good perennial grass and forb cover, but no shrub cover.

2004 winter range condition (DCI) – very poor-poor (34) Mid-level potential scale

#### 2007 Post-treatment Assessment

The high vegetation cover on this study prevented substantial erosion. Perennial grasses established well on the seeding. It is difficult to determine the effectiveness of the seeding because bluebunch wheatgrass was included in the seed mix, but was also growing naturally in the non-burned area to the north of the study. However, bluebunch wheatgrass cover was much higher in the burn than the unburned area, and increased substantially from 2004 to 2007. Crested wheatgrass and orchardgrass did not establish well. Annual grass cover increased from 1% to 4%, while perennial grass cover increased from 13% to 32%. The seeded forbs provided very little cover, and only two seeded species established. Annual forb nested frequency increased three-fold, and perennial forb nested frequency decreased 16%. The fire removed nearly all sagebrush cover. The DCI score remained very poor-poor due to the lack of browse cover.

2007 winter range condition (DCI) – very poor-poor (37) Mid-level potential scale



<b>Rattlesnake Fire Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Percent of Mix</b>
Crested Wheatgrass 'Douglas'	450	3
Crested Wheatgrass 'Hycrest'	1550	10
Western Wheatgrass 'Arriba'	2000	13
Snake River Wheatgrass 'Secar'	255	2
Bluebunch Wheatgrass 'Goldar'	1750	11
Orchardgrass 'Paiute'	2000	13
Russian Wildrye 'Bozoisky'	350	2
Sheep Fescue	526	3
Western Yarrow	300	2
Alfalfa 'Ladak+'	2000	13
Sainfoin	2000	13
Small Burnet 'Delar'	2500	16
<b>Total</b>	<b>15681</b>	<b>100</b>

HERBACEOUS TRENDS --

Management unit 01R, Study no: 2

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	1	-	.01
G	Agropyron spicatum	<sub>a</sub> 254	<sub>a</sub> 270	8.46	21.40
G	Bromus tectorum (a)	<sub>a</sub> 86	<sub>b</sub> 169	.82	4.26
G	Dactylis glomerata	5	-	.03	-
G	Poa fendleriana	<sub>b</sub> 21	<sub>a</sub> 2	.40	.01
G	Poa secunda	<sub>a</sub> 188	<sub>b</sub> 283	3.96	10.25
Total for Annual Grasses		86	169	0.82	4.26
Total for Perennial Grasses		468	556	12.85	31.67
Total for Grasses		554	725	13.68	35.94
F	Achillea millefolium	<sub>a</sub> 5	<sub>a</sub> 9	.06	.21
F	Agoseris glauca	<sub>a</sub> 83	<sub>a</sub> 111	.45	.72
F	Alyssum alyssoides (a)	<sub>a</sub> 13	<sub>b</sub> 204	.04	.84
F	Allium sp.	115	-	.52	-
F	Arabis sp.	-	5	-	.01
F	Astragalus convallarius	<sub>a</sub> 11	<sub>a</sub> 16	.11	.24
F	Astragalus sp.	<sub>a</sub> 16	<sub>a</sub> 1	.10	.03
F	Astragalus utahensis	3	-	.00	-
F	Balsamorhiza sagittata	-	-	.03	-
F	Borago sp.	6	-	.21	-
F	Camelina microcarpa (a)	-	2	-	.01
F	Calochortus nuttallii	26	-	.09	-

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
		F	Cirsium sp.	<sub>a</sub> 8	<sub>a</sub> 7
F	Collomia linearis (a)	<sub>a</sub> 39	<sub>b</sub> 70	.14	.26
F	Comandra pallida	-	11	-	.07
F	Collinsia parviflora (a)	<sub>a</sub> 3	<sub>b</sub> 234	.00	1.01
F	Crepis acuminata	-	2	-	.03
F	Cymopterus sp.	<sub>a</sub> 44	<sub>a</sub> 34	.60	.06
F	Descurainia pinnata (a)	<sub>a</sub> 9	<sub>b</sub> 128	.05	.83
F	Haplopappus acaulis	-	3	-	.18
F	Helianthus annuus (a)	-	-	.15	-
F	Hedysarum boreale	3	-	.04	-
F	Lappula occidentalis (a)	<sub>a</sub> 11	<sub>b</sub> 35	.16	.10
F	Lactuca serriola	<sub>a</sub> 8	<sub>a</sub> 5	.08	.07
F	Lomatium sp.	-	-	.01	-
F	Lupinus argenteus	<sub>a</sub> 28	<sub>a</sub> 38	.70	1.54
F	Lupinus sp.	<sub>a</sub> 10	<sub>a</sub> 18	.54	.06
F	Mentzelia sp.	2	-	.01	-
F	Microsteris gracilis (a)	<sub>a</sub> 8	<sub>b</sub> 178	.02	.67
F	Phlox austromontana	<sub>a</sub> 24	<sub>a</sub> 28	.61	.94
F	Phlox longifolia	<sub>a</sub> 19	<sub>b</sub> 48	.07	.39
F	Polygonum douglasii (a)	<sub>a</sub> 2	<sub>b</sub> 16	.01	.03
F	Ranunculus testiculatus (a)	-	33	-	.06
F	Sanguisorba minor	3	-	.01	-
F	Sisymbrium altissimum (a)	<sub>a</sub> 26	<sub>a</sub> 38	3.22	.46
F	Townsendia sp.	-	2	-	.03
F	Tragopogon dubius	-	6	-	.06
F	Veronica biloba (a)	<sub>b</sub> 277	<sub>a</sub> 214	3.81	1.08
F	Vicia americana	-	5	-	.03
Total for Annual Forbs		388	1152	7.61	5.38
Total for Perennial Forbs		414	349	4.50	4.92
Total for Forbs		802	1501	12.12	10.31

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 01R, Study no: 2

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia nova	0	1	-	-
B	Artemisia tridentata vaseyana	3	9	.01	.30
B	Chrysothamnus nauseosus	0	1	-	-
B	Chrysothamnus viscidiflorus viscidiflorus	59	53	2.15	2.24
B	Gutierrezia sarothrae	0	17	-	.99
B	Symphoricarpos oreophilus	0	1	-	.00
B	Tetradymia canescens	0	0	-	-
Total for Browse		62	82	2.16	3.54

CANOPY COVER, LINE INTERCEPT --

Management unit 01R, Study no: 2

Species	Percent Cover	
	'04	'07
Artemisia tridentata vaseyana	-	.21
Chrysothamnus nauseosus	-	.23
Chrysothamnus viscidiflorus viscidiflorus	2.38	4.40
Gutierrezia sarothrae	-	.23
Symphoricarpos oreophilus	-	.21

BASIC COVER --

Management unit 01R, Study no: 2

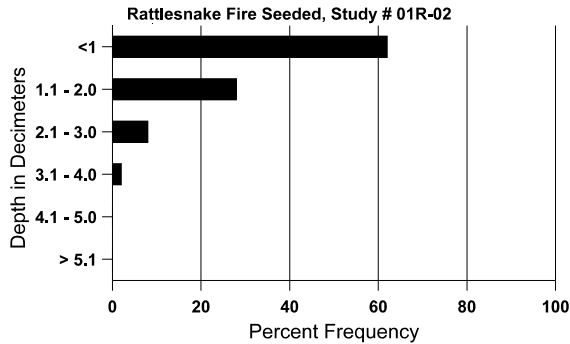
Cover Type	Average Cover %	
	'04	'07
Vegetation	29.43	43.40
Rock	6.19	6.56
Pavement	18.62	10.65
Litter	10.44	25.47
Cryptogams	.13	.07
Bare Ground	43.52	22.68

SOIL ANALYSIS DATA --

Management unit 1R, Study no: 2, Study Name: Rattlesnake Fire Seeded

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.4	60.2 (14.1)	7.0	47.2	38.6	14.2	4.1	13.5	291.2	0.6

Stoniness Index



PELLET GROUP DATA --

Management unit 01R, Study no: 2

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	1	8	-	-
Deer	5	1	15 (38)	1 (2)

BROWSE CHARACTERISTICS --

Management unit 01R, Study no: 2

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	20	-	-	20	-	-	0	0	-	-	0	13/31
<b>Artemisia tridentata vaseyana</b>												
04	80	360	60	-	20	520	0	25	25	-	0	9/19
07	240	-	180	60	-	220	17	0	0	-	0	16/22
<b>Chrysothamnus nauseosus</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	20	-	-	20	-	-	0	0	-	-	0	17/17

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>3740</b>	1160	160	3560	20	-	0	0	1	-	0	11/11
07	<b>2700</b>	-	100	2100	500	40	.74	1	19	5	15	11/17
<i>Gutierrezia sarothrae</i>												
04	<b>0</b>	-	-	-	-	-	0	0	0	-	0	-/-
07	<b>1120</b>	-	160	620	340	60	0	0	30	-	30	6/9
<i>Symphoricarpos oreophilus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	10/21
07	<b>20</b>	-	-	20	-	-	100	0	-	-	0	20/39
<i>Tetradymia canescens</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	8/10
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	11/20

Trend Study 1R-3-07

Study site name: Rattlesnake Fire Unseeded .

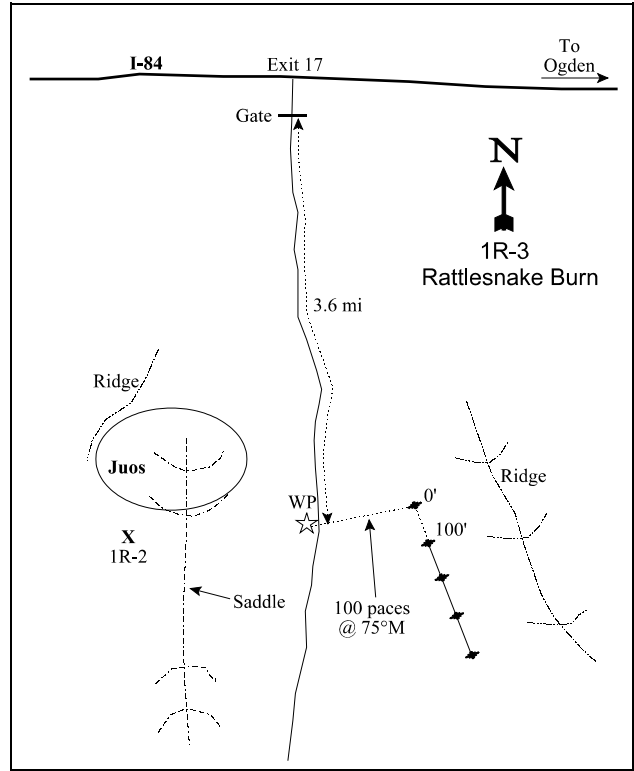
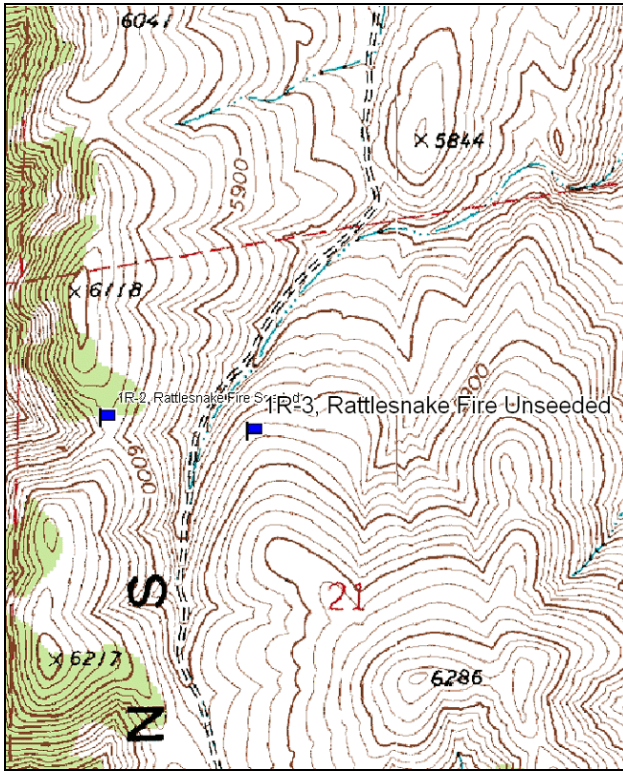
Vegetation type: Burn/Perennial Grass .

Compass bearing: frequency baseline 158 degrees magnetic.

Frequency belt placement: line 1 (11 & 95ft), line 2 (34ft), line 3 (59ft), line 4 (71ft).

LOCATION DESCRIPTION

Take Exit 17 off of I-84 and pass through a gate. Travel south for 3.6 miles to a witness post on the right hand side of the road. The beginning of the baseline is to the left of the witness post about 100 paces at 75°M. The 0-foot stake is marked with browse tag #31.



Map Name: Bulls Pass

Diagrammatic Sketch

Township 13N , Range 6W , Section 21

GPS: NAD 83 UTM 12T 371615 E 4633910 N

## DISCUSSION

### Rattlesnake Fire Unseeded – Trend Study No. 1R-03

#### Study Information

This comparison study was established in 2004 to monitor the effectiveness of a post-burn seeding [elevation: 5,900 feet (1,800 m), slope: 20%-30%, aspect: west]. It is located 0.2 miles (0.3 km) west of Rattlesnake Fire Seeded (1R-02) on an area that was not treated. It is also part of the fire that occurred in the northern Promontory Mountains in 2003. It is located in a 16-18 inch (406-457 mm) precipitation zone (USDA et al. 1999). Local precipitation data were incomplete, however, annual precipitation for wildlife management unit 1 was above normal in 2004 and 2005 and 95% of normal in 2006. Spring precipitation was above normal in 2005 and 2006 and 37% of normal in 2007 (Utah Climate Summaries 2007). Deer use estimates were 5 days use/acre (13 ddu/ha) in 2004 and 3 days use/acre (7 ddu/ha) in 2007. Sharptail grouse pellets were noted in 2007.

#### Soil

The soil is the Middle-Broad association. Soils in this association are moderately deep, well drained, and moderately-slowly permeable. They are formed in residuum and colluvium from sandstone, limestone, and quartzite on mountains (USDA-NRCS 2007). The soil is a shallow stony loam with a neutral pH (7.0). Soil phosphorus concentration was marginal and potassium was high in 2004 (Tiedemann and Lopez 2004). Relative bare ground cover decreased from 40% in 2004 to 14% in 2007. Relative vegetation cover increased from 27% in 2004 to 42% in 2007. The erosion condition was considered stable in 2004 and 2007.

#### Browse

Six browse species were sampled in 2004: mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), rubber rabbitbrush (*Chrysothamnus nauseosus*), stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), Fremont's buckwheat (*Eriogonum corymbosum*), broom snakeweed (*Gutierrezia sarothrae*), and gray horsebrush (*Tetradymia canescens*). Stickyleaf rabbitbrush was dominant in 2004 and 2007 with approximately 4% and 6% canopy cover, respectively. The other browse species combined provided less than 1% canopy cover in 2004, but provided 6% in 2007. Mountain big sagebrush density decreased from 60 plants/acre (148 plants/ha) in 2004 to 20 plants/acre (49 plants/ha) in 2007. Stickyleaf rabbitbrush density was 4,220 plants/acre (10,432 plants/ha) in 2004, but decreased to 3,700 plants/acre (9,139 plants/ha) in 2007.

#### Herbaceous Understory

The grass diversity is low. Only four grass species were sampled in 2004: bluebunch wheatgrass (*Agropyron spicatum*), cheatgrass (*Bromus tectorum*), mutton bluegrass (*Poa fendleriana*), and Sandberg bluegrass (*Poa secunda*). Of these four species, mutton bluegrass was the only species that was not sampled in 2007. Bluebunch wheatgrass cover increased from 9% in 2004 to 20% in 2007, and Sandberg bluegrass cover increased from 4% in 2004 to 11% in 2007. Cheatgrass provided only 1% cover in 2004 and less than 1% in 2007. It was sampled in 62% of the quadrats in 2004, but only 34% in 2007.

Twelve perennial and 8 annual forbs were sampled in 2004, but 13 perennial and 11 annual species were sampled in 2007. Perennial species provided nearly 5% cover in 2004 and 2007, and annuals provided approximately 4% both years. Two-lobe speedwell (*Veronica biloba*) was dominant in 2004, pale alyssum (*Alyssum alyssoides*) was dominant in 2007, and silvery lupine (*Lupinus argenteus*) was common both years. Speedwell provided 3% cover in 2004, pale alyssum provided 3% cover in 2007, and lupine provided approximately 2% cover both years.

#### 2004 Post-treatment Assessment

When comparing the seeded and unseeded studies, there are few differences in composition and density of herbaceous species between the two. The only difference in grass composition is that orchardgrass was

sampled on the seeded site in a few quadrats. Eight fewer perennial forbs and two fewer annual forbs were sampled on the unseeded study. Only one of the seeded forb species, small burnet (*Sanguisorba minor*), was sampled on the treated area and not on the unseeded. Bare ground and vegetation cover were identical on both studies. More total browse cover was sampled on the unseeded area, but the dominant browse species, stickyleaf rabbitbrush, cover was very similar between the treatments. The Desirable Components Index (DCI) rating was very poor-poor due to no key browse cover, good perennial grass cover, and excellent perennial forb cover.

2004 winter range condition (DCI) – very poor-poor (34) Mid-level potential scale

2007 Post-treatment Assessment

Perennial grass cover increased from 13% to 31% and perennial grass nested frequency increased 28%. There were significant increases in the nested frequencies of bluebunch wheatgrass and Sandberg bluegrass. Cheatgrass nested frequency decreased 55%, and cover decreased slightly. Grass diversity decreased from three perennial species to two. Forb composition became more annual dominated. Perennial forb cover did not change, but perennial forb nested frequency decreased 25%. Annual forb cover increased from 3% to 4% and annual forb nested frequency increased 77%. Total browse canopy cover increased from 5% to 12%. Both years, stickyleaf low rabbitbrush was the dominant browse species. The DCI score improved to poor due to an increase in perennial grass cover.

2007 winter range condition (DCI) – poor (39) Mid-level potential scale

HERBACEOUS TRENDS --

Management unit 01R, Study no: 3

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron spicatum</i>	<sub>a</sub> 292	<sub>b</sub> 340	9.10	19.91
G	<i>Bromus tectorum</i> (a)	<sub>b</sub> 189	<sub>a</sub> 85	1.08	.43
G	<i>Poa fendleriana</i>	2	-	.03	-
G	<i>Poa secunda</i>	<sub>a</sub> 233	<sub>b</sub> 336	3.80	11.00
Total for Annual Grasses		189	85	1.08	0.43
Total for Perennial Grasses		527	676	12.94	30.92
Total for Grasses		716	761	14.03	31.35
F	<i>Achillea millefolium</i>	<sub>a</sub> 7	<sub>a</sub> 11	.19	.18
F	<i>Agoseris glauca</i>	<sub>a</sub> 38	<sub>a</sub> 17	.10	.08
F	<i>Alyssum alyssoides</i> (a)	<sub>a</sub> 95	<sub>b</sub> 363	.38	2.90
F	<i>Allium</i> sp.	<sub>b</sub> 89	<sub>a</sub> 4	.35	.01
F	<i>Arabis</i> sp.	-	1	-	.03
F	<i>Astragalus convallarius</i>	<sub>b</sub> 47	<sub>a</sub> 23	.59	.19
F	<i>Camelina microcarpa</i> (a)	1	-	.00	-
F	<i>Calochortus nuttallii</i>	<sub>b</sub> 20	<sub>a</sub> 4	.08	.01
F	<i>Chenopodium</i> sp. (a)	6	-	.01	-



T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Collomia linearis</i> (a)	-	2	-	.00
F	<i>Collinsia parviflora</i> (a)	-	90	-	.28
F	<i>Cordylanthus</i> sp. (a)	-	2	-	.03
F	<i>Crepis acuminata</i>	-	-	-	.00
F	<i>Cymopterus</i> sp.	<sub>b</sub> 58	<sub>a</sub> 31	.39	.16
F	<i>Descurainia pinnata</i> (a)	<sub>b</sub> 19	<sub>a</sub> 12	.19	.01
F	<i>Lappula occidentalis</i> (a)	-	1	-	.00
F	<i>Lactuca serriola</i>	<sub>b</sub> 8	<sub>a</sub> 1	.05	.00
F	<i>Lupinus argenteus</i>	<sub>a</sub> 31	<sub>b</sub> 43	1.52	2.05
F	<i>Lupinus</i> sp.	<sub>a</sub> 20	<sub>a</sub> 25	.66	.22
F	<i>Microsteris gracilis</i> (a)	-	66	-	.15
F	<i>Phlox austromontana</i>	<sub>a</sub> 28	<sub>a</sub> 41	.24	.78
F	<i>Phlox longifolia</i>	<sub>a</sub> 89	<sub>b</sub> 123	.33	.85
F	<i>Polygonum douglasii</i> (a)	<sub>a</sub> 1	<sub>a</sub> 3	.00	.00
F	<i>Ranunculus testiculatus</i> (a)	<sub>a</sub> 2	<sub>b</sub> 69	.00	.19
F	<i>Sisymbrium altissimum</i> (a)	<sub>a</sub> 2	<sub>a</sub> 10	.00	.36
F	<i>Tragopogon dubius</i>	<sub>a</sub> 3	<sub>a</sub> 5	.15	.03
F	<i>Veronica biloba</i> (a)	<sub>b</sub> 304	<sub>a</sub> 141	2.84	.45
Total for Annual Forbs		430	759	3.46	4.40
Total for Perennial Forbs		438	329	4.68	4.62
Total for Forbs		868	1088	8.14	9.02

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 01R, Study no: 3

T y p e	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata vaseyana</i>	2	1	-	.03
B	<i>Chrysothamnus nauseosus</i>	1	1	.00	-
B	<i>Chrysothamnus viscidiflorus viscidiflorus</i>	71	64	2.75	3.25
B	<i>Eriogonum corymbosum</i>	4	18	.03	.45
B	<i>Gutierrezia sarothrae</i>	1	54	.00	3.04
B	<i>Purshia tridentata</i>	0	0	-	-

B	Tetradymia canescens	26	28	.92	1.17
Total for Browse		105	166	3.71	7.96

CANOPY COVER, LINE INTERCEPT --

Management unit 01R, Study no: 3

Species	Percent Cover	
	'04	'07
Chrysothamnus nauseosus	.13	-
Chrysothamnus viscidiflorus viscidiflorus	3.70	5.68
Eriogonum corymbosum	-	1.06
Gutierrezia sarothrae	-	2.73
Tetradymia canescens	1.03	2.53

BASIC COVER --

Management unit 01R, Study no: 3

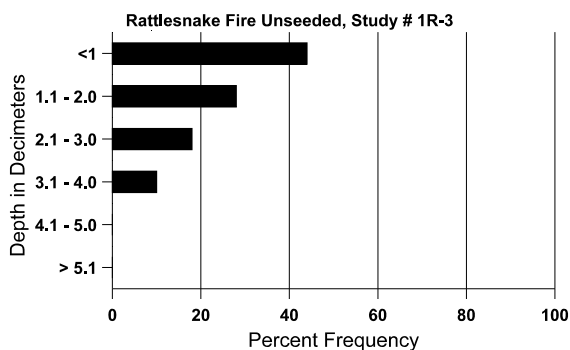
Cover Type	Average Cover %	
	'04	'07
Vegetation	29.12	45.83
Rock	4.49	4.82
Pavement	12.78	9.35
Litter	18.79	32.77
Cryptogams	0	.18
Bare Ground	42.95	15.58

SOIL ANALYSIS DATA --

Management unit 1R, Study no: 3, Study Name: Rattlesnake Fire Unseeded

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
10.9	64.2 (12.6)	7.0	47.2	38.6	14.2	5.1	13.5	291.2	0.6

### Stoniness Index



PELLET GROUP DATA --  
 Management unit 01R, Study no: 3

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	1	1	-	-
Grouse	-	2	-	-
Deer	-	1	5 (13)	3 (7)

BROWSE CHARACTERISTICS --  
 Management unit 01R, Study no: 3

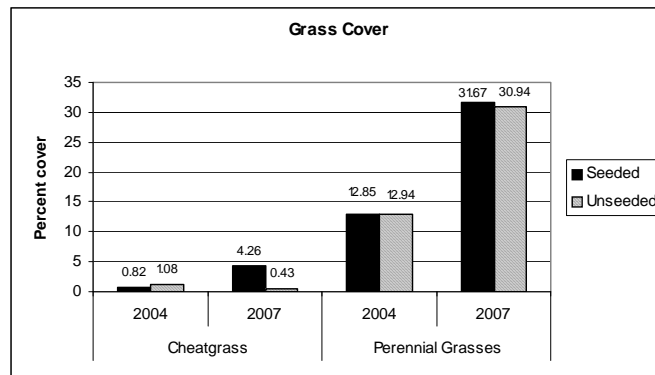
		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata vaseyana</i>												
04	<b>60</b>	60	40	20	-	1080	0	0	-	-	0	35/42
07	<b>20</b>	20	20	-	-	-	0	0	-	-	0	21/13
<i>Chrysothamnus nauseosus</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	17/18
07	<b>20</b>	-	-	20	-	-	0	100	-	-	0	24/30
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>4220</b>	54360	160	4020	40	2700	0	0	1	-	0	11/13
07	<b>3700</b>	-	200	1620	1880	40	0	0	51	9	45	12/18
<i>Eriogonum corymbosum</i>												
04	<b>140</b>	-	-	140	-	-	0	0	0	-	0	8/10
07	<b>680</b>	-	-	640	40	-	15	0	6	-	0	10/14
<i>Gutierrezia sarothrae</i>												
04	<b>20</b>	-	-	20	-	-	0	0	0	-	0	7/5
07	<b>7400</b>	-	1160	5440	800	-	0	0	11	.54	36	6/7
<i>Purshia tridentata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	8/21
<i>Tetradymia canescens</i>												
04	<b>1380</b>	-	260	1120	-	-	0	0	0	-	0	11/16
07	<b>1060</b>	-	20	420	620	20	0	2	58	11	28	13/24

## Summary and Comparison of Rattlesnake Fire Seeded (1R-2) and Rattlesnake Fire Unseeded (1R-3)

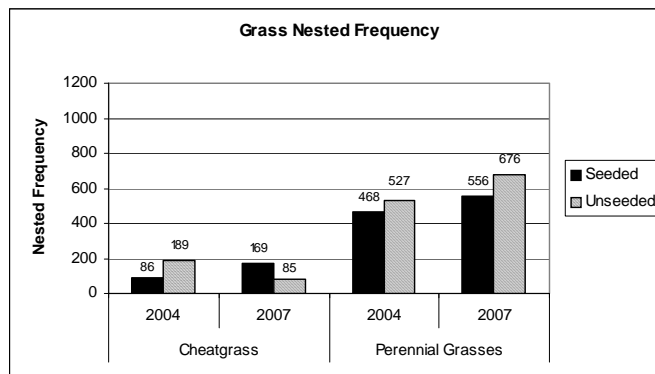
These studies were established in 2004 to monitor the effectiveness of a seeding treatment on a fire in the northern Promontory Mountains. Two studies were established, one seeded and the other not seeded. They were similar in species composition, slope, and aspect. The unseeded study aspect was slightly more northward than the seeded, otherwise their topographies were quite similar. Deer use was also similar between the two studies both years. One of the biggest differences between the studies, which is not reflected in the data, is that burned juniper trees were present in the seeded study, but were not present in the unseeded study. Juniper cover appears to have been low on the seeded study previous to the fire.

Browse appears to have been greatly reduced due to the fire. In 2004, 520 dead sagebrush plants/acre (1,284 plants/ha) were sampled on the seeded study and 1,080 dead plants/acre (2,668 plants/ha) were sampled on the unseeded study. Very few sagebrush plants have been sampled after the fire on both studies.

Few differences were sampled between the two studies in grass composition, cover, and nested frequency (Figures 1 and 2). Five perennial grass species were sampled at the seeded study and three were sampled at the unseeded study. Of the five species sampled on the seeded study, three were seeded. Two of these species (crested wheatgrass and orchardgrass), however, provided very little cover and nested frequency. Bluebunch wheatgrass, which was also in the seed mix, was sampled in high cover and nested frequency values, but was also sampled at similar cover and nested frequency values on the unseeded study. Based on the similarity of the two studies, it is quite likely that the seeded bluebunch wheatgrass provided little additional plant cover to the existing population. Figures 1 and 2 illustrate the similarity between the cover and nested frequency of perennial grasses at both the seeded and unseeded studies in 2004 and 2007. Perennial grass cover increased from 2004 to 2007 as the species recovered from the fire, but nested frequency changed little.



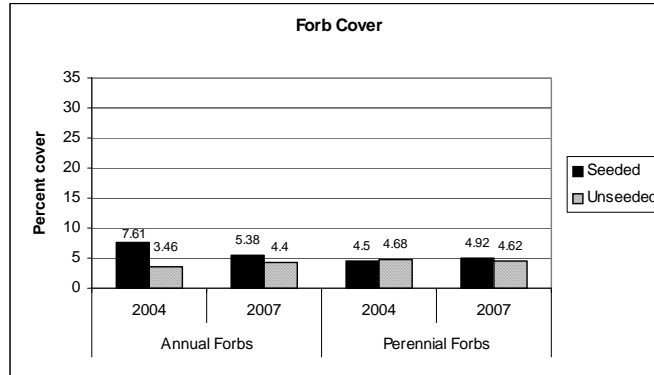
**Figure 1.** Comparison of grass cover between the seeded (1R-2) and unseeded (1R-3) studies for cheatgrass and perennial grasses in 2004 and 2007.



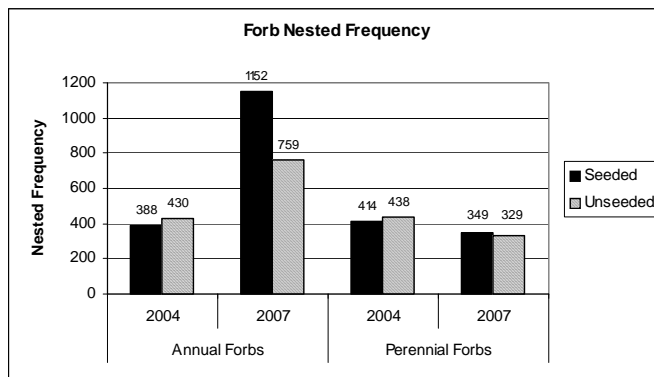
**Figure 2.** Comparison of grass nested frequency between the seeded (1R-2) and unseeded (1R-3) studies for cheatgrass and perennial grasses in 2004 and 2007.

Cheatgrass cover and nested frequency were low at both studies both years (Figures 1 and 2). In 2004, cheatgrass cover and nested frequency were slightly higher in the unseeded study, but were slightly higher in the seeded study in 2007 (Figures 1 and 2). It appears as though the perennial grass cover is preventing the spread and dominance of cheatgrass, as described by Monsen (1994).

Forb cover was similar both years between annuals and perennials on both studies (Figures 3 and 4). Perennial forb nested frequency was similar to that of annual forbs in 2004, changed little from 2004 to 2007, and was similar between studies. Annual forb nested frequency increased substantially on both studies in 2007, although the nested frequency was much larger on the seeded study than the unseeded study (Figures 3 and 4).



**Figure 3.** Comparison of forb cover between the seeded (1R-2) and unseeded (1R-3) studies for annual and perennial forbs in 2004 and 2007.



**Figure 4.** Comparison of forb nested frequency between the seeded (1R-2) and unseeded (1R-3) studies for annual and perennial forbs in 2004 and 2007.

Trend Study 2R-9-07

Study site name: Rabbit Creek Burn .

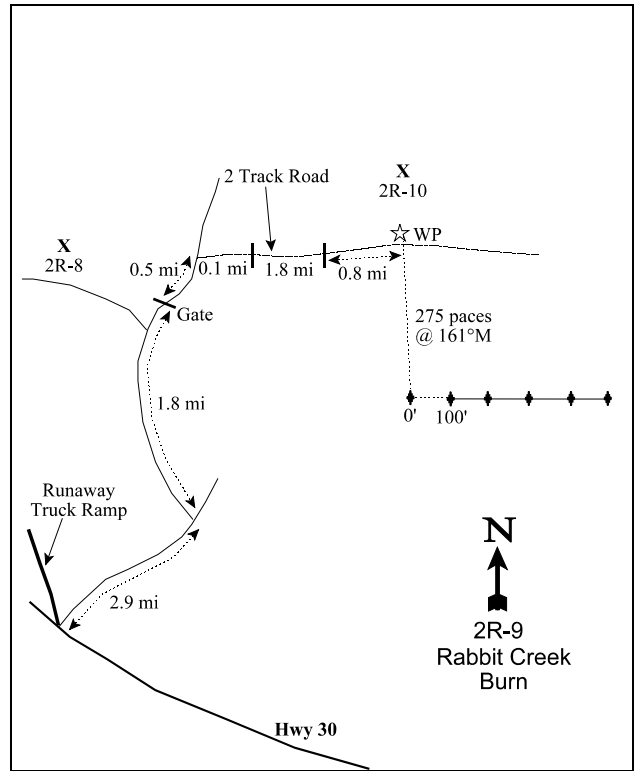
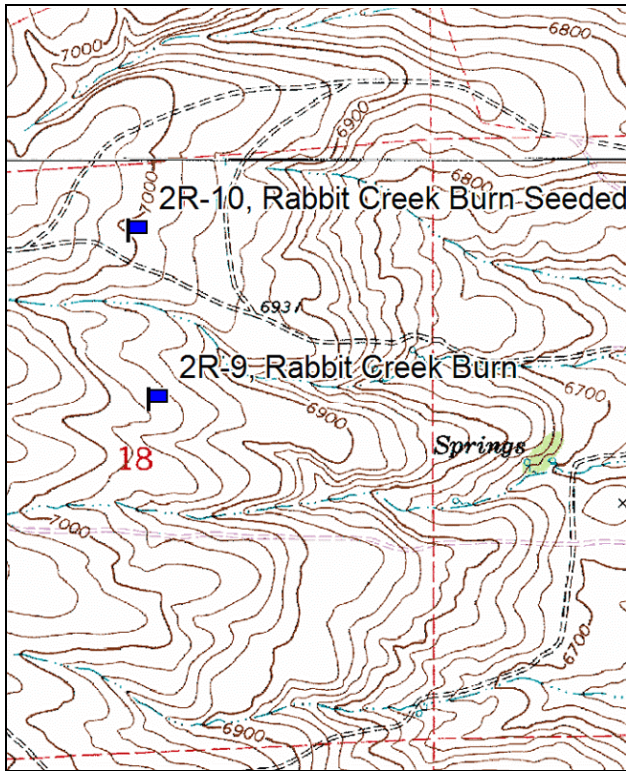
Vegetation type: Burn/Perennial Grass .

Compass bearing: frequency baseline 76 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Traveling on Highway 30, toward Bear Lake from Sage Creek Junction, turn right on a road that turns off the highway along with a runaway truck ramp. The road turns to the west of the ramp. Follow this road for 2.9 miles to a road that comes in on the left. Drive 1.8 miles to a gate. Continue 0.5 miles to a two-track road on the right. Turn onto this and follow it for 0.1 miles to a gate, continue 1.8 miles to another gate. Then travel 0.8 miles to the witness post on the left side of the road. The 0-foot post is 275 paces at 161°M from the witness post, and is marked with browse tag #33.



Map Name: Sage Creek

Diagrammatic Sketch

Township 13N , Range 7E , Section 18

GPS: NAD 83, UTM 12T 483726 E 4635213 N

## DISCUSSION

### Rabbit Creek Burn - Trend Study No. 2R-9

#### Study Information

This study was established on private land in 2004 to monitor the vegetation response to a naturally- caused fire which burned about 800 acres (324 ha) east of Bear Lake in the fall of 2003 [elevation: 7,000 feet (2,134 m), slope: 8%, aspect: east]. Since this study was not rehabilitated, the Rabbit Creek Burn Seeded study (2R-10) was established 0.3 miles to the north on an area that was drill seeded after the fire. The study is located in a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Data collected in Laketown, 7.1 miles (11.4 km) southwest of the study, indicated that annual precipitation was above normal in 2004 and 2005 and normal in 2006. Spring precipitation was above normal in 2005, 72% of normal in 2006, and 80% of normal in 2007 (Utah Climate Summaries 2007). The area is important habitat for antelope, wintering deer, and sage-grouse. About a dozen sage-grouse were seen west of the study in some unburned sagebrush. Cattle also graze the area. Pellet group transect data estimates were 1 cow day use/acre (2 cdu/ha) in 2004 and 20 cow days use/acre (48 cdu/ha) in 2007. Sage-grouse pellets were sampled in 1% of the quadrats in 2004. In 2007, 9 sage-grouse pellets/acre (21 pellets/ha) were sampled.

#### Soil

The soil is in the Kearsley series, which consists of moderately deep, well-drained, moderately permeable soils that formed in residuum and colluvium derived from sandstone. The soil is on upland and foothill slopes (USDA-NRCS 2007). The soil texture is silt loam and pH is neutral (6.8). Soil phosphorus is marginal at only 7 ppm, which may limit plant growth and development (Tiedemann and Lopez 2004). Relative bare ground cover decreased from 50% in 2004 to 30% in 2007. Relative vegetation cover increased from 21% to 38% and relative litter cover increased from 2% to 26%. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Wyoming big sagebrush was the dominant browse species prior to the burn. It provided important habitat for sage-grouse. Only a few remnant plants survived the fire and no plants were sampled in 2004. No preferred browse species were present after the fire. In 2007, 60 sagebrush seedlings/acre (148 seedlings/ha) were sampled.

Stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) is the dominant browse species. This species resprouts after fire. Rabbitbrush density was 10,060 plants/acre (24,849 plants/ha) in 2004, but decreased to 8,620 plants/acre (21,291 plants/ha) in 2007. It provided 5% canopy cover in 2004 and 9% in 2007. Other species found in 2004 include: Fremont's buckwheat (*Eriogonum corymbosum*), snowberry (*Symphoricarpos oreophilus*), and graystem horsebrush (*Tetradymia canescens*).

#### Herbaceous Understory

The herbaceous understory was diverse and abundant with 40 species sampled in 2004 and 37 in 2007. Six and nine perennial grass species were sampled in 2004 and 2007, respectively. Western wheatgrass (*Agropyron smithii*) was the most abundant species both years. It was sampled in 79% of the quadrats in 2004 and 85% in 2007. Western wheatgrass cover was 4% in 2004 and 10% in 2007. Mutton bluegrass (*Poa fendleriana*) and Sandberg bluegrass (*Poa secunda*) were both abundant. Bluebunch wheatgrass (*Agropyron spicatum*) also provided substantial cover in 2007. Perennial grass cover increased from 6% in 2004 to 17% in 2007. Bulbous bluegrass (*Poa bulbosa*) was sampled for the first time in 2007.

Cheatgrass was the only annual grass species sampled, and was only found in 1% and 7% of the quadrats in 2004 and 2007, respectively.

Forbs are very diverse. Perennial forbs provided 8% cover in 2004 and 13% in 2007. Annual forbs provided 1% cover in 2004 and 2% in 2007. False dandelion (*Agoseris glauca*), an astragalus (*Astragalus* sp.), thistle (*Cirsium* sp.), tansymustard (*Descurainia pinnata*), purple daisy fleabane (*Erigeron corymbosus*), longleaf phlox (*Phlox longifolia*), and clover (*Trifolium* sp.) provided 1% cover or more one or both years.

2007 Post-treatment Assessment

Following the fire, key browse cover remained very low. Sagebrush seedlings were sampled on the study for the first time in 2007. Stickyleaf low rabbitbrush remained the dominant browse species and increased in cover. Perennial grass cover increased substantially, and cheatgrass remained a minor component. In 2004, perennial forbs provided more cover than perennial grasses, but perennial grass cover was slightly higher in 2007. However, perennial forb cover increased substantially in 2007 as well. The 2004 Desirable Components Index (DCI) score was poor due to the lack of key browse cover and moderate perennial grass cover. The 2007 DCI score was fair due to the increase in perennial grass cover.

2004 winter range condition (DCI) - poor (22) Low potential scale

2007 winter range condition (DCI) - fair (40) Low potential scale

HERBACEOUS TRENDS --

Management unit 02R, Study no: 9

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron dasystachyum</i>	<sub>a</sub> 271	<sub>b</sub> 318	4.30	10.30
G	<i>Agropyron spicatum</i>	<sub>a</sub> 1	<sub>b</sub> 36	.03	1.15
G	<i>Bromus tectorum</i> (a)	<sub>a</sub> 1	<sub>b</sub> 16	.00	.03
G	<i>Dactylis glomerata</i>	-	2	-	.03
G	<i>Koeleria cristata</i>	-	33	-	.71
G	<i>Poa bulbosa</i>	-	3	-	.03
G	<i>Poa fendleriana</i>	<sub>a</sub> 64	<sub>b</sub> 87	1.07	3.34
G	<i>Poa secunda</i>	<sub>a</sub> 60	<sub>b</sub> 88	.40	1.63
G	<i>Sitanion hystrix</i>	<sub>a</sub> 6	<sub>a</sub> 2	.04	.03
G	<i>Stipa lettermani</i>	<sub>a</sub> 7	<sub>a</sub> 13	.01	.10
Total for Annual Grasses		1	16	0.00	0.03
Total for Perennial Grasses		409	582	5.86	17.35
Total for Grasses		410	598	5.86	17.38
F	<i>Agoseris glauca</i>	<sub>a</sub> 174	<sub>a</sub> 194	1.14	1.82
F	<i>Alyssum alyssoides</i> (a)	3	-	.00	-
F	<i>Allium</i> sp.	8	-	.01	-
F	<i>Antennaria rosea</i>	3	-	.00	-
F	<i>Astragalus cibarius</i>	<sub>a</sub> 2	<sub>b</sub> 12	.03	.09
F	<i>Astragalus convallarius</i>	<sub>a</sub> 24	<sub>a</sub> 26	.15	.26
F	<i>Astragalus</i> sp.	<sub>a</sub> 123	<sub>a</sub> 132	1.93	1.77



Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Calochortus nuttallii	5	-	.01	-
F	Chenopodium album (a)	2	-	.01	-
F	Chenopodium sp. (a)	3	-	.00	-
F	Chenopodium fremontii (a)	1	-	.00	-
F	Cirsium sp.	<sub>a</sub> 52	<sub>a</sub> 28	1.65	.93
F	Collomia linearis (a)	<sub>a</sub> 13	<sub>b</sub> 68	.03	.33
F	Collinsia parviflora (a)	<sub>a</sub> 8	<sub>b</sub> 64	.01	.22
F	Cordylanthus sp. (a)	6	-	.01	-
F	Crepis acuminata	<sub>a</sub> 10	<sub>a</sub> 3	.16	.30
F	Cryptantha sp.	-	4	-	.09
F	Delphinium nuttallianum	-	6	-	.04
F	Descurainia pinnata (a)	<sub>a</sub> 26	<sub>b</sub> 209	.48	1.27
F	Erigeron corymbosus	<sub>a</sub> 37	<sub>b</sub> 60	.66	1.57
F	Gayophytum ramosissimum(a)	<sub>a</sub> 3	<sub>a</sub> 12	.04	.10
F	Lactuca serriola	-	3	-	.00
F	Lomatium sp.	<sub>a</sub> 13	<sub>a</sub> 19	.25	.35
F	Lupinus argenteus	<sub>a</sub> 4	<sub>a</sub> 5	.03	.04
F	Machaeranthera canescens	-	1	-	.00
F	Microsteris gracilis (a)	<sub>a</sub> 2	<sub>b</sub> 25	.00	.10
F	Penstemon radicosus	<sub>a</sub> 24	<sub>a</sub> 15	.10	.50
F	Phlox hoodii	<sub>a</sub> 48	<sub>b</sub> 84	.31	1.39
F	Phlox longifolia	<sub>a</sub> 72	<sub>b</sub> 171	.28	2.28
F	Polygonum douglasii (a)	<sub>a</sub> 2	<sub>a</sub> 4	.01	.01
F	Schoenocrambe linifolia	<sub>a</sub> 36	<sub>a</sub> 50	.30	.24
F	Senecio integerrimus	<sub>b</sub> 15	<sub>a</sub> 1	.11	.03
F	Tragopogon dubius	<sub>a</sub> 9	<sub>a</sub> 3	.10	.00
F	Trifolium sp.	<sub>b</sub> 146	<sub>a</sub> 97	1.10	1.27
F	Veronica biloba (a)	<sub>a</sub> 2	<sub>b</sub> 13	.01	.03
F	Viola sp.	5	-	.01	-
F	Zigadenus paniculatus	3	-	.00	-
Total for Annual Forbs		71	395	0.63	2.08
Total for Perennial Forbs		813	914	8.40	13.05
Total for Forbs		884	1309	9.03	15.13

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 02R, Study no: 9

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Amelanchier utahensis	0	0	-	-
B	Artemisia tridentata wyomingensis	0	0	-	.00
B	Chrysothamnus viscidiflorus viscidiflorus	88	89	3.92	6.07
B	Eriogonum corymbosum	1	6	-	.12
B	Symphoricarpos oreophilus	5	6	.15	.53
B	Tetradymia canescens	43	39	.66	1.43
Total for Browse		137	140	4.73	8.17

CANOPY COVER, LINE INTERCEPT --

Management unit 02R, Study no: 9

Species	Percent Cover	
	'04	'07
Chrysothamnus viscidiflorus viscidiflorus	4.50	9.26
Symphoricarpos oreophilus	.48	.91
Tetradymia canescens	.55	2.01

BASIC COVER --

Management unit 02R, Study no: 9

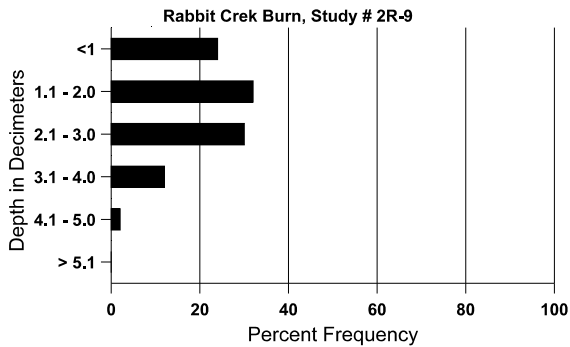
Cover Type	Average Cover %	
	'04	'07
Vegetation	22.79	43.17
Rock	.59	.85
Pavement	28.48	5.43
Litter	1.61	28.72
Cryptogams	0	.00
Bare Ground	53.30	34.23

SOIL ANALYSIS DATA --

Management unit 2R, Study no: 9, Study Name: Rabbit Creek Burn

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
14.0	59.8 (17.2)	6.8	34.6	47.9	17.5	3.2	7.2	336.0	0.8

## Stoniness Index



### PELLET GROUP DATA --

Management unit 02R, Study no: 9

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	1	13	-	-
Grouse	1	-	-	9 pellets/acre
Deer	-	1	-	-
Cattle	-	4	1 (2)	20 (48)

### BROWSE CHARACTERISTICS --

Management unit 02R, Study no: 9

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	22/25
<b>Artemisia tridentata wyomingensis</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	60	-	-	-	-	0	0	-	-	0	-/-
<b>Chrysothamnus viscidiflorus viscidiflorus</b>												
04	10060	200	5960	4100	-	-	0	0	0	-	0	8/10
07	8620	20	260	7560	800	-	.23	0	9	1	6	10/15
<b>Eriogonum corymbosum</b>												
04	20	-	20	-	-	-	0	0	-	-	0	5/7
07	120	20	-	120	-	-	33	0	-	-	0	6/6

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Symphoricarpos oreophilus</i>												
04	<b>180</b>	-	160	20	-	-	0	0	-	-	0	14/19
07	<b>180</b>	-	20	160	-	-	0	0	-	-	0	16/29
<i>Tetradymia canescens</i>												
04	<b>1160</b>	380	920	240	-	-	0	0	0	-	0	7/9
07	<b>1220</b>	-	140	1000	80	-	10	0	7	3	7	10/18

Trend Study 2R-10-07

Study site name: Rabbit Creek Burn Seeded .

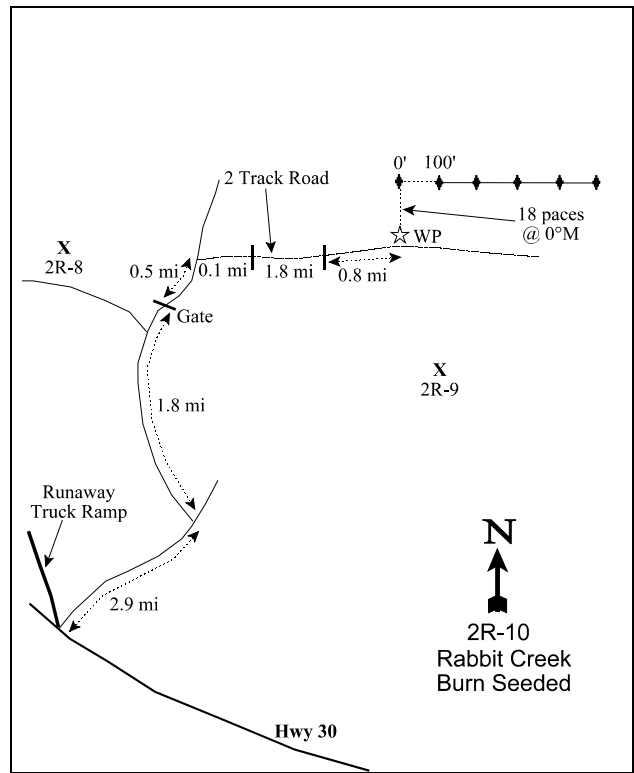
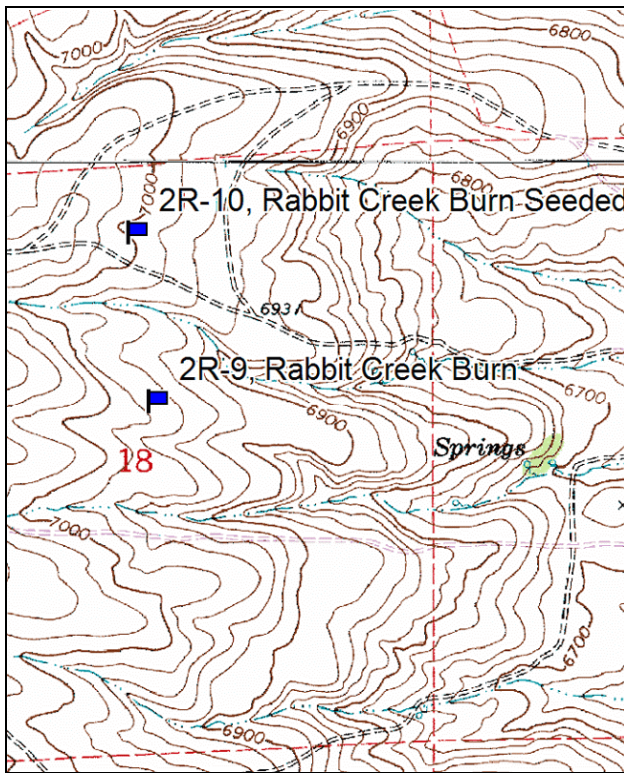
Vegetation type: Burn/Perennial Grass .

Compass bearing: frequency baseline 90 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Traveling on Highway 30, toward Bear Lake from Sage Creek Junction, turn right on a road that turns off the highway along with a runaway truck ramp. The road turns to the west of the ramp. Follow this road for 2.9 miles to a road that comes in on the left. Turn here and drive 1.8 mi to a gate. Continue 0.5 miles to a two-track road on the right. Turn onto this and follow it for 0.1 miles to a gate, continue 1.8 miles to another gate. Then travel 0.8 miles to the witness post on the left side of the road. The 0-foot post is 18 paces at 0°M from the witness post, and is marked with browse tag #34.



Map Name: Sage Creek

Diagrammatic Sketch

Township 13N , Range 7E , Section 18

GPS: NAD 83, UTM 12T 483672 E 4635677 N

## DISCUSSION

### Rabbit Creek Burn Seeded - Trend Study No. 2R-10

#### Study Information

This study was established on private land in 2004 to monitor the vegetation response to a naturally- caused fire which burned about 800 acres (324 ha) east of Bear Lake in the fall of 2003 [elevation: 7,000 feet (2,134 m), slope: 5%, aspect: east]. Approximately 500 acres (202 ha) of private land and 300 acres (121 ha) of BLM land were burned in the fire. The study is located in an area that was drill seeded in 2003. The private landowner payed for grass seed, labor, and equipment while the DWR supplied the forb and browse seed. The study is located in a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Data collected in Laketown, 7.3 miles (11.7 km) southwest of the study, indicated that annual precipitation was above normal in 2004 and 2005 and normal in 2006. Spring precipitation was above normal in 2005, 72% of normal in 2006, and 80% of normal in 2007 (Utah Climate Summaries 2007). The landowner agreed to rest the pasture for two growing seasons following the seeding. A single cow was seen on the study in June 2004, and in 2007, cattle use was heavy. A pellet group transect along the baseline estimated 1 cow day use/acre (4 cdu/ha) in 2004 and 49 cow days use/acre (120 cdu/ha) in 2007. Deer use was estimated at 1 day use/acre (2 ddu/ha) in 2007. A dozen sage-grouse were seen just east of the study in some unburned sagebrush in 2004, and sage-grouse pellet estimates were 9 pellets/acre (21 pellets/ha) in 2007.

#### Soil

The soil is the Thatcher series, which consists of very deep, well-drained soils that are moderately slowly permeable. They are formed in alluvium, colluvium, and lake sediments from sandstone and conglomerate and are found on foothill slopes, hills terraces, and alluvial fans (USDA-NRCS 2007). The soil texture is clay loam with a neutral pH (6.6). Relative bare ground cover decreased from 60% in 2004 to 31% in 2007. Relative vegetation cover increased from 30% to 38% and relative litter cover increased from 2% to 27%. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) was the dominant browse species prior to the burn and provided important habitat for sage-grouse. Only a few remnant plants survived the fire. In 2004, 120 seedlings/acre (296 seedlings/ha) and 20 young sagebrush plants/acre (49 plants/ha) were sampled. In 2007, sagebrush density had increased to 180 seedlings/acre (445 seedlings/ha), 220 young plants/acre (543 plants/ha), and 140 mature plants/acre (346 plants/ha). No other preferred browse species were sampled.

Stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) was the most abundant species both sample years. This species resprouts after fire. Rabbitbrush density was 6,700 plants/acre (16,549 plants/ha) in 2004 and 6,000 plants/acre (14,820 plants/ha) in 2007. It provided 2% and 5% canopy cover in 2004 and 2007, respectively. Other species sampled include: Fremont's buckwheat (*Eriogonum corymbosum*), snowberry (*Symphoricarpos oreophilus*), and graystem horsebrush (*Tetradymia canescens*). Fourwing saltbush (*Atriplex canescens*) and bitterbrush (*Purshia tridentata*) were included in the seed mix, but were not sampled.

#### Herbaceous Understory

Species diversity is high at this study. Twelve grass and 35 forb species were sampled in 2004, and 15 grasses and 26 forbs were sampled in 2007. Perennial grasses provided 10% and 17% cover in 2004 and 2007, respectively. Thickspike wheatgrass (*Agropyron dasystachyum*) was the dominant grass. It provided 4% cover in 2004 and 10% in 2007. The seed mix included four grass and two forb species. During the first growing season in 2004, orchardgrass (*Dactylis glomerata*) was the most abundant seeded species. It was sampled in 48% of the quadrats with about 2% cover. In 2007, it had decreased to 12% quadrat frequency and 1% cover. Intermediate wheatgrass (*Agropyron intermedium*) was the only other seeded grass sampled in

2004, but Russian wildrye (*Elymus junceus*) and Great Basin wildrye (*Elymus cinereus*) were both sampled in 2007. Russian wildrye provided 2% cover in 2007. Cheatgrass was sampled, but was not abundant during either sampling. Quadrat frequency was only 8% in 2004 and increased to 16% in 2007.

Perennial forbs provided 12% cover both years sampled, and annual forb cover decreased from nearly 5% in 2004 to 3% in 2007. The two seeded forbs, small burnet (*Sanguisorba minor*) and alfalfa (*Medicago sativa*), were sampled both years. Small burnet was seeded at a higher rate than alfalfa and was found with greater quadrat frequency. It was sampled in 47% of the quadrats in 2004 and 7% in 2007. Alfalfa quadrat frequency was 21% in 2004 and 7% in 2007. Small burnet provided 1.5% cover in 2004, but much less than 1% in 2007. Several other native perennial forbs were sampled with 1% or greater cover.

2007 Post-treatment Assessment

Sagebrush slowly increased in density following the fire, from 20 plants/acre (49 plants/ha) in 2004 to 360 plants/acre (890 plants/ha) in 2007. Stickyleaf low rabbitbrush density remained relatively stable, although its canopy cover increased. Perennial grass cover increased substantially from 10% in 2004 to 17% in 2007. Annual grass cover remained low, although Japanese brome (*Bromus japonicus*) was sampled for the first time in 2007. Two of the four seeded grass species decreased in cover and nested frequency, but the other two were sampled for the first time in 2007. The two seeded forb species both significantly decreased in nested frequency and substantially decreased in cover. Perennial forb cover remained 12% and annual forb cover decreased from nearly 5% to 3%. The 2004 Desirable Components Index (DCI) score was fair due to low key browse cover, high perennial grass and forb cover, and low annual grass cover. The 2007 DCI score remained fair due to maintenance of high perennial grass and forb cover and low annual grass cover.

2004 winter range condition (DCI) - fair (29) Low potential scale

2007 winter range condition (DCI) - fair (40) Low potential scale

<u>Rabbit Creek Seed Mix</u>	<u>Bulk lbs/acre</u>
Alfalfa, 'Ranger'	1.0
Small Burnet, VNS	2.4
Fourwing Saltbush	0.5
Bitterbrush	0.2
Orchardgrass	1.0
Great Basin Wildrye	1.0
Russian Wildrye	2.0
Intermediate Wheatgrass	1.0
<b>Total Bulk lbs/acre</b>	<b>9.1</b>

HERBACEOUS TRENDS --

Management unit 02R, Study no: 10

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	a5	a2	.18	.15
G	Agropyron dasystachyum	a228	b337	4.40	10.18
G	Agropyron intermedium	b30	a8	.63	.04
G	Agropyron spicatum	-	8	-	.33
G	Bromus japonicus (a)	-	9	-	.01

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
		G	Bromus tectorum (a)	<sub>a</sub> 14	<sub>a</sub> 39
G	Dactylis glomerata	<sub>b</sub> 116	<sub>a</sub> 29	2.22	1.27
G	Elymus cinereus	-	5	-	.03
G	Elymus junceus	-	84	-	2.28
G	Koeleria cristata	-	4	-	.15
G	Melica bulbosa	-	-	.00	-
G	Oryzopsis hymenoides	<sub>a</sub> 3	<sub>a</sub> 1	.00	.00
G	Poa bulbosa	-	-	-	.00
G	Poa fendleriana	<sub>a</sub> 23	<sub>a</sub> 15	.66	.54
G	Poa secunda	<sub>a</sub> 41	<sub>b</sub> 116	.98	1.95
G	Sitanion hystrix	<sub>a</sub> 1	<sub>a</sub> 1	.00	.03
G	Stipa columbiana	15	-	.39	-
G	Stipa comata	4	-	.03	-
G	Stipa lettermani	<sub>a</sub> 16	<sub>a</sub> 16	.12	.25
Total for Annual Grasses		14	48	0.24	0.14
Total for Perennial Grasses		482	626	9.65	17.25
Total for Grasses		496	674	9.89	17.39
F	Achillea millefolium	2	-	.15	-
F	Agoseris glauca	<sub>a</sub> 124	<sub>a</sub> 127	1.00	1.33
F	Alyssum alyssoides (a)	-	2	-	.00
F	Allium sp.	-	-	.00	-
F	Astragalus cibarius	15	-	.97	-
F	Astragalus convallarius	<sub>a</sub> 6	<sub>a</sub> 6	.02	.04
F	Astragalus sp.	<sub>b</sub> 104	<sub>a</sub> 69	1.06	.84
F	Astragalus utahensis	-	3	-	.01
F	Calochortus nuttallii	3	-	.01	-
F	Chenopodium album (a)	18	-	.10	-
F	Chenopodium fremontii (a)	2	-	.03	-
F	Chenopodium leptophyllum(a)	1	-	.00	-
F	Cirsium sp.	<sub>a</sub> 12	<sub>a</sub> 8	.15	.20
F	Collomia linearis (a)	-	23	-	.04
F	Collinsia parviflora (a)	<sub>a</sub> 52	<sub>a</sub> 64	.39	.16
F	Cordylanthus sp. (a)	3	-	.00	-
F	Crepis acuminata	14	-	.04	-
F	Cryptantha sp.	5	-	.01	-
F	Cymopterus sp.	-	4	-	.00



Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Descurainia pinnata</i> (a)	<sub>a</sub> 129	<sub>b</sub> 277	3.69	2.46
F	<i>Draba</i> sp. (a)	1	-	.03	-
F	<i>Erigeron corymbosus</i>	<sub>a</sub> 82	<sub>a</sub> 75	2.32	2.27
F	<i>Erigeron filifolius</i>	8	-	.15	-
F	<i>Eriogonum umbellatum</i>	1	-	.03	-
F	<i>Gayophytum ramosissimum</i> (a)	4	-	.03	-
F	<i>Lactuca serriola</i>	-	-	.00	-
F	<i>Linum lewisii</i>	<sub>a</sub> 1	<sub>a</sub> 9	.00	.05
F	<i>Lupinus argenteus</i>	-	-	-	.00
F	<i>Medicago sativa</i>	<sub>b</sub> 50	<sub>a</sub> 18	.38	.10
F	<i>Microsteris gracilis</i> (a)	<sub>a</sub> 2	<sub>a</sub> 14	.01	.05
F	<i>Penstemon radicosus</i>	<sub>a</sub> 1	<sub>a</sub> 2	.00	.00
F	<i>Phlox hoodii</i>	<sub>a</sub> 24	<sub>a</sub> 20	.14	.40
F	<i>Phlox longifolia</i>	<sub>a</sub> 73	<sub>b</sub> 207	.26	2.82
F	<i>Polygonum douglasii</i> (a)	<sub>b</sub> 25	<sub>a</sub> 5	.18	.00
F	<i>Ranunculus testiculatus</i> (a)	<sub>a</sub> 7	<sub>b</sub> 36	.03	.16
F	<i>Sanguisorba minor</i>	<sub>b</sub> 110	<sub>a</sub> 12	1.56	.13
F	<i>Schoenrambe linifolia</i>	<sub>a</sub> 14	<sub>a</sub> 21	.55	.19
F	<i>Senecio integerrimus</i>	<sub>b</sub> 20	<sub>a</sub> 2	.81	.01
F	<i>Sphaeralcea grossulariifolia</i>	<sub>a</sub> 3	<sub>a</sub> 1	.03	.03
F	<i>Taraxacum officinale</i>	3	-	.06	-
F	<i>Tragopogon dubius</i>	-	-	.00	-
F	<i>Trifolium</i> sp.	<sub>a</sub> 198	<sub>a</sub> 198	1.79	3.35
F	<i>Veronica biloba</i> (a)	-	23	-	.08
F	<i>Viola</i> sp.	26	-	.20	-
F	<i>Zigadenus paniculatus</i>	-	1	-	.03
<b>Total for Annual Forbs</b>		<b>244</b>	<b>444</b>	<b>4.51</b>	<b>2.98</b>
<b>Total for Perennial Forbs</b>		<b>899</b>	<b>783</b>	<b>11.78</b>	<b>11.86</b>
<b>Total for Forbs</b>		<b>1143</b>	<b>1227</b>	<b>16.30</b>	<b>14.85</b>

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 02R, Study no: 10

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	1	16	.01	.10
B	Chrysothamnus viscidiflorus	0	0	-	.03
B	Chrysothamnus viscidiflorus viscidiflorus	80	87	2.17	5.21
B	Eriogonum corymbosum	2	6	.03	.63
B	Symphoricarpos oreophilus	1	1	-	.03
B	Tetradymia canescens	26	36	.27	1.17
Total for Browse		110	146	2.50	7.17

CANOPY COVER, LINE INTERCEPT --

Management unit 02R, Study no: 10

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	-	.10
Chrysothamnus viscidiflorus viscidiflorus	2.46	5.18
Eriogonum corymbosum	.11	.21
Symphoricarpos oreophilus	.31	.63
Tetradymia canescens	.25	1.61

BASIC COVER --

Management unit 02R, Study no: 10

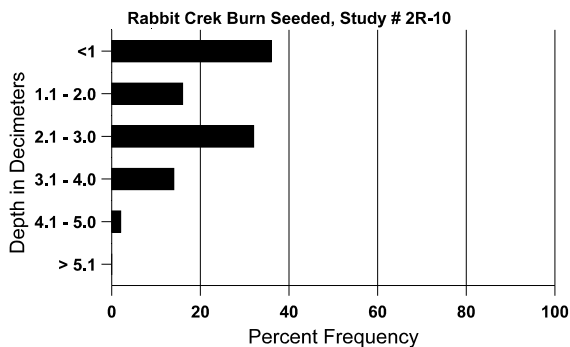
Cover Type	Average Cover %	
	'04	'07
Vegetation	32.12	43.76
Rock	.53	.26
Pavement	9.01	3.31
Litter	1.81	31.26
Bare Ground	65.31	35.20

SOIL ANALYSIS DATA --

Management unit 2R, Study no: 10, Study Name: Rabbit Creek Burn Seeded

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
13.1	63.8 (15.0)	6.6	32.6	40.1	27.3	3.9	19.1	195.2	0.9

Stoniness Index



PELLET GROUP DATA --

Management unit 02R, Study no: 10

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	-	15	-	-
Grouse	1	2	-	9 pellets/acre
Deer	-	-	-	1 (2)
Cattle	-	5	1 (4)	49 (120)

BROWSE CHARACTERISTICS --

Management unit 02R, Study no: 10

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia tridentata wyomingensis</b>												
04	20	120	20	-	-	-	0	0	-	-	0	-/-
07	360	180	220	140	-	-	17	6	-	-	0	9/11
<b>Chrysothamnus viscidiflorus viscidiflorus</b>												
04	6700	720	3560	3140	-	-	0	0	0	-	0	8/9
07	6000	-	140	4960	900	-	0	3	15	.66	9	10/15
<b>Eriogonum corymbosum</b>												
04	60	-	60	-	-	-	0	0	-	-	0	6/6
07	200	-	-	200	-	-	0	0	-	-	0	9/11

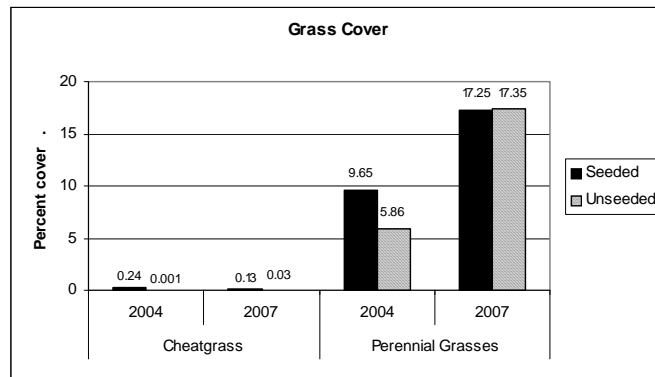
		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Symphoricarpos oreophilus</i>												
04	<b>40</b>	-	40	-	-	-	0	0	-	-	0	24/41
07	<b>40</b>	-	-	40	-	-	0	0	-	-	0	23/45
<i>Tetradymia canescens</i>												
04	<b>900</b>	60	680	220	-	-	0	0	-	-	0	8/10
07	<b>1000</b>	-	120	880	-	-	6	0	-	-	0	11/21

Summary and Comparison of Rabbit Creek Burn (2R-9) and Rabbit Creek Burn Seeded (2R-10)

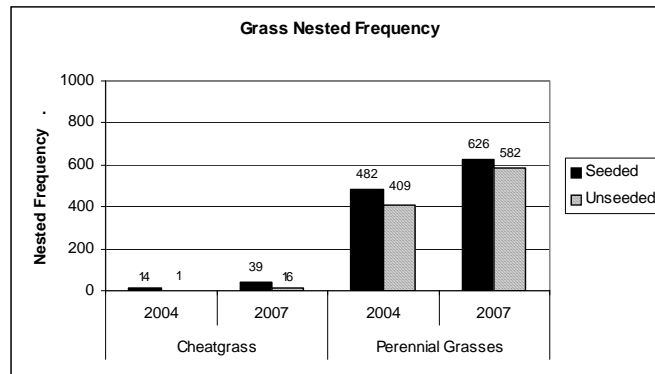
These studies were established in 2004 to monitor the effectiveness of a seeding treatment on an 800-acre (324-ha) fire east of Bear Lake. Two studies were established, one seeded and the other not seeded. They were similar in species composition, slope, and aspect. The largest difference between the two studies, other than the treatment, is that the seeded study (2R-10) is located directly next to a dirt road and the other study is located approximately one-quarter mile south of the road.

Browse appeared to have been greatly reduced due to the fire. On both studies, stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) was the dominant browse species in both 2004 and 2007. It provided 5% canopy cover in 2004 and 9% in 2007 on the unseeded study, but only 2% in 2004 and 5% in 2007 on the seeded study. Very few sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) plants were sampled after the fire on both studies. The sagebrush density on the seeded study was slightly higher than on the unseeded study in 2004 and 2007.

Few differences were sampled between the two studies in grass cover and nested frequency (Figures 1 and 2). Perennial grass cover was higher on the seeded study than the unseeded in 2004, but were the same by 2007 (Figure 1). Eleven perennial grass species were sampled on the seeded study in 2004 and 13 in 2007, while only seven were sampled on the unseeded study in 2004 and 10 in 2007. Four seeded species were sampled on the seeded study. At both studies, thickspike wheatgrass (*Agropyron dasystachyum*) provided the majority of the grass cover; 4% and 10% cover in 2004 and 2007, respectively.



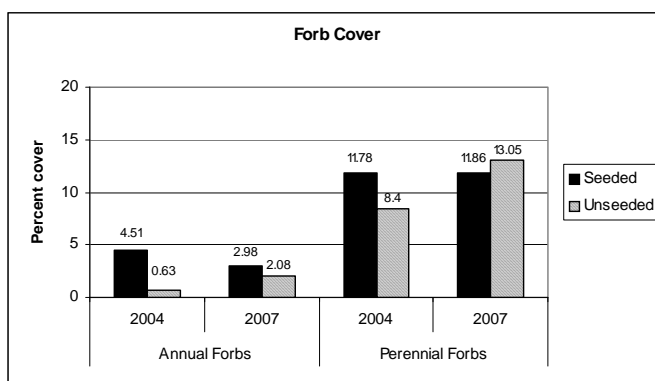
**Figure 1.** Comparisons in the grass cover of the seeded (2R-10) and unseeded (2R-9) studies for cheatgrass and perennial grasses in 2004 and 2007.



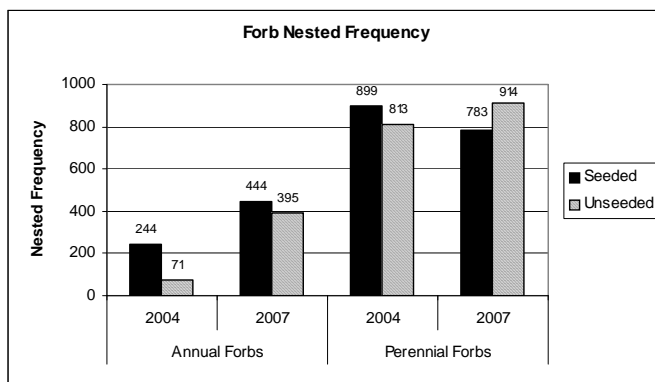
**Figure 2.** Comparisons in the grass nested frequency of the seeded (2R-10) and unseeded (2R-9) studies for cheatgrass and perennial grasses in 2004 and 2007.

Cheatgrass cover and nested frequency were low at both studies both years (Figures 1 and 2). It appears as though the perennial grass cover is preventing the spread and dominance of cheatgrass, as described by Monsen (1994).

Annual forb cover was higher at the seeded study than the unseeded study in 2004 and 2007 (Figure 3). Perennial forb cover was higher on the seeded study in 2004, but in 2007 it was slightly higher on the unseeded study (Figure 3). Perennial forb nested frequency was similar between the two studies both years and was similar for annual forbs in 2007 (Figure 4). In 2004, as with annual forb cover, annual forb nested frequency was higher on the seeded study than the unseeded study (Figure 4). There was also an increase in perennial forb cover and nested frequency from 2004 to 2007 on the unseeded study, but no change in perennial forb cover and a slight decrease in nested frequency on the seeded study (Figures 3 and 4).



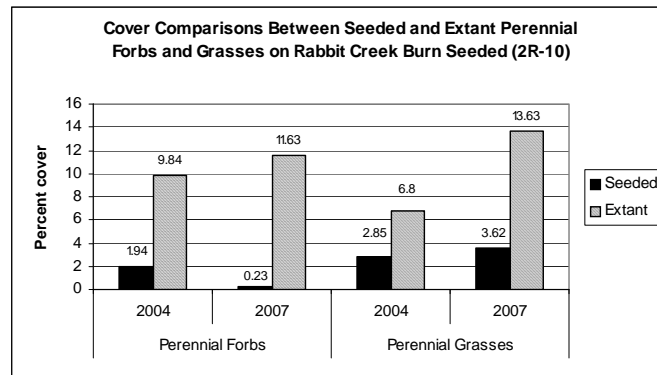
**Figure 3.** Comparisons in the forb cover of the seeded (2R-10) and unseeded (2R-9) studies for annual and perennial forb species in 2004 and 2007.



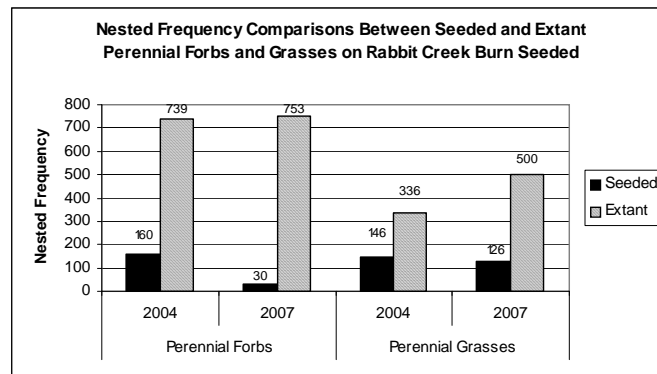
**Figure 4.** Comparisons in the forb nested frequency of the seeded (2R-10) and unseeded (2R-9) studies for annual and perennial forb species in 2004 and 2007.

On the seeded study, the majority of grass and forb cover and nested frequency were provided by extant species that had survived the fire (Figures 5 and 6). In 2004, the combined grass and forb cover of seeded species was nearly 5%, but had decreased slightly in 2007 to 4%. This was due to a decrease in the cover of seeded forb species (Figure 5).

In 2004, cattle use was 1 cow day use/acre (3 cdu/ha) at both studies, which indicates that the private landowner had been resting the property. In 2007, cattle use estimates were 20 cow days use/acre (48 cdu/ha) at the unseeded study and 49 cow days use/acre (120 cdu/ha) at the seeded study. It was also noted that cattle grazing on the seeded study appeared much heavier than the unseeded study. The likely difference in cattle use in 2007 between these studies is that the seeded study is adjacent to a dirt road, so the cattle are more likely to spend time there if salt blocks or watering troughs are present along the road. There was only 1 deer day use/acre (2 ddu/ha) estimated at the seeded study in 2007, no other deer sign was sampled all other years at either study. Sage-grouse estimates for both studies in 2007 were 9 pellets/acre (22 pellets/ha). No sage-grouse pellets were sampled in the pellet group transect in 2004, but in one quadrat at each study. Other than cattle use, there is no apparent difference in animal use between these two studies.



**Figure 5.** Comparison of cover between seeded and extant perennial forb and perennial grass species on the seeded study, Rabbit Creek Burn Seeded (2R-10), in 2004 and 2007.



**Figure 6.** Comparison of nested frequency between seeded and extant perennial forb and perennial grass species on the seeded study, Rabbit Creek Burn Seeded (2R-10), in 2004 and 2007.

Trend Study 6R-1-07

Study site name: Cache Cave 1.

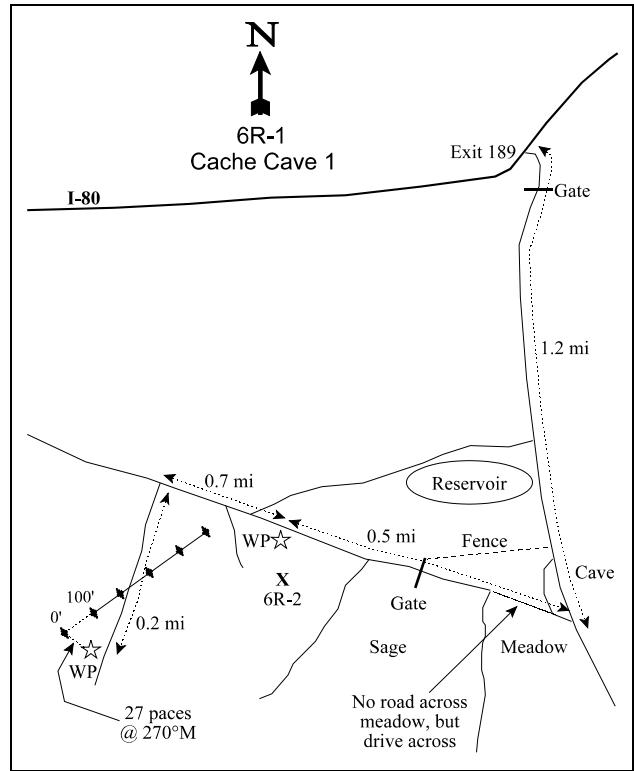
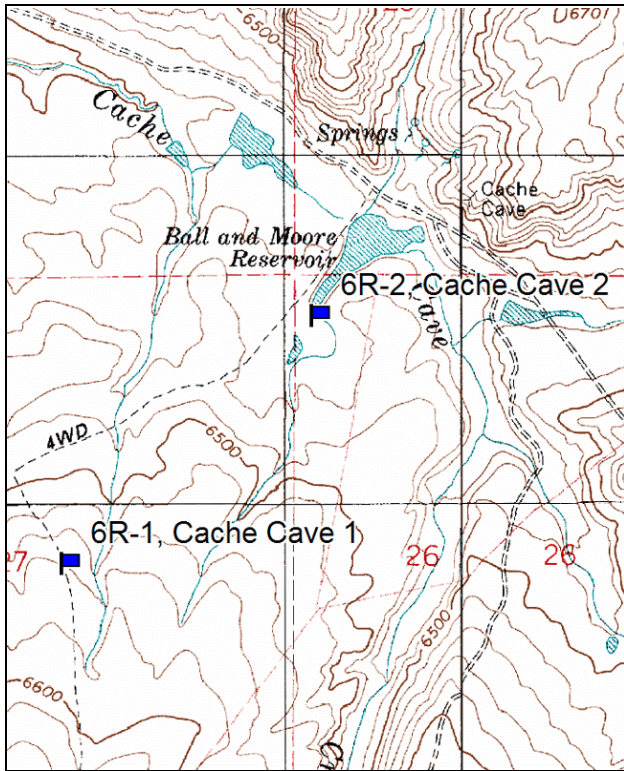
Vegetation type: Basin Big Sagebrush.

Compass bearing: frequency baseline 343 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From I-80 take exit 189. Travel 1.2 miles south to a road that comes in from the right. Turn here and travel 0.5 miles northwest through a meadow to a road. There is a witness post on the left side of the road. Continue 0.7 miles to a road on the left. Take this road and travel 0.2 miles to a witness post on the right side of the road. The 0-foot stake is 27 paces from the witness post at 270°M, and is marked with browse tag #32.



Map Name: Shearing Corral

Diagrammatic Sketch

Township 5N, Range 7E, Section 27

GPS: NAD 83, UTM 12T 488295 E 4553998 N



## DISCUSSION

### Cache Cave 1 - Trend Study No. 6R-1

#### Study Information

This study was established just southeast of Interstate 80 between Echo and Evanston in a privately-owned mature basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) community [elevation: 6,750 feet (2,057 m), slope: 5%, aspect: north]. It was established to monitor the effects of a 500-acre (202-ha) double drum aerator and seeding treatment that took place in fall 2004. The objectives of the treatment were to reduce sagebrush canopy and to enhance the herbaceous understory. Pre-treatment baseline data were collected in summer 2004 and post-treatment data were collected in summer 2007. Another study, Cache Cave 2 (6R-2), was established 0.7 miles (1.1 km) to the northeast to monitor the same treatment in two locations, but not as comparisons of one another. The study is located within a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Data collected in Coalville, 20.3 miles (32.7 km) southwest of the study, indicated that annual precipitation was above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005 and 2006 and 50% of normal in 2007 (Utah Climate Summaries 2007). Sheep ranching is the primary use of the land. Deer and elk also use the area. Sheep pellet group data estimates were 26 days use/acre (64 sdu/ha) in 2004 and 39 days use/acre (96 sdu/ha) in 2007. A single cow day use/acre (2 cdu/ha) was estimated for 2004. Deer pellet group data estimates were 7 days use/acre (18 ddu/ha) in 2004 and 3 days use/acre (7 ddu/ha) in 2007. Elk use was estimated at 3 days use/acre (7 edu/ha) in 2004 and 1 day use/acre (2 edu/ha) in 2007.

#### Soil

The soil is in the Richsum-Heiners complex, which consists of deep and very deep, well-drained, moderately permeable soils on high tablelands, low mountains, and valley sides. They are formed in residuum, slope alluvium, and valley alluvium from shale, sandstone, and conglomerate (USDA-NRCS 2007). The soil profile is very rocky. The texture is loam and the pH is slightly acidic (6.5). Phosphorus and potassium levels were good for wildland soils. The erosion condition was classified as stable in 2004 and 2007. Protective ground cover was abundant before and after the treatment. Relative bare ground cover was 19% in 2004 and 16% in 2007. Combined relative vegetation and litter cover was 67% in 2004 and 78% in 2007.

#### Browse

Basin big sagebrush was the dominant species in 2004. The aerator treatment greatly decreased the sagebrush cover from 23% in 2004 to 6% in 2007. Sagebrush density only decreased from 4,600 plants/acre (11,362 plants/ha) in 2004 to 4,360 plants/acre (10,769 plants/ha) in 2007. Mature plants decreased from 59% of the population in 2004 to 18% in 2007, but young plants increased from 3% of the population in 2004 to 56% in 2007. Seedlings increased from 1,120 plants/acre (2,766 plants/ha) in 2004 to 2,900 plants/acre (7,163 plants/ha) in 2007. Decadence decreased from 38% in 2004 to 26% in 2007. Plants classified as dying decreased from 18% of the population in 2004 to 7% in 2007. Use remained mostly light. Average height decreased from 44 inches (112 cm) in 2004 to 29 inches (74 cm) in 2007.

Stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) was the only other abundant browse species. Rabbitbrush density was 9,220 plants/acre (22,773 plants/ha) in 2004, but decreased slightly to 8,660 plants/acre (21,390 plants/ha) in 2007. Rabbitbrush canopy cover remained 7%. Fourwing saltbush (*Atriplex canescens*) was seeded on the study, but was not sampled in 2007.

#### Herbaceous Understory

The herbaceous understory is diverse and abundant. Nine grass or grass-like species were sampled in 2004 and 11 in 2007. Perennial grass cover increased from 5% in 2004 to 20% in 2007. Western wheatgrass was the most abundant species. It was sampled in 73% of the quadrats in 2004 and 84% in 2007. It provided nearly 3% cover in 2004 and 10% in 2007. This rhizomatous species increased in abundance and cover after the treatment with the reduced competition from sagebrush. Sandberg bluegrass (*Poa secunda*) and Letterman

needlegrass (*Stipa lettermani*) also increased in cover after the treatment in 2007. Orchardgrass (*Dactylis glomerata*), a seeded species, was sampled for the first time in 2007 at 1% cover. Cheatgrass (*Bromus tectorum*) was sampled in 22% and 26% of the quadrats in 2004 and 2007, respectively. Cheatgrass cover was less than 1% in 2004, but increased to 3% in 2007. The abundant perennial species appear to be outcompeting the cheatgrass despite the disturbance.

Forbs are also diverse, but annuals dominate. Perennial forbs provided 1% cover in 2004 and nearly 3% in 2007, but annual forbs provided 4% cover in 2004 and 8% cover in 2007. Very little forb forage for wildlife or livestock was sampled on the study in 2004, and it increased slightly due to the aerator treatment and seeding. Small burnet (*Sanguisorba minor*), sainfoin (*Onobrychis viciaefolia*), and alfalfa (*Medicago sativa*) were sampled in 2007 at a combined cover of less than 1%. Pale alyssum (*Alyssum alyssoides*) increased from 1% cover in 2004 to 7% in 2007. The noxious weed musk thistle (*Carduus nutans*) was sampled in a single quadrat in 2007.

Of the four bunchgrass and four forb species seeded during the treatment, only orchardgrass, bluebunch wheatgrass (*Agropyron spicatum*), sainfoin, alfalfa, and small burnet were sampled in 2007. With the exception of orchardgrass, the seeded species provided very little cover on the study.

2007 Post-treatment Assessment

The study was very successful at decreasing basin big sagebrush cover. However, rather than reduce the sagebrush over the long-term, the treatment invigorated the sagebrush population. The treatment enhanced the perennial grass cover from 5% to 20%. Cheatgrass cover also increased, but its spread appeared to be slowed by the perennial grass component. Only two seeded grasses were sampled in 2007, however, orchardgrass provided 1% cover. The aerator treatment also appeared to enhance the forb component, increasing cover from 5% to 11%. Most of the cover was provided by weedy annuals, but some of the increase was due to high-value perennial species. Three seeded forb species were sampled and provided less than 1% cover. Seeded species provided 2% combined cover in 2007, which was 4% of the total vegetation cover. The 2004 Desirable Components Index (DCI) score was poor due to high sagebrush decadence, low recruitment, and low perennial forb cover. The 2007 DCI score increased to fair despite a decrease in sagebrush cover, but due to increases in young plants, perennial grass cover, perennial forb cover, and a decrease in sagebrush decadence.

2004 winter range condition (DCI) - poor (43) Mid-level potential scale

2007 winter range condition (DCI) - fair (62) Mid-level potential scale

<u>Cache Cave Seed Mix</u>	<u>Bulk lbs/ac</u>
Sainfoin	2.0
Alfalfa 'Ladak+'	1.3
Small Burnet 'Delar'	2.0
Cicer Milkvetch 'Lutana'	1.3
Great Basin Wildrye 'Trailhead'	1.0
Russian Wildrye 'Bozoisky'	1.0
Orchardgrass 'Paiute'	1.0
Bluebunch Wheatgrass 'Goldar'	1.5
Fourwing Saltbush--Juab UT	0.5
<b>Total</b>	<b>11.6</b>

HERBACEOUS TRENDS --  
Management unit 06R, Study no: 1

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron smithii	a248	a304	2.59	10.39
G	Agropyron spicatum	-	-	-	.00
G	Bromus tectorum (a)	a58	b89	.35	3.00
G	Carex sp.	b34	a16	.26	.26
G	Dactylis glomerata	-	77	-	1.21
G	Juncus balticus	5	-	.03	-
G	Poa fendleriana	b69	a33	.61	.70
G	Poa pratensis	-	8	-	.18
G	Poa secunda	a8	b184	.06	4.35
G	Sitanion hystrix	a29	a32	.73	.49
G	Stipa comata	a12	a25	.27	.93
G	Stipa lettermani	b52	a33	.31	1.18
Total for Annual Grasses		58	89	0.35	3.00
Total for Perennial Grasses		457	712	4.88	19.73
Total for Grasses		515	801	5.24	22.74
F	Achillea millefolium	-	1	-	.00
F	Agoseris glauca	a3	a2	.01	.00
F	Alyssum alyssoides (a)	a229	b408	.88	7.01
F	Allium sp.	a3	a1	.01	.00
F	Antennaria rosea	a43	a30	.20	.41
F	Arabis sp.	-	7	-	.01
F	Astragalus beckwithii	2	-	.01	-
F	Carduus nutans (a)	-	1	-	.03
F	Calochortus nuttallii	4	-	.01	-
F	Chenopodium leptophyllum(a)	a11	a1	.02	.00
F	Cirsium sp.	-	1	-	.03
F	Collinsia parviflora (a)	a22	a26	.05	.06
F	Cordylanthus sp. (a)	b157	a29	2.50	.21
F	Descurainia pinnata (a)	a4	a11	.01	.02
F	Erigeron pumilus	a1	b13	.00	.04
F	Lappula occidentalis (a)	a4	a-	.01	.00
F	Medicago sativa	-	20	-	.09
F	Microsteris gracilis (a)	b104	a35	.23	.13
F	Navarretia intertexta (a)	3	-	.00	-
F	Onobrychis viciaefolia	-	21	-	.25

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
		F	Phlox austromontana	<sub>a</sub> 17	<sub>b</sub> 25
F	Phlox longifolia	<sub>a</sub> 86	<sub>a</sub> 65	.24	.37
F	Polygonum douglasii (a)	<sub>a</sub> 19	<sub>b</sub> 51	.05	.12
F	Ranunculus testiculatus (a)	<sub>a</sub> 40	<sub>b</sub> 91	.10	.36
F	Sanguisorba minor	-	27	-	.46
F	Schoenocrambe linifolia	-	3	-	.00
F	Sphaeralcea munroana	-	3	-	.01
F	Taraxacum officinale	<sub>a</sub> 14	<sub>a</sub> 10	.19	.09
F	Tragopogon dubius	4	-	.00	-
F	Trifolium sp.	5	-	.01	-
F	Verbascum thapsus	-	4	-	.15
F	Viola sp.	7	-	.02	-
Total for Annual Forbs		593	653	3.86	7.98
Total for Perennial Forbs		189	233	0.96	2.53
Total for Forbs		782	886	4.83	10.52

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 06R, Study no: 1

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
		B	Artemisia tridentata tridentata	90	82
B	Chrysothamnus viscidiflorus viscidiflorus	77	80	6.36	6.33
B	Gutierrezia sarothrae	0	2	.00	.06
B	Tetradymia canescens	1	0	.00	-
Total for Browse		168	164	27.47	13.41

CANOPY COVER, LINE INTERCEPT --

Management unit 06R, Study no: 1

Species	Percent Cover	
	'04	'07
Artemisia tridentata tridentata	23.25	6.40
Chrysothamnus viscidiflorus viscidiflorus	7.18	7.25
Gutierrezia sarothrae	-	.06

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 06R, Study no: 1

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata tridentata	1.4	1.4

BASIC COVER --

Management unit 06R, Study no: 1

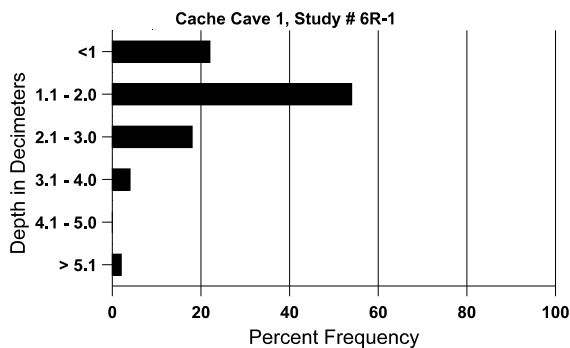
Cover Type	Average Cover %	
	'04	'07
Vegetation	42.38	43.72
Rock	.39	.40
Pavement	.45	1.63
Litter	38.98	43.13
Cryptogams	15.86	4.85
Bare Ground	22.38	17.75

SOIL ANALYSIS DATA --

Management unit 6R, Study no: 1, Study Name: Cache Cave 1

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.8	63.6 (13.6)	6.5	47.3	29.4	23.3	2.8	27.0	166.4	0.7

Stoniness Index



PELLET GROUP DATA --  
 Management unit 06R, Study no: 1

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Sheep	5	37	26 (64)	39 (96)
Rabbit	20	41	-	-
Elk	1	-	3 (7)	1 (2)
Deer	2	1	7 (18)	3 (7)
Cattle	-	-	1 (2)	-

BROWSE CHARACTERISTICS --  
 Management unit 06R, Study no: 1

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata tridentata</i>												
04	<b>4600</b>	1120	120	2720	1760	1600	0	.43	38	18	18	44/37
07	<b>4360</b>	2900	2440	800	1120	2040	13	1	26	7	16	29/28
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>9220</b>	380	140	9040	40	-	0	0	0	.21	.21	9/12
07	<b>8660</b>	180	160	7620	880	20	30	13	10	.69	2	6/12
<i>Gutierrezia sarothrae</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>120</b>	-	-	120	-	-	0	0	-	-	0	4/5
<i>Tetradymia canescens</i>												
04	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-

Trend Study 6R-2-07

Study site name: Cache Cave 2.

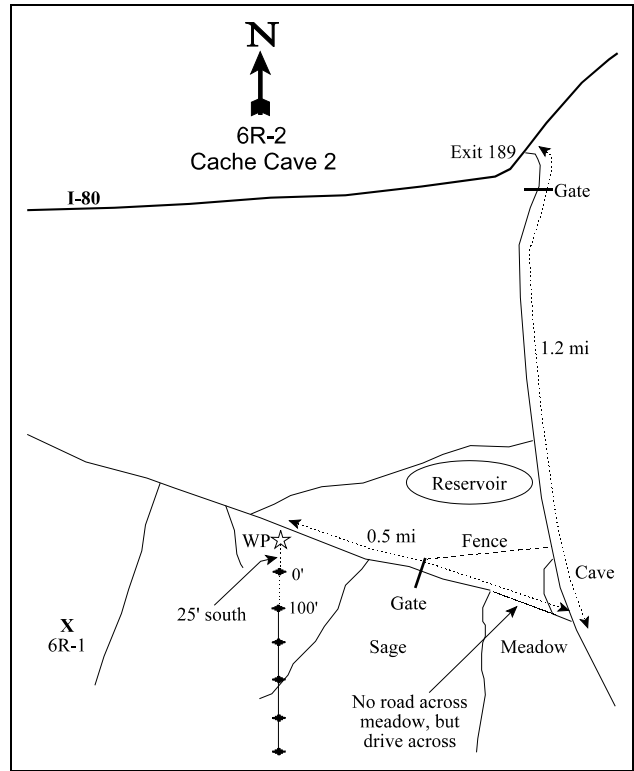
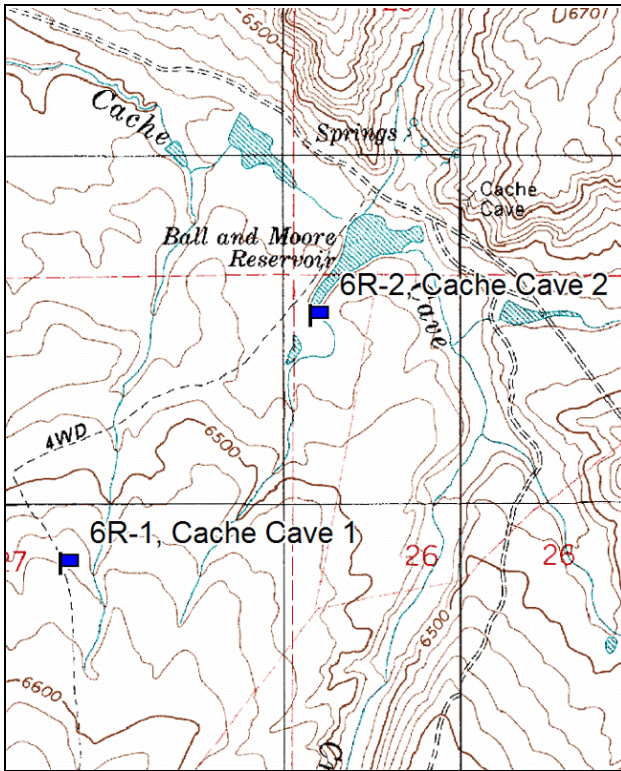
Vegetation type: Black/Basin Big Sagebrush.

Compass bearing: frequency baseline 180 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From I-80 take exit 189. Travel 1.2 miles south to a road that comes in from the right. Turn here and travel 0.5 miles northwest through a meadow to a road. There is a witness post on the left side of the road. The 0-foot stake is 25 feet south of the witness post.



Map Name: Shearing Corral

Diagrammatic Sketch

Township 5N, Range 7E, Section 26

GPS: NAD 83, UTM 12T 489017 E 4554708 N

## DISCUSSION

### Cache Cave 2 - Trend Study No. 6R-2

#### Study Information

This study was established to monitor a 500-acre (202-ha) double drum aerator treatment of a mature basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) community near Ball and Moore Reservoir in Echo Canyon [elevation: 6,450 feet (1,966 m), slope: 3%, aspect: north]. Patches of black sagebrush (*Artemisia nova*) are interspersed throughout the community. The area was treated with an aerator and seeded in fall 2004. The objectives of the study were to reduce sagebrush canopy and to enhance the herbaceous understory. Pre-treatment baseline data were collected in summer 2004 and post-treatment data were collected in summer 2007. This study is located in a bottom area, which is more mesic than the upland Cache Cave 1 (6R-1) study located 0.7 miles (1.1 km) to the southwest. These studies were established to monitor the same treatment in two locations, but not as comparisons of one another. The study is located within a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Data collected in Coalville, 21 miles (33.8 km) southwest of the study, indicated that annual precipitation was above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005 and 2006 and 50% of normal in 2007 (Utah Climate Summaries 2007).

Sheep ranching is the primary use of the land. Sheep were grazing the area when data were collected in 2004. Deer and elk also use the area. Sheep pellet group data estimates were 25 days use/acre (61 sdu/ha) in 2004 and 70 days use/acre (172 sdu/ha) in 2007. Cattle use was estimated at 1 day use/acre (4 cdu/ha) in 2004 and 4 days use/acre (9 cdu/ha) in 2007. Horse use estimates were 1 day use/acre (1 hdu/ha) in 2004 and 2007. Deer use was estimated at 3 days use/acre (8 ddu/ha) in 2004 and 1 day use/acre (3 ddu/ha) in 2007. Elk pellet group estimates were 6 days use/acre (15 edu/ha) in 2004 and 1 day use/acre (3 edu/ha) in 2007. Grasses were heavily grazed in both 2004 and 2007.

#### Soil

The soil is in the Richsum-Heiners complex, which consists of deep and very deep, well-drained, moderately permeable soils on high tablelands, low mountains, and valley sides. They are formed in residuum, slope alluvium, and valley alluvium from shale, sandstone, and conglomerate (USDA-NRCS 2007). No rocks were noted in the soil profile in this low-lying area. There appears to be a restrictive clay layer below the surface where black sagebrush is located. The soil texture is clay loam and the pH is neutral (7.3). Phosphorus and potassium are abundant for wildland soils. The erosion condition was classified as stable in 2004 and 2007. Relative combined vegetation and litter cover was high at 66% and 73% in 2004 and 2007, respectively.

#### Browse

Basin big sagebrush, black sagebrush, and stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) were the abundant browse species prior to treatment. Of the browse species, the sagebrush species were the most heavily affected by the aerator treatment. Basin big sagebrush canopy cover decreased from 15% in 2004 to 1% in 2007. Density decreased from 3,980 plants/acre (9,830 plants/ha) in 2004 to 2,400 plants/acre (5,928 plants/ha) in 2007. The majority of the population was classified as mature or decadent (87%) in 2004 and young plants only made up 13% of the population. The aerator treatment changed the population composition to one dominated by young plants (56%) by 2007. Mature plants only made up 16% of the population in 2007. Decadent plants comprised 31% and 28% of the population in 2004 and 2007, respectively. Plants classified as dying decreased from 20% of the population in 2004 to 1% in 2007. In 2007, 600 living plants/acre (1,482 plants/ha) had been trampled by the aerator, but 1,880 plants/acre (4,644 plants/ha) had been killed by the treatment. Seedlings decreased from 3,540 plants/acre (8,744 plants/ha) in 2004 to 1,000 plants/acre (2,470 plants/ha) in 2007. Utilization was very light both years.

A population of early sagebrush (*Artemisia longiloba*) was sampled by the US Forest Service Shrub Sciences Laboratory near the study. It is likely that the black sagebrush sampled on the study is actually early



sagebrush, but until this is confirmed it will be treated as black sagebrush. It was sampled in patches, likely in locations with shallower soils. Black sagebrush canopy cover decreased from 10% in 2004 to 3% in 2007. Black sagebrush density decreased from 4,140 plants/acre (10,226 plants/ha) in 2004 to 2,800 plants/acre (6,916 plants/ha) in 2007. Mature and decadent plants were the dominant age classes in 2004 and 2007, despite the treatment. Mature plants made up 85% of the population in 2004 and 79% in 2007. Seedlings increased slightly from 40 plants/acre (99 plants/ha) in 2004 to 360 plants/acre (889 plants/ha) in 2007. Decadence increased from 14% to 21% of the population, and poor vigor increased from 4% to 25%. In 2007, 520 living plants/acre (1,284 plants/ha) and 60 dead plants/acre (148 plants/ha) had been trampled by the aerator. Utilization was light.

Rabbitbrush was very abundant and was not impacted by the treatment. It provided 16% canopy cover both sample years, and density remained approximately 18,000 plants/acre (44,460 plants/ha).

#### Herbaceous Understory

The herbaceous understory was sparse in 2004 with only 4% grass and 3% forb cover. Grass cover was greatly increased from 4% in 2004 to 22% following the aerator treatment. The rhizomatous western wheatgrass (*Agropyron smithii*) was the most abundant grass both years at 2% and 9% cover in 2004 and 2007, respectively. It was sampled in 68% of the quadrats in 2004 and 82% in 2007. Letterman needlegrass (*Stipa lettermani*) was the second-most abundant species. It provided 2% cover in 2004 and 5% in 2007. An unknown annual grass species was sampled in 2004, but was not sampled in 2007. Grass species seeded as part of the study only provided 1% cover, most of which was provided by orchardgrass (*Dactylis glomerata*), in 2007. Extant grass species diversity increased from six species sampled in 2004 to eight in 2007.

Forb composition is made up of mostly low growing, poor forage species. Rose pussytoes (*Antennaria rosea*) was the dominant forb species; it provided approximately 1% cover both years. Total forb cover increased from 3% to 5%. Annual forbs provided 52% of the total forb cover in 2004 and 40% in 2007.

Four bunchgrasses, four forb species, and fourwing saltbush (*Atriplex canescens*) were seeded (see table below). Bluebunch wheatgrass (*Agropyron spicatum*), orchardgrass, Russian wildrye (*Elymus junceus*), sainfoin (*Onobrychis viciaefolia*), and small burnet (*Sanguisorba minor*) were sampled in 2007. Sainfoin and small burnet provided less than 0.5% combined cover. Orchardgrass, Russian wildrye, and bluebunch wheatgrass also provided little cover. Combined, all seeded species provided less than 2% cover in 2007.

#### 2007 Post-treatment Assessment

As on the drier site (6R-1), the treatment was very successful at decreasing the cover and density of both sagebrush species. The treatment enhanced the perennial grass cover from 4% to 22%. Three of the four seeded grass species established and were sampled in 2007. These species, primarily orchardgrass, only provided 1% combined cover. The treatment increased forb cover slightly as well. Forb cover increased from 3% to 5%, approximately half of which was provided by annual forbs. The two seeded forb species, sainfoin and small burnet, provided less than 0.5% cover. Seeded species provided nearly 2% combined cover in 2007, which was 4% of the total vegetation cover. The 2004 Desirable Components Index (DCI) score was poor-fair due to moderate sagebrush decadence, low recruitment, and low perennial grass and forb cover. Despite a decrease in sagebrush cover, the 2007 DCI score increased to fair. This improvement was due to increases in young sagebrush and perennial grass cover.

2004 winter range condition (DCI) - poor-fair (48) Mid-level potential scale

2007 winter range condition (DCI) - fair (56) Mid-level potential scale

<b>Cache Cave Seed Mix</b>	<b>Bulk lbs/ac</b>
Sainfoin	2.0
Alfalfa 'Ladak+'	1.3
Small Burnet 'Delar'	2.0
Cicer Milkvetch 'Lutana'	1.3
Great Basin Wildrye 'Trailhead'	1.0
Russian Wildrye 'Bozoisky'	1.0
Orchardgrass 'Paiute'	1.0
Bluebunch WG 'Goldar'	1.5
Fourwing Saltbush--Juab UT	0.5
<b>Total</b>	<b>11.6</b>

HERBACEOUS TRENDS --

Management unit 06R, Study no: 2

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron smithii	<sub>a</sub> 200	<sub>b</sub> 294	1.64	9.05
G	Agropyron spicatum	-	3	-	.03
G	Carex sp.	<sub>a</sub> 30	<sub>a</sub> 54	.13	.39
G	Dactylis glomerata	-	105	-	1.18
G	Elymus junceus	-	11	-	.09
G	Juncus balticus	-	6	-	.06
G	Poa fendleriana	<sub>a</sub> 83	<sub>a</sub> 67	.69	2.79
G	Poa pratensis	-	9	-	.36
G	Poa secunda	-	88	-	2.46
G	Sitanion hystrix	<sub>a</sub> 8	<sub>b</sub> 27	.02	.32
G	Stipa lettermani	<sub>a</sub> 153	<sub>a</sub> 159	1.50	5.44
G	Unknown grass - annual (a)	31	-	.08	-
Total for Annual Grasses		31	0	0.08	0
Total for Perennial Grasses		474	823	4.00	22.20
Total for Grasses		505	823	4.08	22.20
F	Achillea millefolium	<sub>a</sub> 34	<sub>a</sub> 33	.14	.28
F	Agoseris glauca	<sub>a</sub> 2	<sub>a</sub> 2	.01	.00
F	Alyssum alyssoides (a)	<sub>a</sub> 55	<sub>b</sub> 134	.09	.62
F	Allium sp.	-	2	-	.00
F	Antennaria rosea	<sub>a</sub> 59	<sub>a</sub> 48	1.18	.93
F	Arabis sp.	<sub>a</sub> 3	<sub>a</sub> 6	.01	.01
F	Chenopodium sp. (a)	4	-	.01	-
F	Chenopodium leptophyllum(a)	-	4	-	.03
F	Collinsia parviflora (a)	<sub>a</sub> 55	<sub>a</sub> 30	.11	.12

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Cordylanthus sp. (a)	<sub>b</sub> 92	<sub>a</sub> 12	.87	.08
F	Cryptantha sp.	1	-	.00	-
F	Descurainia pinnata (a)	<sub>a</sub> 5	<sub>b</sub> 77	.01	.27
F	Draba sp. (a)	-	5	-	.01
F	Gayophytum ramosissimum(a)	4	-	.02	-
F	Lappula occidentalis (a)	<sub>a</sub> 2	<sub>a</sub> 8	.01	.02
F	Microsteris gracilis (a)	<sub>a</sub> 57	<sub>a</sub> 29	.10	.10
F	Onobrychis viciaefolia	-	5	-	.01
F	Orthocarpus luteus (a)	-	3	-	.00
F	Phlox austromontana	<sub>a</sub> 5	<sub>a</sub> 6	.06	.09
F	Phlox longifolia	<sub>a</sub> 45	<sub>a</sub> 47	.12	.16
F	Polygonum douglasii (a)	<sub>a</sub> 70	<sub>b</sub> 147	.16	.66
F	Ranunculus testiculatus (a)	<sub>a</sub> 33	<sub>b</sub> 161	.09	.99
F	Sanguisorba minor	-	21	-	.41
F	Sphaeralcea munroana	-	2	-	.03
F	Taraxacum officinale	<sub>a</sub> 4	<sub>a</sub> 3	.00	.00
F	Tragopogon dubius	-	1	-	.03
F	Trifolium sp.	11	-	.03	-
F	Unknown forb-annual (a)	-	3	-	.03
F	Viola sp.	17	-	.05	-
Total for Annual Forbs		377	613	1.48	2.97
Total for Perennial Forbs		181	176	1.62	1.98
Total for Forbs		558	789	3.10	4.96

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 06R, Study no: 2

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia nova	45	42	8.83	3.54
B	Artemisia tridentata tridentata	77	55	11.21	1.27
B	Chrysothamnus viscidiflorus viscidiflorus	97	95	11.38	13.62
B	Gutierrezia sarothrae	0	0	.03	-
Total for Browse		219	192	31.46	18.45

CANOPY COVER, LINE INTERCEPT --  
 Management unit 06R, Study no: 2

Species	Percent Cover	
	'04	'07
Artemisia nova	9.66	2.73
Artemisia tridentata tridentata	14.85	1.26
Chrysothamnus viscidiflorus viscidiflorus	16.20	15.76

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 06R, Study no: 2

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata tridentata	1.9	1.1

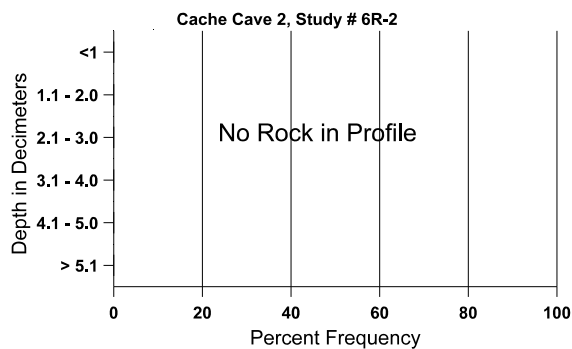
BASIC COVER --  
 Management unit 06R, Study no: 2

Cover Type	Average Cover %	
	'04	'07
Vegetation	40.45	42.89
Rock	.04	.05
Pavement	.13	.42
Litter	35.42	39.23
Cryptogams	5.05	.65
Bare Ground	34.38	29.57

SOIL ANALYSIS DATA --  
 Management unit 6R, Study no: 2, Study Name: Cache Cave 2

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.6	55.6 (15.6)	7.3	33.3	36.2	30.6	2.3	34.9	268.8	0.8

### Stoniness Index



PELLET GROUP DATA --  
 Management unit 06R, Study no: 2

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Sheep	5	42	25 (61)	70 (172)
Rabbit	22	31	-	-
Horse	-	1	1 (1)	1 (1)
Elk	5	1	6 (15)	1 (3)
Deer	4	4	3 (8)	1 (3)
Cattle	1	-	1 (4)	4 (9)

BROWSE CHARACTERISTICS --  
 Management unit 06R, Study no: 2

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia nova</i>												
04	<b>4140</b>	40	40	3500	600	140	5	4	14	4	4	8/15
07	<b>2800</b>	360	-	2200	600	220	8	0	21	6	25	6/15
<i>Artemisia tridentata tridentata</i>												
04	<b>3980</b>	3540	520	2240	1220	640	2	.50	31	20	20	37/36
07	<b>2400</b>	1000	1360	380	660	1880	6	.83	28	.83	26	20/17
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>17880</b>	760	1060	16760	60	40	0	0	0	-	0	8/12
07	<b>18420</b>	480	2400	14620	1400	40	19	5	8	3	3	8/15

Trend Study 9R-3-07

Study site name: Deadman Greenstrip .

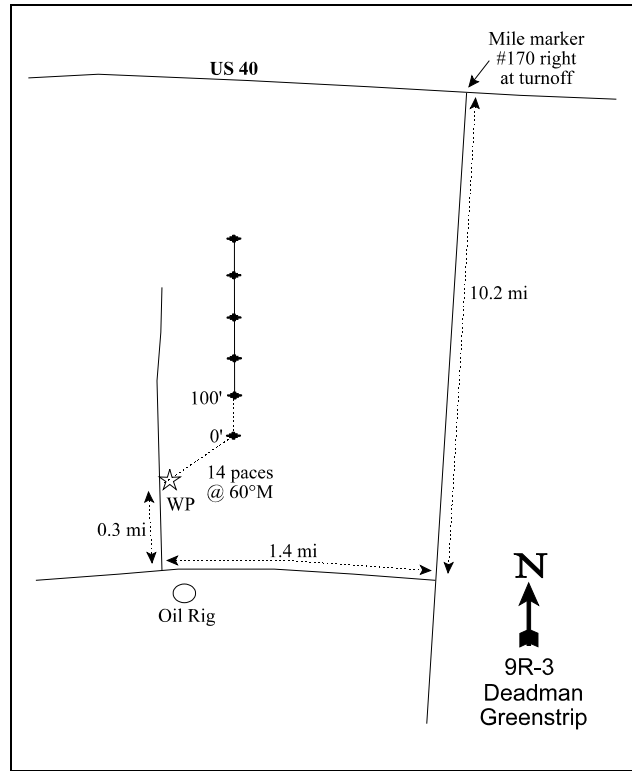
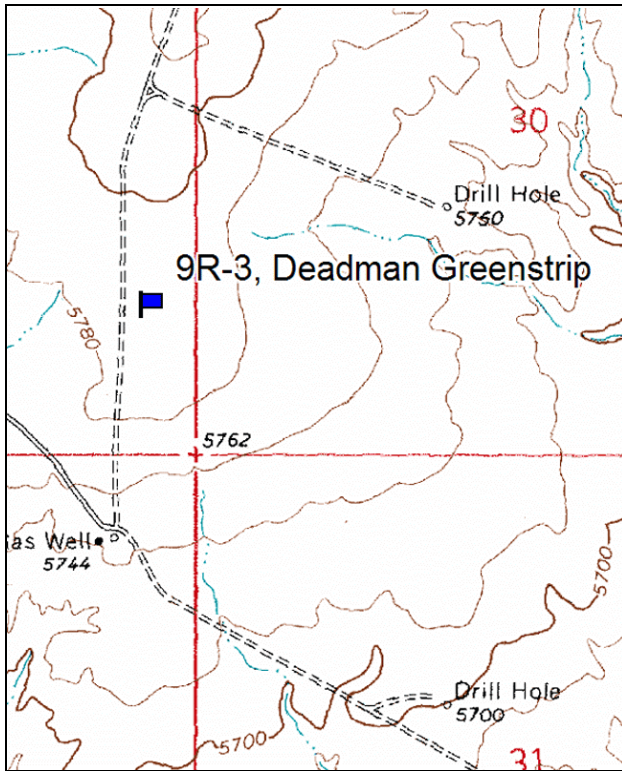
Vegetation type: Wyoming Big Sagebrush .

Compass bearing: frequency baseline 0 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From US 40 turn right (south) at the turnoff after mile marker 168. Drive south for 10.2 miles to a road that comes in from the right (west). Turn here and travel 1.4 miles, passing an oil rig on the left, to a road on the right. Take this road 0.3 miles to a witness post on the right side of the road. The 0-foot stake is about 14 paces from the witness post at 60°M, and is marked with browse tag #135.



Map Name: Dinosaur NW

Diagrammatic Sketch

Township 7S , Range 24E , Section 25

GPS: NAD 83, UTM 12T 657086 E 4448957 N

## DISCUSSION

### Deadman Greenstrip - Trend Study No. 9R-3

#### Study Information

This study was established in June 2004 to monitor a greenstripping project on Deadman Bench approximately 8 miles (12.9 km) south of US 40 [elevation: 5,800 feet (1,767 m), slope: 1%, aspect: south]. This area is managed by the BLM. The purpose in creating greenstrips along roads is to prevent future wildfires from swelling into very large complexes that destroy large amounts of important habitat. The area was treated with a single drum aerator followed by a land imprinter, which took place in fall 2004. Post-treatment data were collected in July 2007. The treatment missed most of the original study, so a new study was established approximately 100 feet (30.5 m) to the west of the original, inside the treated area. It is located in a 8-10 inch (203-254 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above normal in 2004 and 2005, and in 2006 the data was incomplete at the Jensen weather station located approximately 16 miles (26 km) northwest of the site. Spring precipitation was above normal in 2005 and 80% of normal in 2006. Fall precipitation was above normal in 2004 and 2005, and the data were incomplete in 2006 (Utah Climate Summaries 2007). This area is mostly used by wild horses, antelope, and deer. It was difficult to distinguish between antelope and deer pellets. The pellet group transect data estimated antelope/deer use at 19 days use/acre (46 adu/ha) in 2004 and 36 days use/acre (89 adu/ha) in 2007. Horse use was estimated at 3 days use/acre (7 hdu/ha) in 2004. Rabbit pellet quadrat frequency was 71% in 2004 and 84% in 2007. There was also coyote scat within the study area in 2007.

#### Soil

The soil is classified as a Solirec-Abracon-Begay complex (USDA-NRCS 2007). The Solirec series consists of very deep, well-drained soils that formed in eolian deposits over slope alluvium or colluvium derived from sandstone and shale. The Abracon series consists of very deep, well-drained soils that formed in slope alluvium and colluvium derived from sandstone, shale, limestone, and quartzite. The Begay series consists of very deep, well-drained, moderately-rapidly permeable soils that formed in eolian deposits and alluvium, derived mainly from sandstone. These soil series are on structural benches, mesas, fan remnants, toeslopes, and hills. Soil texture is sandy clay loam and is slightly alkaline in reactivity (pH 7.5). The soil phosphorus concentration is 7.1 ppm. A clay hardpan was noted at about 12-13 inches (30.5-33 cm) in depth with a hard caliche layer at 15 inches (38.1 cm). The combined relative cover of vegetation and litter increased from 51% in 2004 to 64% in 2007. The relative bare ground cover decreased from 40% in 2004 to 35% in 2007. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) was the dominant browse species prior to treatment, and its canopy cover was 16% in 2004. After the treatment, sagebrush canopy cover decreased to 4%. Sagebrush density was 5,420 plants/acre (13,387 plants/ha) in 2004 and 2,760 plants/acre (6,817 plants/ha) in 2007. This population of sagebrush was negatively affected by drought conditions in both sample years. Decadence was high at 59% in 2004 and 72% in 2007. Plants showing poor vigor increased from 30% of the population in 2004 to 72% in 2007. These increases in decadence and poor plant vigor were due in part to the use of the aerator and imprinter in the treatment. Browse use was mostly light-moderate in both sample years. In 2004, leader growth was very poor and averaged 0.7 inches (1.8 cm), but increased to 2.2 inches (5.6 cm) in 2007.

Forage kochia (*Kochia prostrata*) and fourwing saltbush (*Atriplex canescens*) were seeded in the treatment (see list below). Forage kochia density was 240 plants/acre (593 plants/ha) in 2007, and all were mature or young plants. There were also an estimated 140 seedling plants/acre (346 plants/ha) in 2007. Plant vigor was excellent and use was light. Fourwing saltbush was not sampled.

### Herbaceous Understory

The herbaceous understory was sparse in 2004. Cheatgrass (*Bromus tectorum*) was the most abundant species and provided 3% cover in 2004 and 26% in 2007. It was widely distributed with a quadrat frequency of 82% in 2004 and 100% in 2007. Western wheatgrass (*Agropyron smithii*) and bottlebrush squirreltail (*Sitanion hystrix*) were the two most abundant perennial species, and together provided 5% cover in 2004 and 2% cover in 2007. Crested wheatgrass (*Agropyron cristatum*), Siberian wheatgrass (*Agropyron fragile*), and western wheatgrass were seeded in the treatment (see list below).

Forbs were very sparse in 2004, providing almost no cover. In 2007, perennial forb cover changed little. However, annual forbs increased and provided 2% cover. Scarlet globemallow (*Sphaeralcea coccinea*) was the dominant perennial forb, and annual stickseed (*Lappula occidentalis*) was the dominant annual forb. Sainfoin (*Onobrychis viciaefolia*), alfalfa (*Medicago sativa*), and small burnet (*Sanguisorba minor*) were seeded in the treatment (see list below). The seeded species are fire resistant, provide low amounts of fuel, compete with cheatgrass and other invaders, remain green for a long period, and should provide a good barrier to spreading fires. They should also provide additional forage for wildlife and livestock.

### 2007 Post-treatment Assessment

The aerator treatment was successful in reducing sagebrush density and cover. Sagebrush density decreased nearly 50%. The recruitment of young remained very low, and decadence increased from 59% of the population to 72%. Plants showing poor vigor increased from 30% to 72% and browse use remained mostly light-moderate. Forage kochia was the only seeded browse species sampled. Its density was 240 plants/acre (593 plants/ha), and all were mature or young plants. There were also an estimated 140 kochia seedling plants/acre (346 plants/ha). The treatment was unsuccessful in establishing the desired grass species. The sum of nested frequency for perennial grasses decreased 41%, and cover decreased from 5% to 2%. The nested frequencies of western wheatgrass and bottlebrush squirreltail decreased significantly. Crested wheatgrass was only sampled in 3% of the quadrats, with less than 1% cover. Siberian wheatgrass was seeded, but was not sampled. The nested frequency of cheatgrass increased 66%, and average cover increased from 3% to 26%. The treatment was also unsuccessful in establishing the desired forb species. The sum of nested frequency of perennial forbs changed little. Of the three seeded forb species, alfalfa was the only species sampled and it was found in only 1% of the quadrats, with nearly no cover. The sum of nested frequency for annual forbs increased more than nine-fold, and average cover increased from less than 1% to 2%. The nested frequencies of pale alyssum (*Alyssum alyssoides*) and annual stickseed increased significantly. In 2004, the winter range condition determined by the Desirable Components Index (DCI) score was fair due to good browse cover with high decadence and low recruitment, as well as low perennial grass, annual grass, and perennial forb cover. In 2007, the DCI score declined to very poor due to decreased browse cover and increased annual grass cover.

2004 winter range condition (DCI) - fair (26) Low potential scale

2007 winter range condition (DCI) - very poor (-10) Low potential scale



<b>Deadman Seed Mix</b>	<b>Bulk lbs/ac</b>
Forage Kochia 'Immigrant'	2.0
Crested Wheatgrass 'Douglas'	0.5
Crested Wheatgrass 'Ephraim'	1.0
Crested Wheatgrass 'Hycrest'	1.5
Siberian Wheatgrass 'Vavilov'	0.5
Fourwing Saltbush–Emery UT	1.0
Western Wheatgrass 'Arriba'	1.0
Sainfoin 'Eski'	1.0
Alfalfa 'Nomad'	1.0
Alfalfa 'Ladak+'	1.0
Alfalfa 'Spredor 3'	1.0
Small Burnet 'Delar'	1.0
<b>Total Bulk lbs/acre</b>	<b>12.5</b>
<b>Total PLS lbs/acre</b>	<b>10.5</b>

HERBACEOUS TRENDS --

Management unit 09R, Study no: 3

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	9	-	.01
G	Agropyron smithii	<sub>b</sub> 163	<sub>a</sub> 71	2.07	.95
G	Bromus tectorum (a)	<sub>a</sub> 276	<sub>b</sub> 459	3.11	25.87
G	Poa secunda	<sub>a</sub> 3	<sub>a</sub> 2	.01	.00
G	Sitanion hystrix	<sub>b</sub> 92	<sub>a</sub> 70	3.23	.97
G	Vulpia octoflora (a)	<sub>a</sub> 1	<sub>a</sub> 13	.00	.05
<b>Total for Annual Grasses</b>		<b>277</b>	<b>472</b>	<b>3.12</b>	<b>25.92</b>
<b>Total for Perennial Grasses</b>		<b>258</b>	<b>152</b>	<b>5.32</b>	<b>1.93</b>
<b>Total for Grasses</b>		<b>535</b>	<b>624</b>	<b>8.44</b>	<b>27.86</b>
F	Alyssum alyssoides (a)	<sub>a</sub> 3	<sub>b</sub> 109	.00	.68
F	Astragalus sp.	-	3	-	.03
F	Collinsia parviflora (a)	-	1	-	.00
F	Descurainia pinnata (a)	-	27	-	.07
F	Gilia sp. (a)	-	116	-	.52
F	Lappula occidentalis (a)	<sub>a</sub> 36	<sub>b</sub> 126	.10	.93
F	Lupinus sp.	<sub>a</sub> 10	<sub>a</sub> 3	.02	.00
F	Medicago sativa	-	2	-	.00
F	Phlox hoodii	-	1	-	.03
F	Phlox longifolia	-	3	-	.00
F	Ranunculus testiculatus (a)	-	1	-	.03

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Schoenocrambe linifolia	-	3	-	.06
F	Sphaeralcea coccinea	<sub>a</sub> 32	<sub>a</sub> 25	.17	.10
F	Trifolium sp.	3	-	.00	-
Total for Annual Forbs		39	380	0.10	2.24
Total for Perennial Forbs		45	40	0.19	0.23
Total for Forbs		84	420	0.30	2.48

Values with different subscript letters are significantly different at alpha = 0.10

**BROWSE TRENDS --**

Management unit 09R, Study no: 3

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	94	75	15.15	3.77
B	Chrysothamnus depressus	1	0	-	.03
B	Grayia spinosa	1	0	.15	-
B	Kochia prostrata	0	8	-	.04
B	Opuntia sp.	24	13	.28	.04
Total for Browse		120	96	15.59	3.88

**CANOPY COVER, LINE INTERCEPT --**

Management unit 09R, Study no: 3

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	16.04	3.96
Opuntia sp.	.21	.05

**KEY BROWSE ANNUAL LEADER GROWTH --**

Management unit 09R, Study no: 3

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	0.7	2.2

**BASIC COVER –**

Management unit 09R, Study no: 3

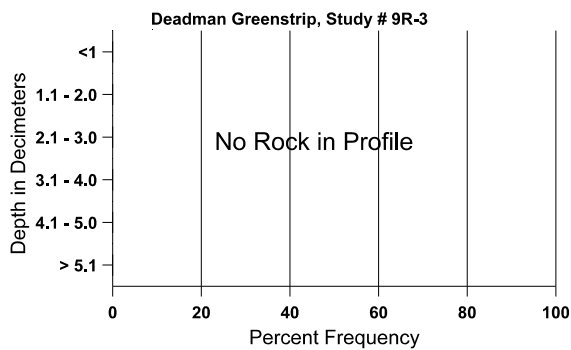
Cover Type	Average Cover %	
	'04	'07
Vegetation	26.31	33.18
Pavement	.02	.02
Litter	29.87	38.54
Cryptogams	10.39	1.12
Bare Ground	44.65	38.71

**SOIL ANALYSIS DATA --**

Management unit 9R, Study no: 3, Study Name: Deadman Greenstrip

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
12.7	65.8 (14.0)	7.5	50.3	25.5	24.2	1.0	7.1	131.2	0.6

**Stoniness Index**



**PELLET GROUP DATA --**

Management unit 09R, Study no: 3

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	71	84	-	-
Elk	-	2	-	-
Cattle	-	2	-	-
Horse	-	-	3 (7)	-
Antelope/Deer	19	34	19 (46)	36 (89)

BROWSE CHARACTERISTICS --  
Management unit 09R, Study no: 3

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>5420</b>	-	100	2140	3180	2580	31	1	59	30	30	24/30
07	<b>2760</b>	20	20	740	2000	4060	25	18	72	15	72	15/19
<i>Chrysothamnus viscidiflorus</i>												
04	<b>20</b>	-	-	-	20	-	0	100	100	100	100	-/-
07	<b>0</b>	-	-	-	-	-	0	0	0	-	0	-/-
<i>Grayia spinosa</i>												
04	<b>20</b>	-	-	20	-	-	100	0	-	-	0	16/21
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>240</b>	140	160	80	-	-	0	0	-	-	0	2/3
<i>Opuntia sp.</i>												
04	<b>740</b>	-	-	440	300	120	0	0	41	3	8	4/9
07	<b>320</b>	-	60	140	120	20	0	0	38	13	25	3/5

Trend Study 9R-4-07

Study site name: Diamond Mountain Bullhog .

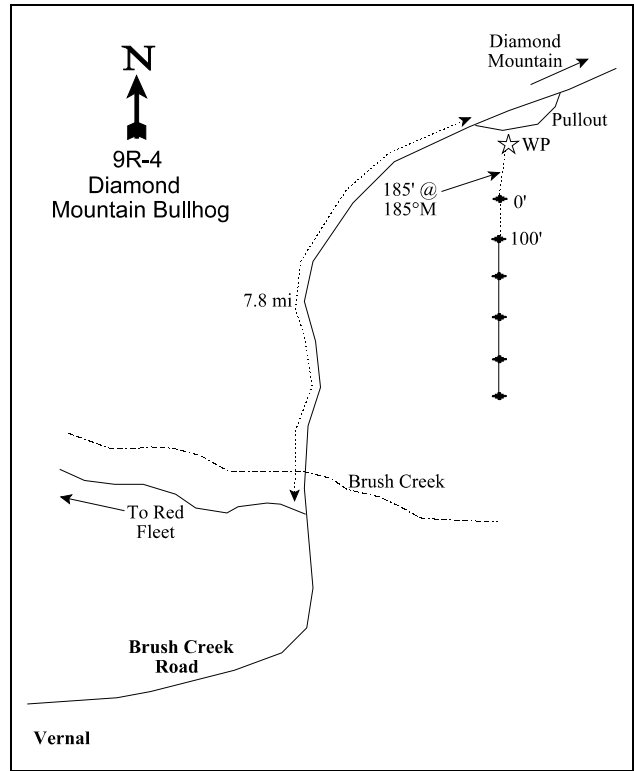
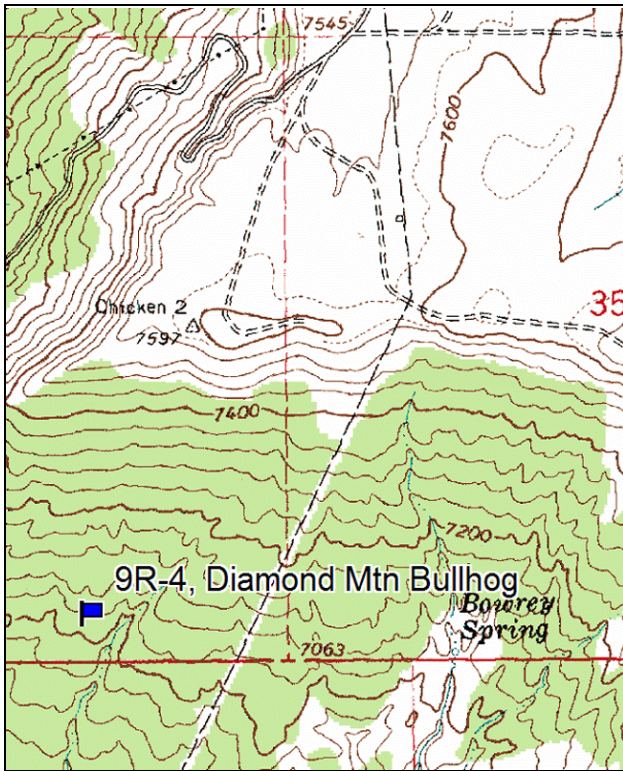
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 200 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Vernal travel northeast on Brush Creek Road heading toward Diamond Mountain for 7.8 miles to a pull off on the right. Turn here. There is a witness post on the south side of the pull off. The 0-foot stake is 185 feet from the witness post at 185°M and is marked with browse tag #133.



Map Name: Jensen Ridge

Diagrammatic Sketch

Township 2S , Range 23E , Section 34

GPS: NAD 83, UTM 12T 642208 E 4495284 N

## DISCUSSION

### Diamond Mountain Bullhog - Trend Study No. 9R-4

#### Study Information

This study was established in June 2004 to monitor a fuels reduction project near the Diamond Mountain rim [elevation: 7,000 feet, slope: 15%, aspect: south]. The BLM treated 320 acres (791 ha) of mature juniper woodland with a bullhog machine in September 2004. The UDWR provided a seed mix of grasses, forbs, and shrubs for the project. The grasses and forbs were applied aerially prior to treatment, while sagebrush seed was applied in late November following the treatment. It remains unknown if the soil disturbance created by the bullhog can sufficiently cover seed for successful establishment. Also, the great amount of tree litter created by the bullhog may prevent seedlings from emerging, or it may help protect seedlings and hold water within the soil profile. This study is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above average for 2004, 2005, and 2006 at the Vernal weather station located approximately 15 miles (24 km) southwest of the site. Spring precipitation was above normal in 2005 and 2006, and 86% of normal in 2007. Fall precipitation was above normal in 2004, 2005, and 2006 (Utah Climate Summaries 2007). This area is considered winter range for deer and elk. The pellet group transect data estimated deer use at 5 days use/acre (12 ddu/ha) in 2004 and 7 days use/acre (18 ddu/ha) in 2007. Elk use estimates were 9 days use/acre (21 edu/ha) in 2004 and 25 days use/acre (63 edu/ha) in 2007. Cattle use estimates were 2 days use/acre (5 cdu/ha) in 2007. Coyote scat was also noted in 2007.

#### Soil

The soil is in the Clapper series, which consists of very deep, well-drained soils that formed in alluvium and colluvium derived from sedimentary, igneous, and metamorphic rocks. Clapper soils are on fan remnants, hillslopes, and mesas (USDA-NRCS 2007). The soil texture is sandy loam, with a neutral reactivity (pH 6.6). The ground surface is very rocky, and rocks were prevalent throughout the profile. Rocks 4 inches (10.2 cm) below the surface were covered with calcium carbonate. The combined relative cover for rock and pavement decreased from 28% in 2004 to 10% in 2007. The relative bare ground cover also decreased from 13% in 2004 to 3% in 2007. However, the combined relative cover of vegetation and litter increased from 57% in 2004 to 87% in 2007. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Utah juniper (*Juniperus osteosperma*) dominated the site prior to treatment. Canopy cover was 39% in 2004 and decreased to 0% in 2007. Juniper density was very high at 444 trees/acre (1,097 trees/ha) in 2004 and decreased to 23 trees/acre (57 trees/ha) in 2007. Average diameter was 13.3 inches (13.5 cm) in 2004 and 5.1 inches (2.5 cm) in 2007. Fifty percent of the trees sampled were 12 feet (3.7 m) tall or greater in 2004. In 2007, some of the trees sampled had been bullhogged, but still had green limbs near the ground. Most of the junipers sampled were seedlings or trees less than 4 feet (1.2 m) tall. The understory shrubs and herbaceous species each provided approximately 3% cover in 2004. The low pre-treatment understory cover is likely a result of the high juniper cover, as demonstrated by Tausch and West (1994). Following the bullhog treatment, the understory shrub cover remained at 3%, however, the herbaceous cover increased to 29%.

Black sagebrush (*Artemisia nova*) density was 2,660 plants/acre (6,323 plants/ha) in 2004 and 1,700 plants/acre (4,199 plants/ha) in 2007. It provided 2%-3% canopy cover in both sample years. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) was seeded in the treatment to improve browse diversity. In 2007, its density was 2,020 plants/acre (4,989 plants/ha), and it provided 1% cover. Other browse species sampled include slenderbush eriogonum (*Eriogonum microthecum*), white rubber rabbitbrush (*Chrysothamnus nauseosus* ssp. *albicaulis*), and antelope bitterbrush (*Purshia tridentata*).

### Herbaceous Understory

Prior to treatment, the herbaceous understory was sparse. Cheatgrass (*Bromus tectorum*) was the most abundant grass both sample years with a quadrat frequency of 49% in 2004 and 90% in 2007. It provided slightly less than 1% cover in 2004 and 14% in 2007. Indian ricegrass (*Oryzopsis hymenoides*), Sandberg bluegrass (*Poa secunda*), bottlebrush squirreltail (*Sitanion hystrix*), and Letterman needlegrass (*Stipa lettermani*) were also sampled in 2004 and 2007, but were not abundant. Three grass species (see list below) were seeded in the treatment. Perennial grass cover was 1% in 2004 and 9% in 2007. The nested frequency of bottlebrush squirreltail significantly increased, and its cover increased from 1% in 2004 to 7% in 2007.

Few forbs were sampled prior to the treatment, but after the treatment more species were sampled, and total forb cover increased from 1% to 6%. Rock goldenrod (*Petradoria pumila*) was the only abundant forb in 2004 with 1% cover, and increased to 2% in 2007. There were five forb species seeded in the treatment (see list below). Four of the five seeded species were sampled and the total number of forbs sampled increased from 10 to 17.

### 2007 Post-treatment Assessment

The preferred browse component improved. Wyoming big sagebrush, which was seeded with the treatment, had a density of 2,020 plants/acre (4,989 plants/ha). Young and mature plants comprised 36% and 64% of the population, respectively, and no decadent plants were sampled. Plant vigor was excellent and use was light. Black sagebrush density decreased 36%. The recruitment of young decreased from 25% of the population to 6%, and decadence decreased from 24% to 4%. Plants showing poor vigor decreased from 7% of the population to 1%, and use decreased to mostly light. The density of all other preferred browse species remained low. The herbaceous understory also improved. The sum of nested frequency for perennial grasses increased 89%, and cover increased from less than 1% to 9%. The nested frequency for bottlebrush squirreltail significantly increased, but the nested frequencies for Indian ricegrass and Letterman needlegrass significantly decreased. However, there were four grasses and grass-like plants sampled for the first time, including western wheatgrass (*Agropyron smithii*) and orchardgrass (*Dactylis glomerata*), which were seeded. The nested frequency of cheatgrass increased more than two-fold, and its average cover increased from 1% to 14%. The sum of the nested frequency for perennial forbs increased 64%, and total cover increased from 1% to 6%. The nested frequencies of Timber poisonvetch (*Astragalus convallarius*), spring parsley (*Cymopterus* sp.), and Russian thistle (*Salsola iberica*) significantly increased, while the nested frequency of rockcress (*Arabis* sp.) significantly decreased. The seeded species Lewis flax (*Linum lewisii*), alfalfa (*Medicago sativa*), sainfoin (*Onobrychis viciaefolia*), and small burnet (*Sanguisorba minor*) were sampled, along with five other forbs that were not previously sampled. In 2004, the winter range condition determined by the Desirable Components Index (DCI) score was very poor due to poor browse cover with high decadence and low recruitment, low perennial grass cover, and low perennial forb cover. In 2007, the DCI score increased to poor due to increased perennial grass and forb cover, despite an increase in annual grass cover.

2004 winter range condition (DCI) - very poor (7) Low potential scale

2007 winter range condition (DCI) - poor (21) Low potential scale

<b>Diamond Rim Seed Mix 1</b>	<b>Bulk lbs/ac</b>
Orchardgrass 'Paiute'	2.0
Western Wheatgrass 'Arriba'	2.0
Sandberg Bluegrass--Toole MT	0.5
Yellow Sweetclover	0.9
Alfalfa 'Ladak+'	2.0
Sainfoin	1.1
Blue Flax 'Appar'	0.9
Small Burnet 'Delar'	2.0
<b>Total Bulk lbs/acre</b>	<b>11.4</b>
<b>Total PLS lbs/acre</b>	<b>10.7</b>

<b>Diamond Rim Seed Mix 2</b>	<b>Bulk lbs/ac</b>	<b>PLS lbs/ac</b>
Sagebrush, Wyoming--Sanpete UT	2	0.3

HERBACEOUS TRENDS --

Management unit 09R, Study no: 4

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	3	-	.22
G	Agropyron smithii	-	10	-	.18
G	Bromus tectorum (a)	<sub>a</sub> 132	<sub>b</sub> 344	.81	14.07
G	Carex sp.	-	4	-	.06
G	Dactylis glomerata	-	17	-	.45
G	Oryzopsis hymenoides	<sub>b</sub> 50	<sub>a</sub> 9	.22	.52
G	Poa secunda	<sub>a</sub> 27	<sub>a</sub> 35	.14	.44
G	Sitanion hystrix	<sub>a</sub> 22	<sub>b</sub> 133	.16	6.75
G	Stipa lettermani	<sub>b</sub> 14	<sub>a</sub> 2	.10	.03
<b>Total for Annual Grasses</b>		<b>132</b>	<b>344</b>	<b>0.81</b>	<b>14.07</b>
<b>Total for Perennial Grasses</b>		<b>113</b>	<b>213</b>	<b>0.63</b>	<b>8.66</b>
<b>Total for Grasses</b>		<b>245</b>	<b>557</b>	<b>1.44</b>	<b>22.73</b>
F	Arabis sp.	<sub>b</sub> 27	<sub>a</sub> 2	.06	.00
F	Arenaria sp.	-	6	-	.03
F	Astragalus convallarius	<sub>a</sub> 5	<sub>b</sub> 45	.01	2.05
F	Cryptantha sp.	<sub>a</sub> 9	<sub>a</sub> 2	.02	.00
F	Cymopterus sp.	<sub>a</sub> 1	<sub>b</sub> 35	.00	.19
F	Descurainia pinnata (a)	-	3	-	.07
F	Gilia sp. (a)	-	16	-	.03
F	Ipomopsis aggregata	-	1	-	.15
F	Linum lewisii	-	20	-	.95
F	Medicago sativa	-	14	-	.43
F	Onobrychis viciaefolia	-	1	-	.03
F	Penstemon humilis	<sub>a</sub> 3	<sub>a</sub> 4	.00	.04



Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Petradoria pumila</i>	<sub>b</sub> 56	<sub>a</sub> 33	1.01	1.66
F	<i>Phlox austromontana</i>	<sub>a</sub> 1	<sub>a</sub> 6	.00	.01
F	<i>Phlox longifolia</i>	2	-	.01	-
F	<i>Salsola iberica</i> (a)	<sub>a</sub> 3	<sub>b</sub> 11	.00	.08
F	<i>Sanguisorba minor</i>	-	6	-	.18
F	<i>Townsendia</i> sp.	-	5	-	.03
F	<i>Trifolium</i> sp.	6	-	.02	-
Total for Annual Forbs		3	30	0.00	0.18
Total for Perennial Forbs		110	180	1.15	5.79
Total for Forbs		113	210	1.15	5.97

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 09R, Study no: 4

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia nova</i>	42	34	2.98	1.83
B	<i>Artemisia tridentata wyomingensis</i>	0	27	-	1.45
B	<i>Atriplex canescens</i>	0	1	-	.00
B	<i>Chrysothamnus nauseosus</i>	0	1	-	-
B	<i>Chrysothamnus nauseosus albicaulis</i>	0	1	-	.06
B	<i>Eriogonum microthecum</i>	2	1	.00	-
B	<i>Gutierrezia sarothrae</i>	1	0	-	-
B	<i>Juniperus osteosperma</i>	23	0	16.80	-
B	<i>Opuntia</i> sp.	2	0	.00	-
B	<i>Purshia tridentata</i>	2	2	-	-
Total for Browse		72	67	19.79	3.34

CANOPY COVER, LINE INTERCEPT --  
 Management unit 09R, Study no: 4

Species	Percent Cover	
	'04	'07
Artemisia nova	2.29	2.59
Artemisia tridentata wyomingensis	-	1.61
Atriplex canescens	-	.36
Juniperus osteosperma	39.00	-
Purshia tridentata	.03	-

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 09R, Study no: 4

Species	Average leader growth (in)	
	'04	'07
Artemisia nova	0.5	1.3
Artemisia tridentata wyomingensis	-	7.0

POINT-QUARTER TREE DATA --  
 Management unit 09R, Study no: 4

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	444	23

Average diameter (in)	
'04	'07
13.3	5.1

BASIC COVER --  
 Management unit 09R, Study no: 4

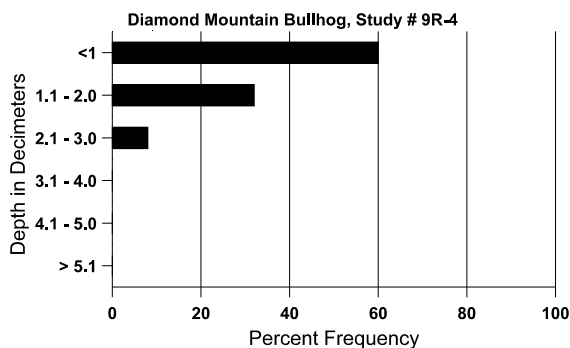
Cover Type	Average Cover %	
	'04	'07
Vegetation	21.13	32.40
Rock	23.10	8.66
Pavement	9.55	2.20
Litter	46.48	62.60
Cryptogams	2.37	.00
Bare Ground	15.22	3.80

SOIL ANALYSIS DATA --

Management unit 9R, Study no: 4, Study Name: Diamond Mountain Bullhog

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%0M	PPM P	PPM K	ds/m
8.0	60.6 (8.0)	6.6	61.4	19.2	19.5	2.0	7.0	153.6	0.6

Stoniness Index



PELLET GROUP DATA --

Management unit 09R, Study no: 4

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	65	23	-	-
Elk	7	19	9 (21)	25 (63)
Deer	1	1	5 (13)	7 (18)
Cattle	-	-	-	2 (5)

BROWSE CHARACTERISTICS --

Management unit 09R, Study no: 4

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
04	<b>2660</b>	180	660	1360	640	220	20	46	24	7	7	9/16
07	<b>1700</b>	860	100	1540	60	120	6	0	4	1	1	10/18
<b>Artemisia tridentata wyomingensis</b>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>2020</b>	1460	720	1300	-	-	.99	0	-	-	0	18/21
<b>Atriplex canescens</b>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	30/49

		Age class distribution (plants per acre)					Utilization						
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)	
<b>Chrysothamnus nauseosus</b>													
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-	
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	24/43	
<b>Chrysothamnus nauseosus albicaulis</b>													
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-	
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	17/17	
<b>Eriogonum microthecum</b>													
04	<b>60</b>	-	20	20	20	-	0	100	33	-	0	1/1	
07	<b>20</b>	-	-	20	-	-	0	0	0	-	0	7/6	
<b>Gutierrezia sarothrae</b>													
04	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-	
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	11/15	
<b>Juniperus osteosperma</b>													
04	<b>500</b>	20	60	380	60	60	4	0	12	-	0	-/-	
07	<b>0</b>	-	-	-	-	80	0	0	0	-	0	-/-	
<b>Opuntia sp.</b>													
04	<b>40</b>	-	-	40	-	-	0	0	-	-	0	3/16	
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-	
<b>Purshia tridentata</b>													
04	<b>60</b>	-	-	40	20	-	0	100	33	33	33	7/46	
07	<b>40</b>	-	-	40	-	-	0	100	0	-	0	8/55	

Trend Study 9R-5-07

Study site name: Little Donkey .

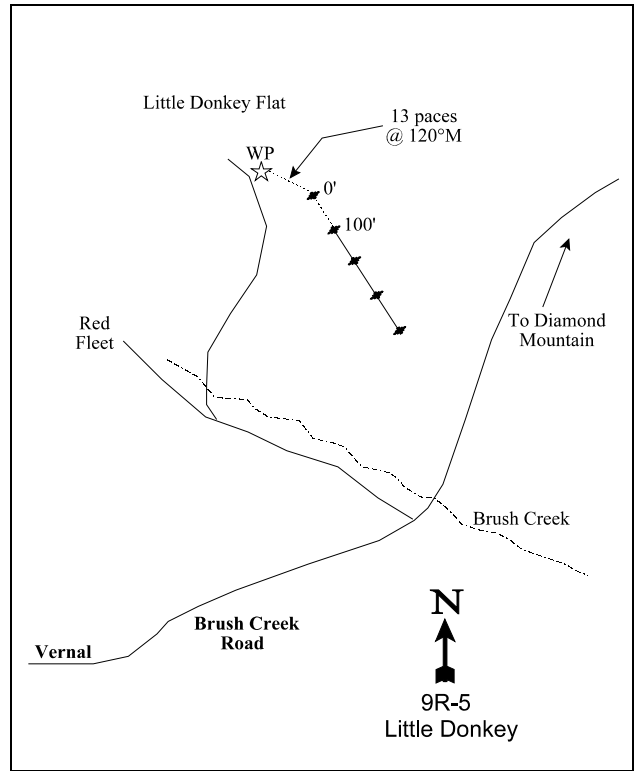
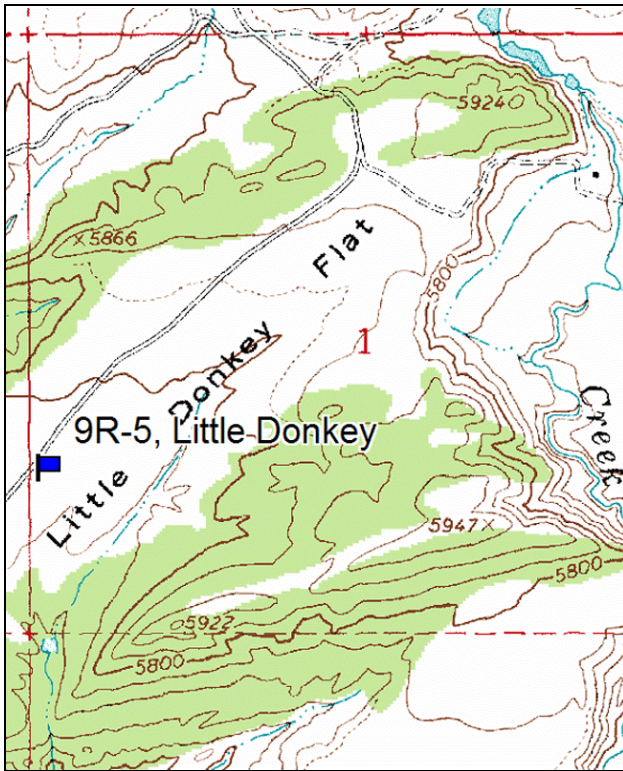
Vegetation type: Perennial Grass .

Compass bearing: frequency baseline 170 degrees magnetic.

Frequency belt placement: line 1 (11& 95ft), line 2 (34ft), line 3 (59ft), line 4 (71ft).

LOCATION DESCRIPTION

From Vernal travel northeast on Brush Creek Road heading toward Diamond Mountain. Take a left at the Red Fleet turnoff right before Brush Creek. Follow the road as it turns north toward Little Donkey Flat. There is a witness post on the right side of the road. The 0-foot stake is 13 paces from the witness post at 120°M.



Map Name: Donkey Flat

Diagrammatic Sketch

Township 3S , Range 22E , Section 1

GPS: NAD 83, UTM 12T 635074 E 4493806 N

## DISCUSSION

### Little Donkey - Trend Study No. 9R-5

#### Study Information

This trend study was established in June 2004 on Little Donkey Flat approximately 1 mile (1.6 km) northeast of the Red Fleet Reservoir Dam [elevation: 5,800 feet (1,768 m), slope: 3%, aspect: southwest]. This treatment is part of the Red Fleet habitat projects. The flat was dominated by a monoculture of crested wheatgrass (*Agropyron cristatum*) surrounded by junipers on the slopes. A more diverse community with preferred browse species, which could make this area a beneficial winter range for wildlife, was desired. In October 2004, parts of the flat were sprayed with GLY-4 Plus (generic Roundup) to kill the crested wheatgrass. In November, the sprayed areas were drill seeded with a mixture of grasses, forbs, and shrubs using a no-till drill. It is located in a 8-10 inch (203-254 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above average for 2004, 2005, and 2006 at the Vernal weather station located approximately 11 miles (18 km) southwest of the site. Spring precipitation was above normal in 2005 and 2006, and 86% of normal in 2007. Fall precipitation was above normal in 2004, 2005, and 2006 (Utah Climate Summaries 2007). From the pellet group transect data, deer use was estimated at 11 days use/acre (28 ddu/ha) in 2004 and 2007. Elk use was estimated at 7 days use/acre (18 edu/ha) in 2004 and 6 days use/acre (15 edu/ha) in 2007. Cattle use was estimated at 6 days use/acre (16 cdu/ha) in 2004 and 7 days use/acre (18 cdu/ha) in 2007.

#### Soil

The soil is in the Solirec series, which consists of very deep, well-drained soils that formed in eolian deposits over slope alluvium or colluvium derived from sandstone and shale. Solirec soils are on fan remnants, mesas, or hills (USDA-NRCS 2007). The soil is a sandy loam and is light red in color, with a neutral reactivity (pH 6.7). Compaction was noted at about 6 inches (15.2 cm). No rock was detected in the soil profile. The combined relative cover for vegetation and litter was 50% in 2004 and 68% in 2007. The relative bare ground cover was 49% in 2004 and 32% in 2007. The erosion condition was classified as stable in all sample years.

#### Browse

Prior to the treatment, the browse component was lacking. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) provided less than 1% cover in 2004 and 2% in 2007 after it was seeded. Density was estimated at only 80 plants/acre (198 plants/ha) in 2004 and 6,440 plants/acre (15,907 plants/ha) in 2007. The population was comprised of mostly mature and decadent plants in 2004, but was entirely young and mature by 2007. Seedlings were sampled for the first time in 2007 at a density of 5,380 plants/acre (13,289 plants/ha). Plant vigor was excellent in both sample years, and use was heavy in 2004 and light-moderate in 2007.

Forage kochia (*Kochia prostrata*) was also seeded in the treatment (see list below). Its density was 2,880 plants/acre (7,114 plants/ha) in 2007. The population was composed of 76% mature and 24% young plants. Seedling plants were also sampled at an estimated density of 540 plants/acre (1,334 plants/ha). There were no decadent plants in the population. Plant vigor was excellent, and use was mostly light-moderate. Broom snakeweed (*Gutierrezia sarothrae*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and prickly pear (*Opuntia* sp.) were also sampled.

#### Herbaceous Understory

In 2004, the herbaceous understory was dominated by crested wheatgrass, which was sampled in 85% of the quadrats and provided 16% cover. In 2007, it was sampled in 40% of the quadrats and its cover was reduced to 2%. Sixweeks fescue (*Vulpia octoflora*) was the dominant herbaceous species in 2007. It increased from being sampled in 81% of the quadrats in 2004 to 100% in 2007, and its average cover increased from 5% in 2004 to 20% in 2007. Galleta (*Hilaria jamesii*), Indian ricegrass (*Oryzopsis hymenoides*), Sandberg bluegrass (*Poa secunda*), Russian wildrye (*Elymus junceus*), and cheatgrass (*Bromus tectorum*) have also been sampled.

Two grass species, Russian wildrye and western wheatgrass (*Agropyron smithii*), were seeded with the treatment.

Scarlet globemallow (*Sphaeralcea coccinea*) was the most abundant perennial forb with approximately 3% cover in 2004 and less than 1% in 2007. It was sampled in 65% of the quadrats in 2004 and 43% in 2007. Woolly plantain (*Plantago patagonica*) was the most abundant annual forb. It was sampled in 68% of the quadrats in 2004 and 99% of the quadrats in 2007, and provided 2% cover in 2004 and 16% cover in 2007. Six forb species were seeded with the treatment (see list below).

#### 2007 Post-treatment Assessment

The preferred browse condition improved. Wyoming big sagebrush density increased substantially from 80 plants/acre (198 plants/ha) to 6,440 plants/acre (15,907 plants/ha). The recruitment of young increased from 0% to 68% of the population, and decadence decreased from 25% to 0%. Plant vigor remained excellent and use decreased from heavy to mostly light-moderate. Forage kochia was also seeded with the treatment. It was not sampled in 2004, however, in 2007 it had a density of 2,880 plants/acre (7,114 plants/ha). There was no decadence in the population and the recruitment of young was 24%. Plant vigor was excellent and use was mostly light-moderate. The seeding of fourwing saltbush (*Atriplex canescens*) was ineffective. It was not measured in either sample year. The grass condition did not improve. The sum of nested frequency of perennial grasses decreased 62%, and the average cover decreased from 17% to 2%. The nested frequency of crested wheatgrass and Sandberg bluegrass significantly decreased. Russian wildrye was the only seeded grass species sampled, and was sampled in 3% of the quadrats. The sum of nested frequency of annual grasses increased more than two-fold, and average cover increased from 5% to 21%. The nested frequency of six weeks fescue significantly increased. Cheatgrass, though not sampled in the 2004 pre-treatment data, was sampled in the post-treatment data. It was found in 53% of the quadrats in 2007. The forb component was dominated by annuals. The sum of nested frequency for annual forbs increased more than two-fold, and average cover increased from 3% to 17%. The nested frequencies of woolly plantain and annual stickseed (*Lappula occidentalis*) significantly increased. The sum of nested frequency of perennial forbs decreased 41%, and average cover decreased from 3% to 1%. The nested frequency of scarlet globemallow significantly decreased. Of the six seeded forb species in the treatment, alfalfa (*Medicago sativa*) was the only one sampled in 2007. It was sampled in 3% of the quadrats. In 2004, the winter range condition determined by the Desirable Components Index (DCI) score was fair due to poor browse cover with high decadence and low recruitment, as well as high perennial grass cover, and low annual grass and perennial forb cover. In 2007, the DCI score declined to very poor due to decreased perennial grass cover and increased annual grass cover.

2004 winter range condition (DCI) - fair (32) Low potential scale

2007 winter range condition (DCI) - very poor (-7) Low potential scale

<b>Red Fleet Seed Mix</b>	<b>Bulk lbs/ac</b>
Russian Wildrye 'Bozoisky'	1.0
Western Wheatgrass 'Arriba'	1.0
Alfalfa 'Ladak+'	1.5
Small Burnet 'Delar'	2.5
Cicer Milkvetch 'Lutana'	1.0
Sagebrush, Wyoming--Sanpete UT	0.4
Sagebrush, Wyoming	0.5
Fourwing Saltbush--Emery UT	1.0
Forage Kochia 'Immigrant'	1.1
Blue Flax 'Appar'	0.1
Western Yarrow	0.1
Sainfoin 'Eski'	1.5
<b>Total Bulk lbs/acre</b>	<b>11.7</b>
<b>Total PLS lbs/acre</b>	<b>9.3</b>

HERBACEOUS TRENDS --

Management unit 09R, Study no: 5

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	<sub>b</sub> 241	<sub>a</sub> 101	16.35	1.56
G	Bromus tectorum (a)	-	145	-	.97
G	Elymus junceus	-	6	-	.06
G	Hilaria jamesii	6	-	.19	-
G	Oryzopsis hymenoides	3	-	.03	-
G	Poa secunda	<sub>b</sub> 42	<sub>a</sub> 4	.70	.04
G	Vulpia octoflora (a)	<sub>a</sub> 301	<sub>b</sub> 490	5.31	19.67
Total for Annual Grasses		301	635	5.31	20.64
Total for Perennial Grasses		292	111	17.27	1.67
Total for Grasses		593	746	22.58	22.32
F	Alyssum alyssoides (a)	-	2	-	.00
F	Calochortus nuttallii	6	-	.01	-
F	Chenopodium leptophyllum(a)	48	-	.11	-
F	Descurainia pinnata (a)	-	7	-	.05
F	Lappula occidentalis (a)	<sub>a</sub> 31	<sub>b</sub> 85	.81	.93
F	Machaeranthera canescens	<sub>a</sub> 1	<sub>a</sub> 1	.03	.00
F	Medicago sativa	-	7	-	.04
F	Plantago patagonica (a)	<sub>a</sub> 207	<sub>b</sub> 442	2.05	15.51
F	Sisymbrium altissimum (a)	-	59	-	.46
F	Sphaeralcea coccinea	<sub>b</sub> 170	<sub>a</sub> 99	2.61	.51
F	Unknown forb-perennial	3	-	.03	-



Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
	Total for Annual Forbs	286	595	2.98	16.97
	Total for Perennial Forbs	180	107	2.68	0.55
	Total for Forbs	466	702	5.66	17.53

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 09R, Study no: 5

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia nova	1	0	-	-
B	Artemisia tridentata wyomingensis	2	73	.38	2.35
B	Chrysothamnus nauseosus	1	5	-	.01
B	Chrysothamnus viscidiflorus	1	7	-	.00
B	Grayia spinosa	0	0	-	.00
B	Gutierrezia sarothrae	58	40	1.16	.86
B	Kochia prostrata	0	54	-	.48
B	Opuntia sp.	44	35	1.54	.13
	Total for Browse	107	214	3.08	3.85

#### CANOPY COVER, LINE INTERCEPT --

Management unit 09R, Study no: 5

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	.16	1.71
Chrysothamnus nauseosus	-	.03
Gutierrezia sarothrae	1.18	1.63
Kochia prostrata	-	.18
Opuntia sp.	1.56	.23

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 09R, Study no: 5

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	-	2.0

BASIC COVER --

Management unit 09R, Study no: 5

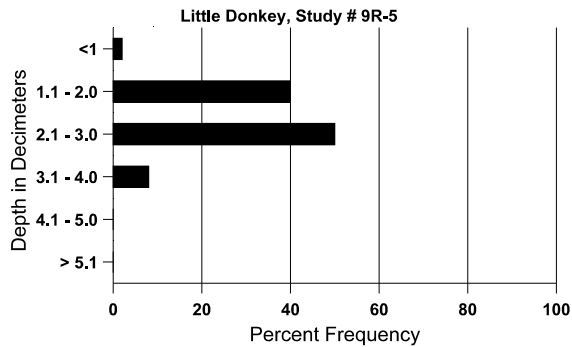
Cover Type	Average Cover %	
	'04	'07
Vegetation	38.31	47.72
Rock	0	.03
Pavement	.05	.01
Litter	17.45	29.25
Cryptogams	1.03	.36
Bare Ground	54.10	36.47

SOIL ANALYSIS DATA --

Management unit 9R, Study no: 5, Study Name: Little Donkey

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
12.7	67.2 (13.2)	6.7	60.4	22.2	17.5	1.0	14.7	316.8	0.6

### Stoniness Index



PELLET GROUP DATA --

Management unit 09R, Study no: 5

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	77	96	-	-
Grouse	1	-	-	-

Type	Quadrat Frequency	
	'04	'07
Elk	11	1
Deer	35	8
Cattle	16	5
Antelope	-	2

Days use per acre (ha)	
'04	'07
7 (18)	6 (15)
11 (26)	11 (28)
6 (16)	7 (18)
-	-

**BROWSE CHARACTERISTICS --**  
Management unit 09R, Study no: 5

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
04	<b>20</b>	-	-	-	20	-	0	100	100	100	100	10/15
07	<b>0</b>	-	-	-	-	-	0	0	0	-	0	-/-
<b>Artemisia tridentata wyomingensis</b>												
04	<b>80</b>	-	-	60	20	-	0	100	25	-	0	14/24
07	<b>6440</b>	5380	4400	2040	-	20	22	3	0	-	0	9/10
<b>Chrysothamnus nauseosus</b>												
04	<b>20</b>	-	-	20	-	60	0	0	-	-	0	8/13
07	<b>100</b>	20	60	40	-	-	20	0	-	-	0	9/10
<b>Chrysothamnus viscidiflorus</b>												
04	<b>40</b>	-	-	40	-	-	0	0	-	-	0	4/7
07	<b>200</b>	20	40	160	-	-	0	0	-	-	0	6/7
<b>Gutierrezia sarothrae</b>												
04	<b>6360</b>	-	1160	5160	40	100	0	0	1	.31	.31	5/6
07	<b>1800</b>	320	140	1220	440	60	4	0	24	13	22	6/8
<b>Kochia prostrata</b>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>2880</b>	540	680	2200	-	-	24	25	-	-	0	5/7
<b>Opuntia sp.</b>												
04	<b>1260</b>	-	60	1140	60	20	0	0	5	-	0	4/18
07	<b>1000</b>	-	20	540	440	60	0	0	44	28	32	3/13

Trend Study 9R-6-07

Study site name: North Little Donkey .

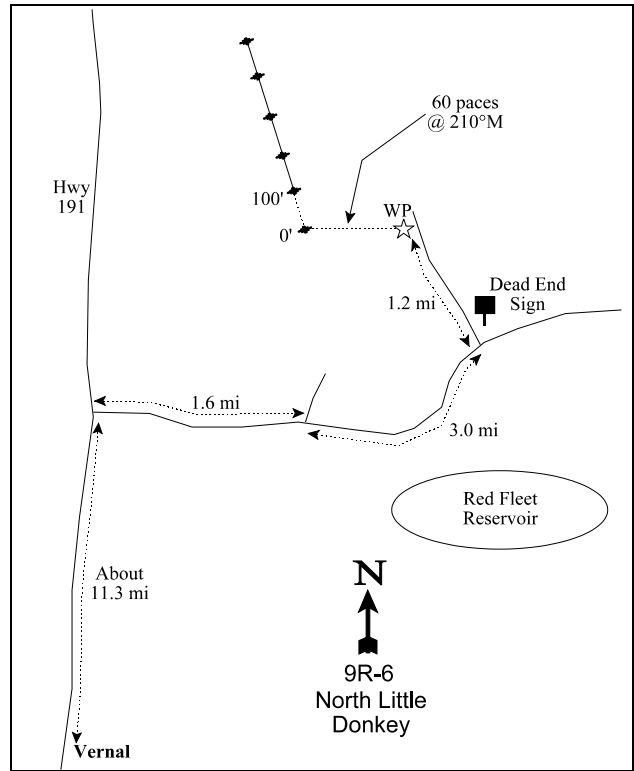
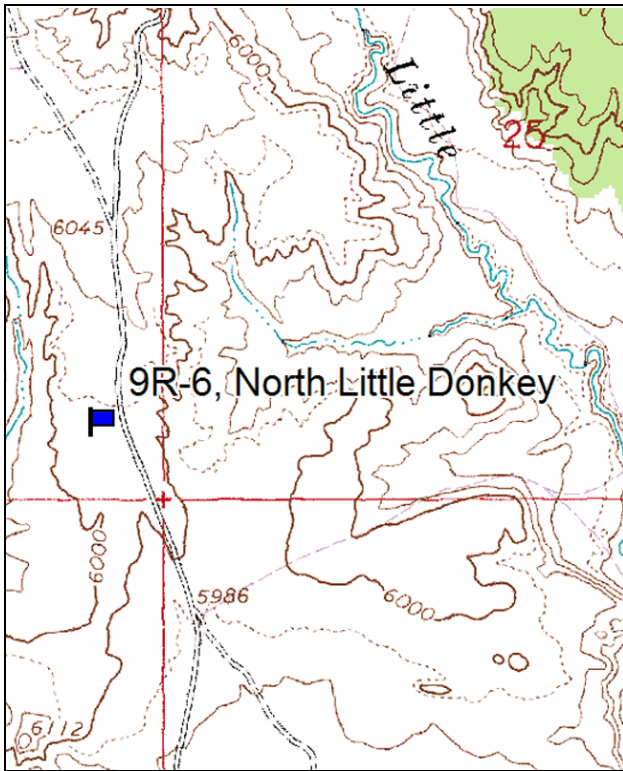
Vegetation type: Wyoming Big Sagebrush .

Compass bearing: frequency baseline 340 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Vernal travel north on Highway 191 for about 11.3 miles to a road that comes in from the right. Turn here and travel 1.6 miles to a fork, stay to the right. Continue 3.0 miles, passing Red Fleet Reservoir, to another fork with a dead end sign and continue left. Drive 1.2 miles to a witness post on the left side of the road. The 0-foot stake is 60 paces from the witness post at 210°M, with browse tag #36.



Map Name: Donkey Flat

Diagrammatic Sketch

Township 2S , Range 22E , Section 26

GPS: NAD 83, UTM 12T 634833 E 4496614 N

## DISCUSSION

### North Little Donkey - Trend Study No. 9R-6

#### Study Information

This study is located on a Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) flat about 2 miles (3.2 km) north of Little Donkey Flat [elevation: 6,000 feet (1,829 m), slope: 1%-2%, aspect: southwest]. This treatment was established in 2004 as part of the Red Fleet habitat projects. In fall 2004, the area was drill seeded to enhance grasses, forbs, and shrubs. It is located in a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above average for 2004, 2005, and 2006 at the Vernal weather station located approximately 12 miles (19 km) southwest of the site. Spring precipitation was above normal in 2005 and 2006, and 86% of normal in 2007. Fall precipitation was above normal in 2004, 2005, and 2006 (Utah Climate Summaries 2007). This area is considered winter range. From the pellet group transect data, deer use was estimated at 21 days use/acre (53 ddu/ha) in 2004 and 11 days use/acre (28 ddu/ha) in 2007. Elk use was estimated at 18 days use/acre (45 edu/ha) in 2004 and 7 days use/acre (18 edu/ha) in 2007. Cattle use was estimated at 25 days use/acre (61 cdu/ha) in 2004 and 20 days use/acre (50 cdu/ha) in 2007. Rabbit use was also high, with a pellet quadrat frequency of 69% in 2004 and 91% in 2007.

#### Soil

The soil is in the Abracon series which consists of very deep, well-drained soils that formed in slope alluvium and colluvium derived from sandstone, shale, limestone, and quartzite. Abracon soils are on fan remnants, hills, toeslopes or mesas (USDA-NRCS 2007). The soil is clay loam that is light red in color, and has neutral reactivity (pH 7.2). Phosphorus is low at only 5 ppm. Soil less than 6 ppm may be limiting to plant growth and development (Tiedemann and Lopez 2004). A layer of calcium carbonate was noted at a depth of about 10 inches (25 cm). No rock was sampled throughout the soil profile. The combined vegetation and litter relative cover was 42% in 2004 and 45% in 2007. The relative bare ground cover was 56% in 2004 and 54% in 2007. It was noted in 2004 that the soil surface was extensively cracked, with pedestalling around shrubs at 1-3 inches (4-8 cm). The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Wyoming big sagebrush was the dominant browse species, but much of the sagebrush had died due to drought and/or winter injury in 2003. The sagebrush density was 1,720 plants/acre (4,248 plants/ha) in 2004 and 2,440 plants/acre (6,027 plants/ha) in 2007. Sagebrush cover was only approximately 1% in both sample years. The recruitment of young plants increased from 1% of the population in 2004 to 35% in 2007, and decadence decreased from 73% to 20%. The estimated number of seedlings increased from 160 plants/acre (395 plants/ha) in 2004 to 4,040 plants/acre (9,979 plants/ha) in 2007. Plants classified as having poor vigor decreased from 57% in 2004 to 18% in 2007. Plants showed signs of heavy use in 2004 and mostly moderate-heavy use in 2007.

Wyoming big sagebrush, fourwing saltbush (*Atriplex canescens*), and forage kochia (*Kochia prostrata*) were seeded in the treatment (see list below). In 2007, the most noticeable sign of the project treatment was the emergence of forage kochia. It had a density of 2,220 plants/acre (5,483 plants/ha). Fifty-nine percent of the population was mature and 41% was young. There were also many seedlings, with an estimated density of 2,200 plants/acre (5,434 plants/ha). Plant vigor was excellent and use was mostly light. Other palatable browse species sampled were fourwing saltbush and rubber rabbitbrush (*Chrysothamnus nauseosus*).

#### Herbaceous Understory

There were only four perennial grass species sampled in 2004 and five in 2007. Two of these species, western wheatgrass (*Agropyron smithii*) and Russian wildrye (*Elymus junceus*), were seeded with the treatment (see list below). Cattle utilization on grasses appeared to be heavy in 2004 and 2007. Crested wheatgrass (*Agropyron cristatum*) was the most abundant species with nearly 5% cover in 2004 and 10% cover in 2007. Sandberg

bluegrass (*Poa secunda*) was not very abundant in 2004, with less than 1% cover, but increased to 1% cover in 2007. Other grasses were not abundant, each providing less than 1% cover. The total perennial grass cover increased from 5% in 2004 to nearly 12% in 2007. Cheatgrass (*Bromus tectorum*) was sampled for the first time in 2007 and was found in 3% of the quadrats.

The forb component was dominated by annuals. Annual stickseed (*Lappula occidentalis*) was extremely abundant with nearly 19% cover in 2004, which decreased to 3% in 2007. It was found in over 90% of the quadrats in both sample years. Scarlet globemallow (*Sphaeralcea coccinea*) was the most abundant perennial forb. It provided 2% cover in 2004 and less than 1% in 2007. The seeded forb species in the treatment were alfalfa (*Medicago sativa*), small burnet (*Sanguisorba minor*), cicer milkvetch (*Astragalus cicer*), blue flax (*Linum perenne*), western yarrow (*Achillea millefolium*), and sainfoin (*Onobrychis viciaefolia*) (see list below). None of these species were sampled in either year.

#### 2007 Post-treatment Assessment

The key browse component improved. The density of Wyoming big sagebrush increased 30%. The recruitment of young increased from 1% of the population to 35%, and decadence decreased from 73% to 20%. Plants showing poor vigor decreased from 57% of the population to 18%, and browse use decreased from heavy to moderate-heavy. Forage kochia was sampled for the first time with a density of 2,220 plants/acre (5,483 plants/ha). There were no decadent plants in the population and the recruitment of young was high at 41%. Use was mostly light. The grass component improved. The sum of nested frequency of perennial grasses increased more than two-fold, and average cover increased from 5% to 12%. The nested frequencies of crested wheatgrass and Sandberg bluegrass increased significantly. Western wheatgrass and Russian wildrye were seeded in the treatment (see list below). However, neither species was very abundant. Annuals continued to dominate the forb component of the understory. The sum of nested frequency of annual forbs changed little, however, the average cover decreased from 19% to 4%. The nested frequency of annual stickseed decreased significantly, and the nested frequency for tansymustard (*Descurainia pinnata*) significantly increased. Scarlet globemallow remained the dominant perennial forb. No seeded forb species were sampled. In 2004, the winter range condition determined by the Desirable Components Index (DCI) score was poor due to low browse cover with high decadence and low recruitment, as well as low perennial grass and forb cover. In 2007, the DCI score improved to fair due to increased perennial grass cover.

2004 winter range condition (DCI) - poor (16) Low potential scale

2007 winter range condition (DCI) - fair (26) Low potential scale

<b>Red Fleet Seed Mix</b>	<b>Bulk lbs/ac</b>
Russian Wildrye 'Bozoisky'	1.0
Western Wheatgrass 'Arriba'	1.0
Alfalfa 'Ladak+'	1.5
Small Burnet 'Delar'	2.5
Cicer Milkvetch 'Lutana'	1.0
Sagebrush, Wyoming--Sanpete UT	0.4
Sagebrush, Wyoming	0.5
Fourwing Saltbush--Emery UT	1.0
Forage Kochia 'Immigrant'	1.1
Blue Flax 'Appar'	0.1
Western Yarrow	0.1
Sainfoin 'Eski'	1.5
<b>Total Bulk lbs/acre</b>	<b>11.7</b>
<b>Total PLS lbs/acre</b>	<b>9.3</b>

HERBACEOUS TRENDS --

Management unit 09R, Study no: 6

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	<sub>a</sub> 199	<sub>b</sub> 302	4.57	10.05
G	Agropyron smithii	-	47	-	.18
G	Bromus tectorum (a)	-	6	-	.01
G	Elymus junceus	<sub>a</sub> 8	<sub>a</sub> 5	.33	.18
G	Oryzopsis hymenoides	1	-	.03	-
G	Poa secunda	<sub>a</sub> 24	<sub>b</sub> 194	.21	1.27
Total for Annual Grasses		0	6	0	0.01
Total for Perennial Grasses		232	548	5.15	11.69
Total for Grasses		232	554	5.15	11.70
F	Chenopodium leptophyllum(a)	4	-	.02	-
F	Comandra pallida	-	1	-	.00
F	Collinsia parviflora (a)	-	1	-	.00
F	Descurainia pinnata (a)	<sub>a</sub> 2	<sub>b</sub> 63	.01	.21
F	Halogeton glomeratus (a)	<sub>a</sub> 2	<sub>a</sub> 9	.00	.05
F	Lappula occidentalis (a)	<sub>b</sub> 430	<sub>a</sub> 322	18.69	3.34
F	Phlox longifolia	<sub>a</sub> 10	<sub>a</sub> 9	.02	.01
F	Ranunculus testiculatus (a)	-	27	-	.04
F	Salsola iberica (a)	20	-	.47	-
F	Sphaeralcea coccinea	<sub>a</sub> 149	<sub>a</sub> 119	2.15	.52
F	Townsendia sp.	3	-	.00	-

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
	Total for Annual Forbs	458	422	19.20	3.65
	Total for Perennial Forbs	162	129	2.18	0.54
	Total for Forbs	620	551	21.39	4.20

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 09R, Study no: 6

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	50	54	.98	.85
B	<i>Atriplex canescens</i>	0	0	-	-
B	<i>Chrysothamnus nauseosus</i>	0	0	-	-
B	<i>Gutierrezia sarothrae</i>	4	5	.01	.03
B	<i>Kochia prostrata</i>	0	29	-	.29
B	<i>Opuntia sp.</i>	2	1	-	-
	Total for Browse	56	89	0.99	1.16

#### CANOPY COVER, LINE INTERCEPT --

Management unit 09R, Study no: 6

Species	Percent Cover	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	1.08	1.01
<i>Gutierrezia sarothrae</i>	-	.08
<i>Kochia prostrata</i>	-	.25

#### KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 09R, Study no: 6

Species	Average leader growth (in)	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	2.5	1.5



**BASIC COVER –**

Management unit 09R, Study no: 6

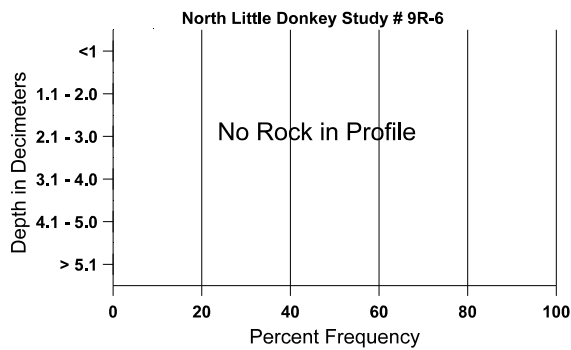
Cover Type	Average Cover %	
	'04	'07
Vegetation	28.79	18.97
Rock	.00	0
Pavement	.50	.09
Litter	17.93	31.28
Cryptogams	.90	1.17
Bare Ground	62.21	60.14

**SOIL ANALYSIS DATA --**

Management unit 9R, Study no: 6, Study Name: North Little Donkey

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
12.6	65.0 (14.7)	7.2	33.0	39.5	27.5	1.3	5.0	300.8	0.6

**Stoniness Index**



**PELLET GROUP DATA --**

Management unit 09R, Study no: 6

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	69	91	-	-
Elk	17	3	18 (450)	7 (18)
Deer	30	7	21 (53)	11 (28)
Cattle	9	4	25 (61)	20 (50)

BROWSE CHARACTERISTICS --  
 Management unit 09R, Study no: 6

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>1720</b>	160	20	440	1260	2820	3	97	73	57	57	11/17
07	<b>2440</b>	4040	860	1100	480	2260	48	36	20	17	18	8/11
<i>Atriplex canescens</i>												
04	<b>0</b>	-	-	-	-	20	0	0	-	-	0	24/27
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	25/32
<i>Chrysothamnus nauseosus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	11/14
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Gutierrezia sarothrae</i>												
04	<b>140</b>	-	20	120	-	-	0	14	0	-	0	5/8
07	<b>220</b>	60	-	100	120	-	18	0	55	45	45	6/9
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>2220</b>	2200	920	1300	-	-	3	3	-	-	0	4/5
<i>Opuntia sp.</i>												
04	<b>60</b>	-	-	20	40	-	0	0	67	-	0	4/12
07	<b>20</b>	-	20	-	-	-	0	0	0	-	0	3/6

Trend Study 9R-7-04

Study site name: Red Fleet Lop and Scatter .

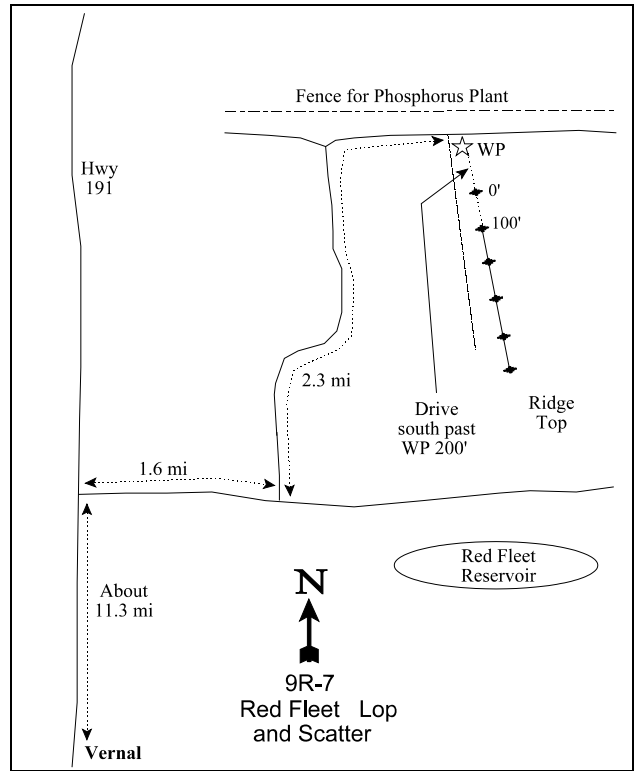
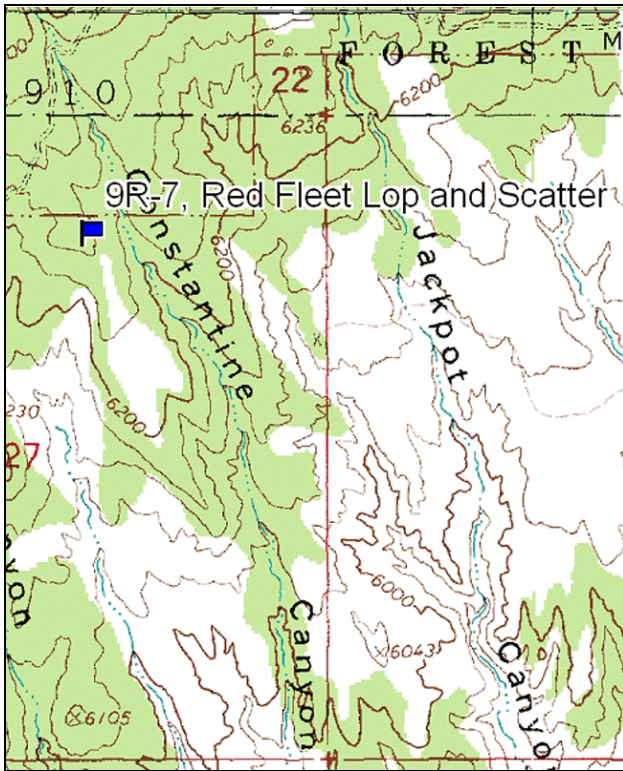
Vegetation type: Pinyon-Juniper Chaining .

Compass bearing: frequency baseline 142 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Vernal travel north on Highway 191 for about 11.3 miles to a road that comes in from the right. Turn here. Travel 1.6 miles to a fork and turn left. Travel 2.3 miles to the witness post. At the fence for the Phosphorus Plant turn right and continue east. The witness post is on the right side. Drive south of the witness post at 155°M for about 200 feet to the 0-foot stake with browse tag #37.



Map Name: Donkey Flat

Diagrammatic Sketch

Township 2S , Range 22E , Section 27

GPS: NAD 83, UTM 12T 632745 E 4497728 N

## DISCUSSION

### Red Fleet Lop and Scatter - Trend Study No. 9R-7

#### Study Information

This study monitors an old juniper (*Juniperus osteosperma*) chaining that was treated in the 1960s or 1970s [elevation: 6,300 feet (1,920 m), slope: 4%, aspect: southeast]. Due to the reinvasion of junipers within the chaining, this area was targeted to be re-treated before junipers dominated again. The study was established in June 2004, and juniper trees were cut in fall 2004. No seeding was done in this area. It is located in a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above average for 2004, 2005, and 2006 at the Vernal weather station located approximately 13 miles (21 km) southwest of the site. Spring precipitation was above normal in 2005 and 2006, and 86% of normal in 2007. Fall precipitation was above normal in 2004, 2005, and 2006 (Utah Climate Summaries 2007). Wildlife and livestock use was moderate in 2004. Elk and deer appear to use the area in winter and spring. From the pellet group transect data, deer use was estimated at 36 days use/acre (89 ddu/ha) in 2004 and 18 days use/acre (45 ddu/ha) in 2007. Elk use was estimated at 46 days use/acre (114 edu/ha) in 2004 and 29 days use/acre (71 edu/ha) in 2007. Cattle use was estimated at 21 days use/acre (52 cdu/ha) in 2004 and 20 days use/acre (48 cdu/ha) in 2007.

#### Soil

The soil is in the Abracon series, which consists of very deep, well-drained soils that formed in slope alluvium and colluvium derived from sandstone, shale, limestone, and quartzite. Abracon soils are on fan remnants, hills, toeslopes or mesas (USDA-NRCS 2007). The soil texture is a loam and reactivity is neutral (pH 7.2). The soil is light brown in color and mixed with gravel in the top 6 inches (15 cm). From 6-10 inches (15-25 cm) in depth, compacted clay and rock were more prominent. A calcium carbonate covered rock layer is located at about 10 inches (25 cm). The relative cover for litter increased from 25% in 2004 to 37% in 2007, but the relative cover for pavement decreased from 24% in 2004 to 15% in 2007. Relative vegetation and rock cover changed little between sample years. The relative bare ground cover was stable at 22% both sample years. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Prior to the lop and scatter treatment, the point-quarter method data estimated juniper density at 66 trees/acre (163 trees/ha). Ten percent of the sampled trees had been knocked over but survived the previous chaining treatment. The post-treatment data estimated density at 41 trees/acre (101 trees/ha), most of which had been cut or were knocked over, but had survived. The mean diameter of juniper trees was 4.1 inches (10.4 cm) in 2004 and 3.4 inches (8.6 cm) in 2007. Juniper canopy cover was 9% in 2004 and 2% in 2007. Removing junipers should allow understory shrubs and herbaceous species to flourish with less competition. Tausch and West (1994) showed in southwestern Utah that as pinyon and juniper cover increase, the herbaceous understory decreases.

The sagebrush population on the study consists of black sagebrush (*Artemisia nova*) and Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*). Black sagebrush density was 1,880 plants/acre (4,644 plants/ha) in 2004 and 2,260 plants/acre (5,582 plants/ha) in 2007. Decadent plants comprised 18% of the population in 2004 and 5% in 2007, and young plants comprised 12% in 2004 and 25% in 2007. Plants showing poor vigor made up 12% of the population in 2004 and 5% in 2007. Browse use was mostly light-moderate in 2004 and increased to mostly heavy in 2007. The average annual leader growth was 2 inches (5.0 cm) in 2004 and 1.1 inches (2.9 cm) in 2007. No live Wyoming big sagebrush were sampled within the density strips in 2004 or 2007, however, a few were scattered throughout the study. The average annual leader growth for Wyoming big sagebrush was 2.1 inches (5.2 cm) in 2007.

Herbaceous Understory

There have been only four grass species sampled in the understory. Crested wheatgrass (*Agropyron cristatum*) was the dominant species with 13% cover in 2004 and 20% cover in 2007. It had a quadrat frequency of 80% in 2004 and 97% in 2007. Grazing was heavy on crested wheatgrass in 2004, and light in 2007. Sandberg bluegrass (*Poa secunda*), needle-and-thread (*Stipa comata*), and cheatgrass (*Bromus tectorum*) were also sampled, but had quadrat frequencies of 10% or less.

There are few forbs. Six perennial and five annual forbs have been measured. The most abundant forb was scarlet globemallow (*Sphaeralcea coccinea*). It provided 2% cover in 2004 and 1% cover in 2007. Although the understory lacks diversity, it should benefit from the removal of juniper.

2007 Post-treatment Assessment

The lop and scatter treatment was effective in reducing the juniper. Density decreased from 66 trees/acre (163 trees/ha) to 41 trees/acre (101 trees/ha), and most of those sampled had been knocked over or had been cut, but there was still noticeable live growth near the base of the tree trunk. The density of black sagebrush increased nearly 20%. Decadence decreased from 18% of the population to 5%, and the recruitment of young increased from 12% to 25%. There were no seedlings in 2004 and an estimated 240 seedling plants/acre (593 plants/ha) in 2007. Plants classified as having poor vigor decreased from 12% of the population to 5%, and browse use increased from light-moderate to heavy. The treatment seemed to have a positive effect on grasses as well. The sum of nested frequency for perennial grasses increased 66% and cover increased from 13% to 20%. The nested frequencies of crested wheatgrass and Sandberg bluegrass increased significantly. However, cheatgrass was sampled for the first time, with a quadrat frequency of 10%. The forb component declined. The sum of nested frequency for perennial forbs decreased 20%, and average cover decreased from 3% to 1%. The nested frequency of timber poisonvetch (*Astragalus convallarius*) significantly decreased and the nested frequency of scarlet globemallow significantly increased. The sum of nested frequency for annual forbs increased more than five-fold, but cover remained less than 1%. In 2004, the winter range condition determined by the Desirable Components Index (DCI) score was fair due to poor browse cover with high decadence and low recruitment, high perennial grass, low annual grass, and moderate perennial forb cover. In 2007, the DCI score remained fair.

2004 winter range condition (DCI) - fair (36) Low potential scale

2007 winter range condition (DCI) - fair (35) Low potential scale

HERBACEOUS TRENDS --

Management unit 09R, Study no: 7

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron cristatum</i>	<sub>a</sub> 257	<sub>b</sub> 416	13.26	20.30
G	<i>Bromus tectorum</i> (a)	-	28	-	.12
G	<i>Poa secunda</i>	<sub>a</sub> 3	<sub>b</sub> 19	.03	.11
G	<i>Stipa comata</i>	<sub>a</sub> 4	<sub>a</sub> 3	.01	.00
Total for Annual Grasses		0	28	0	0.12
Total for Perennial Grasses		264	438	13.30	20.42
Total for Grasses		264	466	13.30	20.54

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
		F	Astragalus convallarius	<sub>b</sub> 35	<sub>a</sub> 7
F	Chenopodium leptophyllum(a)	<sub>b</sub> 19	<sub>a</sub> 1	.10	.00
F	Cryptantha sp.	<sub>a</sub> 3	<sub>a</sub> 2	.00	.03
F	Descurainia pinnata (a)	<sub>a</sub> -	<sub>b</sub> 41	.00	.08
F	Draba sp. (a)	-	3	-	.00
F	Erigeron sp.	-	1	-	.00
F	Gilia sp. (a)	1	-	.00	-
F	Ipomopsis congesta	10	-	.09	-
F	Lappula occidentalis (a)	<sub>a</sub> -	<sub>b</sub> 70	.00	.32
F	Sphaeralcea coccinea	<sub>a</sub> 61	<sub>b</sub> 80	2.21	1.27
F	Townsendia sp.	3	-	.00	-
Total for Annual Forbs		20	115	0.12	0.41
Total for Perennial Forbs		112	90	3.37	1.38
Total for Forbs		132	205	3.49	1.80

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 09R, Study no: 7

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
		B	Artemisia nova	22	24
B	Artemisia tridentata wyomingensis	0	0	-	-
B	Chrysothamnus nauseosus	1	0	.15	-
B	Chrysothamnus viscidiflorus viscidiflorus	1	1	-	.03
B	Gutierrezia sarothrae	9	15	.06	.05
B	Juniperus osteosperma	7	5	7.62	.68
B	Opuntia sp.	11	10	.48	.21
B	Purshia tridentata	0	0	-	-
Total for Browse		51	55	10.58	2.75

CANOPY COVER, LINE INTERCEPT --  
 Management unit 09R, Study no: 7

Species	Percent Cover	
	'04	'07
Artemisia nova	.91	.71
Chrysothamnus viscidiflorus viscidiflorus	-	.15
Juniperus osteosperma	9.21	2.48
Opuntia sp.	.71	.21

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 09R, Study no: 7

Species	Average leader growth (in)	
	'04	'07
Artemisia nova	2.0	1.1
Artemisia tridentata wyomingensis	-	2.1

POINT-QUARTER TREE DATA --  
 Management unit 09R, Study no: 7

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	66	41

Average diameter (in)	
'04	'07
4.2	3.4

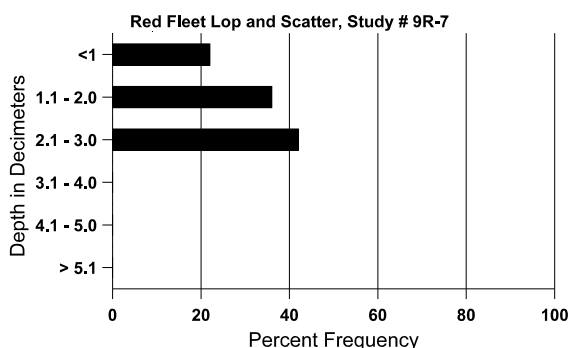
BASIC COVER --  
 Management unit 09R, Study no: 7

Cover Type	Average Cover %	
	'04	'07
Vegetation	26.77	25.87
Rock	2.28	1.36
Pavement	26.86	16.01
Litter	27.71	41.33
Cryptogams	3.43	.90
Bare Ground	25.02	24.80

SOIL ANALYSIS DATA --  
 Management unit 9R, Study no: 7, Study Name: Red Fleet Lop and Scatter

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
10.2	63.0 (10.9)	7.2	40.6	35.9	23.5	4.2	13.3	217.6	1.3

## Stoniness Index



### PELLET GROUP DATA --

Management unit 09R, Study no: 7

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	26	67	-	-
Elk	47	12	46 (114)	29 (71)
Deer	25	9	36 (89)	18 (45)
Cattle	2	6	21 (52)	20 (48)

### BROWSE CHARACTERISTICS --

Management unit 09R, Study no: 7

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
04	<b>1880</b>	-	220	1320	340	1000	40	1	18	12	12	5/12
07	<b>2260</b>	240	560	1580	120	560	11	79	5	4	5	7/13
<b>Artemisia tridentata wyomingensis</b>												
04	<b>0</b>	-	-	-	-	260	0	0	-	-	0	10/19
07	<b>0</b>	-	-	-	-	140	0	0	-	-	0	16/24
<b>Chrysothamnus nauseosus</b>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	9/13
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	16/12
<b>Chrysothamnus viscidiflorus viscidiflorus</b>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	7/11



		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Gutierrezia sarothrae</i>												
04	<b>200</b>	20	40	160	-	-	0	0	0	-	0	7/11
07	<b>500</b>	1720	40	280	180	60	4	32	36	8	44	8/11
<i>Juniperus osteosperma</i>												
04	<b>160</b>	-	-	160	-	-	13	0	0	-	0	-/-
07	<b>100</b>	-	-	80	20	20	0	0	20	20	80	-/-
<i>Opuntia sp.</i>												
04	<b>300</b>	-	-	280	20	-	0	0	7	7	7	4/17
07	<b>220</b>	20	-	160	60	-	0	9	27	18	18	3/11
<i>Purshia tridentata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	15/75

Trend Study 10-3-07

Study site name: Lower McCook Ridge Chaining .

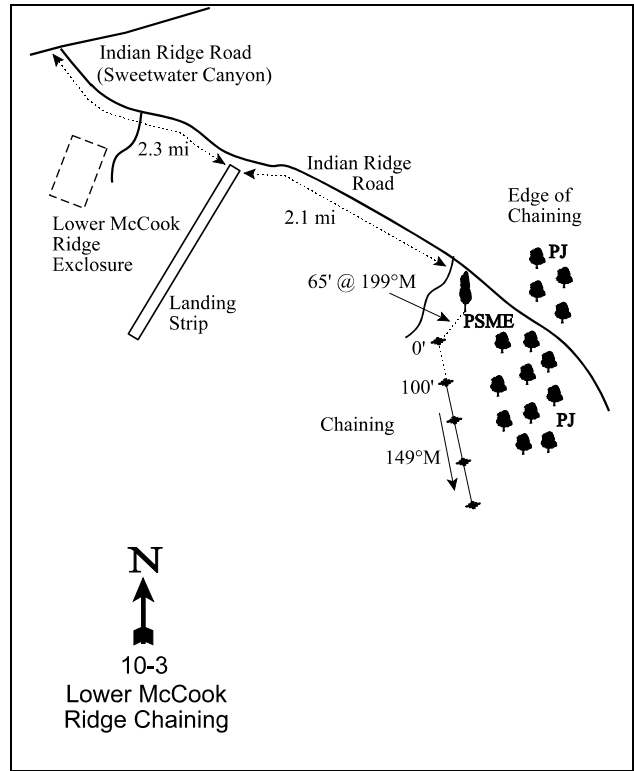
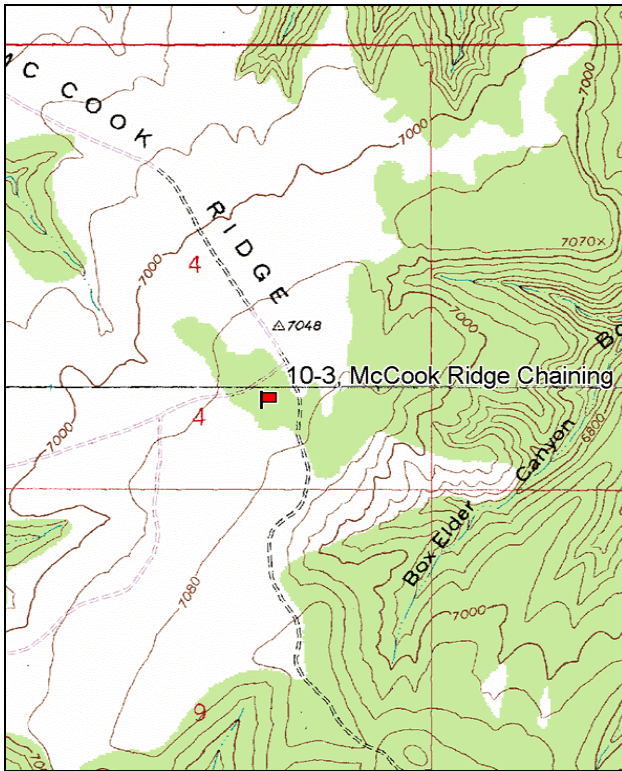
Vegetation type: Chained, Seeded PJ .

Compass bearing: frequency baseline 149 degrees magnetic.

Frequency belt placement: line 1 (11 & 95ft), line 2 (34ft), line 3 (59ft), line 4 (71ft).

LOCATION DESCRIPTION

From the intersection of the Indian Ridge and McCook Ridge roads, go southeast on McCook Ridge for 2.3 miles to a landing strip on the right side of the road (just past enclosure). Proceed an additional 2.1 miles up McCook Ridge into a chained area. Turn right off the main road before the edge of the chaining, and proceed over to a large, lone douglas fir. The 0-foot baseline stake, marked by browse tag # 9036, is 13 paces from the tree at a bearing of 199°M. The frequency baseline is marked by green, 12-18 inch tall fenceposts.



Map Name: Burnt Timber Canyon .

Diagrammatic Sketch

Township 14S , Range 24E , Section 4

GPS: NAD 83, UTM 12S 651666 E 4387543 N

## DISCUSSION

### Lower McCook Ridge Chaining - Trend Study No. 10-3

#### Study Information

This study was established in 1982 as a permanent range trend study. It is located on a pinyon-juniper chaining that was treated in the 1960s, approximately 2 miles (3.2 km) southeast of the Lower McCook Ridge enclosure [elevation: 7,030 feet (2,143 m), slope: 5%, aspect: southwest]. The study area was re-treated in April 2005 with a bullhog to remove much of the pinyon and juniper. A total of 600 acres (243 ha) were bullhogged, but were not seeded. In 2007, the study was sampled to measure the effectiveness of the bullhog treatment. It is located in a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). There were no local precipitation data available for the study, however, annual precipitation for wildlife management unit 10 was above normal in 2005 and 87% of normal in 2006. Spring precipitation was 65% of normal in 2005, 94% in 2006, and 75% in 2007. Fall precipitation was above normal in 2005 and 2006 (Utah Climate Summaries 2007). The area is considered important deer and elk winter range that is also grazed by livestock in the Sweetwater allotment from May 1 to October 31. Cattle use the area on a rotational deferred management system, with selective periods for rest. From the pellet group transect data, deer use was estimated at 25 days use/acre (62 ddu/ha) in 2000, 24 days use/acre (60 ddu/ha) in 2005, and 32 days use/acre (79 ddu/ha) in 2007. Elk use was estimated at 19 days use/acre (47 edu/ha) in 2000, 20 days use/acre (50 edu/ha) in 2005, and 12 days use/acre (30 edu/ha) in 2007. Cattle use was estimated at 2 cattle days use/acre (4 cdu/ha) in 2005 and 11 days use/acre (27 cdu/ha) in 2007. It was noted in 2005 and 2007 that cattle were using the area during sampling. A large wildfire started in the area in late May 2000. The firefighters were finishing putting the fire out when the site was read during the first week of June 2000. The edge of the fire came within 1,000 feet (305 m) of the study area to the east. Grasses were abundant in the burned area in 2005.

#### Soil

The soil is classified as a Tabyago-Cedarknoll association. The Tabyago series consists of moderately deep, well-drained soils that formed in eolian deposits over residuum derived from sandstone and shale. The Cedarknoll series consists of shallow, well-drained soils that formed in eolian deposits over residuum derived from siltstone and sandstone (USDA-NRCS 2007). The soil texture is a clay loam with a neutral reaction (pH 7.1). Organic matter is 4%, and there is evidence of shrinking clays in the soil with surface cracks present. The combined relative cover of rock and pavement decreased from 5% in 1995 to 2% in 2007. The combined relative cover of vegetation and litter decreased from 64% in 1995 to 60% in 2000, and increased to 69% by 2007. The relative cover for bare ground increased from 25% in 1995 to 34% in 2005, and decreased to 28% in 2007. In 2007, the erosion condition was classified as slight due to pedestalling, the formation of rills, flow patterns, and the movement of litter and soil.

#### Browse

Photos indicate that pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) trees that survived the chaining increased considerably in size from 1982 to 2000. Point-quarter data estimated 106 pinyon trees/acre (262 trees/ha) in 1995 and 127 trees/acre (314 trees/ha) in 2000. After the bullhog treatment, pinyon density was reduced to 42 trees/acre (104 trees/ha) in 2005 and 20 trees/acre (49 trees/ha) in 2007. Line-intercept data estimated an average of 4% overhead canopy cover from pinyon trees in 2000, and less than 1% in 2005 and 2007.

Juniper density was 89 trees/acre (220 trees/ha) in 1995 and 147 trees/acre (363 trees/ha) in 2000. After the bullhog treatment, juniper density was 65 trees/acre (161 trees/ha) in 2005 and 51 trees/acre (126 trees/ha) in 2007. Line-intercept data estimated 1% juniper cover in 2005 and less than 1% in 2007. In 2005, it was noted that the pinyon-juniper density may decline, since 64% of the pinyon trees and 68% of the juniper trees sampled had been treated by the bullhog, but still had live green branches near the base of the tree.

Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) is the key browse species. There are some individual sagebrush plants that appear to be hybrids between mountain big sagebrush and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) or black sagebrush (*Artemisia nova*), but all sagebrush was classified as mountain big sagebrush until 2007 when the species were split and sampled individually. Mountain big sagebrush canopy cover was 5% in 2005 and 2007. Its density was 1,932 plants/acre (4,772 plants/ha) in 1982, 1,532 plants/acre (3,784 plants/ha) in 1988, 3,160 plants/acre (7,805 plants/ha) in 1995, 2,980 plants/acre (7,361 plants/ha) in 2000, 2,320 plants/acre (5,730 plants/ha) in 2005, and 2,360 plants/acre (5,829 plants/ha) in 2007. Some of the decline in 2005 may be due to trampling from the bullhog treatment. The reduction of pinyon and juniper may reduce competition enough for sagebrush to increase in the future. The recruitment of young decreased from 34% of the population in 1982 to 11% in 1988, increased to 50% in 1995, decreased to 3% by 2005, and increased to 13% in 2007. Decadence increased from 0% of the population in 1982 to 26% in 1988, decreased to 3% in 1995, increased to 34% in 2000, decreased to 27% in 2005, and increased to 29% in 2007. Plants showing poor vigor increased from 0% of the population in 1982 to 9% in 1988, decreased to 1% in 1995, increased to 28% in 2005, and decreased to 8% in 2007. Browse use was mostly light-moderate from 1982 to 2000 and mostly moderate-heavy in 2005 and 2007.

Black sagebrush had a density of 140 plants/acre (346 plants/ha) in 2007, and canopy cover was 1%. The recruitment of young and decadence were each 14% of the population. Plants showing poor vigor comprised 14% of the population, and browse use was light. Black sagebrush canopy cover was 1% in 2007.

Dwarf rabbitbrush (*Chrysothamnus depressus*) was very abundant. It had a density of 6,266 plants/acre (15,477 plants/ha) in 1982 and 27,266 plants/acre (67,347 plants/ha) by 1988. Densities then dropped to 13,660 plants/acre (33,740 plants/ha) in 1995, 15,500 plants/acre (38,285 plants/ha) in 2000, 11,020 plants/acre (27,219 plants/ha) in 2005, and 11,660 plants/acre (28,800 plants/ha) in 2007. Cover has remained constant at about 5% from 1995 to 2005. The recruitment of young has been 10% of the population or less in all sample years, except in 1988 when 45% of the population were young plants. Decadence has been 5% or less in all sample years, except in 2000 when 17% of the population was decadent. Plant vigor has been good in all sample years. Use was heavy in 1982, light-moderate from 1988 to 2000, and moderate-heavy in 2005 and 2007.

Other preferred species include fringed sagebrush (*Artemisia frigida*) and winterfat (*Ceratoides lanata*). However, these species are infrequent and in low densities. If more preferred shrubs such as antelope bitterbrush (*Purshia tridentata*), true mountain mahogany (*Cercocarpus montanus*) or fourwing saltbush (*Atriplex canescens*) were a part of the original seed mixture, they have failed to become established.

#### Herbaceous Understory

Thirteen grass species have been sampled on the study, all of which are perennials. Grass cover was 12% in 1995 and 2005, 14% in 2000, and 23% in 2007. The most common species is crested wheatgrass (*Agropyron cristatum*). Its cover was 6% in 1995 and 2005, 10% in 2000, and 12% in 2007. Blue grama (*Bouteloua gracilis*) is also common. Its cover was 1% in 1995 and 2005, 2% in 2000, and 4% in 2007. Grasses and grass-like species that were measured in every sample year include thickspike wheatgrass (*Agropyron dasystachyum*), sedge (*Carex* sp.), Russian wildrye (*Elymus junceus*), prairie junegrass (*Koeleria cristata*), and Sandberg bluegrass (*Poa secunda*). Grasses were reportedly heavily grazed in the past. Smooth brome (*Bromus inermis*) decreased with each sampling and was not found in 2005 and 2007.

Forb composition is diverse, but not abundant. As many as 20 forb species have been sampled, but total forb cover has been 4% or less. Perennial forbs have been dominant. Perennial forb cover decreased from 4% in 1995 to 1% in the following sample years. Annual forbs were sparse and provided almost no cover in all sample years. The only seeded forb sampled was alfalfa (*Medicago sativa*), which had a quadrat frequency of 6% in 1995, 4% in 2000, 2% in 2005, and 1% in 2007. Its cover was 1% or less in all sample years.

### 1988 TREND ASSESSMENT

The browse trend is slightly down. The density for mountain big sagebrush decreased 21%. The recruitment of young to the population decreased from 34% to 11%, and decadence increased from 0% to 26%. Plants showing poor vigor increased from 0% to 9%, and browse use remained mostly light-moderate. However, the density for dwarf rabbitbrush increased more than three-fold. The recruitment of young increased from 0% to 45% of the population, and decadence increased slightly from 0% to 2%. Plant vigor was excellent, and browse use decreased from heavy to mostly light-moderate. The herbaceous understory was not measured in this sample year.

browse - slightly down (-1)      grass - N/A      forb - N/A

### 1995 TREND ASSESSMENT

The browse trend is stable. The density of mountain big sagebrush increased two-fold. The recruitment of young increased to 50% of the population, and decadence decreased to 3%. Plants classified as showing poor vigor improved from 9% of the population to nearly 0%. Browse use remained mostly light-moderate. The density of dwarf rabbitbrush decreased 50%. The recruitment of young decreased from 45% to 6% of the population, and decadence decreased slightly from 2% to 0%. Plant vigor was excellent, and browse use decreased from light-moderate to light. The changes in browse densities are partly due to the increased sample area. The grass trend is up. The sum of nested frequency for perennial grasses increased 31%. The nested frequencies for thickspike wheatgrass, blue grama, prairie junegrass, and Sandberg bluegrass increased significantly and the nested frequencies for crested wheatgrass, intermediate wheatgrass (*Agropyron intermedium*), smooth brome, and sedge all significantly decreased. The forb trend is up. The sum of nested frequency for perennial forbs increased 60%. The nested frequency of rayless tansyaster (*Machaeranthera grindelioides*) significantly decreased. The number of perennial forb species sampled increased from nine to 17. Annual forbs were sparse. The Desirable Components Index (DCI) score was good due to the high recruitment of young preferred browse into the population and low decadence.

winter range condition (DCI) - good (75) Mid-level potential scale  
browse - stable (0)      grass - up (+2)      forb - up (+2)

### 2000 TREND ASSESSMENT

The trend for browse is stable. The density for mountain big sagebrush decreased slightly. The recruitment of young decreased to 5% of the population, and decadence increased to 34%. Plants showing poor vigor increased to 19% of the population, and browse use remained mostly light-moderate. The density for dwarf rabbitbrush increased 14%. The recruitment of young increased slightly to 10% of the population, and decadence increased to 17%. Plants showing poor increased slightly from 0% to 3% of the population, and browse use increased from light to light-moderate. The grass trend is down. The sum of nested frequency for perennial grasses decreased 23%. The nested frequencies of blue grama and prairie junegrass decreased significantly. The forb trend is down. The sum of nested frequency for perennial forbs decreased 48%. The nested frequencies of rose pussytoes (*Antennaria rosea*), rockcress (*Arabis* sp.), and longleaf phlox (*Phlox longifolia*) significantly decreased. No annual forbs were sampled. The significant decrease in the sum of nested frequencies in the herbaceous understory may be partly due to drought conditions (Utah Climate Summaries 2007). The DCI score decreased to fair due to decreased browse cover and recruitment of young, increased browse decadence, and decreased perennial forb cover.

winter range condition (DCI) - fair (58) Mid-level potential scale  
browse - stable (0)      grass - down (-2)      forb - down (-2)

### 2005 TREND ASSESSMENT

The browse trend is down. The density of mountain big sagebrush decreased 22%. The recruitment of young decreased slightly from 5% of the population to 3%, and decadence decreased slightly from 34% to 27%.

Plants showing poor vigor increased to 28% of the population, and browse use increased from light-moderate to moderate-heavy. The density of dwarf rabbitbrush decreased 29%. The recruitment of young decreased from 10% of the population to 3%, and decadence decreased from 17% to 5%. The proportion of plants showing poor vigor remained stable at 3%, and browse use increased from light-moderate to moderate-heavy. The grass trend is stable. The sum of nested frequency for perennial grasses changed little. However, the nested frequencies of crested wheatgrass and thickspike wheatgrass significantly decreased. The forb trend is down. The sum of nested frequency for perennial forbs decreased 25%. One annual forb was sampled. The significant decrease in the sum of nested frequencies in the herbaceous understory may be due in part to drought conditions (Utah Climate Summaries 2007). The DCI score remained fair.

winter range condition (DCI) - fair (50) Mid-level potential scale  
browse - down (-2)                      grass - stable (0)                      forb - down (-2)

#### 2007 TREND ASSESSMENT

The browse trend is stable. The preferred browse changed little after the bullhog treatment. The density of mountain big sagebrush increased slightly. Recruitment of young increased from 3% of the population to 13%, and decadence increased slightly from 27% to 29%. Plants showing poor vigor decreased from 28% of the population to 8%, and browse use remained mostly moderate-heavy. Black sagebrush had a density of 140 plants/acre (346 plants/ha). Young plants and decadent plants each comprised 14% of the population. Vigor was good on most plants, and browse use was light. The density of dwarf rabbitbrush increased slightly. Young recruitment decreased from 3% of the population to 0%, and decadence decreased from 5% to 2%. Plants showing poor vigor changed little from 3% of the population to 2%, and browse use remained mostly moderate-heavy. The grass trend is up. The treatment seemed to improve the grass component. The sum of nested frequency for perennial grasses increased 27%, and average cover increased from 12% to 23%. The nested frequencies for blue grama, Russian wildrye, and needle-and-thread (*Stipa comata*) increased significantly, and the nested frequency of Sandberg bluegrass significantly declined. The forb trend is up. The sum of nested frequency for perennial forbs increased 22%. Annual forbs remained sparse. The DCI score remained fair.

winter range condition (DCI) - fair (57) Mid-level potential scale  
browse - stable (0)                      grass - up (+2)                      forb - up (+2)

HERBACEOUS TRENDS --  
Management unit 10 , Study no: 3

T y p e	Species	Nested Frequency					Average Cover %			
		'88	'95	'00	'05	'07	'95	'00	'05	'07
G	Agropyron cristatum	c <sub>257</sub>	ab <sub>168</sub>	b <sub>196</sub>	a <sub>143</sub>	a <sub>161</sub>	6.43	10.21	5.64	11.80
G	Agropyron dasystachyum	a <sub>2</sub>	c <sub>132</sub>	c <sub>104</sub>	ab <sub>41</sub>	b <sub>58</sub>	.56	.64	.37	.69
G	Agropyron intermedium	b <sub>67</sub>	a <sub>21</sub>	-	a <sub>14</sub>	a <sub>27</sub>	.16	-	.24	.42
G	Agropyron spicatum	a <sub>13</sub>	a <sub>16</sub>	-	a <sub>4</sub>	a <sub>9</sub>	.16	-	.03	.33
G	Bouteloua gracilis	a <sub>6</sub>	d <sub>106</sub>	bc <sub>86</sub>	b <sub>58</sub>	cd <sub>106</sub>	1.25	1.59	1.49	4.47
G	Bromus inermis	b <sub>52</sub>	a <sub>22</sub>	a <sub>3</sub>	-	-	.28	.03	-	-
G	Carex sp.	b <sub>33</sub>	a <sub>11</sub>	a <sub>3</sub>	a <sub>10</sub>	a <sub>10</sub>	.36	.30	.12	.10
G	Elymus junceus	a <sub>16</sub>	a <sub>12</sub>	a <sub>3</sub>	a <sub>6</sub>	b <sub>31</sub>	.33	.15	.33	1.00
G	Koeleria cristata	a <sub>11</sub>	c <sub>54</sub>	ab <sub>28</sub>	bc <sub>43</sub>	c <sub>56</sub>	.48	.14	.77	1.75
G	Oryzopsis hymenoides	a <sub>6</sub>	a <sub>6</sub>	-	a <sub>7</sub>	a <sub>10</sub>	.07	-	.19	.24
G	Poa secunda	a <sub>18</sub>	c <sub>81</sub>	bc <sub>73</sub>	c <sub>90</sub>	ab <sub>47</sub>	2.02	1.40	2.41	.44
G	Sitanion hystrix	a <sub>8</sub>	a <sub>4</sub>	-	a <sub>4</sub>	a <sub>2</sub>	.01	-	.06	.03
G	Stipa comata	a <sub>1</sub>	a <sub>9</sub>	-	b <sub>31</sub>	c <sub>54</sub>	.01	-	.71	1.35
Total for Annual Grasses		0	0	0	0	0	0	0	0	0
Total for Perennial Grasses		490	642	496	451	571	12.16	14.48	12.39	22.67
Total for Grasses		490	642	496	451	571	12.16	14.48	12.39	22.67
F	Antennaria rosea	-	b <sub>30</sub>	a <sub>12</sub>	ab <sub>19</sub>	a <sub>2</sub>	.17	.03	.11	.00
F	Arabis sp.	ab <sub>7</sub>	b <sub>29</sub>	a <sub>5</sub>	a <sub>2</sub>	ab <sub>16</sub>	.87	.01	.03	.03
F	Arenaria fendleri	a <sub>14</sub>	a <sub>3</sub>	a <sub>5</sub>	a <sub>11</sub>	a <sub>1</sub>	.03	.04	.02	.01
F	Astragalus spatulatus	b <sub>34</sub>	-	a <sub>5</sub>	-	-	-	.03	-	-
F	Caulanthus crassicaulis	2	-	-	-	-	-	-	-	-
F	Calochortus nuttallii	-	a <sub>6</sub>	-	a <sub>2</sub>	-	.01	-	.00	-
F	Castilleja sp.	-	22	-	-	-	.11	-	-	-
F	Crepis acuminata	-	6	-	-	-	.01	-	-	-
F	Cymopterus sp.	-	-	-	5	-	-	-	.01	-
F	Delphinium sp.	-	2	-	-	-	.00	-	-	-
F	Erigeron sp.	-	-	5	-	-	-	.01	-	-
F	Erigeron pumilus	-	a <sub>3</sub>	a <sub>6</sub>	a <sub>1</sub>	a <sub>3</sub>	.04	.02	.00	.03
F	Haplopappus acaulis	a <sub>11</sub>	a <sub>8</sub>	a <sub>15</sub>	a <sub>8</sub>	a <sub>8</sub>	.33	.54	.21	.16
F	Hymenoxys acaulis	-	a <sub>12</sub>	a <sub>1</sub>	a <sub>3</sub>	-	.80	.00	.03	-
F	Lappula occidentalis (a)	-	a <sub>2</sub>	-	a <sub>2</sub>	-	.00	-	.00	-
F	Machaeranthera canescens	-	-	-	-	10	-	-	-	.08
F	Machaeranthera grindelioides	b <sub>62</sub>	a <sub>13</sub>	a <sub>23</sub>	a <sub>8</sub>	a <sub>23</sub>	.14	.17	.08	.17
F	Medicago sativa	a <sub>1</sub>	a <sub>14</sub>	a <sub>8</sub>	a <sub>5</sub>	a <sub>3</sub>	1.24	.39	.06	.00
F	Oenothera caespitosa	-	-	1	-	-	-	.00	-	-

Type	Species	Nested Frequency					Average Cover %			
		'88	'95	'00	'05	'07	'95	'00	'05	'07
F	Orthocarpus sp. (a)	-	4	-	-	-	.01	-	-	-
F	Penstemon pachyphyllus	-	<sub>a</sub> 3	-	<sub>a</sub> 4	<sub>a</sub> -	.02	-	.06	.00
F	Physaria acutifolia	-	-	1	-	-	-	.00	-	-
F	Phlox austromontana	2	-	-	-	-	-	-	-	-
F	Phlox longifolia	-	<sub>b</sub> 41	<sub>a</sub> 13	<sub>a</sub> 2	<sub>a</sub> 18	.08	.03	.00	.09
F	Physaria sp.	<sub>a</sub> 9	-	-	-	<sub>a</sub> 3	-	-	-	.00
F	Polygonum douglasii (a)	-	7	-	-	-	.02	-	-	-
F	Salsola iberica (a)	-	-	-	-	1	-	-	-	.00
F	Sphaeralcea coccinea	-	<sub>a</sub> 28	<sub>a</sub> 19	<sub>a</sub> 18	<sub>a</sub> 22	.08	.04	.22	.14
F	Streptanthus cordatus	-	<sub>a</sub> 1	-	<sub>a</sub> 1	-	.00	-	.03	-
F	Taraxacum officinale	-	6	-	-	-	.01	-	-	-
Total for Annual Forbs		0	13	0	2	1	0.03	0	0.00	0.00
Total for Perennial Forbs		142	227	119	89	109	3.99	1.34	0.89	0.74
Total for Forbs		142	240	119	91	110	4.02	1.34	0.89	0.74

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 10 , Study no: 3

Type	Species	Strip Frequency				Average Cover %			
		'95	'00	'05	'07	'95	'00	'05	'07
B	Artemisia frigida	1	1	1	1	-	.15	.03	.03
B	Artemisia nova	0	0	0	3	-	-	-	.30
B	Artemisia tridentata vaseyana	52	54	46	43	5.73	7.76	4.46	4.24
B	Atriplex canescens	0	0	0	0	-	-	-	-
B	Ceratoides lanata	5	7	3	4	.09	.01	-	.03
B	Chrysothamnus depressus	47	48	43	44	5.34	4.88	4.76	4.59
B	Chrysothamnus nauseosus	0	0	0	0	-	-	-	-
B	Chrysothamnus nauseosus hololeucus	1	1	2	3	-	.00	.00	.03
B	Chrysothamnus viscidiflorus viscidiflorus	0	0	0	1	-	-	-	-
B	Gutierrezia sarothrae	31	29	30	36	.35	.36	.42	.25
B	Juniperus osteosperma	0	7	4	3	1.62	1.14	.18	-
B	Leptodactylon pungens	0	3	1	0	-	.15	-	-
B	Opuntia fragilis	1	0	0	0	.01	-	-	-



B	Pediocactus simpsonii	0	0	5	0	-	-	-	.00
B	Pinus edulis	0	4	3	4	1.79	3.83	.78	-
Total for Browse		138	154	138	142	14.95	18.32	10.67	9.48

CANOPY COVER, LINE INTERCEPT --

Management unit 10 , Study no: 3

Species	Percent Cover		
	'00	'05	'07
Artemisia frigida	-	-	-
Artemisia nova	-	-	.86
Artemisia tridentata vaseyana	-	4.88	5.31
Chrysothamnus depressus	-	3.40	4.91
Gutierrezia sarothrae	-	.25	1.39
Juniperus osteosperma	-	.61	.05
Pinus edulis	4.40	.35	.05

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 10 , Study no: 3

Species	Average leader growth (in)	
	'05	'07
Artemisia tridentata vaseyana	1.9	2.4

POINT-QUARTER TREE DATA --

Management unit 10 , Study no: 3

Species	Trees per Acre		
	'00	'05	'07
Juniperus osteosperma	147	65	51
Pinus edulis	127	42	20

Average diameter (in)		
'00	'05	'07
2.5	3.4	1.3
4.2	3.2	0.4

BASIC COVER --

Management unit 10 , Study no: 3

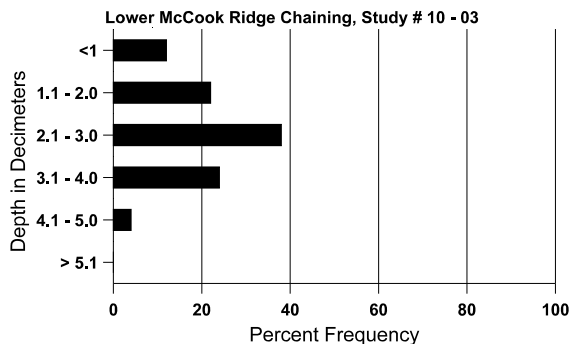
Cover Type	Average Cover %					
	'82	'88	'95	'00	'05	'07
Vegetation	5.25	12.50	32.93	34.54	21.94	33.57
Rock	1.00	2.50	2.11	1.52	.46	.97
Pavement	.75	5.25	2.95	1.11	1.33	1.22
Litter	73.25	69.00	36.46	34.29	46.71	44.93
Cryptogams	0	.50	6.62	5.81	2.19	.69
Bare Ground	19.75	10.25	26.86	37.16	36.87	31.81

SOIL ANALYSIS DATA --

Herd Unit 10, Study no: 3, Study Name: Lower McCook Ridge Chaining

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	ppm P	ppm K	dS/m
15.7	56.6 (16.1)	7.1	34.0	31.4	34.6	4.0	7.8	144.0	0.8

Stoniness Index



PELLET GROUP DATA --

Management unit 10 , Study no: 3

Type	Quadrat Frequency			
	'95	'00	'05	'07
Rabbit	16	33	47	62
Elk	24	5	11	18
Deer	13	6	18	18
Cattle	2	1	1	-

Days use per acre (ha)		
'00	'05	'07
-	-	-
19 (48)	20 (50)	12 (30)
25 (62)	24 (60)	32 (79)
-	2 (4)	11 (27)

BROWSE CHARACTERISTICS --

Management unit 10 , Study no: 3

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Artemisia frigida												
82	0	-	-	-	-	-	0	0	-	-	0	-/-
88	0	-	-	-	-	-	0	0	-	-	0	-/-
95	60	-	-	60	-	-	0	0	-	-	0	9/11
00	80	-	-	80	-	-	0	0	-	-	0	7/5
05	20	-	-	20	-	-	0	0	-	-	0	2/4
07	20	-	-	20	-	-	0	100	-	-	0	6/6

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
82	0	-	-	-	-	-	0	0	0	-	0	-/-
88	0	-	-	-	-	-	0	0	0	-	0	-/-
95	0	-	-	-	-	-	0	0	0	-	0	-/-
00	0	-	-	-	-	-	0	0	0	-	0	-/-
05	0	-	-	-	-	-	0	0	0	-	0	-/-
07	140	-	20	100	20	-	0	0	14	14	14	12/16
<b>Artemisia tridentata vaseyana</b>												
82	1932	400	666	1266	-	-	48	17	0	-	0	22/25
88	1532	266	266	866	400	-	57	13	26	-	9	24/29
95	3160	40	1580	1480	100	-	27	0	3	.63	.63	24/31
00	2980	-	160	1800	1020	100	40	9	34	19	19	23/26
05	2320	-	60	1640	620	160	38	33	27	18	28	19/24
07	2360	-	300	1380	680	360	34	50	29	8	8	23/29
<b>Atriplex canescens</b>												
82	0	-	-	-	-	-	0	0	-	-	0	-/-
88	0	-	-	-	-	-	0	0	-	-	0	-/-
95	0	-	-	-	-	-	0	0	-	-	0	-/-
00	0	-	-	-	-	-	0	0	-	-	0	26/24
05	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	-/-
<b>Ceratoides lanata</b>												
82	0	-	-	-	-	-	0	0	0	-	0	-/-
88	199	-	133	66	-	-	0	0	0	-	0	15/5
95	120	-	-	120	-	-	0	0	0	-	0	6/8
00	160	-	-	140	20	-	38	0	13	13	13	9/8
05	100	-	20	60	20	-	20	60	20	20	20	5/6
07	120	-	-	120	-	-	17	83	0	-	0	5/5
<b>Chrysothamnus depressus</b>												
82	6266	-	-	6266	-	-	0	100	0	-	0	3/9
88	27266	1266	12200	14533	533	-	40	.48	2	-	.24	4/9
95	13660	60	860	12800	-	-	0	0	0	-	0	5/11
00	15500	-	1620	11320	2560	160	54	.25	17	3	3	3/10
05	11020	-	320	10100	600	180	42	39	5	2	3	4/8
07	11660	160	-	11400	260	140	52	37	2	.51	2	4/12
<b>Chrysothamnus nauseosus</b>												

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
82	0	-	-	-	-	-	0	0	-	-	0	-/-
88	0	-	-	-	-	-	0	0	-	-	0	-/-
95	0	-	-	-	-	-	0	0	-	-	0	-/-
00	0	-	-	-	-	-	0	0	-	-	0	-/-
05	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	27/29
<i>Chrysothamnus nauseosus hololeucus</i>												
82	0	-	-	-	-	-	0	0	0	-	0	-/-
88	0	-	-	-	-	-	0	0	0	-	0	-/-
95	60	60	40	20	-	-	0	0	0	-	0	36/43
00	20	-	20	-	-	-	0	0	0	-	0	37/38
05	40	-	20	-	20	-	50	0	50	50	50	18/9
07	60	-	40	20	-	-	0	33	0	-	0	26/30
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
82	0	-	-	-	-	-	0	0	-	-	0	-/-
88	0	-	-	-	-	-	0	0	-	-	0	-/-
95	0	-	-	-	-	-	0	0	-	-	0	-/-
00	0	-	-	-	-	-	0	0	-	-	0	-/-
05	0	-	-	-	-	-	0	0	-	-	0	-/-
07	160	-	-	160	-	-	0	0	-	-	0	-/-
<i>Gutierrezia sarothrae</i>												
82	66	-	-	66	-	-	0	0	0	-	0	4/1
88	4598	-	1066	3466	66	-	0	0	1	-	0	8/5
95	1480	40	340	1140	-	-	0	0	0	-	0	7/7
00	1380	-	360	900	120	-	0	0	9	1	1	4/5
05	1120	40	140	980	-	-	0	0	0	-	0	6/7
07	1800	40	40	1760	-	-	1	0	0	-	0	6/7
<i>Juniperus osteosperma</i>												
82	66	-	66	-	-	-	0	0	0	-	0	-/-
88	132	66	66	66	-	-	50	0	0	-	0	118/79
95	0	-	-	-	-	-	0	0	0	-	0	-/-
00	140	-	100	40	-	-	0	0	0	-	0	-/-
05	80	20	60	-	20	-	0	0	25	-	25	-/-
07	80	-	60	-	20	-	0	0	25	25	25	-/-
<i>Leptodactylon pungens</i>												
82	0	-	-	-	-	-	0	0	-	-	0	-/-

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
88	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
95	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
00	<b>80</b>	-	-	80	-	-	0	0	-	-	0	8/11
05	<b>20</b>	-	-	20	-	-	0	0	-	-	0	4/9
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	4/9
<i>Opuntia fragilis</i>												
82	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
88	<b>66</b>	-	66	-	-	-	0	0	-	-	0	-/-
95	<b>20</b>	-	20	-	-	-	0	0	-	-	0	4/14
00	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
05	<b>0</b>	-	-	-	-	-	0	0	-	-	0	3/12
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Pediocactus simpsonii</i>												
82	<b>66</b>	-	-	66	-	-	0	0	-	-	0	1/4
88	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
95	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
00	<b>0</b>	-	-	-	-	-	0	0	-	-	0	0/1
05	<b>120</b>	-	-	120	-	-	0	0	-	-	0	½
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Pinus edulis</i>												
82	<b>400</b>	-	-	400	-	-	0	0	0	-	0	33/18
88	<b>399</b>	-	266	133	-	-	0	0	0	-	0	94/73
95	<b>0</b>	-	-	-	-	-	0	0	0	-	0	-/-
00	<b>80</b>	40	40	40	-	-	0	0	0	-	0	-/-
05	<b>60</b>	20	60	-	-	-	0	0	0	-	0	-/-
07	<b>80</b>	-	40	20	20	-	0	0	25	-	25	-/-

Trend Study 14R-7-07

Study site name: Adams CE Harrow .

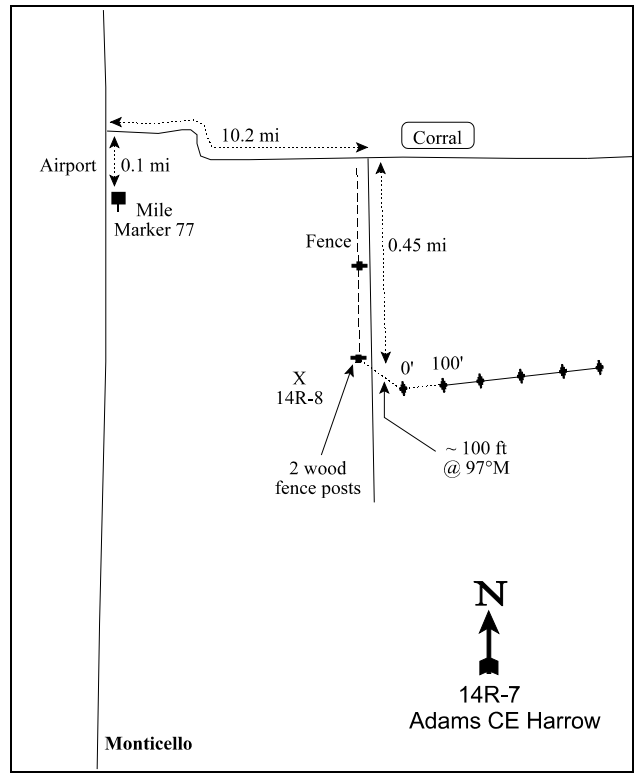
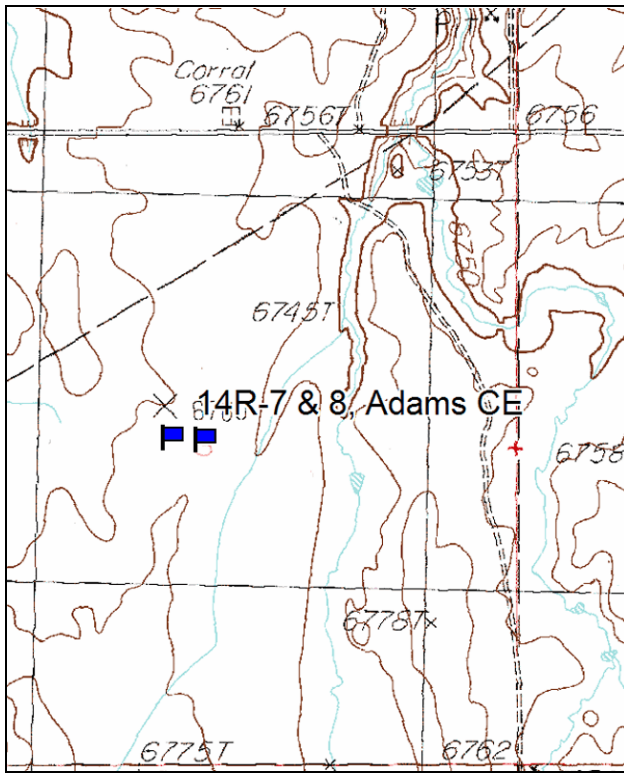
Vegetation type: Black Sagebrush .

Compass bearing: frequency baseline 80 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

On US 191 travel north of Monticello for about 5.5 miles to mile marker 77. Continue 0.1 miles to a road that comes in from the right. Turn here and follow this road 10.2 miles to another road that comes in from the right. Turn here and travel south 0.45 miles to the second pair of wood fence posts on the right side of the road. The 0-foot stake is about 100 feet from these fence posts at 97°M.



Map Name: Eastland NW

Diagrammatic Sketch

Township 33S , Range 25E , Section 3

GPS: NAD 83, UTM 12S 661341 E 4200538 N

## DISCUSSION

### Adams CE Harrow – Trend Study No. 14R-7

#### Study Information

This study was established within a Dixie pipe harrow treatment on private property 10 miles (16 km) northwest of Monticello, 0.5 mile (0.8 km) south of Hickman Flat Road (CR 332) [elevation: 6,800 feet (2,073 m), slope: 2%-5%, aspect: northwest]. Approximately 320 acres (129 ha) of black sagebrush (*Artemisia nova*) dominated land was harrowed in alternating strips in fall 2001. A 2-direction treatment, a single-direction treatment, and untreated sagebrush were alternated in strips running east to west. Seed was applied with a broadcast seeder attached to the tractor pulling the harrow. This monitoring study was established within the harrow treatment, what appeared to be the 2-direction harrow treatment, in summer 2004. A control study, Adams CE Control (14R-08), was established about 250 feet (76 m) west of this study, outside of the treatment area. The study is located in a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Annual precipitation was 97% of normal in 2001, 94% in 2003, and above average for 2004, 2005, and 2006 at the Monticello weather station located approximately 11 miles (18 km) southwest of the site. Precipitation data were incomplete in 2002. Spring precipitation was above normal in 2001, 62% of normal in 2003, 53% in 2004, 94% in 2005, above average in 2006, and 92% in 2007. Fall precipitation was 66% of normal in 2001 and 85% in 2005, and above normal in 2002, 2003, 2004 and 2006 (Utah Climate Summaries 2007). From the pellet group transect data, cattle use was estimated at 4 days use/acre (11 cdu/ha) in 2004 and 15 days use/acre (36 cdu/ha) in 2007. Sage-grouse use was estimated at 26 pellets/acre (64 pellets/ha) in 2004 and 104 pellets/acre (257 pellets/ha) in 2007. In 2004, it was noted that the pellets sampled were in the untreated strips, and cow pats were from previous years.

#### Soil

The soil is in the Montvale series, which consists of shallow or very shallow, well-drained soils that formed in material weathered from sandstone (USDA-NRCS 2007). The soil is a shallow clay with a neutral reaction (pH 7.1). The soil phosphorus concentration is only 2.6 ppm. Values less than 6 ppm may limit normal plant growth and development in wildland soils (Tiedemann and Lopez 2004). The soil profile contains very little rock and is slightly more sandy at the surface. Relative cover of vegetation increased from 18% in 2004 to 32% in 2007. Relative cover for litter changed little at 18%-20% cover in both sample years, and the combined relative cover for rock and pavement also changed little at 2%-3%. Relative bare ground cover decreased from 62% in 2004 to 45% in 2007. The soil erosion condition was classified as stable in 2004 and 2007.

#### Browse

There are several preferred browse species. Black sagebrush density remained stable at approximately 5,000 plants/acre (12,350 plants/ha) in both sample years. The recruitment of young was low at 0% of the population in 2004 and increased to 8% in 2007. Decadent plants comprised 59% of the population in 2004 and 41% in 2007. Plants showing poor vigor comprised 39% of the population in 2004 and 11% in 2007, and browse use was mostly light-moderate. The average cover for black sagebrush was 7%-8% in both sample years. Average sagebrush leader growth was 1.1 inches (2.9 cm) in 2004 and 0.9 inches (2.2 cm) in 2007.

Winterfat (*Ceratoides lanata*) was also abundant. It had a density of 3,420 plants/acre (8,447 plants/ha) in 2004 and 9,980 plants/acre (24,651 plants/ha) in 2007. Mature individuals made up 96% of the population in 2004 and young individuals made up the other 4%. In 2007, 57% of the population was mature, 39% were young and 5% were decadent. Plant vigor has been excellent in both sample years, and browse use has been mostly light. Average winterfat leader growth was 3.9 inches (9.9 cm) in 2004 and 2.3 inches (5.8 cm) in 2007. Other preferred browse that have been sampled include Utah serviceberry (*Amelanchier utahensis*), dwarf rabbitbrush (*Chrysothamnus depressus*), and slenderbush eriogonum (*Eriogonum microthecum*).

### Herbaceous Understory

Eight grass species were sampled in 2004 and 11 were sampled in 2007. Crested wheatgrass (*Agropyron cristatum*) was the dominant grass with 4% cover in 2004 and 11% in 2007. Western wheatgrass (*Agropyron smithii*) and bottlebrush squirreltail (*Sitanion hystrix*) were also abundant. Western wheatgrass provided 2% cover both sample years, and squirreltail provided 1% cover in 2004 and 4% in 2007. Six grass species were seeded in the treatment (see list below). Western wheatgrass and crested wheatgrass were the only grass species in the seed mix that were sampled in 2004 and 2007. However, they were also sampled on the control study (14R-8), so it is possible that they were established previous to the treatment.

Sixteen species of forbs were sampled in either 2004 or 2007, seven of which were annuals. However, most provided little cover. Desert phlox (*Phlox austromontana*) and scarlet globemallow (*Sphaeralcea grossulariifolia*) were the only species that provided 1% cover or more in both sample years. Three forb species were seeded in the treatment (see list below). Alfalfa (*Medicago sativa*) and small burnet (*Sanguisorba minor*) were sampled in 2004 and 2007, and Lewis flax (*Linum lewisii*) was sampled in 2007. However, these seeded species provided very little cover and had low nested frequency values.

### 2004 Post-treatment Assessment

The preferred browse species provided 11% cover. Black sagebrush and winterfat were the dominant species. The density of black sagebrush was 5,000 plants/acre (12,350 plants/ha). No young plants were sampled, and decadence was 59% of the population. Plants showing poor vigor comprised 39% of the population, and browse use was mostly light-moderate. The density of winterfat was 3,420 plants/acre (8,447 plants/ha). Young recruitment was 4% of the population, and no decadent plants were sampled. Plant vigor was excellent, and browse use was mostly light. Eight perennial grasses were sampled and provided 7% combined cover. Twelve forb species were sampled, five of which were annuals. Forb cover was 3%. Desert phlox and scarlet globemallow were the dominant forbs. The Desirable Components Index (DCI) was rated as fair due to moderate browse cover with high decadence and low recruitment, and moderate perennial grass and forb cover.

2004 winter range condition (DCI) - fair (36) Low potential scale

### 2007 Post-treatment Assessment

The preferred browse component improved. The density of black sagebrush remained stable. Young recruitment increased from 0% of the population to 8%, and decadence decreased from 59% to 41%. Plants showing poor vigor decreased from 39% of the population to 11%, and browse use was mostly light-moderate. Winterfat density increased nearly three-fold. The recruitment of young increased from 4% of the population to 39%, and decadence increased slightly from 0% to 5%. Vigor remained excellent, and browse use remained light. Grasses improved after the treatment. The sum of nested frequency for perennial grasses increased 97%, and average cover increased from 7% to 21%. The nested frequencies for crested wheatgrass, intermediate wheatgrass (*Agropyron intermedium*), and bottlebrush squirreltail increased significantly. The forb component also improved. The sum of nested frequency for perennial forbs increased 26%, and the sum of nested frequency for annual forbs increased more than two-fold. The average cover for forbs increased from 3% to 6%. The nested frequencies for tansymustard (*Descurainia pinnata*), annual stickseed (*Lappula occidentalis*), Russian thistle (*Salsola iberica*), bladderpod (*Lesquerella* sp.), and scarlet globemallow significantly increased. The DCI rating improved to excellent due to a decrease in browse decadence and increases in browse recruitment and perennial grass cover.

2007 winter range condition (DCI) - excellent (71) Low potential scale



Adams CE Harrow Seed Mix	Approximate Bulk lbs/acre
Western wheatgrass	1.0
Thickspike wheatgrass	2.0
Bluebunch wheatgrass	2.0
Slender wheatgrass	1.0
Pubescent wheatgrass	1.0
Crested wheatgrass	1.0
Alfalfa	2.0
Small burnet	2.0
Blue flax	0.3
<b>Total</b>	<b>12.3</b>

HERBACEOUS TRENDS --  
Management unit 14R, Study no: 7

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	<sub>a</sub> 76	<sub>b</sub> 195	3.99	11.25
G	Agropyron intermedium	<sub>a</sub> 4	<sub>b</sub> 30	.03	.31
G	Agropyron smithii	<sub>a</sub> 102	<sub>a</sub> 111	1.52	2.32
G	Bouteloua gracilis	<sub>a</sub> 1	<sub>a</sub> 1	.03	.03
G	Bromus inermis	-	10	-	.46
G	Bromus tectorum (a)	-	13	-	.02
G	Elymus junceus	<sub>a</sub> 4	<sub>b</sub> 14	.09	.70
G	Hilaria jamesii	<sub>a</sub> 10	<sub>a</sub> 14	.22	.48
G	Koeleria cristata	-	4	-	.38
G	Oryzopsis hymenoides	<sub>a</sub> 15	<sub>a</sub> 24	.25	1.06
G	Sitanion hystrix	<sub>a</sub> 50	<sub>b</sub> 112	1.01	4.15
Total for Annual Grasses		0	13	0	0.02
Total for Perennial Grasses		262	515	7.16	21.16
Total for Grasses		262	528	7.16	21.18
F	Antennaria rosea	-	1	-	.00
F	Chenopodium leptophyllum(a)	60	-	.15	-
F	Cordylanthus sp. (a)	6	-	.04	-
F	Cryptantha sp.	<sub>a</sub> 6	<sub>a</sub> 3	.04	.04
F	Descurainia pinnata (a)	<sub>a</sub> 4	<sub>b</sub> 109	.02	.85
F	Draba sp. (a)	-	4	-	.01
F	Erigeron pumilus	<sub>a</sub> 2	<sub>a</sub> 4	.03	.15
F	Lappula occidentalis (a)	<sub>a</sub> 5	<sub>b</sub> 45	.02	.58
F	Lesquerella sp.	<sub>a</sub> 8	<sub>b</sub> 26	.16	.30

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Linum lewisii</i>	-	1	-	.03
F	<i>Medicago sativa</i>	<sub>a</sub> 12	<sub>a</sub> 5	.03	.02
F	<i>Phlox austromontana</i>	<sub>a</sub> 132	<sub>a</sub> 137	1.10	2.67
F	<i>Ranunculus testiculatus</i> (a)	-	3	-	.00
F	<i>Salsola iberica</i> (a)	<sub>a</sub> 11	<sub>b</sub> 30	.05	.07
F	<i>Sanguisorba minor</i>	8	-	.01	-
F	<i>Sphaeralcea grossulariifolia</i>	<sub>a</sub> 71	<sub>b</sub> 123	.93	1.73
Total for Annual Forbs		86	191	0.28	1.52
Total for Perennial Forbs		239	300	2.30	4.96
Total for Forbs		325	491	2.59	6.49

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 14R, Study no: 7

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Amelanchier utahensis</i>	1	0	-	-
B	<i>Artemisia frigida</i>	0	0	-	-
B	<i>Artemisia nova</i>	73	81	6.92	7.53
B	<i>Ceratoides lanata</i>	45	65	2.46	3.39
B	<i>Chrysothamnus depressus</i>	55	58	1.32	2.12
B	<i>Eriogonum microthecum</i>	15	19	.02	.05
B	<i>Gutierrezia sarothrae</i>	9	8	.18	.03
B	<i>Tetradymia canescens</i>	1	1	-	-
Total for Browse		199	232	10.92	13.13

#### CANOPY COVER, LINE INTERCEPT --

Management unit 14R, Study no: 7

Species	Percent Cover	
	'04	'07
<i>Artemisia nova</i>	5.98	6.81
<i>Ceratoides lanata</i>	3.13	3.46
<i>Chrysothamnus depressus</i>	3.76	3.18
<i>Eriogonum microthecum</i>	.05	.03

Species	Percent Cover	
	'04	'07
Gutierrezia sarothrae	.08	.13
Tetradymia canescens	.18	.28

KEY BROWSE ANNUAL LEADER GROWTH --  
Management unit 14R, Study no: 7

Species	Average leader growth (in)	
	'04	'07
Artemisia nova	1.1	0.9
Ceratoides lanata	3.9	2.3

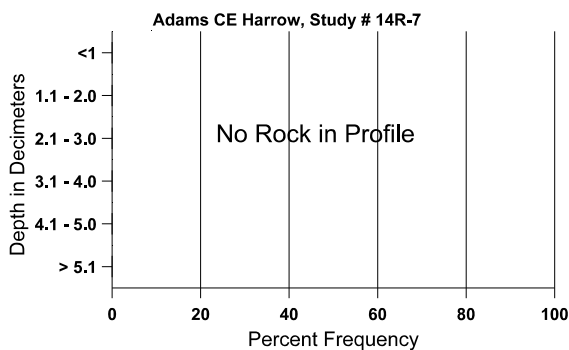
BASIC COVER --  
Management unit 14R, Study no: 7

Cover Type	Average Cover %	
	'04	'07
Vegetation	20.27	35.60
Rock	.39	.14
Pavement	1.95	3.16
Litter	19.76	22.18
Cryptogams	.04	.16
Bare Ground	67.80	50.92

SOIL ANALYSIS DATA --  
Management unit 14R, Study no: 7, Study Name: Adams CE Harrow

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
14.3	60.8 (15.2)	7.1	31.3	28.2	40.5	1.8	2.6	182.4	0.5

### Stoniness Index



PELLET GROUP DATA --  
Management unit 14R, Study no: 7

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	2	35	-	-
Cattle	-	-	4 (11)	15 (36)
Grouse	-	1	26 pellets/acre	104 pellets/acre

BROWSE CHARACTERISTICS --  
Management unit 14R, Study no: 7

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Amelanchier utahensis</b>												
04	<b>40</b>	-	-	-	40	-	0	0	100	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	0	-	0	-/-
<b>Artemisia frigida</b>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	4/8
<b>Artemisia nova</b>												
04	<b>5000</b>	140	-	2060	2940	3780	15	18	59	37	39	9/14
07	<b>4980</b>	500	380	2560	2040	1280	35	0	41	11	11	9/16
<b>Ceratoides lanata</b>												
04	<b>3420</b>	2540	140	3280	-	-	13	2	0	-	0	8/11
07	<b>9980</b>	2500	3860	5640	480	-	6	8	5	1	1	7/10
<b>Chrysothamnus depressus</b>												
04	<b>4220</b>	120	20	3700	500	40	13	0	12	5	7	8/14
07	<b>3820</b>	200	360	3020	440	20	14	1	12	5	5	5/9
<b>Eriogonum microthecum</b>												
04	<b>480</b>	20	-	480	-	-	4	0	0	-	0	3/5
07	<b>600</b>	80	80	420	100	-	3	23	17	10	10	3/4
<b>Gutierrezia sarothrae</b>												
04	<b>220</b>	40	20	200	-	-	0	0	-	-	0	6/9
07	<b>160</b>	-	40	120	-	-	0	0	-	-	0	5/7
<b>Tetradymia canescens</b>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	-/-
07	<b>60</b>	-	-	60	-	-	100	0	-	-	0	9/15

Trend Study 14R-8-07

Study site name: Adams CE Control.

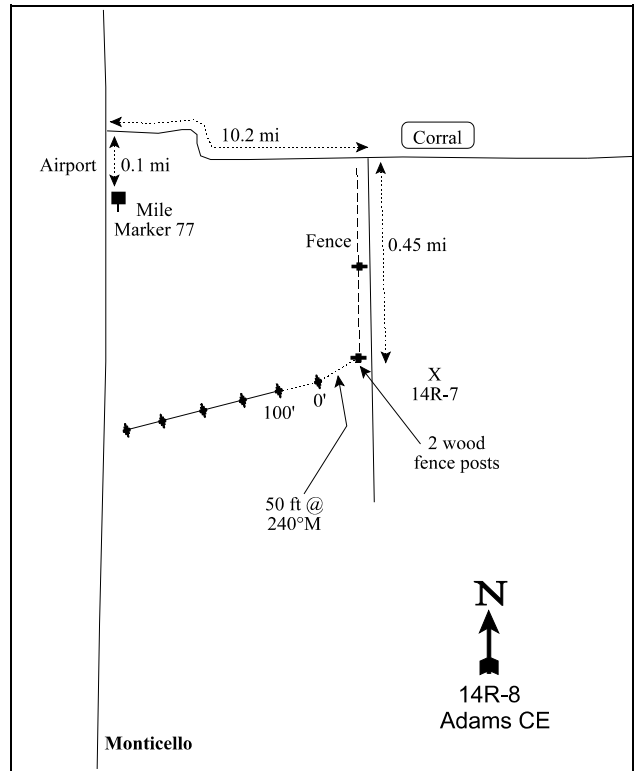
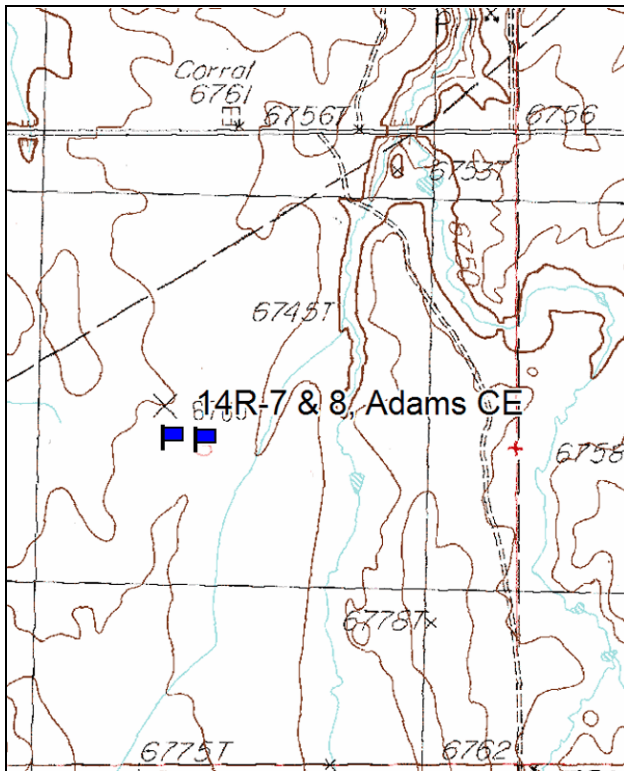
Vegetation type: Black Sagebrush .

Compass bearing: frequency baseline 255 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

On US 191 travel north of Monticello for about 5.5 miles to mile marker 77. Continue 0.1 miles to a road that comes in from the right. Turn here and follow this road 10.2 miles to another road that comes in from the right. Turn here and travel south 0.45 miles to the second pair of wood fence posts on the right side of the road. The 0-foot stake is 50 feet from the fence posts at 240°M.



Map Name: Eastland NW

Diagrammatic Sketch

Township 33S, Range 25E, Section 3

GPS: NAD 83, UTM 12S 661258 E 4200540 N

## DISCUSSION

### Adams CE Control – Trend Study No. 14R-8

#### Study Information

The Adams CE Control study was established outside a Dixie pipe harrow treatment on private property to act as a control to the treatment monitoring study. The study area is located 10 miles (16 km) northwest of Monticello, 0.5 mile (0.8) km south of Hickman Flat Road (CR 332) [elevation: 6,800 feet (2,073 m), slope: 2%-5%, aspect: northwest]. Approximately 320 acres (129 ha) of black sagebrush (*Artemisia nova*) dominated land was harrowed in alternating strips in fall 2001. A 2-direction harrow treatment, a single-direction harrow treatment, and untreated sagebrush were alternated in strips running east to west. Seed was applied with a broadcast seeder attached to the tractor pulling the harrow. This monitoring study was established outside the harrow treatment in summer 2004, approximately 250 feet (76 m) west of the Adams CE Harrow (14R-7) study. Although not treated with the harrow in 2001, the area where the control was established had been treated years before. The study is located in a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Annual precipitation was 97% of normal in 2001, 94% in 2003, and above average for 2004, 2005, and 2006 at the Monticello weather station located approximately 11 miles (18 km) southwest of the site. Precipitation data were incomplete in 2002. Spring precipitation was above normal in 2001, 62% of normal in 2003, 53% in 2004, 94% in 2005, above average in 2006, and 92% in 2007. Fall precipitation was 66% of normal in 2001 and 85% in 2005, and above normal in 2002, 2003, 2004 and 2006 (Utah Climate Summaries 2007). From the pellet group transect data, cattle use was estimated at 8 days use/acre (20 cdu/ha) in 2004 and 15 days use/acre (36 cdu/ha) in 2007. Sage-grouse use was estimated at 9 pellets/acre (78 pellets/ha) in 2004 and 470 pellets/acre (1,158 pellets/ha) in 2007.

#### Soil

The soil is in the Montvale series, which consists of shallow or very shallow, well-drained soils that formed in material weathered from sandstone (USDA-NRCS 2007). The soil is a shallow clay loam with a neutral reaction (pH 7.2). The soil profile contains no rock, and a hard clay layer is found at a depth of 6-8 inches (15-20 cm). The combined relative cover of vegetation and litter increased from 38% in 2004 to 45% in 2007, and relative bare ground cover decreased from 61% in 2004 to 55% in 2007. The soil erosion condition was classified as stable in 2004 and 2007.

#### Browse

Black sagebrush is the key browse species. Canopy cover was 23% in 2004 and 20% in 2007. Sagebrush density was 7,700 plants/acre (19,019 plants/ha) in 2004 and 6,980 plants/acre (17,241 plants/ha) in 2007. Young recruitment has been low at 3%-4% of the population, and decadence was 25% in 2004 and 40% in 2007. Plants classified as showing poor vigor comprised 10% of the population in 2004 and 17% in 2007. Browse use has been light-moderate. Average sagebrush leader growth was 1.0 inch (2.6 cm) in 2004 and 0.8 inches (2 cm) in 2007.

Winterfat (*Ceratoides lanata*) was also sampled. It had a density of 220 plants/acre (543 plants/ha) in 2004 and 160 plants/acre (395 plants/ha) in 2007. There were no young plants in the population, and decadence was 18% of the population in 2004 and 0% in 2007. Plants classified with poor vigor comprised 9% of the population in 2004 and 0% in 2007. Browse use has been mostly light. Average winterfat leader growth was 2.5 inches (6.3 cm) in 2004 and 2007. Other preferred browse species sampled were dwarf rabbitbrush (*Chrysothamnus depressus*) and slenderbush eriogonum (*Eriogonum microthecum*).

#### Herbaceous Understory

Nine grass species have been sampled, eight of which were perennials. The perennial grasses provided 8% cover in 2004 and 14% cover in 2007. Crested wheatgrass (*Agropyron cristatum*) was the dominant grass with 5% cover in 2004 and 10% in 2007. Western wheatgrass (*Agropyron smithii*) was also abundant at 2% cover

in both sample years. All other grasses sampled provided 1% or less cover. On the harrowed study (14R-7), six grass species were seeded, but only western wheatgrass and crested wheatgrass were sampled. The presence of these two species on the control study suggests that they may have been present prior to the treatment.

Seventeen forb species have been sampled, six of which were annuals. Total forb cover was 1%-2% in both sample years. None of the species sampled were in the seed mix (14R-7), which suggests that the seeded forb species sampled on the harrowed study were not present prior to the treatment.

#### 2004 Post-treatment Assessment

Black sagebrush was the dominant browse species and provided 23% canopy cover. The density of black sagebrush was 7,700 plants/acre (19,019 plants/ha). Young plants comprised 3% of the population, and decadent plants made up 25%. Plants showing poor vigor comprised 25% of the population, and use was mostly light. The density of winterfat was 220 plants/acre (543 plants/ha). No young plants were sampled, and decadence was 18% of the population. Plants showing poor vigor made up 18% of the population, and browse use was light. All of the grasses sampled were perennials, and they provided 8% combined cover. There were 13 total forb species sampled, but they provided only 1% combined cover. The Desirable Components Index (DCI) score was good due to favorable browse cover and moderate perennial grass cover.

2004 winter range condition (DCI) – good (47) Low potential scale

#### 2007 Post-treatment Assessment

The canopy cover of black sagebrush decreased to 20%, and the density decreased 9%. The recruitment of young slightly increased to 4% of the population, and decadence increased to 40%. Plants showing poor vigor increased to 17% of the population, and use was light-moderate. The density of winterfat decreased 27%. There were no decadent or young plants, however, seedling density was an estimated 800 plants/acre (1,976 plants/ha). Plant vigor was excellent, and use was light. The grass component improved. The sum of nested frequency for perennial grasses increased 38%, and cover increased from 8% to 14%. The nested frequencies of crested wheatgrass, prairie junegrass (*Koeleria cristata*), and Indian ricegrass (*Oryzopsis hymenoides*) significantly increased. There were only 9 forb species sampled, but cover increased from 1% to 2%. The sum of nested frequency for perennial forbs changed little. However, the sum of nested frequency for annual forbs increased more than three-fold. The nested frequencies of tansymustard (*Descurainia pinnata*) and annual stickseed (*Lappula occidentalis*) increased significantly. The DCI score remained good.

2007 winter range condition (DCI) – good (57) Low potential scale

HERBACEOUS TRENDS --  
Management unit 14R, Study no: 8

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron cristatum</i>	<sub>a</sub> 160	<sub>b</sub> 235	5.00	9.78
G	<i>Agropyron intermedium</i>	-	7	-	.66
G	<i>Agropyron smithii</i>	<sub>a</sub> 127	<sub>a</sub> 118	2.17	2.46
G	<i>Bouteloua gracilis</i>	-	4	-	.18
G	<i>Bromus tectorum</i> (a)	-	3	-	.00
G	<i>Hilaria jamesii</i>	1	-	.03	-
G	<i>Koeleria cristata</i>	<sub>a</sub> 2	<sub>b</sub> 26	.03	.70
G	<i>Oryzopsis hymenoides</i>	<sub>a</sub> 2	<sub>b</sub> 9	.06	.21
G	<i>Sitanion hystrix</i>	<sub>a</sub> 9	<sub>a</sub> 16	.26	.46
Total for Annual Grasses		0	3	0	0.00
Total for Perennial Grasses		301	415	7.56	14.48
Total for Grasses		301	418	7.56	14.48
F	<i>Calochortus nuttallii</i>	3	-	.00	-
F	<i>Chenopodium leptophyllum</i> (a)	10	-	.02	-
F	<i>Descurainia pinnata</i> (a)	<sub>a</sub> 4	<sub>b</sub> 31	.01	.22
F	<i>Draba sp.</i> (a)	-	15	-	.03
F	<i>Erigeron eatonii</i>	3	-	.01	-
F	<i>Erigeron sp.</i>	3	-	.03	-
F	<i>Erigeron pumilus</i>	<sub>a</sub> 2	<sub>a</sub> 10	.00	.19
F	<i>Holosteum umbellatum</i> (a)	-	11	-	.07
F	<i>Lappula occidentalis</i> (a)	<sub>a</sub> 7	<sub>b</sub> 19	.01	.18
F	<i>Lupinus sp.</i>	3	-	.00	-
F	<i>Penstemon sp.</i>	-	-	-	.00
F	<i>Phlox austromontana</i>	<sub>a</sub> 61	<sub>a</sub> 57	.56	.95
F	<i>Ranunculus testiculatus</i> (a)	-	5	-	.01
F	<i>Sphaeralcea grossulariifolia</i>	<sub>a</sub> 29	<sub>a</sub> 31	.16	.13
F	<i>Tragopogon dubius</i>	1	-	.00	-
F	<i>Trifolium sp.</i>	<sub>a</sub> 20	<sub>a</sub> 23	.07	.08
F	Unknown forb-perennial	3	-	.03	-
Total for Annual Forbs		21	81	0.04	0.52
Total for Perennial Forbs		128	121	0.89	1.37
Total for Forbs		149	202	0.94	1.90

Values with different subscript letters are significantly different at alpha = 0.10



BROWSE TRENDS --

Management unit 14R, Study no: 8

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia nova	97	95	17.06	16.34
B	Ceratoides lanata	8	6	.09	.06
B	Chrysothamnus depressus	5	4	.00	-
B	Chrysothamnus viscidiflorus viscidiflorus	4	7	-	.15
B	Eriogonum microthecum	7	6	.09	.15
B	Gutierrezia sarothrae	8	0	.04	-
B	Tetradymia canescens	0	0	-	-
Total for Browse		129	118	17.29	16.71

CANOPY COVER, LINE INTERCEPT --

Management unit 14R, Study no: 8

Species	Percent Cover	
	'04	'07
Artemisia nova	22.85	19.60
Ceratoides lanata	.28	.06
Chrysothamnus depressus	.18	-
Chrysothamnus viscidiflorus viscidiflorus	-	.16
Eriogonum microthecum	.11	-
Gutierrezia sarothrae	.18	-

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 14R, Study no: 8

Species	Average leader growth (in)	
	'04	'07
Artemisia nova	1.0	0.8
Ceratoides lanata	2.5	2.5

BASIC COVER --

Management unit 14R, Study no: 8

Cover Type	Average Cover %	
	'04	'07
Vegetation	24.42	29.58
Rock	.07	.01

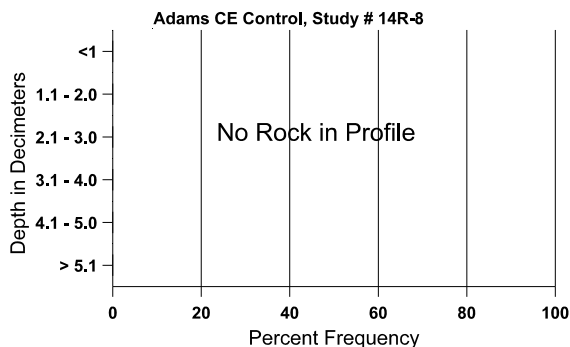
Cover Type	Average Cover %	
	'04	'07
Pavement	.90	.32
Litter	17.09	20.28
Cryptogams	.62	.68
Bare Ground	66.58	60.93

SOIL ANALYSIS DATA --

Management unit 14R, Study no: 8, Study Name: Adams CE Control

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
14.0	59.8 (16.0)	7.2	33.3	31.4	35.3	1.5	12.4	160.0	0.6

### Stoniness Index



PELLET GROUP DATA --

Management unit 14R, Study no: 8

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	1	17	-	-
Grouse	1	7	9 pellets/acre	470 pellets/acre
Cattle	5	6	8 (20)	15 (36)

BROWSE CHARACTERISTICS --  
Management unit 14R, Study no: 8

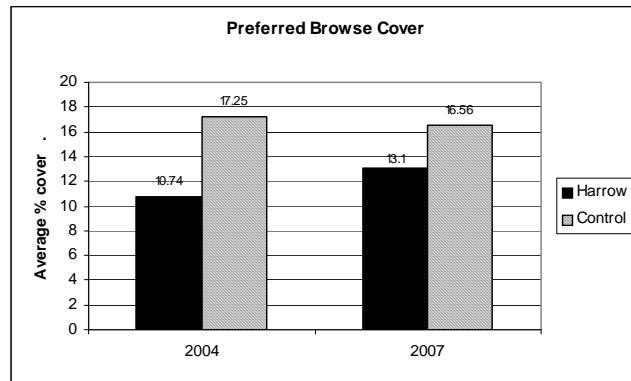
		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia nova</i>												
04	<b>7700</b>	80	200	5540	1960	1320	4	0	25	10	10	12/21
07	<b>6980</b>	80	280	3900	2800	720	13	0	40	16	17	13/22
<i>Ceratoides lanata</i>												
04	<b>220</b>	-	-	180	40	-	9	0	18	9	9	7/10
07	<b>160</b>	800	-	160	-	-	0	0	0	-	0	7/9
<i>Chrysothamnus depressus</i>												
04	<b>140</b>	-	-	120	20	-	0	0	14	14	14	4/7
07	<b>80</b>	-	-	60	20	-	0	0	25	25	25	5/15
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>80</b>	-	-	80	-	-	0	0	0	-	0	10/16
07	<b>160</b>	20	-	140	20	-	0	0	13	13	25	7/12
<i>Eriogonum microthecum</i>												
04	<b>220</b>	-	-	220	-	-	36	0	0	-	0	4/5
07	<b>220</b>	-	-	180	40	-	0	0	18	-	0	6/10
<i>Gutierrezia sarothrae</i>												
04	<b>220</b>	-	-	220	-	-	0	0	-	-	0	5/11
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	4/3
<i>Tetradymia canescens</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	11/22
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-

### Summary and Comparison of Adams CE Harrow (14R-7) and Adams CE Control (14R-8)

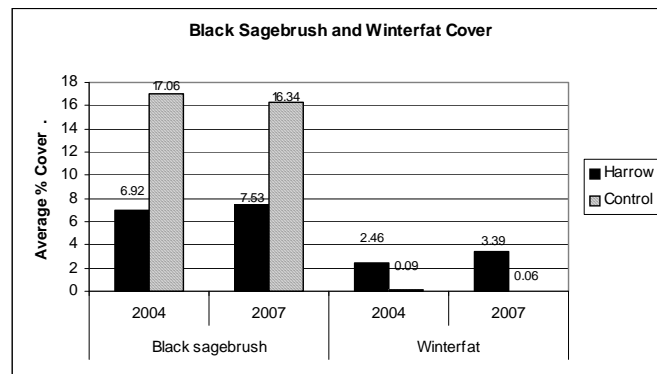
These studies were established in 2004 to compare the recovery of vegetation on a black sagebrush (*Artemisia nova*) flat that was treated with a Dixie pipe harrow and seeded (14R-7) to that of a nearby black sagebrush flat control study (14R-8). Approximately 320 acres (129 ha) of black sagebrush dominated land was harrowed in alternating strips in fall 2001. A 2-direction harrow treatment, a single-direction harrow treatment, and untreated sagebrush were alternated in strips running east to west. Seed was applied with a broadcast seeder attached to the tractor pulling the harrow. The Adams CE Harrow study was placed within an area that appeared to be part of the 2-direction harrow treatment. The Adams CE Control study was placed approximately 250 feet (76 m) west of this study, outside of the treatment area.

The treatment altered the abundance and cover of most of the preferred browse species. The average preferred browse cover on the harrowed study was 38% lower than that on the control study in 2004 and 21% lower in 2007 (Figure 1). Black sagebrush is the dominant preferred browse on both studies. The density of black sagebrush on the harrow treatment was 5,000 plants/acre (12,350 plants/ha) in 2004 and 4,980 plants/acre (12,301 plants/ha) in 2007. The density of black sagebrush on the control study was 7,700 plants/acre (19,019 plants/ha) in 2004 and 6,980 plants/acre (17,241 plants/ha) in 2007. The average cover of black sagebrush on the harrow treatment was less than half of that of the control both sample years (Figure 2).

The density of winterfat on the treatment area was 3,420 plants/acre (8,447 plants/ha) in 2004 and 9,980 plants/acre (24,651 plants/ha) in 2007, and average cover was 2% in 2004 and 3% in 2007 (Figure 2). In the control area, the density was 220 plants/acre (543 plants/ha) in 2004 and 160 plants in 2007 (395 plants/ha), and average cover was nearly 0% in 2004 and 2007 (Figure 2).

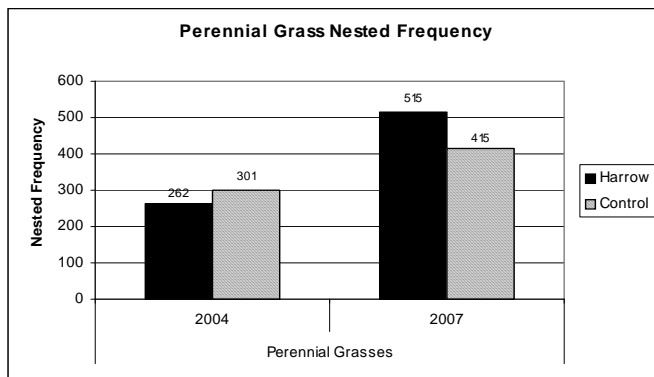


**Figure 1.** Average preferred browse cover for Adams CE Harrow (14R-7) and control (14R-8), 2004 and 2007.

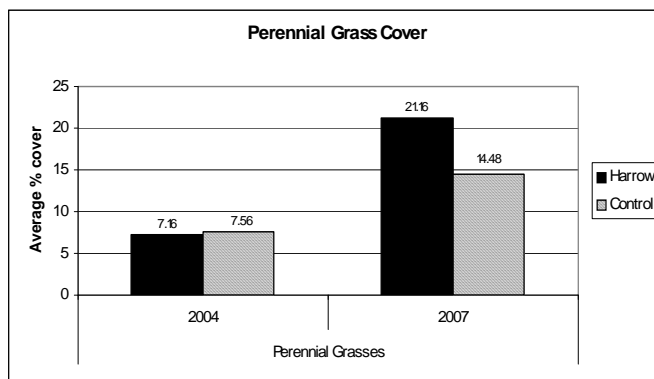


**Figure 2.** Average black sagebrush and winterfat cover for Adams CE Harrow (14R-7) and Adams CE Control (14R-8), 2004 and 2007.

The treatment did not seem to affect perennial grasses in 2004, however, perennial grass frequency and cover increased in 2007. The sum of nested frequency for perennial grasses was 15% greater on the control study than the harrowed study in 2004. However, in 2007, the sum of nested frequency for perennial grasses on the harrowed study increased 97%, while on the control study it increased only 38% (Figure 3). The cover for perennial grasses on the harrowed study was 7% in 2004 and 21% in 2007, and the cover for the control study was 8% in 2004 and 14% in 2007 (Figure 4).

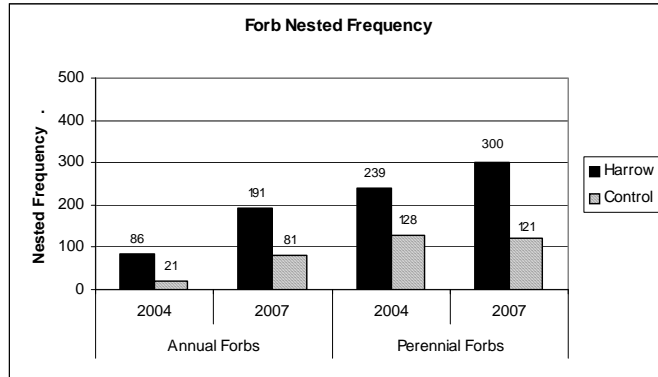


**Figure 3.** Perennial grass nested frequency on the Adams CE Harrow (14R-7) and Adams CE Control (14R-8) studies, 2004 and 2007.

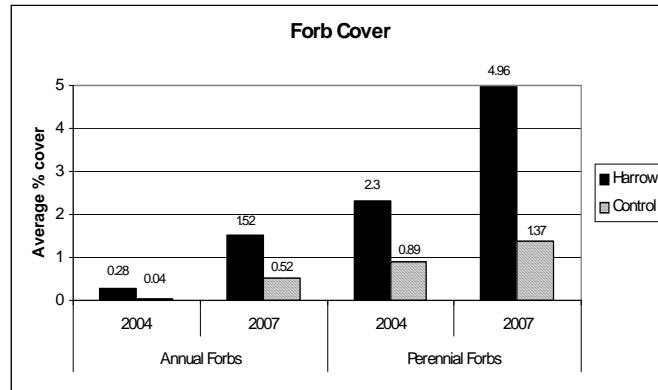


**Figure 4.** Average perennial grass cover on the Adams CE Harrow (14R-7) and Adams CE Control (14R-8) studies, 2004 and 2007.

The treatment seemed to increase the frequency and cover of both annual and perennial forbs. The sum of nested frequency was 300% greater for annual forbs and 87% greater for perennial forbs on the harrow study compared to the control study in 2004. The sum of nested frequency for annual forbs increased substantially on both the harrow and control studies in 2007. The sum of nested frequency for perennial forbs also increased greatly on the harrow study, but they remained stable on the control study (Figure 5). The average cover for annual forbs was near 0% in 2004 and 1% in 2007 on the control study, and near 0% in 2004 and 2% in 2007 for the harrow study. The average cover for perennial forbs was almost 1% in 2004 and 2007 on the control study, and 2% in 2004 and 5% in 2007 for the harrow study (Figure 6).



**Figure 5.** Forb nested frequency on the Adams CE Harrow (14R-7) and Adams CE Control (14R-8) studies, 2004 and 2007.



**Figure 6.** Average forb cover for on the Adams CE Harrow (14R-7) and Adams CE Control (14R-8) studies, 2004 and 2007.

Trend Study 16R-11-07

Study site name: Lower Cedar Bench .

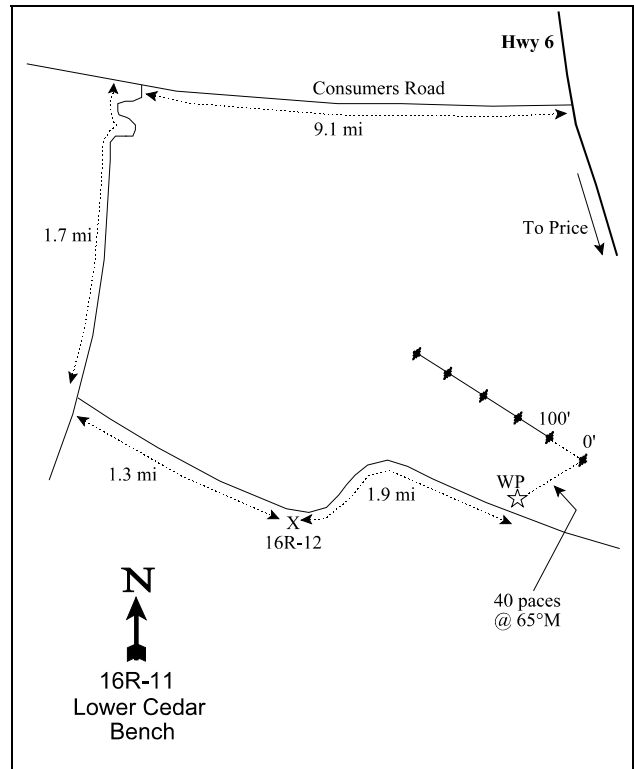
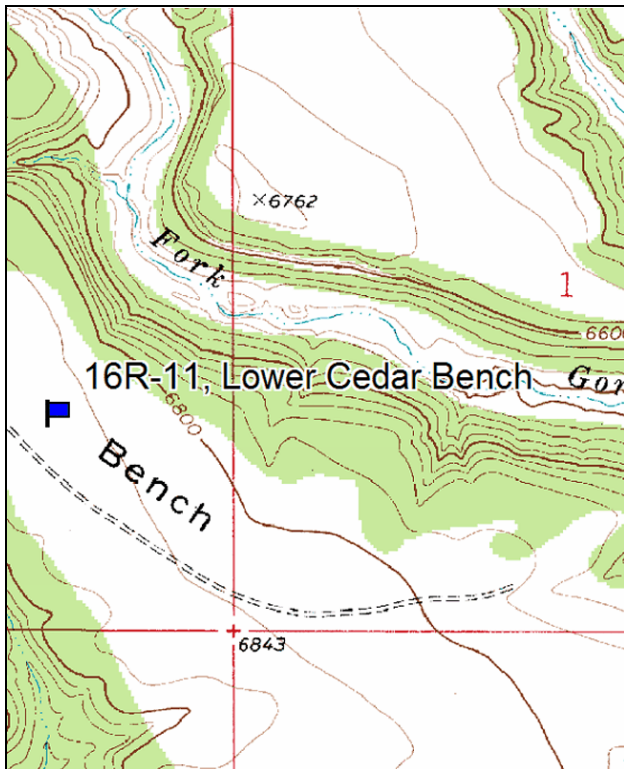
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 305 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Highway 6 north of Price, turn west onto Consumers Road. Travel 9.1 miles to a road that comes in from the left (south). Turn here and follow this road 1.7 miles to another road that comes in from the left. Turn here and travel 1.3 miles to a witness post on the right. Continue 1.9 miles to a witness post on the left side of the road. The 0-foot stake is 40 paces from the witness post at 65°M, and is marked with browse tag #47.



Map Name: Standardville

Diagrammatic Sketch

Township 14S , Range 8E , Section 2

GPS: NAD 83, UTM 12S 500910 E 4387112 N

## DISCUSSION

### Lower Cedar Bench – Trend Study No. 16R-11

#### Study Information

This study monitors a pinyon-juniper removal on Cedar Bench approximately 10 miles (16 km) west of Price [elevation: 6,800 feet (2,073 m), slope: 3%-5%, aspect: northeast]. The big game winter range habitat on Cedar Bench has degraded as pinyon-juniper canopy cover has increased. The treatment area is located about 1 mile (1.6 km) south of Consumers Road (SSR 139) and is located within the Gordon Creek Withdrawal grazing allotment. Another study, Upper Cedar Bench (16R-12), was established 1.6 miles (2.6 km) to the west, in the same treatment area. The purpose of the treatment was to open the canopy and establish desirable forage and browse species in the area. In spring 2005, seed (see list below) was hand broadcast on the treatment area, and trees were removed by pushing with D-6 CAT bulldozers. In 2007, when talking to the habitat biologist, it was discussed that the treatment may not have been seeded. It is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation data was incomplete for 2004 and 2005, and 81% of normal in 2006 at the Price weather station located approximately 10 miles (16 km) southeast of the site. Spring precipitation was 75% of normal in 2005, 61% in 2006, and 55% in 2007. Fall precipitation was above normal in 2004 and 2006, and the data were incomplete in 2005 (Utah Climate Summaries 2007). From the pellet group transect data, deer use was estimated at 119 days use/acre (294 ddu/ha) in 2004 and 94 days use/acre (231 ddu/ha) in 2007. Elk use was estimated at 12 days use/acre (30 edu/ha) in 2004 and 25 days use/acre (63 edu/ha) in 2007. Most pellets were from winter use.

#### Soil

The soil is in the Chupadera series, which consists of moderately deep, well-drained soils that formed in eolian sands and residuum from limestone on rolling bedrock controlled uplands and on structural benches of plateaus (USDA-NRCS 2007). The soil is a shallow sandy clay loam with a neutral reaction (pH 6.8). No rock is in the soil profile, and the relative cover of rock and pavement was less than 2% in both sample years. The combined relative cover of vegetation and litter was 68% in 2004 and increased to 73% in 2007. The relative cover for bare ground was 26%-27% both sample years. In 2004, the soil erosion condition was classified as slight due to pedestals over 1 inch (2.5 cm) tall, as well as a moderate number of rills and flow patterns. The erosion condition improved to stable in 2007.

#### Browse

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) was the only preferred browse species sampled. It provided 3% cover in 2004 and 6% cover in 2007. It had a density of 2,200 plants/acre (5,434 plants/ha) in 2004 and 2,800 plants/acre (6,916 plants/ha) in 2007. Young plants comprised 5% of the population in 2004 and 39% in 2007, and decadence was 66% in 2004 and 24% in 2007. Plants classified with poor vigor made up 49% of the population in 2004 and 16% in 2007. Browse use was moderate-heavy in 2004 and mostly light in 2007. The average leader growth for sagebrush was 3.8 inches (9.6 cm) in 2004 and 1.3 inches (3.3 cm) in 2007.

Combined pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) canopy cover was 27% in 2004 and 5% in 2007. Tausch and West (1994) showed that as pinyon-juniper cover increases, the herbaceous and browse understories decrease. Generally, pinyon-juniper cover of over 15% greatly diminishes the understory cover. The estimated pinyon density was 285 trees/acre (704 trees/ha) in 2004 and 59 trees/acre (146 trees/ha) in 2007. The average trunk diameter was 4.2 inches (10.7 cm) in 2004 and 1.5 inches (3.8 cm) in 2007. The estimated juniper density was 82 trees/acre (203 trees/ha) in 2004 and 52 trees/acre (128 trees/ha) in 2007. The average trunk diameter was 3.3 inches (8.4 cm) in 2004 and 2.9 inches (7.4 cm) in 2007.



### Herbaceous Understory

Ten species of grasses were sampled in 2004 and 2007, one of which was an annual. Perennial grasses provided 5% cover in 2004 and 15% cover in 2007. Salina wildrye (*Elymus salina*), bottlebrush squirreltail (*Sitanion hystrix*), blue grama (*Bouteloua gracilis*), and needle-and-thread (*Stipa comata*) were the dominant grass species in 2004, with 1% cover each. Needle-and-thread and bottlebrush squirreltail were the dominant grasses in 2007 and provided 7% and 3% cover, respectively. Cheatgrass (*Bromus tectorum*) provided less than 1% cover both sample years; it was sampled in 3% of the quadrats in 2004 and 16% of quadrats in 2007.

Twenty-four forb species have been sampled in the study, nine of which were annuals. Perennial and annual forbs each provided 1% cover in 2004. Perennial forb cover increased to 6% in 2007, while annual forb cover remained constant. The dominant perennial forb in 2007 was prickly lettuce (*Lactuca serriola*). Previous to the treatment, the encroaching pinyon and juniper may have suppressed forb growth.

### 2007 Post-treatment Assessment

The treatment reduced pinyon-juniper canopy cover and density, and seemed to help improve the preferred browse component. Wyoming big sagebrush density and recruitment increased, and decadence decreased. Vigor improved throughout the sagebrush population. The grass component also benefitted from the treatment. The sum of nested frequency for perennial grasses increased 48% and average cover increased from 5% to 15%. The nested frequencies of mutton bluegrass (*Poa fendleriana*), bottlebrush squirreltail, and needle-and-thread increased significantly, but the nested frequencies of Salina wildrye and blue grama decreased significantly. The nested frequency for cheatgrass increased significantly, however, its cover remained stable at less than 1%. The treatment also improved the forb component. The sum of nested frequency of perennial forbs increased more than three-fold, and cover increased from 1% to 6%. The nested frequencies of scarlet globemallow (*Sphaeralcea grossulariifolia*) and hoary aster (*Machaeranthera canescens*) significantly increased, and prickly lettuce (*Lactuca serriola*) was sampled for the first time and provided 3% cover. The nested frequency for annual forbs decreased 63%, but cover remained at 1%. The nested frequencies of groundsmoke (*Gayophytum ramosissimum*) and douglas knotweed (*Polygonum douglasii*) significantly decreased, and goosefoot (*Chenopodium* sp.) was not sampled. The 2004 Desirable Components Index (DCI) score was poor due to a lack of browse cover, low perennial grass cover, and low perennial forb cover. In 2007, the DCI score improved to excellent due to increased preferred browse cover with increased recruitment and decreased decadence, as well as an increase in perennial grass and forb cover.

2004 winter range condition (DCI) – poor (16) Low potential scale

2007 winter range condition (DCI) – excellent (69) Low potential scale

<b>Lower Cedar Bench Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Great Basin Wildrye 'Trailhead'	80	0.5
Alfalfa 'Spredor 3'	175	1.2
Blue Flax 'Appar'	33	0.2
Bitterbrush–Ada/Boise ID	54	0.4
Fourwing Saltbush–Emery UT	100	0.7
Sagebrush, Wyoming--Sanpete UT	100	0.7
<b>Total</b>	<b>542</b>	<b>3.6</b>
<b>Total PLS/acre</b>		<b>2.5</b>
<b>Live Seeds/sq. ft.</b>		<b>10.5</b>

HERBACEOUS TRENDS --  
Management unit 16R, Study no: 11

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron smithii</i>	a <sup>9</sup>	a <sup>3</sup>	.18	.00
G	<i>Agropyron spicatum</i>	a <sup>-</sup>	b <sup>15</sup>	.00	1.18
G	<i>Bouteloua gracilis</i>	b <sup>31</sup>	a <sup>23</sup>	.91	.81
G	<i>Bromus tectorum</i> (a)	a <sup>9</sup>	b <sup>28</sup>	.16	.27
G	<i>Elymus salina</i>	b <sup>26</sup>	a <sup>2</sup>	1.20	.41
G	<i>Oryzopsis hymenoides</i>	a <sup>10</sup>	a <sup>21</sup>	.31	1.28
G	<i>Poa fendleriana</i>	a <sup>8</sup>	b <sup>27</sup>	.06	1.16
G	<i>Poa secunda</i>	6	-	.09	-
G	<i>Sitanion hystrix</i>	a <sup>60</sup>	b <sup>113</sup>	.86	3.01
G	<i>Stipa comata</i>	a <sup>71</sup>	b <sup>122</sup>	1.44	6.64
<b>Total for Annual Grasses</b>		<b>9</b>	<b>28</b>	<b>0.15</b>	<b>0.27</b>
<b>Total for Perennial Grasses</b>		<b>221</b>	<b>326</b>	<b>5.07</b>	<b>14.51</b>
<b>Total for Grasses</b>		<b>230</b>	<b>354</b>	<b>5.23</b>	<b>14.78</b>
F	<i>Arabis</i> sp.	a <sup>10</sup>	a <sup>13</sup>	.03	.06
F	<i>Astragalus convallarius</i>	a <sup>8</sup>	a <sup>9</sup>	.36	.31
F	<i>Astragalus tenellus</i>	-	3	-	.07
F	<i>Astragalus</i> sp.	2	-	.00	-
F	<i>Castilleja linariaefolia</i>	-	2	-	.15
F	<i>Calochortus nuttallii</i>	a <sup>3</sup>	a <sup>4</sup>	.00	.01
F	<i>Chaenactis douglasii</i>	a <sup>-</sup>	a <sup>5</sup>	.00	.20
F	<i>Chenopodium</i> sp. (a)	55	-	.16	-
F	<i>Chenopodium fremontii</i> (a)	-	1	-	.00
F	<i>Collinsia parviflora</i> (a)	-	-	.00	-
F	<i>Descurainia pinnata</i> (a)	a <sup>13</sup>	a <sup>23</sup>	.06	.22
F	<i>Eriogonum cernuum</i> (a)	-	1	-	.00
F	<i>Gayophytum ramosissimum</i> (a)	b <sup>38</sup>	a <sup>11</sup>	.21	.16
F	<i>Lappula occidentalis</i> (a)	a <sup>11</sup>	b <sup>37</sup>	.07	.17
F	<i>Lactuca serriola</i>	-	88	-	2.90
F	<i>Lepidium</i> sp. (a)	-	4	-	.04
F	<i>Lesquerella</i> sp.	a <sup>7</sup>	a <sup>18</sup>	.01	.42
F	<i>Machaeranthera canescens</i>	a <sup>8</sup>	b <sup>20</sup>	.06	.37
F	<i>Penstemon comarrhenus</i>	a <sup>3</sup>	a <sup>8</sup>	.01	.04
F	<i>Penstemon pachyphyllus</i>	a <sup>10</sup>	a <sup>14</sup>	.13	.40
F	<i>Phlox longifolia</i>	a <sup>4</sup>	a <sup>6</sup>	.03	.01
F	<i>Polygonum douglasii</i> (a)	b <sup>151</sup>	a <sup>21</sup>	.48	.24

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Schoenocrambe linifolia</i>	a <sup>3</sup>	a <sup>6</sup>	.00	.09
F	<i>Sphaeralcea grossulariifolia</i>	a <sup>16</sup>	b <sup>33</sup>	.28	.75
Total for Annual Forbs		268	98	1.01	0.86
Total for Perennial Forbs		74	229	0.95	5.80
Total for Forbs		342	327	1.96	6.67

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 16R, Study no: 11

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	54	59	3.32	5.62
B	<i>Chrysothamnus viscidiflorus stenophyllus</i>	0	1	-	-
B	<i>Chrysothamnus viscidiflorus viscidiflorus</i>	40	43	1.93	2.10
B	<i>Gutierrezia sarothrae</i>	1	0	-	.00
B	<i>Juniperus osteosperma</i>	10	6	3.88	1.68
B	<i>Opuntia sp.</i>	19	15	.90	.04
B	<i>Pediocactus simpsonii</i>	4	0	.00	-
B	<i>Pinus edulis</i>	17	7	16.00	1.93
Total for Browse		145	131	26.05	11.40

#### CANOPY COVER, LINE INTERCEPT --

Management unit 16R, Study no: 11

Species	Percent Cover	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	4.21	7.75
<i>Chrysothamnus viscidiflorus viscidiflorus</i>	2.81	3.09
<i>Juniperus osteosperma</i>	5.80	1.91
<i>Opuntia sp.</i>	.13	.11
<i>Pediocactus simpsonii</i>	.06	-
<i>Pinus edulis</i>	20.95	3.46

KEY BROWSE ANNUAL LEADER GROWTH --  
Management unit 16R, Study no: 11

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	3.8	1.3

POINT-QUARTER TREE DATA --  
Management unit 16R, Study no: 11

Species	Trees per Acre		Average diameter (in)	
	'04	'07	'04	'07
Juniperus osteosperma	82	52	3.3	2.9
Pediocactus simpsonii	285	59	4.2	3.8

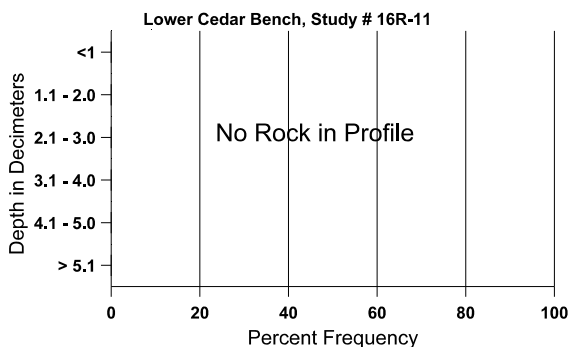
BASIC COVER --  
Management unit 16R, Study no: 11

Cover Type	Average Cover %	
	'04	'07
Vegetation	33.28	32.64
Rock	1.36	.19
Pavement	.33	.14
Litter	49.95	51.77
Cryptogams	5.03	1.62
Bare Ground	32.87	29.59

SOIL ANALYSIS DATA --  
Management unit 16R, Study no: 11, Study Name: Lower Cedar Bench

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.3	62.8 (11.9)	6.8	45.6	27.1	27.2	1.4	15.0	105.6	0.6

### Stoniness Index



PELLET GROUP DATA --

Management unit 16R, Study no: 11

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	20	41	-	-
Elk	3	8	12 (30)	25 (63)
Deer	33	26	119 (294)	94 (231)

BROWSE CHARACTERISTICS --

Management unit 16R, Study no: 11

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>2200</b>	100	120	620	1460	2480	44	34	66	48	49	19/23
07	<b>2800</b>	13660	1100	1020	680	620	14	11	24	16	16	23/31
<i>Chrysothamnus viscidiflorus stenophyllus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	4/7
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>2040</b>	-	80	1940	20	80	0	0	1	-	.98	9/13
07	<b>2680</b>	740	260	2420	-	-	0	2	0	-	0	8/13
<i>Gutierrezia sarothrae</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	9/11
07	<b>0</b>	40	-	-	-	-	0	0	-	-	0	10/14
<i>Juniperus osteosperma</i>												
04	<b>220</b>	-	80	140	-	-	0	0	-	-	0	-/-
07	<b>120</b>	20	40	80	-	40	0	0	-	-	50	-/-
<i>Opuntia sp.</i>												
04	<b>520</b>	-	80	440	-	40	0	0	0	-	0	4/12
07	<b>320</b>	-	100	180	40	20	0	0	13	6	6	3/9
<i>Pediocactus simpsonii</i>												
04	<b>80</b>	-	40	40	-	-	0	0	-	-	0	2/4
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Pinus edulis</i>												
04	<b>340</b>	-	160	160	20	20	0	0	6	-	6	-/-
07	<b>160</b>	-	20	140	-	60	0	0	0	-	50	-/-

Trend Study 16R-12-07

Study site name: Upper Cedar Bench .

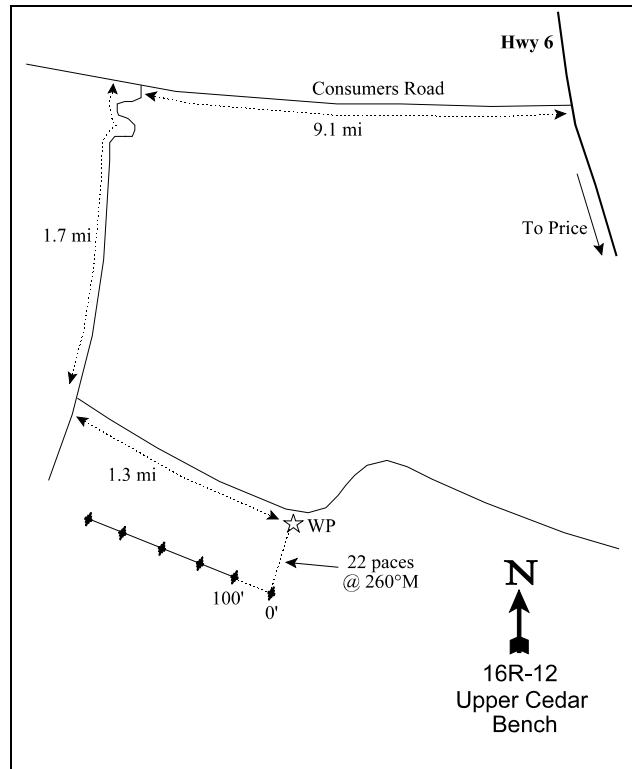
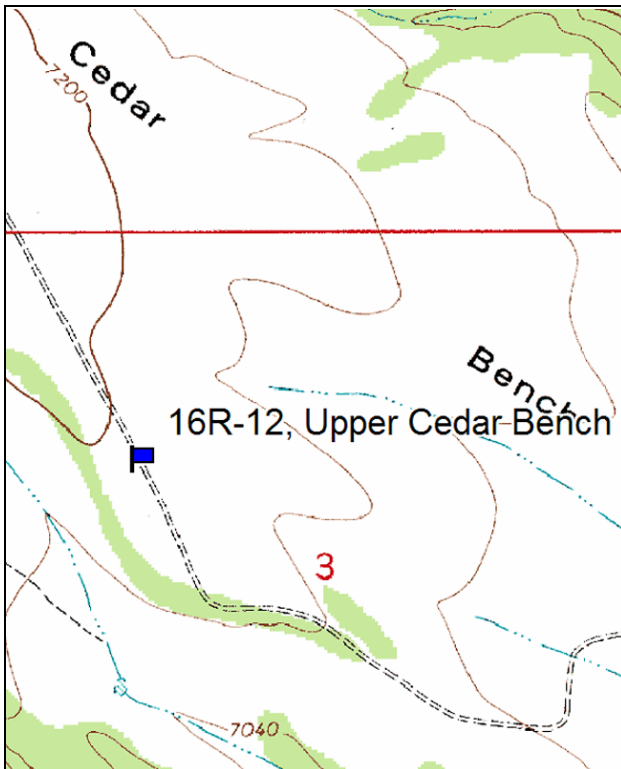
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 320 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Highway 6 north of Price, turn west onto Consumers Road. Travel 9.1 miles to a road that comes in from the left (south). Turn here and follow this road 1.7 miles to another road that comes in from the left. Turn here and travel 1.3 miles to a witness post on the right. The 0-foot stake is 22 paces from the witness post at 260°M, and is marked with browse tag #48.



Map Name: Jump Creek

Diagrammatic Sketch

Township 14S , Range 8E , Section 3

GPS: NAD 83, UTM 12S 498404 E 4387723 N

## DISCUSSION

### Upper Cedar Bench – Trend Study No. 16R-12

#### Study Information

This study monitors a pinyon-juniper removal on Cedar Bench approximately 10 miles (16 km) west of Price. The treatment area is located about 1 mile (1.6 km) south of Consumers Road (SSR 139) and is located within the Gordon Creek Withdrawl grazing allotment [elevation: 7,200 feet (2,195 m), slope: 3%, aspect: southwest]. The big game winter range habitat on Cedar Bench has degraded as pinyon-juniper canopy cover has increased. Another study, Lower Cedar Bench (16R-11), was established 1.6 miles (2.6 km) to the east, on the same treatment area. The purpose of the treatment was to open the canopy and establish desirable forage and browse species in the area. In spring 2005, seed (see list below) was hand broadcast on the treatment area, and trees were removed by pushing with D-6 CAT bulldozers. In 2007, when talking to the habitat biologist, it was discussed that the treatment may not have been seeded. This study is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation data was incomplete for 2004 and 2005, and 81% of normal in 2006 at the Price weather station located approximately 11 miles (18 km) southeast of the site. Spring precipitation was 75% of normal in 2005, 61% in 2006, and 55% in 2007. Fall precipitation data was above normal in 2004 and 2006, and incomplete in 2005 (Utah Climate Summaries 2007). From the pellet group transect data deer use was estimated at 52 days use/acre (127 ddu/ha) in 2004 and 40 days use/acre (99 ddu/ha) in 2007. Elk use was estimated at 53 days use/acre (131 edu/ha) in 2004 and 29 days use/acre (71 edu/ha) in 2007. Most pellets were from winter use.

#### Soil

The soil is in the Chupadera series, which consists of moderately deep, well-drained soils that formed in eolian sands and residuum from limestone on rolling bedrock controlled uplands and on structural benches of plateaus (USDA-NRCS 2007). The soil is a shallow clay loam with a neutral reactivity (pH 7.1). No rock is in the soil profile and less than 2% of the soil surface relative cover was rock and pavement in both sample years. The combined relative cover of litter and vegetation was 67% in 2004 and increased to 84% in 2007. The relative bare ground cover was 28% in 2004 and decreased to 16% in 2007. The erosion condition was classified as stable in 2004 and slight in 2007 due to pedestalling around plants and rill formation.

#### Browse

Black sagebrush (*Artemisia nova*) and Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*) are the dominant preferred browse species. Black sagebrush provided 6% cover in 2004 and 5% cover in 2007. Its density was 2,820 plants/acre (6,965 plants/ha) in 2004 and 2,200 plants/acre (5,434 plants/ha) in 2007. The recruitment of young was 15% of the population in 2004 and 9% in 2007. Decadence was 31% of the population both sample years. Plants classified with poor vigor comprised 21% of the population in 2004 and 18% in 2007. Browse use was mostly light-moderate both sample years. The average annual leader growth of black sagebrush was 1.4 inches (3.6 cm) in 2004 and 1.6 inches (3.6 cm) in 2007.

Wyoming big sagebrush provided 2% cover in 2004 and 1% cover in 2007. Its density was 800 plants/acre (1,976 plants/ha) in 2004 and 580 plants/acre (1,433 plants/ha) in 2007. Young recruitment was 10% of the population both sample years, and decadence was 53% in 2004 and 55% in 2007. Plants classified as showing poor vigor made up 48% of the population in 2004 and 31% in 2007. The density of dead plants decreased from 1,200 plants/acre (2,965 plants/ha) in 2004 to 920 plants/acre (2,273 plants/ha) in 2007. The number of dead plants sampled may have decreased when the D-6 CAT trampled sagebrush skeletons, and not as a direct result of the change in pinyon and juniper cover. Browse use was light-moderate in 2002 and moderate-heavy in 2007. The average annual leader growth was 2.2 inches (5.6 cm) in 2004 and 1.9 inches (4.9 cm) in 2007. Utah serviceberry (*Amelanchier utahensis*) was also sampled, but was sparse. Its average annual leader growth was 4.6 inches (11.6 cm) in 2004 and 3.2 inches (8.1 cm) in 2007.

The combined pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) canopy cover was 8% in 2004 and 0% in 2007. Tausch and West (1994) showed that as pinyon-juniper cover increases, the herbaceous and browse understories decrease. Generally, pinyon-juniper cover of over 15% greatly diminishes the understory cover. However, the positive response of the understory following the treatment suggests that the pinyon-juniper canopy was already out-competing the shrub and herbaceous species. The estimated pinyon density was 78 trees/acre (193 trees/ha) in 2004 and 36 trees/acre (89 trees/ha) in 2007. The average trunk diameter was 3.7 inches (9.4 cm) in 2004 and 1.5 inches (3.8 cm) in 2007. The estimated juniper density was 75 trees/acre (185 trees/ha) in 2004 and 32 trees/acre (79 trees/ha) in 2007. The average trunk diameter was 4.0 inches (10.2 cm) in 2004 and 2.9 inches (7.4 cm) in 2007. The tree densities are much lower than those of the Lower Cedar Bench (16R-11) study, which is reflected in the higher browse and herbaceous understory cover.

### Herbaceous Understory

Ten species of grass have been sampled, nine of which were perennials. Perennial grasses provided 14% cover in 2004 and 22% cover in 2007. Salina wildrye (*Elymus salina*), mutton bluegrass (*Poa fendleriana*), and needle-and-thread (*Stipa comata*) were the dominant grass species in 2004, providing 12% combined cover. In 2007, salina wildrye, mutton bluegrass, needle-and-thread, Sandberg bluegrass (*Poa secunda*), and western wheatgrass (*Agropyron spicatum*) were the dominant grass species, providing 21% combined cover. Salina wildrye provided 4% cover, mutton bluegrass provided 10% cover, needle-and-thread 1% cover, Sandberg bluegrass 1% cover, and western wheatgrass 4% cover.

Twenty-six species of forbs have been sampled, five of which were annuals. Perennial forbs provided 3% cover in 2004 and 4% cover in 2007. Timber poisonvetch (*Astragalus convallarius*), bastard toadflax (*Comandra pallida*), and longleaf phlox (*Phlox longifolia*) have been the most abundant forbs sampled. Annual forb cover was sparse at less than 1% both sample years.

### 2007 Post-treatment Assessment

The treatment was effective in reducing pinyon and juniper density, however, it did not improve the preferred browse component. The density of black sagebrush decreased 22%. The recruitment of young decreased from 15% of the population to 9%, and decadence remained stable at 31%. Plants showing poor vigor decreased slightly from 21% of the population to 18%, and browse use remained mostly light-moderate. The density of Wyoming big sagebrush decreased 28%. The recruitment of young remained stable at 10% of the population, and decadence slightly increased from 53% to 55%. Plants showing poor vigor decreased from 48% of the population to 31%, and browse use remained mostly light-moderate. The grass component improved from the treatment. The sum of nested frequency for perennial grasses increased 34%, and cover increased from 14% to 22%. The nested frequencies for bluebunch wheatgrass, mutton bluegrass, and Sandberg bluegrass increased significantly. However, cheatgrass was also sampled for the first time, with a quadrat frequency of 7%. The forb component improved from the treatment. The sum of nested frequency for perennial forbs increased 43%, and cover increased from 3% to 4%. The nested frequencies of bastard toadflax, longleaf phlox, and slenderleaf schoenrambe (*Schoenrambe linifolia*) increased significantly. Annual forbs were sparse, providing almost no cover. The 2004 Desirable Components Index (DCI) score was good due to moderate browse cover, excellent perennial grass cover, and good perennial forb cover. In 2007, the DCI score remained good.

2004 winter range condition (DCI) – good (56) Low potential scale

2007 winter range condition (DCI) - good (56) Low potential scale



Upper Cedar Bench Seed Mix	Bulk lbs in mix	Bulk lbs/acre
Great Basin Wildrye 'Trailhead'	80	0.5
Alfalfa 'Spredor 3'	175	1.2
Blue Flax 'Appar'	33	0.2
Bitterbrush–Ada/Boise ID	54	0.4
Fourwing Saltbush–Emery UT	100	0.7
Sagebrush, Wyoming--Sanpete UT	100	0.7
<b>Total</b>	<b>542</b>	<b>3.6</b>
<b>Total PLS/acre</b>		<b>2.5</b>
<b>Live Seeds/sq. ft.</b>		<b>10.5</b>

HERBACEOUS TRENDS --

Management unit 16R, Study no: 12

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron smithii	<sub>a</sub> 28	<sub>a</sub> 46	.23	.43
G	Agropyron spicatum	<sub>a</sub> 17	<sub>b</sub> 97	.45	3.95
G	Bouteloua gracilis	<sub>a</sub> 11	<sub>a</sub> 5	.36	.15
G	Bromus tectorum (a)	-	15	-	.08
G	Elymus salina	<sub>b</sub> 222	<sub>a</sub> 109	7.00	3.99
G	Oryzopsis hymenoides	<sub>a</sub> 6	<sub>a</sub> 6	.30	.03
G	Poa fendleriana	<sub>a</sub> 147	<sub>b</sub> 257	4.06	10.42
G	Poa secunda	<sub>a</sub> 11	<sub>b</sub> 86	.05	1.45
G	Sitanion hystrix	<sub>a</sub> 6	<sub>a</sub> 16	.09	.33
G	Stipa comata	<sub>a</sub> 39	<sub>a</sub> 32	1.11	1.38
Total for Annual Grasses		0	15	0	0.08
Total for Perennial Grasses		487	654	13.67	22.15
Total for Grasses		487	669	13.67	22.24
F	Agoseris glauca	-	12	-	.05
F	Arabis sp.	2	-	.00	-
F	Astragalus convallarius	<sub>a</sub> 60	<sub>a</sub> 55	1.36	.68
F	Astragalus tenellus	-	23	-	.67
F	Aster sp.	-	1	-	.00
F	Astragalus sp.	8	-	.21	-
F	Castilleja linariaefolia	-	9	-	.04
F	Calochortus nuttallii	<sub>a</sub> 2	<sub>a</sub> 4	.00	.01
F	Comandra pallida	<sub>a</sub> 64	<sub>b</sub> 89	.80	1.42
F	Collinsia parviflora (a)	-	3	-	.00

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Cymopterus sp.	<sub>a</sub> 1	<sub>a</sub> 1	.00	.00
F	Descurainia pinnata (a)	-	2	-	.00
F	Eriogonum racemosum	2	-	.04	-
F	Gayophytum ramosissimum(a)	1	-	.00	-
F	Lappula occidentalis (a)	<sub>a</sub> 7	<sub>b</sub> 21	.01	.05
F	Lactuca serriola	-	2	-	.00
F	Machaeranthera canescens	<sub>a</sub> 1	<sub>a</sub> 5	.00	.06
F	Penstemon pachyphyllus	<sub>a</sub> 9	<sub>a</sub> 11	.08	.07
F	Phlox longifolia	<sub>a</sub> 41	<sub>b</sub> 96	.10	.45
F	Polygonum douglasii (a)	40	-	.10	-
F	Schoenocrambe linifolia	<sub>a</sub> 1	<sub>b</sub> 11	.00	.13
F	Sedum lanceolatum	-	2	-	.01
F	Senecio multilobatus	<sub>a</sub> 43	<sub>a</sub> 26	.21	.40
F	Sphaeralcea grossulariifolia	<sub>a</sub> 8	<sub>a</sub> 1	.03	.00
F	Tragopogon dubius	<sub>a</sub> 1	<sub>a</sub> 1	.00	.03
F	Trifolium sp.	<sub>a</sub> 23	<sub>a</sub> 30	.32	.14
Total for Annual Forbs		48	26	0.12	0.06
Total for Perennial Forbs		266	379	3.20	4.21
Total for Forbs		314	405	3.33	4.27

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 16R, Study no: 12

T y p e	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Amelanchier utahensis	2	2	.15	.30
B	Artemisia nova	62	57	6.45	5.31
B	Artemisia tridentata wyomingensis	28	20	2.30	.85
B	Chrysothamnus viscidiflorus viscidiflorus	34	29	1.44	1.26
B	Gutierrezia sarothrae	30	34	1.02	.82
B	Juniperus osteosperma	1	0	-	-
B	Opuntia sp.	5	4	-	-
B	Pediocactus simpsonii	1	1	-	-

B	Pinus edulis	6	3	7.55	-
Total for Browse		169	150	18.94	8.56

CANOPY COVER, LINE INTERCEPT –

Management unit 16R, Study no: 12

Species	Percent Cover	
	'04	'07
Amelanchier utahensis	-	.30
Artemisia nova	5.18	5.73
Artemisia tridentata wyomingensis	1.25	.96
Chrysothamnus viscidiflorus viscidiflorus	1.45	1.43
Gutierrezia sarothrae	1.68	.88
Juniperus osteosperma	.61	-
Pinus edulis	7.26	-

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 16R, Study no: 12

Species	Average leader growth (in)	
	'04	'07
Amelanchier utahensis	4.6	3.2
Artemisia nova	-	1.6
Artemisia tridentata wyomingensis	2.2	1.9

POINT-QUARTER TREE DATA --

Management unit 16R, Study no: 12

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	75	32
Pinus edulis	78	36

Average diameter (in)	
'04	'07
4.0	2.9
3.7	1.5

BASIC COVER --

Management unit 16R, Study no: 12

Cover Type	Average Cover %	
	'04	'07
Vegetation	36.40	37.54
Rock	.16	.13
Pavement	1.38	.22

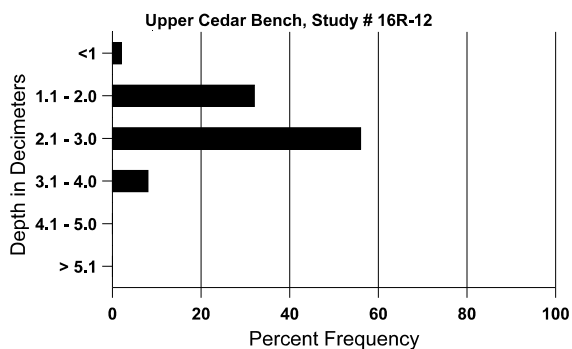
Cover Type	Average Cover %	
	'04	'07
Litter	41.90	41.95
Cryptogams	3.92	3.57
Bare Ground	33.15	28.02

SOIL ANALYSIS DATA --

Management unit 16R, Study no: 12, Study Name: Upper Cedar Bench

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
10.5	62.8 (10.9)	7.1	39.6	29.1	31.3	2.1	11.2	70.4	0.6

### Stoniness Index



PELLET GROUP DATA --

Management unit 16R, Study no: 12

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	12	34	-	-
Elk	28	28	53 (131)	29 (71)
Deer	32	20	52 (127)	40 (99)

BROWSE CHARACTERISTICS --  
Management unit 16R, Study no: 12

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Amelanchier utahensis</b>												
04	<b>40</b>	-	-	40	-	-	0	100	-	-	0	25/31
07	<b>40</b>	-	-	40	-	-	50	50	-	-	0	30/36
<b>Artemisia nova</b>												
04	<b>2820</b>	2020	420	1520	880	1380	16	.70	31	18	21	12/21
07	<b>2200</b>	8120	200	1320	680	700	21	8	31	15	18	12/22
<b>Artemisia tridentata wyomingensis</b>												
04	<b>800</b>	220	80	300	420	1200	28	20	53	48	48	19/24
07	<b>580</b>	2440	60	200	320	920	48	17	55	24	31	20/31
<b>Chrysothamnus viscidiflorus viscidiflorus</b>												
04	<b>1320</b>	-	60	1260	-	-	0	0	0	-	0	7/12
07	<b>1340</b>	100	120	1200	20	60	22	0	1	-	1	9/16
<b>Gutierrezia sarothrae</b>												
04	<b>1980</b>	-	100	1880	-	20	0	0	0	-	0	7/10
07	<b>2080</b>	140	140	1900	40	-	0	0	2	.96	.96	6/8
<b>Juniperus osteosperma</b>												
04	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	40	0	0	-	-	0	-/-
<b>Opuntia sp.</b>												
04	<b>100</b>	-	-	100	-	-	0	0	-	-	0	3/9
07	<b>100</b>	-	60	40	-	-	0	0	-	-	0	4/9
<b>Pediocactus simpsonii</b>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	2/2
07	<b>20</b>	-	20	-	-	-	0	0	-	-	0	4/8
<b>Pinus edulis</b>												
04	<b>120</b>	-	80	40	-	-	0	0	-	-	0	-/-
07	<b>60</b>	-	20	40	-	-	0	0	-	-	0	-/-

Trend Study 16R-13-07

Study site name: Upper Porphyry Bench .

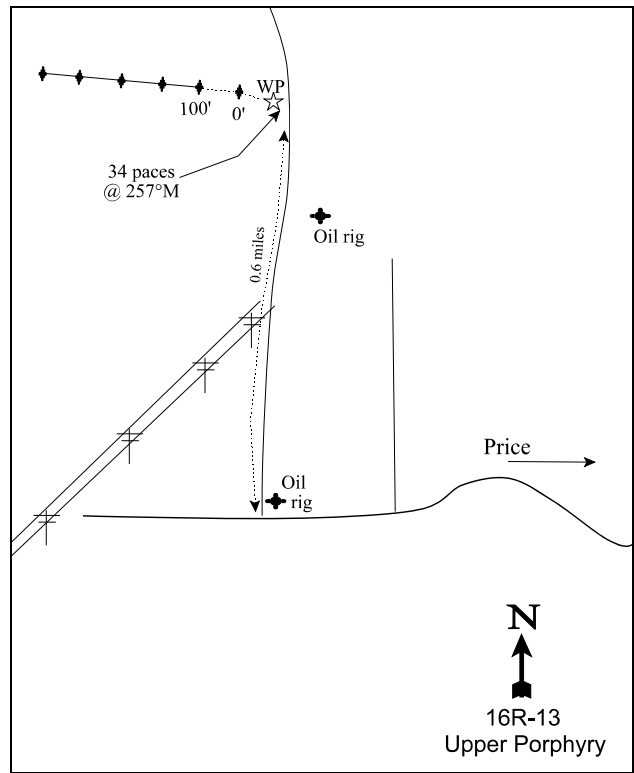
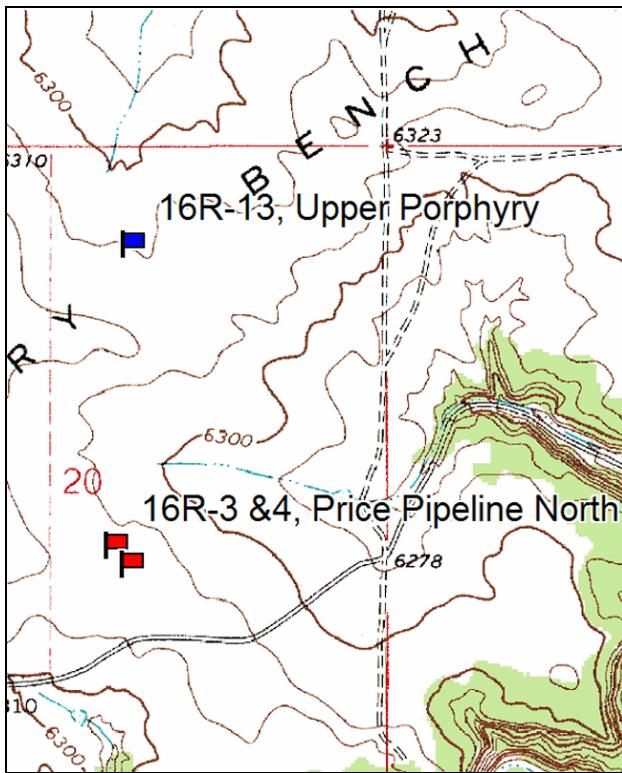
Vegetation type: Wyoming Big Sagebrush .

Compass bearing: frequency baseline 249 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Take Westwood Blvd (1550 W) northwest out of Price 2.35 miles to a major intersection. Turn left onto Gordon Creek Road and travel 0.45 miles to a fork. Bear left away from Gordon Creek, going 0.1 miles to a gravel pit. Continue 5.5 miles on the Pinnacle Peak Road to a 3-way fork at the top of the bench. An oil rig is near this intersection. Take the right fork and drive 0.6 miles to the north past another oil rig, to a witness post on the left side of the road. The 0-foot post is 34 paces from the witness post at 257°M, and is marked with browse tag #51.



Map Name: Pinnacle Peak

Diagrammatic Sketch

Township 14S , Range 9E , Section 20

GPS: NAD 83, UTM 12S 505484 E 4383157 N

## DISCUSSION

### Upper Porphyry Bench – Trend Study No. 16R-13

#### Study Information

This study is located approximately 5 miles (8 km) west of Price, within the Porphyry Bench treatment area [elevation: 6,300 feet (1,920 m), slope: 2%, aspect: northeast]. In spring 2003, approximately 19,000 acres (7,689 ha) of sagebrush suffered severe die-off and 24,000 acres (9,712 ha) suffered moderate die-off within a 50-mile (80-km) radius of Price, Utah. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) showed the largest amount of die-off, compared with other sagebrush species and subspecies. This project, the first of several phases, was designed to rehabilitate 1,160 acres (469 ha) of critical deer winter range and greater sage-grouse habitat on private and Utah Division of Wildlife Resources (UDWR) land. The treatment area was divided into 27 parcels. Parcels 1 through 13 were treated in October and November of 2004, and parcels 15 through 27 were treated in April and May of 2005. This study, Upper Porphyry Bench (16R-13), is located in parcel 12. Parcels 1, 2, and 3 were seeded with native species (mixes B1 and C2) and the other parcels received a mix of native and non-native species (mixes B2 and C1). All parcels (except parcel 6) were treated with a Lawson double drum aerator, pulled by a D-6 CAT, in strips that disturbed between one-third to one-half of the area. Seed was dispersed from a seed box mounted above the second aerator drum. Parcel 6, which is on UDWR property, was drill seeded with native seed mixes B2 and C1 at the end of November 2004. In December of 2004, the entire treatment area was aerially seeded with a mix of winterfat (*Ceratoides lanata*) and forage kochia (*Kochia prostrata*). The study is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation data were incomplete for 2004, 2005, and 81% of normal in 2006 at the Price weather station located approximately 7 miles (11 km) east of the site. Spring precipitation was 75% of normal in 2005, 61% in 2006, and 55% in 2007. Fall precipitation was above normal in 2004 and 2006, and the data were incomplete in 2005 (Utah Climate Summaries 2007). From the pellet group transect data, deer use was estimated at 96 days use/acre (236 ddu/ha) in 2004 and 171 days use/acre (423 ddu/ha) in 2007. Elk use was 1 day use/acre (3 edu/ha) in 2007. Cattle use was 1 day use/acre (2 cdu/ha) in 2004 and 5 days use/acre (13 cdu/ha) in 2007. Horse use was 1 day use/acre (1 hdu/ha) in 2004.

Besides the Upper Porphyry Bench study, three permanent Range Trend studies were treated by this project. Porphyry Bench (16B-18) was in parcel 7, Price Pipeline Native North (16R-3) was in parcel 13, and Price Pipeline North (16R-4) was in parcel 15. All three of these other studies were aerially seeded, aerated, and seeded with the C1 and B2 mixes. The Price Pipeline North study was the only monitoring study that was treated in spring 2005, as opposed to fall 2004.

#### Soil

The soil is in the Hernandez-Atrac complex. The Hernandez series consists of very deep, well-drained soils that formed in mixed alluvium and eolian sediments on alluvial fans and valley fill. The Atrac series consists of deep, well-drained soils that formed in loamy alluvial material derived from sandstone and shale. The soil is a shallow clay loam with a neutral reaction (pH 7.1). There was no rock and very little pavement on the soil surface or in the profile both sample years. The combined vegetation and litter relative cover was 42% in 2004 and 53% in 2007. Relative bare ground cover was 54% in 2004 and 46% in 2007. The soil erosion condition was classified as stable in 2004 and slight in 2007 due to pedestalling, flow patterns, and light litter and soil movement.

#### Browse

Wyoming big sagebrush is the dominant preferred browse species. Though established in the treatment area, it was also included the seed mix (see list below). It provided 4% cover in 2004 and 6% in 2007. Sagebrush density was 2,380 plants/acre (5,879 plants/ha) in 2004 and 3,420 plants/acre (8,447 plants/ha) in 2007. There were no young plants in the population in 2004, and 37% were young in 2007. Decadent plants made up 96% of the population in 2004 and 47% in 2007. Plants classified as showing poor vigor comprised 69% of the

population in 2004 and 30% in 2007. The density of dead plants was high in both sample years, although dead plants decreased from 2,980 plants/acre (7,363 plants/ha) in 2004 to 2,540 plants/acre (6,276 plants/ha) in 2007. Browse use has been mostly light-moderate. The average annual leader growth was 3.5 inches (9.0 cm) in 2004 and 1.4 inches (3.5 cm) in 2007.

Slenderbush eriogonum (*Eriogonum microthecum*) had a density of 2,200 plants/acre (5,434 plants/ha) in 2004 and 4,760 plants/acre (11,757 plants/ha) in 2007. The recruitment of young was 17% of the population in 2004 and 42% in 2007. There were no decadent plants measured in either sample year. Plant vigor was excellent, and browse use was mostly light.

Forage kochia was seeded (see list below) as part of the treatment. In 2007, it had a density of 60 plants/acre (148 plants/ha). There was no decadence in the population, and 67% were young plants. Plant vigor was excellent, and browse use was light. Winterfat was not sampled in 2004 or 2007.

#### Herbaceous Understory

The grass component is diverse. Eight perennial grasses and two annual grasses have been sampled. Perennial grasses provided 1% cover in 2004 and 11% cover in 2007. Bottlebrush squirreltail (*Sitanion hystrix*) was the dominant grass, providing nearly 1% cover in 2004 and 5% cover in 2007. Crested wheatgrass (*Agropyron cristatum*), Siberian wheatgrass (*Agropyron fragile vavilov*), and Russian wildrye (*Elymus junceus*) are seeded species (see list below) that were sampled. Cheatgrass (*Bromus tectorum*) and sixweeks fescue (*Vulpia octoflora*) are annual grasses that were measured for the first time in 2007, but both provided very little cover.

Twenty-one forb species have been sampled, 11 of which were annuals. Perennial forbs provided 2% cover in 2004 and 3% cover in 2007, and annual forbs provided 9% cover in 2004 and 5% cover in 2007. Slimleaf goosefoot (*Chenopodium leptophyllum*) was the dominant forb species in 2004 with 4% cover. Scarlet globemallow (*Sphaeralcea grossulariifolia*) was also abundant with nearly 2% cover, and groundsmoke (*Gayophytum ramosissimum*) and annual stickseed (*Lappula occidentalis*) each provided 1% cover. All other forbs provided less than 1% cover. In 2007, annual stickseed was the dominant forb and provided 4% cover. Scarlet globemallow provided 2% cover, and all other forbs provided less than 1% cover.

#### 2007 Post-treatment Assessment

Since the aerator was only used in strips for the treatment, certain parts of the sample belts were treated and others were not. The treatment seemed to improve the preferred browse component. The density of Wyoming big sagebrush increased 30%. The recruitment of young increased from 0% of the population to 37%, and decadence decreased from 96% to 47%. Plants showing poor vigor decreased from 69% of the population to 30%, and browse use remained mostly light-moderate. It was noted that there was no apparent difference in young and seedling sagebrush distribution from the treated or untreated areas. The density of slenderbush eriogonum increased 54%. The recruitment of young increased from 17% of the population to 42%, and no decadent plants were sampled. Plant vigor remained excellent, and use increased slightly from light to 15% of the population displaying moderate-heavy use. Forage kochia was seeded with the treatment and had a density of 60 plants/acre (148 plants/ha). The recruitment of young was 67% of the population, and there were no decadent plants. Plant vigor was excellent and use was light. The treatment improved the grass component. The sum of nested frequency for perennial grasses increased three-fold, and cover increased from 1% to 11%. The nested frequencies of crested wheatgrass and bottlebrush squirreltail increased significantly. Siberian wheatgrass and Russian wildrye, which were seeded in the treatment, were sampled for the first time. It was noted that Siberian wheatgrass had blown into the untreated bands. Cheatgrass and sixweeks fescue were also sampled for the first time. The forb component also seemed to improve from the treatment. The sum of nested frequency for perennial forbs increased more than two-fold, and cover increased from 2% to 3%. The nested frequencies of longleaf phlox (*Phlox longifolia*) and scarlet globemallow increased significantly. The sum of nested frequency for annual forbs changed little, but cover decreased from 9% to 5%. The nested frequencies of annual stickseed, nodding buckwheat (*Eriogonum cernuum*), and wooly plantain (*Plantago patagonica*)



increased significantly, while slimleaf goosefoot and groundsmoke, which were the dominant forbs in 2004, were not sampled in 2007. The 2004 Desirable Components Index (DCI) score was poor due to low browse cover with low recruitment of young and high decadence, as well as very poor perennial grass and forb cover. In 2007, the DCI score improved to good due to increased browse recruitment and perennial grass cover.

2004 winter range condition (DCI) – poor (12) Low potential scale

2007 winter range condition (DCI) – good (52) Low potential scale

The following are the five seed mixes applied to the treatment. Seed mix A was applied to the entire treatment in December 2004. Seed mixes C2 and B1 were applied to parcels 1, 2, and 3 in fall 2004. Seed mixes C1 and B2 were applied to the other parcels in fall 2004 (parcels 4-13) and spring 2005 (parcels 15-27).

<b>Upper Porphyry Bench Aerial Seed Mix (A)</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Forage Kochia 'Immigrant'	865	0.7
Winterfat--Duchesne/Uintah UT	75	0.1
<b>Total</b>	<b>940</b>	<b>0.8</b>
<b>PLS lbs/acre</b>		<b>0.5</b>
<b>Live seeds/sq. ft.</b>		<b>3.1</b>

<b>Upper Porphyry Bench Browse Seed Mix 1 (B1)</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Sagebrush, Wyoming--Sanpete UT	75	0.9
<b>Total</b>	<b>75</b>	<b>0.9</b>
<b>PLS lbs/acre</b>		<b>0.3</b>
<b>Live seeds/sq. ft.</b>		<b>4.0</b>

<b>Upper Porphyry Bench Browse Seed Mix 2 (B2)</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Sagebrush, Wyoming--Sanpete UT	440	0.9
Fourwing Saltbush--Emery UT	128	0.3
<b>Total</b>	<b>568</b>	<b>1.1</b>
<b>PLS lbs/acre</b>		<b>0.3</b>
<b>Live seeds/sq. ft.</b>		<b>4.1</b>

<b>Upper Porphyry Bench Grass/Forb Seed Mix 1 (C1)</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Russian Wildrye 'Bozoisky'	880	2.1
Crested Wheatgrass 'Douglas'	500	1.2
Siberian Wheatgrass 'Vavilov'	450	1.1
Small Burnet 'Delar'	215	0.5
Yellow Sweetclover	225	0.5
Fourwing Saltbush--Emery UT	615	1.5
<b>Total</b>	<b>2885</b>	<b>7.0</b>
<b>PLS lbs/acre</b>		<b>5.7</b>

<b>Upper Porphyry Bench Grass/Forb Seed Mix 2 (C2)</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Great Basin Wildrye 'Trailhead'	90	1.1
Sheep Fescue	95	1.1
Indian Ricegrass 'Rimrock'	85	1.0
Western Wheatgrass 'Arriba'	100	1.2
Blue Flax 'Appar'	9	0.1
Rocky Mountain Beeplant--Sanpete UT	17	0.2
Fourwing Saltbush--Emery UT	126	1.5
<b>Total</b>	<b>522</b>	<b>6.1</b>
<b>PLS lbs/acre</b>		<b>4.9</b>

HERBACEOUS TRENDS --  
Management unit 16R, Study no: 13

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	<sub>a</sub> 1	<sub>b</sub> 34	.03	.66
G	Agropyron fragile vavilov	-	51	-	1.38
G	Agropyron smithii	<sub>a</sub> 9	<sub>a</sub> 17	.16	.61
G	Bouteloua gracilis	<sub>a</sub> 1	<sub>a</sub> 8	.03	.53
G	Bromus tectorum (a)	-	38	-	.22
G	Elymus junceus	-	15	-	.13
G	Oryzopsis hymenoides	<sub>a</sub> 45	<sub>a</sub> 51	.15	.76
G	Sitanion hystrix	<sub>a</sub> 59	<sub>b</sub> 217	.70	5.21
G	Stipa comata	<sub>a</sub> 32	<sub>a</sub> 55	.16	1.45
G	Vulpia octoflora (a)	-	5	-	.02
Total for Annual Grasses		0	43	0	0.25
Total for Perennial Grasses		147	448	1.24	10.74
Total for Grasses		147	491	1.24	10.99
F	Arabis sp.	<sub>a</sub> 2	<sub>a</sub> 4	.03	.00
F	Astragalus convallarius	<sub>a</sub> 5	<sub>a</sub> 9	.09	.21
F	Castilleja sp.	4	-	.00	-
F	Chenopodium fremontii (a)	3	-	.21	-
F	Chenopodium leptophyllum(a)	184	-	4.44	-
F	Cordylanthus sp. (a)	<sub>b</sub> 44	<sub>a</sub> 13	.64	.02
F	Descurainia pinnata (a)	<sub>a</sub> 53	<sub>a</sub> 43	.46	.15
F	Draba sp. (a)	-	2	-	.01
F	Eriogonum cernuum (a)	<sub>a</sub> 15	<sub>b</sub> 30	.16	.12
F	Gayophytum ramosissimum(a)	50	-	1.25	-
F	Gilia sp. (a)	2	-	.00	-

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Lappula occidentalis (a)	<sub>a</sub> 42	<sub>b</sub> 273	1.02	4.25
F	Lesquerella sp.	-	7	-	.07
F	Penstemon sp.	1	-	.03	-
F	Penstemon sp.	<sub>a</sub> 6	<sub>a</sub> 15	.07	.08
F	Phlox hoodii	-	3	-	.03
F	Phlox longifolia	<sub>a</sub> 20	<sub>b</sub> 64	.09	.22
F	Plantago patagonica (a)	<sub>a</sub> 26	<sub>b</sub> 75	.47	.57
F	Salsola iberica (a)	<sub>a</sub> 8	<sub>a</sub> 27	.31	.05
F	Schoenocrambe linifolia	-	4	-	.01
F	Sphaeralcea grossulariifolia	<sub>a</sub> 49	<sub>b</sub> 124	1.67	2.31
Total for Annual Forbs		427	463	9.01	5.18
Total for Perennial Forbs		87	230	1.98	2.95
Total for Forbs		514	693	11.00	8.14

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 16R, Study no: 13

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	74	78	4.24	5.75
B	Chrysothamnus viscidiflorus viscidiflorus	45	83	1.58	3.29
B	Eriogonum microthecum	30	35	.36	.47
B	Gutierrezia sarothrae	0	28	-	.10
B	Kochia prostrata	0	3	-	.00
B	Opuntia sp.	7	13	.00	.00
Total for Browse		156	240	6.19	9.63

CANOPY COVER, LINE INTERCEPT --  
 Management unit 16R, Study no: 13

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	5.78	4.13
Chrysothamnus viscidiflorus viscidiflorus	1.61	3.71
Eriogonum microthecum	.55	.58
Gutierrezia sarothrae	-	.18
Kochia prostrata	-	.01

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 16R, Study no: 13

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	3.5	1.4

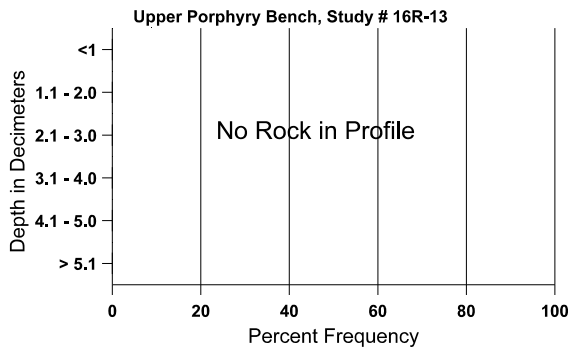
BASIC COVER --  
 Management unit 16R, Study no: 13

Cover Type	Average Cover %	
	'04	'07
Vegetation	19.82	30.82
Pavement	0	.01
Litter	26.92	29.48
Cryptogams	4.80	1.99
Bare Ground	60.34	52.40

SOIL ANALYSIS DATA --  
 Management unit 16R, Study no: 13, Study Name: Upper Porphyry Bench

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
12.8	62.2 (12.9)	7.1	43.6	28.9	27.5	1.7	8.9	80.0	0.5

# Stoniness Index



## PELLET GROUP DATA -- Management unit 16R, Study no: 13

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	56	89	-	-
Elk	1	6	-	1 (3)
Deer	47	52	96 (236)	171 (423)
Cattle	3	2	1 (2)	5 (12)
Horse	-	-	1 (1)	-

## BROWSE CHARACTERISTICS -- Management unit 16R, Study no: 13

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>2380</b>	-	-	100	2280	2980	13	29	96	68	69	20/30
07	<b>3420</b>	22960	1280	540	1600	2540	19	7	47	29	30	20/30
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>2080</b>	3380	-	2080	-	80	0	0	0	-	0	9/13
07	<b>12100</b>	4540	5920	6160	20	60	2	6	0	-	0	6/9
<i>Eriogonum microthecum</i>												
04	<b>2200</b>	-	380	1820	-	-	0	0	-	-	0	6/7
07	<b>4760</b>	6200	2020	2740	-	-	3	12	-	-	0	4/4
<i>Gutierrezia sarothrae</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>1260</b>	940	440	820	-	-	0	0	-	-	0	7/7

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Kochia prostrata												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>60</b>	40	40	20	-	-	0	0	-	-	0	2/3
Opuntia sp.												
04	<b>140</b>	-	-	140	-	-	0	0	0	-	0	2/8
07	<b>260</b>	-	100	100	60	-	0	0	23	-	0	2/7

Trend Study 16R-20-07

Study site name: Howerton's.

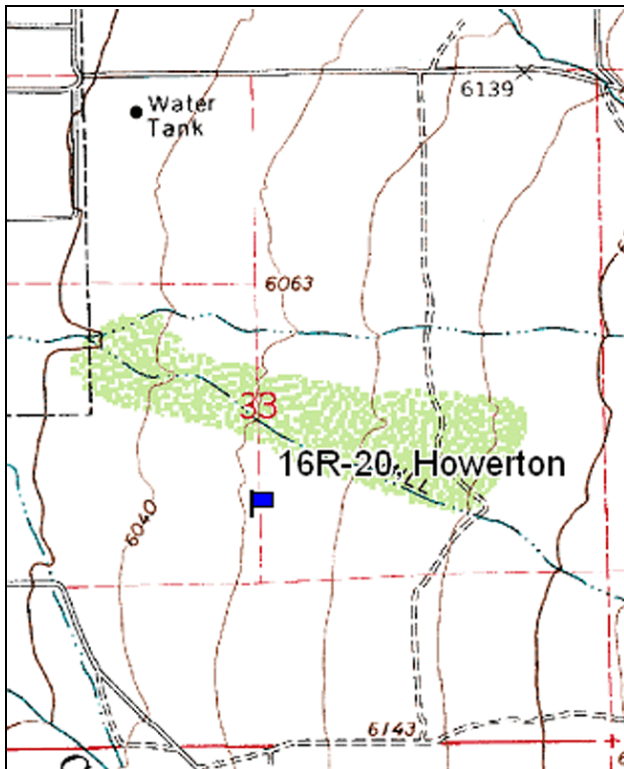
Vegetation type: Cheatgrass / P-J.

Compass bearing: frequency baseline 270 degrees magnetic.

Frequency belt placement: line 1 (11 and 95ft), line 2 (59ft), line 3 (34 and 71ft).

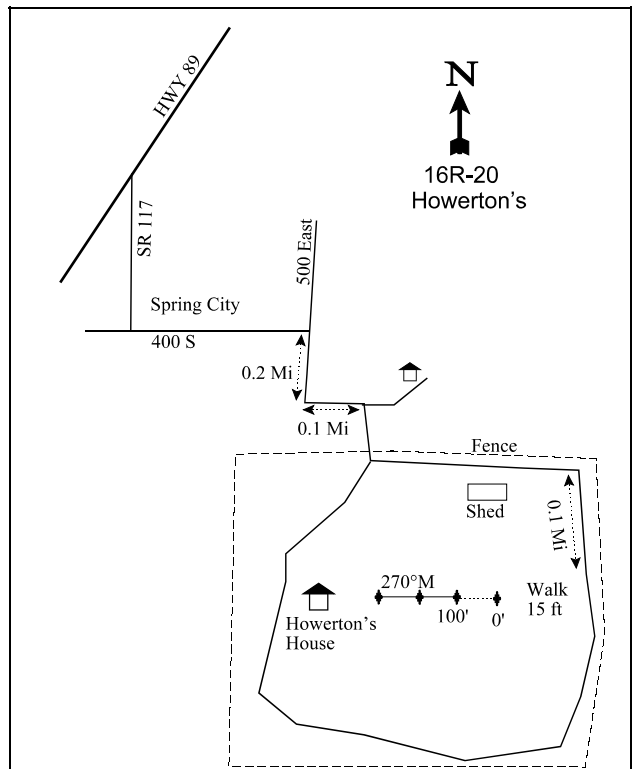
LOCATION DESCRIPTION

From the junction of US 89 and SR 117, take SR 117 (Main St.) into Spring City. Drive to 400 S and turn left (east) and drive to 500 E. Turn right on 500 E and drive 0.2 miles to an intersection. Turn left and drive 0.1 miles to the drive way of Howerton's property. Before the house the road will split, take the left fork paralleling a fence and drive until the road turns right (south). From the turn, drive 0.1 miles and park. Walk 15 feet westward to the 0' stake. The 0' stake is marked with browse tag #96.



Map Name: Spring City

Township 15S, Range 4E, Section 33



Diagrammatic Sketch

GPS: NAD 83, UTM 12S 458887 E 4368756 N

## DISCUSSION

### Howerton's - Trend Study No. 16R-20

#### Study Information

This study was established on 50 acres (20 ha) of juniper (*Juniperus osteosperma*) and cheatgrass (*Bromus tectorum*) invaded land on the southeast corner of Spring City [elevation: 6,100 feet (1,859 m), slope: 4%, aspect: west]. The objective was to treat the cheatgrass-infested land with the herbicide Plateau®, disturb the ground, and seed with beneficial species. The purpose of the treatment was not only to benefit local deer and elk herds through habitat improvements, but also to serve as a Plateau® demonstration for private landowners. After removing a few juniper trees, the property was disked to decrease cheatgrass cover. The areas between trees were drill seeded. Areas under trees were spike harrowed with an ATV, then hand seeded. The property was sprayed with Plateau® at a rate of 4 ounces active ingredient/acre (292 mL/ha). The single-nozzle sprayer was mounted to a pickup truck and sprayed 10 feet to each side of the truck. Two other properties were treated. These included 29 acres (12 ha) to the east of Howerton's, and 98 acres (40 ha) approximately 1 mile to the northeast. The northeast property was treated similarly to Howerton's, although more pinyon and juniper trees were removed by bulldozer. The east property was more rocky than the other two properties, so a 12-foot Dixie pipe harrow was pulled around the property to remove the cheatgrass cover rather than a disk. Howerton's is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above average for 2005 and 2006 at the Ephriam weather station located approximately 10 miles (16 km) southwest of the site. Spring precipitation was above normal in 2006 and 57% of normal in 2007. Fall precipitation was above normal in 2005 and 2006 (Utah Climate Summaries 2007). From the pellet group transect data, deer use was estimated at 10 days use/acre (25 ddu/ha) in 2004 and 13 days use/acre (33 ddu/ha) in 2007. Most of the deer use was from winter and early spring, but there was some year-round use. In 2007, there was a doe with two fawns on the property.

#### Soil

The soil is a Borvant-Doyce complex. The Borvant series consists of shallow, well-drained soil over a petrocalcic horizon, and formed in alluvium or colluvium derived from limestone and sandstone. Borvant soils are on fan remnants, hills, and ridges on mountains. The Doyce series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in mixed alluvium derived from sedimentary and igneous rocks on fan terraces (USDA-NRCS 2007). The soil is a shallow sandy loam with a mildly alkaline reactivity (pH 7.7). Relative vegetation cover increased slightly from 54% in 2005 to 57% in 2007, and relative litter cover decreased from 28% to 12%. Relative bare ground cover increased from 17% in 2004 to 28% in 2007. Vegetation cover was high because of high cheatgrass cover, therefore erosion was low. The erosion condition was classified as stable in 2005 and 2007.

#### Browse

No browse species were sampled in the pre-treatment data in 2005. However, fourwing saltbush (*Atriplex canescens*), antelope bitterbrush (*Purshia tridentata*), and forage kochia (*Kochia prostrata*) were seeded in the treatment (see list below). Forage kochia was the only seeded browse species sampled in 2007. It had a density of 3,540 plants/acre (8,744 plants/ha). The population is comprised of young and mature plants, however, seedlings were also sampled at a density of 2,980 plants/acre (7,361 plants/ha). Plant vigor was excellent, and browse use was mostly light. Juniper density was estimated at 20 trees/acre (49 trees/ha), and canopy cover was 5% in 2005 and 2007. All of the junipers had been highlined by cattle.

#### Herbaceous Understory

Eight grass species were sampled in 2005 and 12 species in 2007, three of which were annuals. In 2005, cheatgrass was very thick and would prevent the establishment of any seeded species without mechanical and chemical treatments. It provided 42% cover in 2005 and decreased to 23% cover in 2007, but was found in



100% of the quadrats in both sample years. The other grasses provided 1% combined cover in 2005 and increased to 10% cover in 2007. Seven grass species were seeded with the treatment (see list below).

Eleven species of forbs were sampled in 2005, six of which were annuals. Most of the species sampled were weedy annuals. Field bindweed (*Convolvulus arvensis*), a noxious weed, was the dominant forb in 2005. It provided 9% cover in 2005 and 2007, and had a quadrat frequency of 78% in 2005 and 65% in 2007. Bur buttercup (*Ranunculus testiculatus*) was the dominant forb in 2007. It provided 5% cover in 2005 and 14% in 2007, with a quadrat frequency of 43% in 2005 and 93% in 2007. Storksbill (*Erodium cicutarium*) cover also noticeably increased from less than 1% cover in 2005 to 7% in 2007, and its quadrat frequency increased from 11% to 73%. Many of the non-weedy species had been seeded in a previous treatment. Five forbs were seeded in the treatment (see list below).

#### 2007 Post-treatment Assessment

With the exception of forage kochia, the treatment did not improve the browse component. It established with a density of 3,540 plants/acre (8,744 plants/ha). There was no decadence in the population, and the recruitment of young was 51%. There were also an estimated 2,980 seedling plants/acre (7,361 plants/ha). Plant vigor was excellent and use was mostly light. The treatment improved the perennial grass component. The sum of nested frequency for perennial grasses increased two-fold, and average cover increased from less than 1% to 6%. The nested frequencies for crested wheatgrass (*Agropyron cristatum*) and intermediate wheatgrass (*Agropyron intermedium*) increased significantly. The sum of nested frequency for annual grasses changed little, but average cover decreased from 43% to 28%. The nested frequency for cheatgrass significantly declined and the nested frequency for Japanese brome (*Bromus japonicus*) increased. The treatment had no apparent effect on perennial forbs. The sum of nested frequency and average cover for perennial forbs changed little. However, the sum of nested frequency for annual forbs increased more than three-fold, and average cover increased from 5% to 21%. The nested frequencies for pale alyssum (*Alyssum alyssoides*), storksbill, and bur buttercup significantly increased. Bur buttercup has allelopathic characteristics that prevent seed germination of many native species (Buchanan et al. 1978), and storksbill has been shown to outcompete and prevent the establishment of native species (Kimball and Schiffman 2003). The landowner mentioned that the treatment had been more effective in summer 2006 with fewer noticeable herbaceous annuals, but in 2007, the herbaceous annuals had re-emerged. Further subsequent sprayings may be required to remove the cheatgrass and other weedy annuals. The 2005 Desirable Components Index (DCI) score was very poor due to no browse cover, little perennial grass cover, and very high annual grass cover. In 2007, the DCI rating remained very poor.

2005 winter range condition (DCI) – very poor (-23) Low potential scale

2007 winter range condition (DCI) – very poor (-9) Low potential scale

<b>Howerton's Seed Mix</b>	<b>Pounds of Bulk seed in mix lbs/acre</b>	
Crested Wheatgrass 'Hycrest'	100	0.6
Intermediate Wheatgrass	250	1.4
Orchardgrass 'Paiute'	100	0.6
Russian Wildrye	250	1.4
Indian Ricegrass 'Nezpar'	163	0.9
Canby Bluegrass 'Canbar'	100	0.6
Blue Flax 'Appar'	92	0.5
Yellow Sweetclover	35	0.2
Alfalfa 'Ladak+'	50	0.3
Alfalfa 'Nomad'	50	0.3
Alfalfa 'Spredor 4'	50	0.3
Sainfoin 'Eski'	350	2.0
Small Burnet 'Delar'	350	2.0
Crested Wheatgrass 'Ephraim'	200	1.1
Fourwing Saltbush--Juab/Millard UT	100	0.6
Bitterbrush	50	0.3
Bluebunch WG 'Goldar'	100	0.6
Bluebunch WG 'P7'	50	0.3
Forage Kochia 'Immigrant'	90	0.5
<b>Total</b>	<b>2530</b>	<b>14.3</b>
<b>PLS lbs/acre</b>		<b>12.6</b>

HERBACEOUS TRENDS --

Management unit 16R, Study no: 20

T y p e	Species	Nested Frequency		Average Cover %	
		'05	'07	'05	'07
G	Aegilops cylindrica (a)	<sub>a</sub> 5	<sub>a</sub> 4	.01	.04
G	Agropyron cristatum	<sub>a</sub> 1	<sub>b</sub> 35	.00	.56
G	Agropyron intermedium	<sub>a</sub> 67	<sub>b</sub> 98	.14	3.67
G	Bromus inermis	-	4	-	.15
G	Bromus japonicus (a)	<sub>a</sub> 86	<sub>b</sub> 181	.71	4.28
G	Bromus tectorum (a)	<sub>b</sub> 485	<sub>a</sub> 433	41.81	23.40
G	Carex sp.	<sub>a</sub> 20	<sub>a</sub> 18	.20	.32
G	Dactylis glomerata	-	1	-	.03
G	Elymus junceus	-	2	-	.00
G	Hordeum jubatum	-	23	-	.74
G	Poa bulbosa	-	5	-	.02
G	Poa fendleriana	<sub>a</sub> 4	<sub>a</sub> -	.01	.00

Type	Species	Nested Frequency		Average Cover %	
		'05	'07	'05	'07
G	<i>Poa secunda</i>	<sub>a</sub> 19	<sub>a</sub> 37	.07	.58
Total for Annual Grasses		576	618	42.54	27.74
Total for Perennial Grasses		111	223	0.43	6.09
Total for Grasses		687	841	42.97	33.84
F	<i>Agoseris glauca</i>	<sub>a</sub> 7	<sub>a</sub> 18	.02	.06
F	<i>Alyssum alyssoides</i> (a)	<sub>a</sub> 57	<sub>b</sub> 208	.17	.63
F	<i>Camelina microcarpa</i> (a)	-	2	-	.01
F	<i>Convolvulus arvensis</i>	<sub>a</sub> 250	<sub>a</sub> 221	8.51	8.52
F	<i>Collinsia parviflora</i> (a)	<sub>a</sub> 4	<sub>a</sub> 1	.03	.00
F	<i>Draba sp.</i> (a)	2	-	.00	-
F	<i>Erodium cicutarium</i> (a)	<sub>a</sub> 35	<sub>b</sub> 243	.22	6.51
F	<i>Lactuca serriola</i>	-	1	-	.00
F	<i>Linum lewisii</i>	<sub>a</sub> 3	<sub>a</sub> 7	.01	.07
F	<i>Melilotus officinalis</i>	-	-	-	.00
F	<i>Medicago sativa</i>	<sub>a</sub> 8	<sub>a</sub> 20	.02	.29
F	<i>Microsteris gracilis</i> (a)	-	11	-	.02
F	<i>Onobrychis viciaefolia</i>	-	3	-	.01
F	<i>Ranunculus testiculatus</i> (a)	<sub>a</sub> 149	<sub>b</sub> 418	4.80	13.89
F	<i>Salsola iberica</i> (a)	5	-	.01	-
F	<i>Sanguisorba minor</i>	<sub>a</sub> 2	<sub>a</sub> 10	.00	.05
F	<i>Sisymbrium altissimum</i> (a)	-	1	-	.01
F	<i>Tragopogon dubius</i>	-	2	-	.00
Total for Annual Forbs		252	884	5.25	21.08
Total for Perennial Forbs		270	282	8.56	9.03
Total for Forbs		522	1166	13.82	30.12

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 16R, Study no: 20

Type	Species	Strip Frequency		Average Cover %	
		'05	'07	'05	'07
B	<i>Juniperus osteosperma</i>	1	1	.36	.15
B	<i>Kochia prostrata</i>	0	42	-	1.23
Total for Browse		1	43	0.35	1.37

CANOPY COVER, LINE INTERCEPT --  
 Management unit 16R, Study no: 20

Species	Percent Cover	
	'05	'07
Juniperus osteosperma	5.33	5.38
Kochia prostrata	-	.10

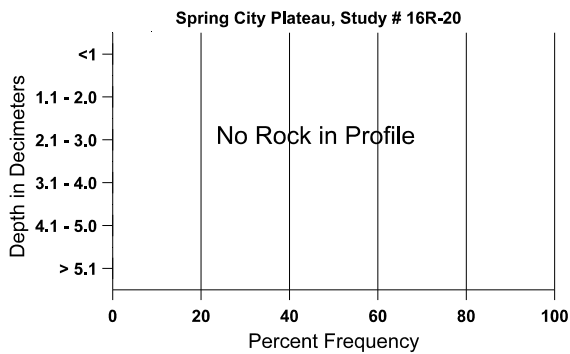
BASIC COVER --  
 Management unit 16R, Study no: 20

Cover Type	Average Cover %	
	'05	'07
Vegetation	57.59	61.17
Rock	.85	1.72
Pavement	.37	.66
Litter	30.35	13.09
Bare Ground	17.92	30.08

SOIL ANALYSIS DATA --  
 Management unit 16R, Study no: 20, Study Name: Spring City Plateau

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.3	- (-)	7.7	52.7	29.7	17.6	1.8	18.2	246.4	0.7

### Stoniness Index



PELLET GROUP DATA --

Management unit 16R, Study no: 20

Type	Quadrat Frequency		Days use per acre (ha)	
	'05	'07	'05	'07
Rabbit	20	23	-	-
Elk	-	1	-	-
Deer	4	2	10 (25)	13 (33)
Cattle	-	1	-	-

BROWSE CHARACTERISTICS --

Management unit 16R, Study no: 20

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Juniperus osteosperma</b>												
05	<b>20</b>	-	-	20	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	-/-
<b>Kochia prostrata</b>												
05	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>3540</b>	2980	1800	1740	-	-	6	5	-	-	0	6/7
<b>Opuntia sp.</b>												
05	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	6/13

Trend Study 17R-11-07

Study site name: Santaquin Greasewood .

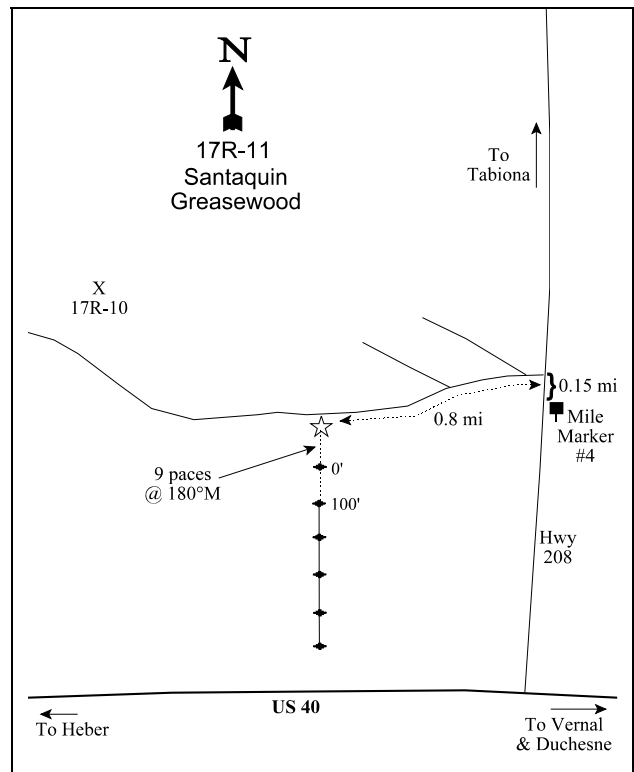
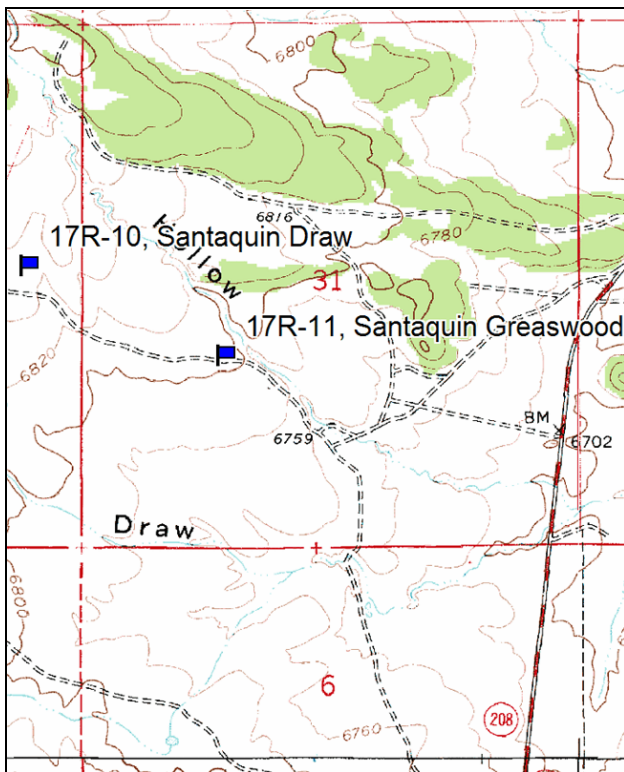
Vegetation type: Basin Big Sagebrush .

Compass bearing: frequency baseline 180 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From US 40 turn north on Highway 208. Travel 0.15 miles north of mile marker 4 to a road that comes in from the left (west). Turn here and drive 0.8 miles to a witness post on the left side of the road. The 0-foot stake is 9 paces from the witness post at 180°M, and is marked with browse tag #40.



Map Name: Tabiona

Diagrammatic Sketch

Township 2S , Range 7W , Section 31

GPS: NAD 83, UTM 12T 523637 E 4456731 N

## DISCUSSION

### Santaquin Greasewood - Trend Study No. 17R-11

#### Study Information

This study monitors the chaining treatment of a black greasewood (*Sarcobatus vermiculatus*)/basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) flat on the Tabby Mountain Wilderness Management Area (WMA) [elevation: 6,800 feet (2,073 m), slope: 2%-3%, aspect: south]. Areas within the WMA dominated by sagebrush, greasewood, and pinyon-juniper were chained with a smooth chain in 2004. The sagebrush stands within Santaquin Draw experienced die-off with extremely dry conditions in 2002 and 2003. The goals of the chaining treatment were to remove greasewood and to establish grasses, forbs, and preferred browse for wildlife winter range. This study was established in July 2004, and the treatment area was seeded, chained, and reseeded aerially with a mix including Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and forage kochia (*Kochia prostrata*) later that fall. The study is located in a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Annual precipitation was above normal for 2004 and 2006, and 98% of normal in 2005 at the Duchesne weather station located approximately 18 miles (29 km) southeast of the site. Spring precipitation was above normal in 2005 and 2006, and 44% of normal in 2007. Fall precipitation data was above normal in 2004, 2005 and 2006 (Utah Climate Summaries 2007). This area is very important winter range for deer and elk. Deer use has been high. From the pellet group transect data, deer use was estimated at 236 days use/acre (584 ddu/ha) in 2004 and 27 days use/acre (68 ddu/ha) in 2007. Elk use was 27 days use/acre (68 edu/ha) in 2004 and 29 days use/acre (71 edu/ha) in 2007. Cattle use was 1 day use/acre (2 cdu/ha) in 2004 and 2007.

#### Soil

The soil is a loam with a neutral reactivity (pH 7.2). Phosphorus was low at only 4 ppm, where less than 6 ppm may be limiting to plant growth and development (Tiedemann and Lopez 2004). Rock and pavement is sparse on the soil surface and throughout the soil profile. The combined vegetation and litter cover was 60% in 2004 and increased to 66% in 2007. The relative bare ground cover was stable at 30%-31% in both sample years. The erosion condition was classified as slight in 2004 due to evident pedestalling around shrubs. The erosion condition was classified as stable in 2007.

#### Browse

Basin big sagebrush was the dominant preferred browse, providing 4% canopy cover in 2004 and 6% in 2007. Its density was 2,640 plants/acre (6,521 plants/ha) in 2004 and 3,760 plants/acre (9,287 plants/ha) in 2007. Young plants comprised 4% of the population in 2004 and 60% in 2007, while decadence was 85% in 2004 and 29% in 2007. Plants classified with poor vigor made up 66% of the population in 2004 and 27% in 2007. Browse use has been mostly light-moderate. Average leader growth was 2.2 inches (5.7 cm) in 2004 and 1.3 inches (3.4 cm) in 2007.

Shadscale (*Atriplex confertifolia*) canopy cover was less than 1% in both sample years. Its density was 160 plants/acre (395 plants/ha) in 2004 and 1,040 plants/acre (2,570 plants/ha) in 2007. Young plants comprised 13% of the population in 2004 and 75% in 2007, and decadence was 13% in 2004 and 0% in 2007. Plant vigor was excellent and browse use was mostly light both sample years.

Greasewood provided the highest canopy cover of all the browse species at 14% in 2004 and 19% in 2007. Its density was 1,340 plants/acre (3,310 plants/ha) in 2004 and 1,280 plants/acre (3,162 plants/ha) in 2007. The population was mostly mature, with young recruitment stable at 16% of the population and decadence less than 10% both sample years.

### Herbaceous Understory

The herbaceous understory was very sparse in 2004, but improved by 2007. Perennial grass cover was 2% in 2004 and 6% in 2007. Three perennial grass species were sampled in 2004, and five more perennial grass species (including three seeded species) were sampled in 2007. Western wheatgrass (*Agropyron smithii*) was the dominant grass species in 2004, providing 1% cover. Western wheatgrass, Russian wildrye (*Elymus junceus*), and Sandberg bluegrass (*Poa secunda*) were the dominant grass species in 2007, each providing 1%-2% cover. All other grass species provided less than 1% cover both sample years.

Annuals dominated the forb component in 2004, providing 3% cover. Tansymustard (*Descurainia pinnata*) and slimleaf goosefoot (*Chenopodium leptophyllum*) were the dominant forb species. In 2007, perennial and annual forbs each provided approximately 2% cover. Fleabane (*Erigeron* sp.) and tansymustard were the dominant forbs in 2007.

### 2007 Post-treatment Assessment

The preferred browse component improved after the treatment. The density of sagebrush increased 42%. Young recruitment increased from 4% of the population to 60%, and seedling density increased from 7,200 plants/acre (17,784 plants/ha) to 9,860 plants/acre (24,354 plants/ha). Wyoming big sagebrush was seeded in the treatment, and therefore it is possible that many of the sagebrush seedlings and young sampled in 2007 were Wyoming big sagebrush. However, all big sagebrush plants were counted as basin big sagebrush. Decadence decreased from 85% to 29%. Plants showing poor vigor decreased from 66% of the population to 27%, and browse use remained mostly light-moderate. The density of shadscale increased more than six-fold. The recruitment of young increased from 13% to 75% of the population, and decadence decreased from 13% to 0%. Plant vigor remained excellent, and browse use was light. The seeded browse species, forage kochia and winterfat (*Ceratoides lanata*), were both sampled but were sparse. The grass component also improved. The sum of nested frequency for perennial grasses increased more than two-fold, and cover increased from 2% to 6%. The nested frequencies of Sandberg bluegrass and bottlebrush squirreltail increased significantly, and Siberian wheatgrass (*Agropyron fragile vavilov*) and Russian wildrye, which were seeded in the treatment, were sampled for the first time. The forb component also improved. Annual forbs remained dominant, but the sum of nested frequency of annual forbs decreased 13%, and cover decreased from 3% to 2%. The nested frequencies of tansymustard and annual stickseed (*Lappula occidentalis*) increased significantly, and the nested frequency of slimleaf goosefoot decreased significantly. The sum of nested frequency for perennial forbs increased more than ten-fold. The nested frequencies of fleabane and longleaf phlox (*Phlox longifolia*) increased significantly. The number of perennial forb species sampled increased from two to six. The 2004 Desirable Components Index (DCI) score was very poor due to low browse cover with low recruitment of young and very high decadence, as well as very poor perennial grass and forb cover. In 2007, the DCI improved to fair due to increased recruitment of young browse and decreased decadence, and increased perennial grass and forb cover.

2004 winter range condition (DCI) - very poor (6) Low potential scale

2007 winter range condition (DCI) - fair (44) Low potential scale



**Santaquin Greasewood Seed Mix 1 Bulk lbs/acre**

Great Basin Wildrye 'Trailhead'	2.0
Alfalfa 'Ladak+'	0.5
Thickspike Wheatgrass 'Critana'	2.0
Sainfoin	1.1
Russian Wildrye 'Bozoisky'	2.0
Fourwing Saltbush–Juab UT	0.8
Siberian Wheatgrass 'Vavilov'	1.1
<b>Total Bulk lbs/acre</b>	<b>9.3</b>
<b>Total PLS lbs/acre</b>	<b>8.4</b>

**Santaquin Greasewood Seed Mix 2 Bulk lbs/acre**

Sagebrush, Wyoming–Sanpete UT	1.0
Sainfoin	1.0
Alfalfa 'Ladak+'	0.5
<b>Total Bulk lbs/acre</b>	<b>2.5</b>
<b>Total PLS lbs/acre</b>	<b>1.7</b>

**Santaquin Greasewood Post-treatment Seed Mix Bulk lbs/acre**

Sagebrush, Wyoming–Sanpete UT	0.8
Forage Kochia 'Immigrant'	0.5
Winterfat–Duchesne/Uintah UT	0.2
Sainfoin 'Eski'	0.6
Alfalfa 'Ladak+'	0.6
Sagebrush, Wyoming	0.1
<b>Total Bulk lbs/acre</b>	<b>2.6</b>
<b>Total PLS lbs/acre</b>	<b>1.7</b>

HERBACEOUS TRENDS --  
Management unit 17R, Study no: 11

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	3	-	.15
G	Agropyron fragile vavilov	-	4	-	.15
G	Agropyron smithii	<sub>a</sub> 31	<sub>a</sub> 36	1.12	1.27
G	Bromus tectorum (a)	<sub>a</sub> 2	<sub>a</sub> 7	.00	.01
G	Elymus junceus	-	35	-	1.56
G	Oryzopsis hymenoides	-	12	-	.71
G	Poa secunda	<sub>a</sub> 35	<sub>b</sub> 78	.46	1.41
G	Sitanion hystrix	<sub>a</sub> 1	<sub>b</sub> 16	.03	.34

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Stipa comata</i>	-	5	-	.01
Total for Annual Grasses		2	7	0.00	0.01
Total for Perennial Grasses		67	189	1.63	5.62
Total for Grasses		69	196	1.63	5.63
F	<i>Alyssum alyssoides</i> (a)	-	1	-	.01
F	<i>Arabis</i> sp.	-	10	-	.03
F	<i>Chenopodium album</i> (a)	27	-	.17	-
F	<i>Chenopodium leptophyllum</i> (a)	<sub>b</sub> 111	<sub>a</sub> 18	1.00	.04
F	<i>Collinsia parviflora</i> (a)	5	-	.03	-
F	<i>Descurainia pinnata</i> (a)	<sub>a</sub> 199	<sub>b</sub> 242	1.87	1.23
F	<i>Erigeron</i> sp.	<sub>a</sub> 8	<sub>b</sub> 78	.04	2.00
F	<i>Gilia</i> sp. (a)	3	-	.01	-
F	<i>Lappula occidentalis</i> (a)	<sub>a</sub> 13	<sub>b</sub> 48	.08	.22
F	<i>Linum lewisii</i>	-	3	-	.16
F	<i>Phlox longifolia</i>	<sub>a</sub> 1	<sub>b</sub> 6	.00	.01
F	<i>Schoenocrambe linifolia</i>	-	11	-	.07
F	<i>Sphaeralcea coccinea</i>	-	2	-	.00
Total for Annual Forbs		358	309	3.18	1.50
Total for Perennial Forbs		9	110	0.05	2.29
Total for Forbs		367	419	3.23	3.80

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 17R, Study no: 11

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata</i> tridentata	56	57	7.02	4.87
B	<i>Atriplex confertifolia</i>	7	17	.51	.25
B	<i>Ceratoides lanata</i>	0	1	-	.00
B	<i>Kochia prostrata</i>	0	3	-	.03
B	<i>Opuntia</i> sp.	34	29	.46	.52
B	<i>Sarcobatus vermiculatus</i>	41	40	11.46	10.67
Total for Browse		138	147	19.47	16.35

CANOPY COVER, LINE INTERCEPT --  
Management unit 17R, Study no: 11

Species	Percent Cover	
	'04	'07
Artemisia tridentata tridentata	4.41	5.66
Atriplex confertifolia	.30	.30
Opuntia sp.	.38	.65
Sarcobatus vermiculatus	13.98	18.64

KEY BROWSE ANNUAL LEADER GROWTH --  
Management unit 17R, Study no: 11

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata tridentata	2.2	1.3

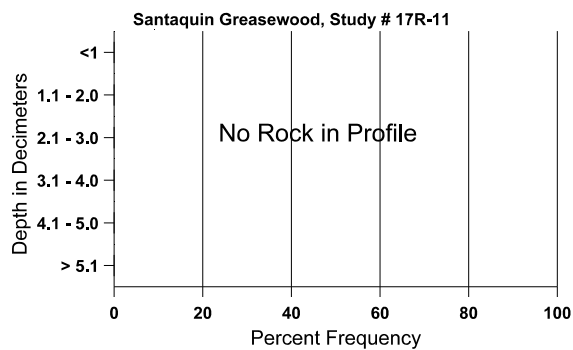
BASIC COVER --  
Management unit 17R, Study no: 11

Cover Type	Average Cover %	
	'04	'07
Vegetation	25.38	25.39
Rock	.38	.00
Pavement	.16	.08
Litter	44.01	50.01
Cryptogams	10.02	3.75
Bare Ground	35.42	34.75

SOIL ANALYSIS DATA --  
Management unit 17R, Study no: 11, Study Name: Santaquin Greasewood

Effective rooting depth (in)	Temp °F (depth)	pH	% sand	% silt	% clay	%OM	PPM P	PPM K	ds/m
12.1	61.6 (15.4)	7.2	49.6	32.9	17.5	1.1	4.5	137.6	1.0

### Stoniness Index



PELLET GROUP DATA --

Management unit 17R, Study no: 11

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	13	42	-	-
Grouse	-	2	-	-
Elk	7	17	27 (68)	29 (71)
Deer	49	33	236 (584)	27 (68)
Cattle	-	-	1 (2)	1 (2)

BROWSE CHARACTERISTICS --

Management unit 17R, Study no: 11

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata tridentata</i>												
04	<b>2640</b>	7200	100	300	2240	6560	25	7	85	66	66	27/30
07	<b>3760</b>	9860	2240	440	1080	4820	5	.53	29	9	27	17/22
<i>Atriplex confertifolia</i>												
04	<b>160</b>	200	20	120	20	60	0	13	13	-	0	13/19
07	<b>1040</b>	440	780	260	-	-	0	0	0	-	0	10/16
<i>Ceratoides lanata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>60</b>	140	20	40	-	-	0	0	-	-	0	5/6
<i>Opuntia sp.</i>												
04	<b>1120</b>	-	80	660	380	180	0	0	34	16	16	5/12
07	<b>920</b>	-	-	680	240	40	2	0	26	11	13	4/10
<i>Sarcobatus vermiculatus</i>												
04	<b>1340</b>	3820	220	1060	60	100	3	0	4	-	1	32/50
07	<b>1280</b>	3060	200	960	120	-	0	0	9	5	16	34/50

Trend Study 17R-12-07

Study site name: Santaquin Chaining .

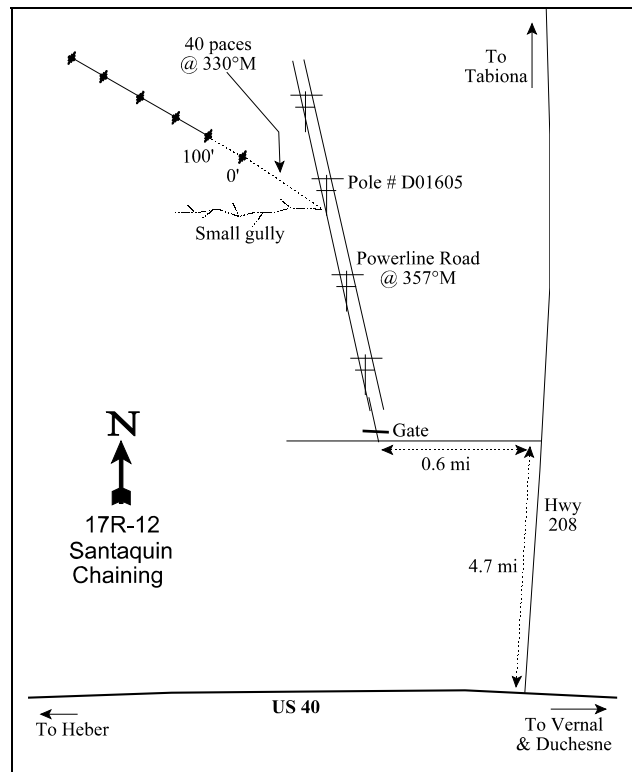
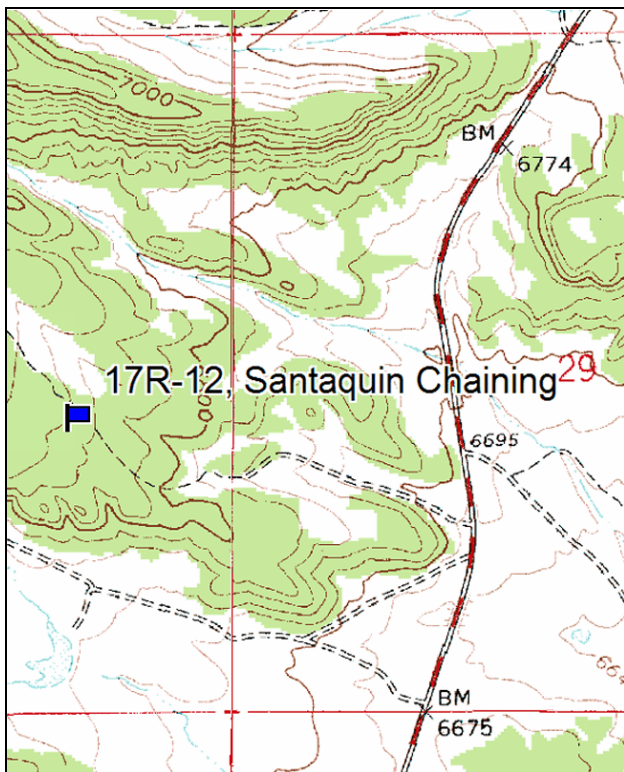
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 294 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From US 40 turn north on Highway 208. Travel 4.7 miles north to a road that comes in from the left (west). Turn here, pass through the gate and travel on this road at 357°M to pole #D01605. The 0-foot stake is 40 paces from this pole at 330°M, and is marked with browse tag #136.



Map Name: Tabiona

Diagrammatic Sketch

Township 2S , Range 7W , Section 30

GPS: NAD 83, UTM 12T 524346 E 4458437 N

## DISCUSSION

### Santaquin Chaining - Trend Study No. 17R-12

#### Study Information

This study monitors a pinyon-juniper chaining treatment north of Santaquin Draw on the Tabby Mountain Wildlife Management Area [elevation: 6,870 feet (2,094 m), slope: 2%-3%, aspect: east]. This area is typified by sagebrush (*Artemisia tridentata*) and greasewood (*Sarcobatus vermiculatus*) covered parks and ridges that are dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). The treatment area included approximately 300 acres (121 ha) of a pinyon-juniper covered ridge. The ridge was seeded, two-way chained with a 60-lb link Ely chain, and seeded aerially with a second mix including Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and forage Kochia (*Kochia prostrata*). The study was established in September 2004, and the chaining treatment took place about a month later in October 2004. The study is within a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). There is no local precipitation data available for this study. It has served as thermal and escape cover for deer and elk, but has provided little forage. A pellet group transect estimated deer use at 26 days use/acre (64 ddu/ha) in 2004 and 40 days use/acre (98 ddu/ha) in 2007. Elk use was estimated at 17 days use/acre (41 edu/ha) in 2004 and 36 days use/acre (89 edu/ha) in 2007.

#### Soil

The soil is a sandy loam with a neutral reaction (pH 7.1). Soil phosphorus and potassium are both high at 16.3 ppm and 128 ppm, respectively (Tiedemann and Lopez 2004). Rocks are prevalent in the upper 8 inches (20.3 cm) of the soil profile. At depths greater than 5 inches (12.7 cm), calcium carbonate has accumulated on rocks. Relative combined rock and pavement cover was 9% in 2004 and 6% in 2007. Relative combined vegetation and litter cover was 68%-71% in both sample years, the majority of which was litter. Relative bare ground cover increased slightly from 16% in 2004 to 22% in 2007, while relative cryptogam cover decreased from 7% to less than 1%. The latter two changes were a product of the treatment. The soil erosion condition was classified as stable in 2004 and 2007.

#### Browse

Mature pinyon and juniper dominated the site prior to treatment. Combined canopy cover was reduced from 46% in 2004 to less than 1% in 2007 following the chaining. Point-centered quarter data estimated juniper density at 235 trees/acre (581 trees/ha) in 2004 and 37 trees/acre (91 trees/ha) in 2007. Average trunk diameter was 9.6 inches (24.4 cm) in 2004 and 3.7 inches (9.4 cm) in 2007. Juniper height varied from 1 foot (0.3 m) to over 12 feet (3.7 m) in 2004, but all of the sampled trees were 1-4 feet (0.3-1.2 m) tall in 2007. Pinyon density was 209 trees/acre (516 trees/ha) in 2004 and 57 trees/acre (141 trees/ha) in 2007. Average trunk diameter was 4.7 inches (11.9 cm) in 2004 and 1.3 inches (3.3 cm) in 2007. Thirty percent of the pinyon trees were taller than 12 feet (3.7 m) in 2004, while the rest were less than 4 feet (1.2 m) tall. In 2007, all of the sampled trees were 1-4 feet (0.3-1.2 m) tall.

Black sagebrush (*Artemisia nova*) is the most abundant preferred browse species, and provided 3% canopy cover in 2004 and 2% in 2007. Its density was 3,440 plants/acre (8,500 plants/ha) in 2004 and 1,260 plants/acre (3,113 plants/ha) in 2007. Almost half of the population was decadent in 2004, but no decadent plants were sampled in 2007 and the population was 90% mature. It appears as though the treatment completely removed the decadent individuals without removing the vigorous mature individuals. Young recruitment has been good at 20% in 2004 and 10% in 2007. Seedlings were sampled at a density of 80 plants/acre (198 plants/ha) in 2004 and 380 plants/acre (939 plants/ha). Dead plant density was 1,920 plants/acre (4,744 plants/ha) in 2004, but decreased to 80 plants/acre (198 plants/ha) by 2007. One-quarter of the population was classified as dying in 2004. No plants were classified as dying in 2007, but 5% of the sampled plants showed poor vigor due to trampling caused by the treatment. Browse use was light in 2004 and light-moderate in 2007. Annual leader growth averaged 1.1 inches (2.8 cm) in 2007.

Wyoming big sagebrush was sampled at a density of 20 plants/acre (49 plants/ha) in 2004 and 740 plants/acre (1,829 plants/ha) in 2007 following the seeding. The population was mostly young and mature in 2007, with 3% decadence. Seedlings were also sampled at a density of 360 plants/acre (890 plants/ha) in 2007. Vigor was good, and browse use was light in both sample years. Average annual leader growth was 2.2 inches (5.7 cm) in 2007. Seeded forage kochia, fourwing saltbush (*Atriplex canescens*), and winterfat (*Ceratoides lanata*) were also scattered throughout the study in low densities.

#### Herbaceous Understory

The herbaceous understory was sparse in 2004 due to the overstory of pinyon and juniper trees. Eight grass species were sampled in 2004, and 13 were sampled in 2007. Total grass cover was 2% in 2004 and 10% in 2007, and was provided mostly by perennials both years. Three of the four seeded grass species were sampled in 2007: crested wheatgrass (*Agropyron cristatum*), orchardgrass (*Dactylis glomerata*), and Russian wildrye (*Elymus junceus*). Crested wheatgrass, bluebunch wheatgrass (*Agropyron spicatum*), Indian ricegrass (*Oryzopsis hymenoides*), and bottlebrush squirreltail (*Sitanion hystrix*) were the most abundant grasses in 2007. Cheatgrass was sampled in one quadrat in 2004 and 23 quadrats in 2007, but provided little cover.

Fifteen forb species were sampled in 2004, and 21 were sampled in 2007. Few annuals were present. Three of the four seeded forbs were sampled in 2007: Lewis flax (*Linum lewisii*), sainfoin (*Onobrychis viciaefolia*), and small burnet (*Sanguisorba minor*). Total forb cover was 2% in 2004 and 6% in 2007. The most common forbs in 2007 were Lewis flax and lobeleaf groundsel (*Senecio multilobatus*).

#### 2007 Post-treatment Assessment

The treatment successfully thinned the pinyon and juniper canopy, and the preferred browse component increased in diversity with the seeding. The black sagebrush population improved in reproduction, decadence, and vigor. However, preferred browse cover did not increase substantially. The removal of pinyon and juniper, along with the seeding, greatly improved the herbaceous understory. The majority of the seeded species established, and total herbaceous cover increased from 4% to 16%. The understory was dominated by perennial species. Cheatgrass was present and increased significantly in nested frequency, but its cover remained low. The 2004 Desirable Components Index (DCI) was rated as very poor-poor due to low preferred browse and herbaceous cover. In 2007, the DCI rating improved to fair due to an increase in perennial herbaceous cover.

2004 winter range condition (DCI) - very poor-poor (10) Low potential scale

2007 winter range condition (DCI) - fair (32) Low potential scale

<b>Santaquin Chaining Seed Mix 1</b>	<b>Bulk lbs/ac</b>
Alfalfa 'Nomad'	1.0
Alfalfa 'Ladak+'	1.0
Small Burnet 'Delar'	1.5
Sainfoin	2.5
Blue Flax 'Appar'	1.0
Thickspike Wheatgrass 'Critana'	0.4
Crested Wheatgrass 'Ephraim'	0.5
Russian Wildrye 'Bozoisky'	1.0
Orchardgrass 'Paiute'	1.1
Fourwing Saltbush--Juab UT	0.1
<b>Total Bulk lbs/acre</b>	<b>10.1</b>
<b>Total PLS lbs/acre</b>	<b>8.6</b>

<b>Santaquin Chaining Seed Mix 2</b>	<b>Bulk lbs/ac</b>
Sagebrush, Wyoming--Sanpete UT	0.5
Sainfoin	1.0
Whitestem Rubber Rabbitbrush	0.5
Alfalfa 'Ladak+'	0.5
<b>Total Bulk lbs/acre</b>	<b>2.5</b>
<b>Total PLS lbs/acre</b>	<b>1.7</b>

<b>Santaquin Chaining Post-treatment Seed Mix</b>	<b>Bulk lbs/ac</b>
Sagebrush, Wyoming--Sanpete UT	0.8
Forage Kochia 'Immigrant'	0.5
Winterfat--Duchesne/Uintah UT	0.2
Sainfoin 'Eski'	0.6
Alfalfa 'Ladak+'	0.6
Sagebrush, Wyoming	0.1
<b>Total Bulk lbs/acre</b>	<b>2.6</b>
<b>Total PLS lbs/acre</b>	<b>1.7</b>



HERBACEOUS TRENDS --  
Management unit 17R, Study no: 12

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	93	-	2.36
G	Agropyron smithii	<sub>a</sub> 45	<sub>a</sub> 24	.21	.48
G	Agropyron spicatum	-	56	-	1.99
G	Bouteloua gracilis	<sub>a</sub> 7	<sub>a</sub> 6	.03	.03
G	Bromus tectorum (a)	<sub>a</sub> 1	<sub>b</sub> 62	.00	.53
G	Carex sp.	<sub>a</sub> 9	<sub>a</sub> 19	.08	.22
G	Dactylis glomerata	-	6	-	.28
G	Elymus junceus	-	3	-	.15
G	Festuca myuros (a)	-	1	-	.00
G	Oryzopsis hymenoides	<sub>a</sub> 52	<sub>a</sub> 43	.66	2.15
G	Poa secunda	<sub>a</sub> 19	<sub>a</sub> 17	.39	.14
G	Sitanion hystrix	<sub>a</sub> 33	<sub>b</sub> 55	.24	1.79
G	Stipa comata	<sub>a</sub> 9	<sub>a</sub> 5	.48	.22
<b>Total for Annual Grasses</b>		<b>1</b>	<b>63</b>	<b>0.00</b>	<b>0.54</b>
<b>Total for Perennial Grasses</b>		<b>174</b>	<b>327</b>	<b>2.11</b>	<b>9.84</b>
<b>Total for Grasses</b>		<b>175</b>	<b>390</b>	<b>2.12</b>	<b>10.38</b>
F	Arabis sp.	<sub>b</sub> 21	<sub>a</sub> 6	.06	.01
F	Astragalus convallarius	10	-	.04	-
F	Astragalus utahensis	-	5	-	.06
F	Chenopodium album (a)	-	2	-	.00
F	Chaenactis douglasii	-	3	-	.00
F	Chenopodium sp. (a)	<sub>a</sub> 2	<sub>a</sub> 1	.00	.03
F	Cryptantha sp.	<sub>a</sub> 1	<sub>a</sub> 12	.00	.07
F	Cymopterus sp.	<sub>a</sub> 11	<sub>a</sub> 7	.02	.04
F	Descurainia pinnata (a)	<sub>a</sub> 4	<sub>b</sub> 17	.00	.03
F	Erigeron eatonii	1	-	.00	-
F	Ipomopsis aggregata	<sub>a</sub> 4	<sub>a</sub> 4	.01	.00
F	Ipomopsis congesta	-	11	-	.19
F	Lappula occidentalis (a)	-	29	-	.61
F	Lactuca serriola	-	10	-	.08
F	Linum lewisii	-	37	-	1.64
F	Machaeranthera canescens	3	-	.00	-
F	Onobrychis viciaefolia	-	2	-	.03
F	Penstemon humilis	<sub>b</sub> 20	<sub>a</sub> 5	.48	.45
F	Phlox hoodii	<sub>a</sub> 19	<sub>a</sub> 17	.57	.31

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Polygonum douglasii</i> (a)	5	-	.01	-
F	<i>Sanguisorba minor</i>	-	22	-	.50
F	<i>Schoenocrambe linifolia</i>	<sub>a</sub> 4	<sub>b</sub> 17	.00	.06
F	<i>Senecio multilobatus</i>	<sub>a</sub> 87	<sub>a</sub> 89	.53	1.75
F	<i>Streptanthus cordatus</i>	-	5	-	.03
F	<i>Trifolium</i> sp.	<sub>b</sub> 11	<sub>a</sub> 3	.04	.01
Total for Annual Forbs		11	49	0.02	0.68
Total for Perennial Forbs		192	255	1.79	5.27
Total for Forbs		203	304	1.81	5.95

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 17R, Study no: 12

T y p e	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia nova</i>	66	34	1.89	1.72
B	<i>Artemisia tridentata</i> <i>wyomingensis</i>	1	16	-	.51
B	<i>Atriplex canescens</i>	0	0	-	-
B	<i>Ceratoides lanata</i>	0	0	-	-
B	<i>Chrysothamnus depressus</i>	0	0	-	-
B	<i>Chrysothamnus viscidiflorus</i> <i>stenophyllus</i>	0	0	-	-
B	<i>Gutierrezia sarothrae</i>	6	4	.03	.00
B	<i>Juniperus osteosperma</i>	12	3	1.06	.38
B	<i>Kochia prostrata</i>	0	3	-	.03
B	<i>Leptodactylon pungens</i>	12	9	.25	.25
B	<i>Opuntia fragilis</i>	0	7	-	.03
B	<i>Opuntia</i> sp.	12	4	.06	.03
B	<i>Pediocactus simpsonii</i>	1	0	-	-
B	<i>Pinus edulis</i>	16	1	6.82	.53
Total for Browse		126	81	10.12	3.50

CANOPY COVER, LINE INTERCEPT --  
 Management unit 17R, Study no: 12

Species	Percent Cover	
	'04	'07
Artemisia nova	2.98	2.16
Artemisia tridentata wyomingensis	-	.63
Gutierrezia sarothrae	-	.11
Juniperus osteosperma	18.50	.01
Kochia prostrata	-	.01
Leptodactylon pungens	.23	-
Opuntia fragilis	-	.13
Opuntia sp.	.13	.05
Pinus edulis	27.33	.40

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 17R, Study no: 12

Species	Average leader growth (in)	
	'04	'07
Artemisia nova	-	1.1
Artemisia tridentata wyomingensis	-	2.2

POINT-QUARTER TREE DATA --  
 Management unit 17R, Study no: 12

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	235	37
Pinus edulis	208	57

Average diameter (in)	
'04	'07
9.6	3.7
4.7	1.3

BASIC COVER --  
 Management unit 17R, Study no: 12

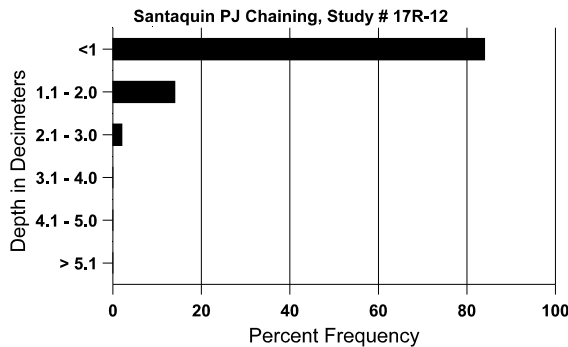
Cover Type	Average Cover %	
	'04	'07
Vegetation	13.21	22.37
Rock	2.91	4.47
Pavement	6.34	2.59
Litter	61.73	55.81
Cryptogams	7.78	.43
Bare Ground	17.40	24.82

SOIL ANALYSIS DATA --

Management unit 17R, Study no: 12, Study Name: Santaquin Chaining

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
6.9	47.0 (8.0)	7.0	65.4	15.2	19.5	3.5	16.3	128.0	0.9

Stoniness Index



PELLET GROUP DATA --

Management unit 17R, Study no: 12

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	19	26	-	-
Elk	11	19	17 (41)	36 (89)
Deer	33	25	26 (64)	40 (98)
Cattle	-	1	-	-

BROWSE CHARACTERISTICS --

Management unit 17R, Study no: 12

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia nova</b>												
04	<b>3440</b>	80	680	1120	1640	1920	4	0	48	25	25	8/15
07	<b>1260</b>	380	120	1140	-	80	30	2	0	-	5	8/15
<b>Artemisia tridentata wyomingensis</b>												
04	<b>20</b>	-	-	20	-	-	0	0	0	-	0	-/-
07	<b>740</b>	360	460	260	20	20	8	5	3	-	3	14/14
<b>Atriplex canescens</b>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	21/16

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Ceratoides lanata</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	8/9
<b>Chrysothamnus depressus</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	3/6
<b>Chrysothamnus viscidiflorus stenophyllus</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	13/22
<b>Gutierrezia sarothrae</b>												
04	200	-	-	200	-	20	0	0	-	-	30	7/7
07	160	-	-	160	-	-	0	0	-	-	0	6/8
<b>Juniperus osteosperma</b>												
04	260	-	80	140	40	-	8	0	15	15	23	-/-
07	60	-	40	20	-	20	0	0	0	-	0	-/-
<b>Kochia prostrata</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	60	-	-	60	-	-	0	0	-	-	0	7/8
<b>Leptodactylon pungens</b>												
04	440	-	-	300	140	80	0	0	32	-	14	5/7
07	360	-	-	360	-	-	11	0	0	-	0	4/7
<b>Opuntia fragilis</b>												
04	0	-	-	-	-	-	0	0	-	-	0	-/-
07	220	-	40	180	-	-	0	0	-	-	0	2/9
<b>Opuntia sp.</b>												
04	640	-	60	400	180	20	0	0	28	-	9	3/12
07	140	-	-	140	-	20	0	0	0	-	0	4/9
<b>Pediocactus simpsonii</b>												
04	20	-	-	20	-	-	0	0	-	-	0	1/3
07	0	-	-	-	-	-	0	0	-	-	0	-/-
<b>Pinus edulis</b>												
04	400	80	260	140	-	20	0	0	-	-	0	-/-
07	20	60	20	-	-	40	0	0	-	-	0	-/-

Trend Study 19R-1-07

Study site name: West Lee's Creek .

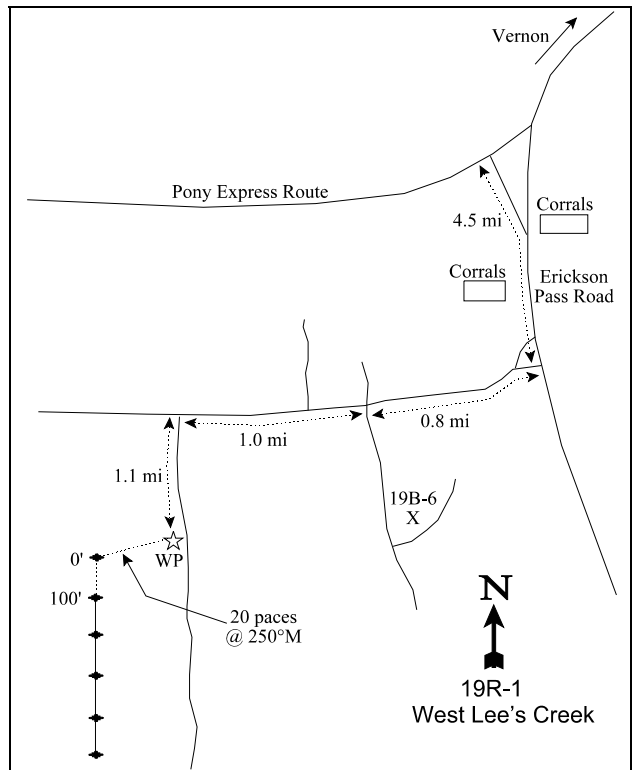
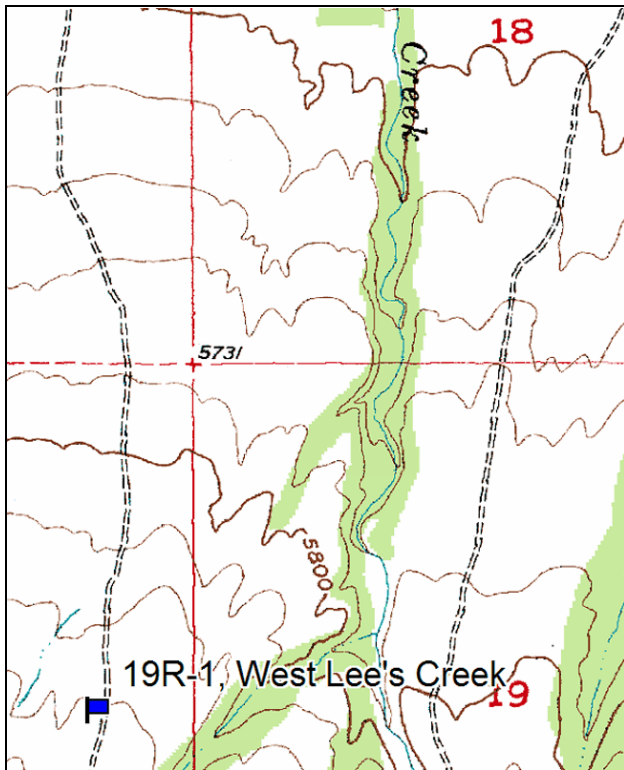
Vegetation type: Chained Pinyon-Juniper .

Compass bearing: frequency baseline 198 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Starting at the intersection of the Erickson Pass and Pony Express Roads, proceed south on the Erickson Pass Road for 4.5 miles to a road that comes in from the right (west). Turn here and proceed west for 1.8 miles to a road that comes in from the left. Turn here and proceed south for 1.1 miles to a witness post on the right side of the road. The 0-foot stake is 20 paces from the witness post at 250°M, and is marked with browse tag #39.



Map Name: Indian Peaks

Diagrammatic Sketch

Township 9S , Range 8W , Section 24

GPS: NAD 83, UTM 12T 355943 E 4431206 N

## DISCUSSION

### West Lee's Creek - Trend Study No. 19R-1

#### Study Information

This study is located on the northeast foothills of the Simpson Mountains [elevation: 5,960 feet (1,817 m), slope: 6%-8%, aspect: north]. The area is administered by the Bureau of Land Management and is part of the Government Creek livestock allotment. The old chaining is dominated by mature Utah junipers (*Juniperus osteosperma*) and Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). This study was placed to monitor a bullhog and seeding project completed in the fall of 2004 and the spring of 2005. The seed was aerially distributed in the fall of 2004 using two different seed mixes. The northern 350 acres (142 ha) were seeded using the Round Canyon mix, and the southern 350 acres (142 ha) were seeded using the Lee Canyon mix (see seed mixes below). The juniper trees were thinned in spring 2005. The study is within a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Data collected in Vernon, 14 miles (22.5 km) northeast of the study, indicated that the precipitation totals were 110% of normal for the year of 2004 and 214% of normal for spring 2005, but were incomplete in subsequent years (Utah Climate Summaries 2007). From the pellet group data, deer use was estimated at 10 days use/acre (25 ddu/ha) in 2004 and 6 days use/acre (15 ddu/ha) in 2007. Elk and antelope use were also noted in 2007, and were estimated at 7 elk days use/acre (18 edu/ha) and 1 antelope day use/acre (2 adu/ha). Cattle use was estimated at 4 days use/acre (9 cdu/ha) in 2004 and 8 days use/acre (20 cdu/ha) in 2007. Rabbit pellet quadrat frequency was 31% in 2004 and 65% in 2007.

#### Soil

The soil is classified within the Abela series (USDA-NRCS 2007). The soils in this series are deep and well-drained, and formed in alluvium or lacustrine deposits derived mainly from limestone, sandstone, and quartzite. The soil is a loam with a neutral reaction (pH 6.9). Soil phosphorus is low at 5.8 ppm. Phosphorus concentrations less than 6.0 ppm may limit normal plant growth and development in wildland soils (Tiedemann and Lopez 2004). The profile is rocky throughout, and relative combined rock and pavement cover was 14% in 2004 and 18% in 2007. Relative combined vegetation and litter cover was approximately 64% in 2004 and 2007, while relative bare ground cover averaged 20%. The soil erosion condition was classified as stable in 2004 and 2007.

#### Browse

The preferred browse species are Wyoming big sagebrush, antelope bitterbrush (*Purshia tridentata*), and forage kochia (*Kochia prostrata*). Wyoming big sagebrush cover was 5% in 2004 and 3% in 2007. Its density was 760 plants/acre (1,878 plants/ha) in 2004 and 500 plants/acre (1,235 plants/ha) in 2007. The population is mostly mature, and decadent plants comprised 18% and 24% of the population in 2004 and 2007, respectively. Recruitment was high in 2004, with 21% of the population composed of young plants, but decreased to 4% in 2007. Seedlings were sampled for the first time in 2007 at a density of 40 plants/acre (99 plants/ha), and the density of dead plants increased from 40 plants/acre (99 plants/ha) in 2004 to 120 plants/acre (297 plants/ha) in 2007. Eight percent and 16% of the population was classified as dying in 2004 and 2007, respectively. An additional 28% of the sampled sagebrush displayed poor vigor and appeared chlorotic, and 24% were infested with the sagebrush defoliator moth (*Aroga websteri*) following the treatment. Browse use was mostly light with some moderate-heavy use in both sample years. Annual leader growth averaged 1.4 inches (3.4 cm) in 2004 and 1.5 inches (3.9 cm) in 2007.

Antelope bitterbrush provided 3%-4% cover in 2004 and 2007. Its density was 180 plants/acre (445 plants/ha) in 2004 and 140 plants/acre (346 plants/ha) in 2007. In 2004, the population was 33% mature, with 56% decadence and 11% young recruitment. By 2007, all of the sampled plants were mature. Eleven percent of the plants were classified as dying in 2004, but all of the plants were vigorous in 2007. Browse use was heavy in 2004 and moderate-heavy in 2007. Average annual leader growth was 3.6 inches (9.0 cm) in 2004 and 2.8

inches (7.1 cm) in 2007. Forage kochia was also scattered throughout the study in low densities in 2007, and was heavily browsed.

Utah juniper averaged 25% canopy cover in 2004, and 19% in 2007 following the bullhog treatment. From the point-centered quarter data, density was estimated at 276 trees/acre (682 trees/ha) in 2004 and 95 trees/acre (235 trees/ha) in 2007. Average trunk diameter was 5.6 inches (14.2 cm) in 2004 and 7.4 inches (18.8 cm) in 2007. Most trees were greater than 8 feet (2.4 m) in height in 2007.

#### Herbaceous Understory

Perennial grasses averaged 13% cover in 2004 and 10% in 2007. The most abundant grass species were crested wheatgrass (*Agropyron cristatum*), bluebunch wheatgrass (*Agropyron spicatum*), and Sandberg bluegrass (*Poa secunda*). Indian ricegrass (*Oryzopsis hymenoides*) and bottlebrush squirreltail (*Sitanion hystrix*) were also present, but provided less than 1% cover. The only seeded grass species sampled was crested wheatgrass, which was sampled at a higher cover and nested frequency before the treatment. Cheatgrass (*Bromus tectorum*) was not sampled in 2004, but was found in five quadrats in 2007 and provided very little cover.

Average perennial forb cover was less than 1% in 2004 and slightly more than 1% in 2007. Eleven forbs were sampled in 2007, seven of which were perennials. This was an increase from five perennial forbs sampled in 2004. The only seeded forb sampled was western yarrow (*Achillea millefolium*), which was found in only 1 quadrat. The most abundant perennial forbs were milkvetch (*Astragalus* sp.), American vetch (*Vicia americana*), and rock goldenrod (*Petroradia pumila*). Annual forbs were not sampled in 2004, but comprised approximately half of the total forb cover in 2007. The most abundant annual forb species were bur buttercup (*Ranunculus testiculatus*) and pale alyssum (*Alyssum alyssoides*).

#### 2007 Post-treatment Assessment

Juniper density declined substantially with the bullhog treatment. Sagebrush and bitterbrush densities also decreased slightly, and sagebrush vigor declined substantially. Bitterbrush vigor improved, and decadence decreased. Kochia established at a low density, however, it comprised only 5% of the seed mix. The sum of nested frequencies of perennial grasses changed little following the seeding. Crested wheatgrass decreased significantly in nested frequency, while Sandberg bluegrass increased significantly in nested frequency. Average perennial grass cover decreased from 13% to 10%. Cheatgrass was sampled for the first time in 2007, but had a quadrat frequency of only 5%. Perennial forb cover increased slightly, and only one of the six seeded forb species established. Annual forbs were sampled for the first time in 2007. Bur buttercup, one of the most abundant forbs, is allelopathic and may inhibit the establishment of other species (Buchanan et al. 1978). The 2004 Desirable Components Index (DCI) rating was good due to low browse cover with high decadence and recruitment, favorable perennial grass cover, low perennial forb cover, and the absence of annual grasses and weeds. In 2007, the DCI rating declined slightly to fair-good due to decreases in browse cover and recruitment, as well as a decrease in perennial grass cover.

2004 winter range condition (DCI) - good (51) Low potential scale

2007 winter range condition (DCI) - fair-good (44) Low potential scale



<b>Round Canyon Seed Mix</b>	<b>Approximate Bulk lbs/acre</b>
Siberian Wheatgrass "Vavilov"	2.00
Russian Wildrye "Bozoski"	2.00
Western Wheatgrass "Arriba"	2.00
Lewis Flax	1.00
Western Yarrow	0.25
Alfalfa "Ladak"	0.50
<b>Total</b>	<b>7.75</b>

<b>Lee Canyon Seed Mix</b>	<b>Approximate Bulk lbs/acre</b>
Siberian Wheatgrass 'Vavilov'	1.00
Crested Wheatgrass 'Hycrest'	1.00
Western Wheatgrass 'Arriba'	1.00
Snake River Wheatgrass 'Secar'	0.43
Bluebunch WG 'Goldar'	0.57
Canby Bluegrass	0.43
Bottlebrush Squirreltail	0.14
Western Yarrow	0.10
Blue Flax 'Appar'	0.57
Alfalfa 'Ladak+'	1.00
Sainfoin 'Eski'	2.43
Small Burnet 'Delar'	2.00
Forage Kochia	0.57
Sagebrush, Wyoming	0.57
<b>Total</b>	<b>11.81</b>

HERBACEOUS TRENDS --  
Management unit 19R, Study no: 1

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron cristatum</i>	<sub>b</sub> 171	<sub>a</sub> 100	5.62	1.81
G	<i>Agropyron spicatum</i>	<sub>a</sub> 104	<sub>a</sub> 97	5.00	2.71
G	<i>Bromus tectorum</i> (a)	-	14	-	.03
G	<i>Oryzopsis hymenoides</i>	-	1	-	.00
G	<i>Poa secunda</i>	<sub>a</sub> 183	<sub>b</sub> 266	2.13	5.51
G	<i>Sitanion hystrix</i>	<sub>a</sub> 3	<sub>a</sub> 4	.03	.03
Total for Annual Grasses		0	14	0	0.03
Total for Perennial Grasses		461	468	12.80	10.08
Total for Grasses		461	482	12.80	10.11
F	<i>Achillea millefolium</i>	-	3	-	.03
F	<i>Alyssum alyssoides</i> (a)	-	81	-	.30
F	<i>Astragalus</i> sp.	<sub>a</sub> 4	<sub>b</sub> 29	.03	.64
F	<i>Collinsia parviflora</i> (a)	-	1	-	.00
F	<i>Descurainia pinnata</i> (a)	-	20	-	.08
F	<i>Petradoria pumila</i>	<sub>a</sub> 16	<sub>a</sub> 16	.37	.25
F	<i>Phlox hoodii</i>	<sub>a</sub> 17	<sub>a</sub> 11	.15	.09
F	<i>Phlox longifolia</i>	<sub>a</sub> 2	<sub>b</sub> 11	.00	.02
F	<i>Ranunculus testiculatus</i> (a)	-	183	-	.64
F	<i>Vicia americana</i>	<sub>a</sub> 4	<sub>a</sub> 14	.03	.11
F	<i>Zigadenus paniculatus</i>	-	6	-	.01
Total for Annual Forbs		0	285	0	1.02
Total for Perennial Forbs		43	90	0.59	1.16
Total for Forbs		43	375	0.59	2.19

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --  
Management unit 19R, Study no: 1

T y p e	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata</i> <i>wyomingensis</i>	30	22	4.87	2.77
B	<i>Chrysothamnus nauseosus</i>	0	0	-	-
B	<i>Chrysothamnus viscidiflorus</i> <i>viscidiflorus</i>	0	0	-	-

B	Gutierrezia sarothrae	4	1	-	.03
B	Juniperus osteosperma	18	9	18.88	6.11
B	Kochia prostrata	0	0	-	-
B	Opuntia sp.	0	0	-	.00
B	Purshia tridentata	7	6	2.95	3.58
<b>Total for Browse</b>		<b>59</b>	<b>38</b>	<b>26.71</b>	<b>12.52</b>

CANOPY COVER, LINE INTERCEPT --

Management unit 19R, Study no: 1

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	4.38	3.75
Gutierrezia sarothrae	.15	-
Juniperus osteosperma	24.95	18.61
Purshia tridentata	1.93	1.93

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 19R, Study no: 1

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	1.4	1.5
Purshia tridentata	3.6	2.8

POINT-QUARTER TREE DATA --

Management unit 19R, Study no: 1

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	276	95

Average diameter (in)	
'04	'07
5.6	7.4

BASIC COVER --

Management unit 19R, Study no: 1

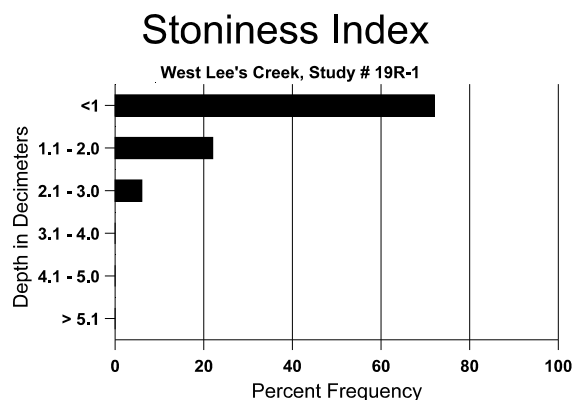
Cover Type	Average Cover %	
	'04	'07
Vegetation	38.44	29.01
Rock	5.34	4.37
Pavement	11.49	15.61
Litter	38.15	43.25

Cover Type	Average Cover %	
	'04	'07
Cryptogams	.43	.80
Bare Ground	25.10	21.24

SOIL ANALYSIS DATA --

Management unit 19R, Study no: 1, Study Name: West Lee's Creek

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
7.2	72.6 (8.6)	6.9	39.3	33.2	27.5	3.3	5.8	217.6	0.8



PELLET GROUP DATA --

Management unit 19R, Study no: 1

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	31	65	-	-
Elk	-	3	-	7 (18)
Deer	13	3	10 (25)	6 (15)
Antelope	-	-	-	1 (2)
Cattle	1	-	4 (9)	8 (20)

BROWSE CHARACTERISTICS --  
Management unit 19R, Study no: 1

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>760</b>	-	160	460	140	40	18	21	18	8	8	24/36
07	<b>500</b>	40	20	360	120	120	12	20	24	16	44	24/34
<i>Chrysothamnus nauseosus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	25/24
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	9/8
<i>Gutierrezia sarothrae</i>												
04	<b>120</b>	-	-	120	-	-	0	0	-	-	0	7/11
07	<b>40</b>	40	-	40	-	-	0	0	-	-	0	7/9
<i>Juniperus osteosperma</i>												
04	<b>380</b>	-	-	380	-	-	11	0	-	-	0	-/-
07	<b>180</b>	-	-	180	-	80	0	0	-	-	0	-/-
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	5/9
<i>Opuntia sp.</i>												
04	<b>0</b>	-	-	-	-	20	0	0	-	-	0	9/19
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	8/18
<i>Purshia tridentata</i>												
04	<b>180</b>	-	20	60	100	-	0	89	56	11	11	26/61
07	<b>140</b>	-	-	140	-	-	71	29	0	-	0	29/61

Trend Study 22R-5-07

Study site name: Black Mountain Forb Seeding.

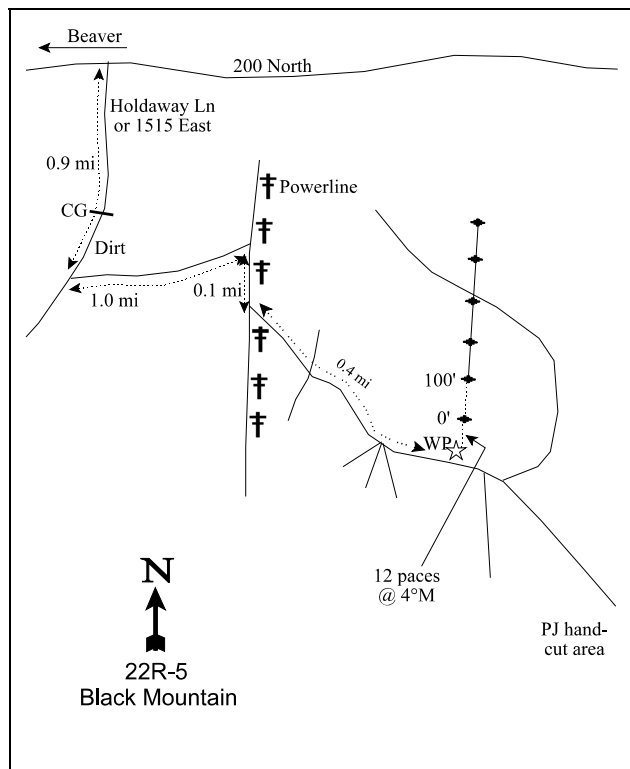
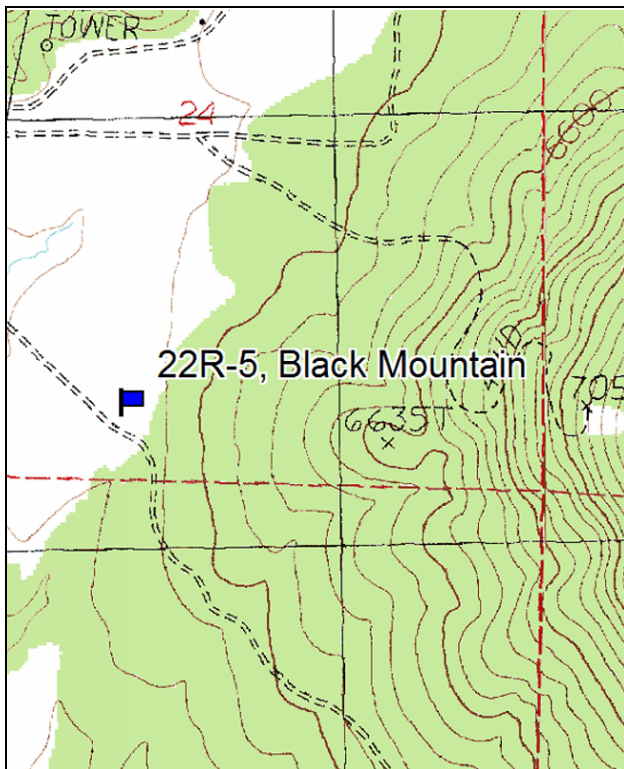
Vegetation type: Wyoming Big Sagebrush.

Compass bearing: frequency baseline 2 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Beaver head east on 200 North. Holdaway Lane (1515 East) comes in from the south. Turn south onto this road and drive 0.9 miles to a road coming in on the left. Turn onto this road and travel 1.0 mile to the powerlines. At the powerlines turn south and travel 0.1 miles to a fork. At the fork go left and travel 0.4 miles to a witness post on the left side of the road. The 0-foot stake is 12 paces from the witness post at 4°M, and is marked with browse tag #42.



Map Name: Black Ridge

Diagrammatic Sketch

Township 29S, Range 7W, Section 24

GPS: NAD 83, UTM 12S 360425 E 4236500 N

## DISCUSSION

### Black Mountain Forb Seeding - Trend Study No. 22R-5

#### Study Information

This study was established to monitor a forb enhancement project within a Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) habitat in the foothills approximately 1 mile (1.6 km) southeast of Beaver [elevation: 6,350 feet (1,935 m), slope: 3%, aspect: southwest]. The project was sponsored by the Utah Sportsmen for Wildlife. In February 2004, a mix of forb seed was applied aerially over the treatment area with no ground disturbance prior to the seeding. It appeared that a lop and scatter treatment was also conducted between 2004 and 2007. The study is within a 12-14 inch (305-356 mm) precipitation zone (USDA et al. 1999). Data collected in Minersville, 18 miles (29 km) from the study, indicated that annual precipitation was slightly above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005, but was 77% of normal in 2006 and 51% of normal in 2007 (Utah Climate Center 2007). Deer use was estimated at 27 days use/acre (68 ddu/ha) in 2004 and 22 days use/acre (55 ddu/ha) in 2007. Cattle use was estimated at 5 days use/acre (13 cdu/ha) in 2004 and 12 days use/acre (29 cdu/ha) in 2007. Deer use was in the winter and most cattle use was in the summer and fall, although some cattle pats sampled in 2007 were from the previous spring. Rabbit pellet quadrat frequency was 4% in 2004 and 58% in 2007.

#### Soil

The soil is classified within the Pharo series (USDA-NRCS 2007). The soils in this series are very deep, somewhat excessively drained, and moderately permeable. They formed in gravelly alluvium derived from mixed sedimentary and some igneous rocks. The soil is a shallow clay loam with a slightly alkaline reaction (pH 7.4). Little rock was sampled in the soil profile. Relative combined rock and pavement cover averaged 20% in 2004 and 2007. Relative combined vegetation and litter cover was 45% in 2004 and 49% in 2007. Relative bare ground cover averaged 33% in 2004 and 2007. The soil phosphorus concentration is low at 5.6 ppm. Phosphorus values less than 6.0 ppm may limit normal plant growth and development in wildland soils (Tiedemann and Lopez 2004). The soil erosion condition was classified as stable in 2004. In 2007, the erosion condition declined to slight due to evidence of surface litter and soil movement, pedestalling around plants, and the formation of rills and flow patterns.

#### Browse

Wyoming big sagebrush comprises the majority of the preferred browse on the study. It provided 17%-18% canopy cover in 2004 and 2007. Sagebrush density was 3,860 plants/acre (9,538 plants/ha) in 2004 and 3,160 plants/acre (7,808 plants/ha) in 2007. The population has been largely mature, with 38% decadence in 2004 and 34% in 2007. Young plants made up less than 1% of the population in 2004, and no young plants were sampled in 2007. Few seedlings have been sampled, and dead plants were sampled at densities of 620 plants/acre (1,532 plants/ha) and 400 plants/acre (988 plants/ha) in 2004 and 2007, respectively. Plants classified as dying comprised 17% of the population in 2004 and 23% in 2007. An additional 20% of the sagebrush population was infested with the sagebrush defoliator moth (*Aroga websteri*) in 2007. Browse use was mostly light-moderate in both sample years, with 11% and 31% of the population showing heavy hedging in 2004 and 2007, respectively. Annual leader growth averaged 1.7 inches (4.2 cm) in 2004 and 0.7 inches (1.8 cm) in 2007. Seeded forage kochia (*Kochia prostrata*) was also sampled at a low density in 2007, but was only found in disturbed areas.

Pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) trees were also scattered across the sample area in 2004, but the larger trees had been thinned with a lop and scatter treatment by 2007. Pinyon and juniper provided a combined canopy cover of 5% in 2004, and were not sampled on any belts in 2007. From the point-centered quarter data, juniper density was 28 trees/acre (69 trees/ha) in 2004 and 34 trees/acre (84 trees/ha) in 2007. Average trunk diameter was 2.9 inches (7.4 cm) in 2004 and 2.0 inches (5.1 cm) in 2007. Pinyon density was 9 trees/acre (22 trees/ha) in 2004 and 20 trees/acre (49 trees/ha) in 2007. Average

trunk diameter was 3.5 inches (8.9 cm) in 2004 and 1.3 inches (3.3 cm) in 2007. The majority of the sampled trees in both years were 1-4 feet (0.3-1.2 m) in height. Despite the lop and scatter treatment, the density of pinyon and juniper increased, most of which was made up of young and seedling trees.

#### Herbaceous Understory

Eight grass species have been sampled since 2004, seven of which were perennials. Perennial grasses provided 4% cover in 2004 and 5% cover in 2007. Indian ricegrass (*Oryzopsis hymenoides*) is the most abundant grass, and provided 3% cover in 2004 and 4% cover in 2007. Needle-and-thread (*Stipa comata*), bottlebrush squirreltail (*Sitanion hystrix*), and western wheatgrass (*Agropyron smithii*) are also relatively common. Cheatgrass (*Bromus tectorum*) was sampled at a quadrat frequency of 6% in 2004, but increased to 79% by 2007. Its cover increased from nearly 0% in 2004 to 2% in 2007.

Thirteen forb species have been sampled, seven of which were perennials. Perennial forbs provided 1% cover in 2004 and 2007, while annual forb cover increased from 1% in 2004 to 3% in 2007. Scarlet globemallow (*Sphaeralcea coccinea*) was the most abundant perennial forb, but provided less than 1% cover, both sample years. Bur buttercup (*Ranunculus testiculatus*), an allelopathic species (Buchanan et al. 1978), has been the most abundant forb, and increased from 1% cover in 2004 to 3% cover in 2007. Alfalfa (*Medicago sativa*), small burnet (*Sanguisorba minor*), and yellow sweetclover (*Melilotus officinalis*) were seeded in 2004. Small burnet was the only seeded forb sampled in 2007, and was found in only one quadrat along a two-track road.

#### 2004 Post-treatment Assessment

None of the seeded species were sampled the summer following the seeding. The timing of the seeding, late in the winter, may have decreased the success of seed germination. The herbaceous understory was sparse, and should provide little competition with the seeded species should they germinate and begin to establish. The lack of ground disturbance may hinder the ability of the seeded species to germinate and establish, however. The Desirable Components Index (DCI) score was rated as fair due to good browse cover, but poor perennial herbaceous cover.

2004 winter range condition (DCI) - fair (33) Low potential scale

#### 2007 Post-treatment Assessment

Of the seeded species, forage kochia and small burnet were sampled, while alfalfa and yellow sweetclover were not. However, the seeded species that established were very sparse and were only found in disturbed areas. Cheatgrass and bur buttercup, both of which are undesirable, increased significantly in nested frequency. Pinyon and juniper canopy cover decreased substantially with the lop and scatter treatment. The density of trees increased, but the individuals were smaller. The sagebrush density decreased 18%, but the population remained relatively stable in age structure, although reproduction and recruitment were not evident. The DCI score remained fair.

2007 winter range condition (DCI) - fair (31) Low potential scale



<b>Black Mountain Seed Mix</b>	<b>Bulk lbs in Mix</b>	<b>Bulk lbs/acre</b>
Alfalfa 'Ladak+'	2800	4.7
Forage Kochia	1952	3.3
Small Burnet 'Delar'	2238	3.8
Yellow Sweetclover	3025	5.1
<b>Total</b>	<b>10,015</b>	<b>17.0</b>
<b>PLS lbs/acre</b>		<b>14.9</b>
<b>Live seeds/sq. ft.</b>		<b>66.3</b>

HERBACEOUS TRENDS --

Management unit 22R, Study no: 5

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron smithii	<sub>a</sub> 24	<sub>a</sub> 27	.14	.24
G	Agropyron spicatum	<sub>a</sub> 6	<sub>a</sub> 15	.03	.09
G	Bromus tectorum (a)	<sub>a</sub> 16	<sub>b</sub> 260	.03	2.25
G	Hilaria jamesii	9	-	.04	-
G	Oryzopsis hymenoides	<sub>a</sub> 148	<sub>a</sub> 168	2.84	3.60
G	Poa secunda	-	5	-	.00
G	Sitanion hystrix	<sub>a</sub> 4	<sub>b</sub> 26	.07	.20
G	Stipa comata	<sub>b</sub> 52	<sub>a</sub> 35	.91	.97
<b>Total for Annual Grasses</b>		<b>16</b>	<b>260</b>	<b>0.03</b>	<b>2.25</b>
<b>Total for Perennial Grasses</b>		<b>243</b>	<b>276</b>	<b>4.03</b>	<b>5.12</b>
<b>Total for Grasses</b>		<b>259</b>	<b>536</b>	<b>4.07</b>	<b>7.37</b>
F	Alyssum alyssoides (a)	-	96	-	.22
F	Astragalus calycosus	-	2	-	.00
F	Astragalus sp.	-	2	-	.00
F	Collinsia parviflora (a)	<sub>a</sub> -	<sub>b</sub> 8	.00	.01
F	Descurainia pinnata (a)	10	-	.02	-
F	Draba sp. (a)	5	-	.01	-
F	Gilia sp. (a)	<sub>b</sub> 56	<sub>a</sub> 12	.16	.02
F	Leucelene ericoides	<sub>a</sub> 52	<sub>a</sub> 44	.46	.38
F	Phlox hoodii	<sub>a</sub> 11	<sub>a</sub> 16	.07	.08
F	Phlox longifolia	<sub>a</sub> 23	<sub>a</sub> 35	.11	.10
F	Ranunculus testiculatus (a)	<sub>a</sub> 193	<sub>b</sub> 404	.88	3.18
F	Sanguisorba minor	-	2	-	.00
F	Sphaeralcea coccinea	<sub>a</sub> 75	<sub>a</sub> 77	.58	.56

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
	Total for Annual Forbs	264	520	1.08	3.44
	Total for Perennial Forbs	161	178	1.23	1.14
	Total for Forbs	425	698	2.31	4.59

Values with different subscript letters are significantly different at alpha = 0.10

**BROWSE TRENDS --**

Management unit 22R, Study no: 5

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	85	80	14.76	12.53
B	<i>Atriplex canescens</i>	0	0	-	-
B	<i>Chrysothamnus viscidiflorus viscidiflorus</i>	0	0	-	.00
B	<i>Juniperus osteosperma</i>	3	2	.98	.00
B	<i>Kochia prostrata</i>	0	0	-	.01
B	<i>Pinus edulis</i>	1	0	1.23	-
	Total for Browse	89	82	16.97	12.55

**CANOPY COVER, LINE INTERCEPT --**

Management unit 22R, Study no: 5

Species	Percent Cover	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	17.64	17.33
<i>Juniperus osteosperma</i>	1.39	-
<i>Pinus edulis</i>	3.31	-

**KEY BROWSE ANNUAL LEADER GROWTH --**

Management unit 22R, Study no: 5

Species	Average leader growth (in)	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	1.7	0.7

POINT-QUARTER TREE DATA –  
Management unit 22R, Study no: 5

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	28	34
Pinus edulis	9	20

Average diameter (in)	
'04	'07
2.9	2.0
3.5	1.3

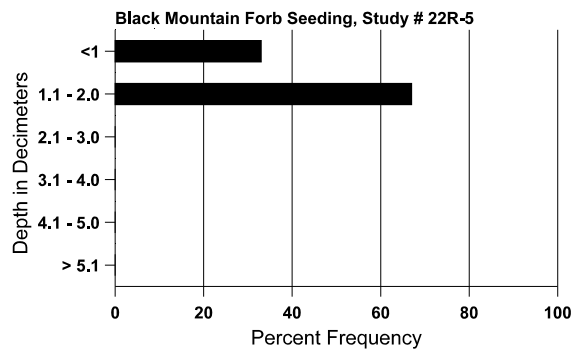
BASIC COVER --  
Management unit 22R, Study no: 5

Cover Type	Average Cover %	
	'04	'07
Vegetation	23.12	27.37
Rock	2.92	3.85
Pavement	20.58	16.42
Litter	28.73	26.25
Cryptogams	.43	.36
Bare Ground	39.30	34.38

SOIL ANALYSIS DATA --  
Management unit 22R, Study no: 5, Study Name: Black Mountain Forb Seeding

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
10.9	67.2 (28.4)	7.4	41.0	31.5	27.5	2.2	5.6	163.2	0.7

### Stoniness Index



PELLET GROUP DATA --

Management unit 22R, Study no: 5

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	4	58	-	-
Deer	11	7	27 (68)	22 (55)
Cattle	3	1	5 (13)	12 (28)

BROWSE CHARACTERISTICS --

Management unit 22R, Study no: 5

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>3860</b>	60	20	2380	1460	620	32	11	38	17	17	19/29
07	<b>3160</b>	-	-	2080	1080	400	25	31	34	23	24	20/32
<i>Atriplex canescens</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	27/37
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	13/15
07	<b>0</b>	40	-	-	-	-	0	0	-	-	0	-/-
<i>Juniperus osteosperma</i>												
04	<b>60</b>	-	40	20	-	-	0	0	-	-	0	-/-
07	<b>40</b>	-	20	20	-	-	0	0	-	-	0	-/-
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	40	-	-	-	-	0	0	-	-	0	-/-
<i>Pinus edulis</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-

Trend Study 22R-6-07

Study site name: Greenville Bench Bullhog .

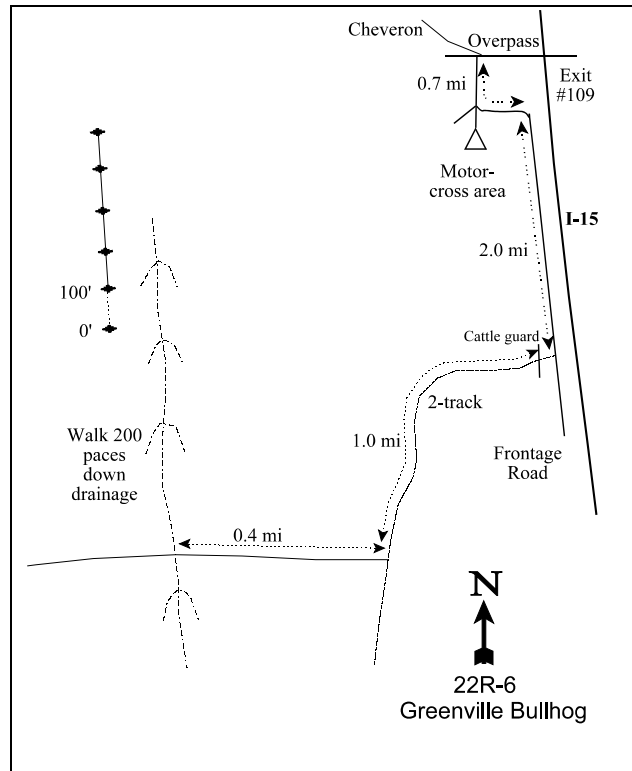
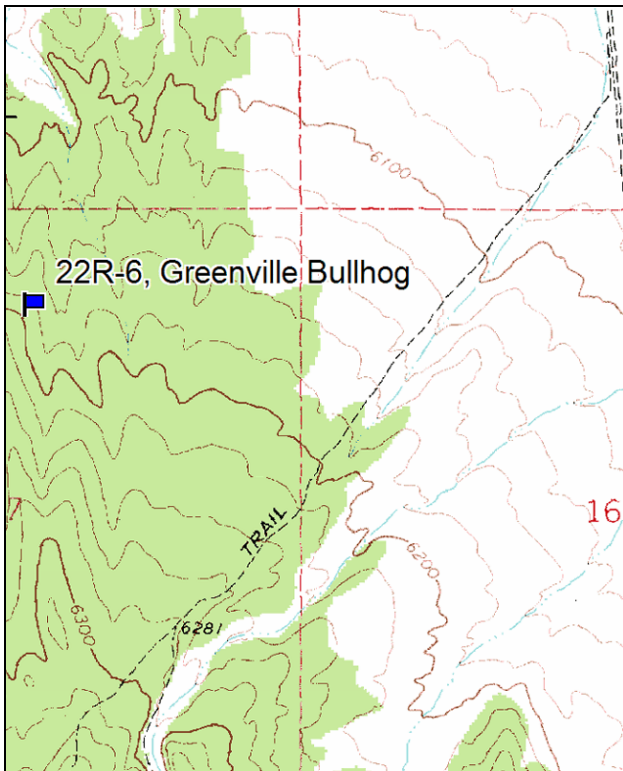
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 353 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Take Exit 109 off of I-15 and go west on the overpass toward a Chevron Station. From the Chevron Station head south on 600 West for 0.7 miles. Turn left before the motor-cross area. Stay on the left most road to where the road turns more south. From here travel 2.0 miles to a road coming in on the right. Turn onto this road and travel 1.0 mile to another road that comes in from the right. Turn west here and travel 0.4 miles to a drainage. Stop here and walk 200 paces north up the drainage to the baseline off to the left. The 0-foot stake is marked with browse tag #188.



Map Name: Greenville Bench

Diagrammatic Sketch

Township 30S , Range 7W , Section 17

GPS: NAD 83, UTM 12S 354093 E 4229694 N

## DISCUSSION

### Greenville Bench Bullhog - Trend Study No. 22R-6

#### Study Information

This study monitors a bullhog treatment approximately 5 miles (8 km) south of Beaver [elevation: 6,200 feet (1,890 m), slope: 5%-10%, aspect: northeast]. In November 2004, a 1,500-acre (607-ha) area dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) was treated with a bullhog, then seeded with a rangeland drill. Later, sagebrush seed was aerially applied to the treated area. The study is within a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Data collected in Minersville, 14 miles (22.5 km) west of the study, indicated that annual precipitation was slightly above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005, but was 77% of normal in 2006 and 51% of normal in 2007. Fall precipitation was above normal in 2004 and 2006, and 83% of normal in 2005 (Utah Climate Center 2007). Deer use was estimated at 8 days use/acre (20 ddu/ha) in 2004 and 15 days use/acre (38 ddu/ha) in 2007, all of which was from winter and spring. A few deer were observed on the site when it was sampled in 2007. Rabbit pellet quadrat frequency was 10% in 2004 and 75% in 2007.

#### Soil

The soil is classified as a Phage-Red Butte complex (USDA-NRCS 2007). Soils in the Phage series are very deep, well or somewhat excessively drained, and moderately permeable. They formed in alluvium derived from sedimentary and basic intermediate igneous rocks. The Red Butte series consists of very deep, well-drained, moderately permeable soils that formed in alluvium and colluvium derived from sedimentary and igneous rocks. The soil is a shallow sandy loam with a neutral reaction (pH 7.3). Soil phosphorus is moderately low at 6.8 ppm (Tiedemann and Lopez 2004). The soil profile is very rocky with a calcium carbonate gravel layer at 11 inches (27.9 cm). Relative rock cover was 5%-6% in 2004 and 2007, while relative pavement cover decreased from 25% in 2004 to 6% in 2007. Relative bare ground cover averaged 20% in both sample years. Relative combined vegetation and litter cover was 49% in 2004 and 68% in 2007. The soil erosion condition was classified as slight in 2004 and 2007 due to moderate pedestalling around shrubs, moderate litter and soil movement, and the formation of flow patterns between drill furrows in 2007.

#### Browse

Preferred browse on the study consists of small populations of antelope bitterbrush (*Purshia tridentata*), Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), and slenderbush eriogonum (*Eriogonum microthecum*). Sagebrush was aerially seeded, although it was also present before the treatment. It provided less than 1% cover in 2004 and 2007. Sagebrush density was 180 plants/acre (445 plants/ha) in 2004 and 500 plants/acre (1,235 plants/ha) in 2007. The population was 89% decadent in 2004, with mature plants comprising only 11% of the sampled plants. By 2007, the population was 76% young and 24% mature. Average sagebrush height and crown width decreased 6 inches (15 cm) and 9 inches (23 cm), respectively. Few seedlings were present either year. The density of dead plants in 2004 was greater than that of live plants at 1,740 plants/acre (4,299 plants/ha), but decreased to 220 plants/acre (544 plants/ha) in 2007. Seventy-eight percent of the sampled plants were classified as dying in 2004, but most plants were vigorous in 2007. Browse use was mostly light-moderate in 2004 and light in 2007. Annual leader growth averaged 2.6 inches (6.7 cm) in 2004 and 2.8 inches (7.2 cm) in 2007.

Antelope bitterbrush was sampled for the first time in 2007. It provided less than 1% cover, and its density was 1,320 plants/acre (3,262 plants/ha). All of the sampled plants were young and vigorous. Seedlings were also sampled at a density of 100 plants/acre (247 plants/ha). Browse use was moderate-heavy. Annual leader growth was 2.7 inches (6.8 cm). Slenderbush eriogonum provided little cover in 2004 and 2007. Its density was 360 plants/acre (890 plants/ha) in 2004 and 40 plants/acre (99 plants/ha) in 2007. Vigor was good in both sample years, and rabbit use was moderate-heavy.

Before the treatment, combined pinyon and juniper canopy cover was 32%. Tausch and West (1994) showed that as pinyon-juniper cover increases, the herbaceous and browse understories decrease. Generally, pinyon-juniper cover of over 15% greatly diminishes the understory cover. In 2007, the canopy was reduced to 3% cover, provided by juniper only. From the point-centered quarter data, juniper density was estimated at 133 trees/acre (329 trees/ha) in 2004 and 34 trees/acre (84 trees/ha) in 2007. Average trunk diameter was 8.8 inches (22.4 cm) in 2004 and 5.3 inches (13.1 cm) in 2007. Pinyon density was 102 trees/acre (252 trees/ha) in 2004 and 27 trees/acre (67 trees/ha) in 2007. Average trunk diameter was 5.2 inches (13.2 cm) in 2004 and 1.9 inches (4.8 cm) in 2007. The majority of the sampled trees were greater than 8 feet (2.4 m) in height in 2004, but in 2007, most were less than 4 feet (1.2 m) in height.

#### Herbaceous Understory

Only two grass species, bottlebrush squirreltail (*Sitanion hystrix*) and cheatgrass (*Bromus tectorum*), were sampled in 2004 before the seeding, and both provided almost no cover. In 2007, eight grass species were sampled and provided 16% cover. Cheatgrass was the only annual species, and comprised 58% of the total grass cover. However, cheatgrass cover was inconsistent across the study. It was sparse in areas where the drill placed seed and dense in areas that the drill missed, but was sampled in 93% of the quadrats. Four of the five seeded grass species were sampled in 2007: crested wheatgrass (*Agropyron cristatum*), pubescent wheatgrass (*Agropyron trichophorum*), Snake River wheatgrass (*Elymus wawawaiensis*), and Indian ricegrass (*Oryzopsis hymenoides*). Snake River wheatgrass, pubescent wheatgrass, and bottlebrush squirreltail were the most abundant perennial species, although bottlebrush squirreltail cover was inconsistent in the same pattern as that of cheatgrass.

Eight forb species were sampled in 2004, four of which were annuals. In 2007, 15 species were sampled, five of which were annuals. No forbs were particularly abundant in 2007, but all were unusually large. Three of the five seeded species were sampled: Lewis flax (*Linum lewisii*), alfalfa (*Medicago sativa*), and small burnet (*Sanguisorba minor*). Total forb cover was less than 1% in 2004 and 2% in 2007.

#### 2007 Post-treatment Assessment

The bullhog and seeding treatment had a positive effect on this winter range. Combined pinyon and juniper canopy cover decreased from 32% to 3%. Antelope bitterbrush, a highly preferred browse species, established very successfully, and the sagebrush population increased in density and improved in vigor. The number of species sampled in the understory more than tripled, and perennial herbaceous cover increased. Bottlebrush squirreltail increased significantly in nested frequency. Cheatgrass also increased significantly in nested frequency, but its cover was only dense in areas that were missed by the drill. The 2004 Desirable Components Index (DCI) was rated as very poor due to the lack of preferred browse and perennial herbaceous cover. In 2007, the DCI rating improved slightly to very poor-poor due to the increase in perennial grass and forb cover.

2004 winter range condition (DCI) - very poor (0) Low potential scale

2007 winter range condition (DCI) - very poor-poor (10) Low potential scale

<b>Greenville Bench Rangeland Drill Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Snake River Wheatgrass 'Secar'	3000	2.0
Indian Ricegrass 'Nezpar'	1600	1.1
Crested Wheatgrass 'Hycrest'	1700	1.1
Pubescent Wheatgrass	2980	2.0
Sandberg Bluegrass 'SID MT'	375	0.3
Blue Flax 'Appar'	1200	0.8
Western Yarrow	150	0.1
Yellow Sweetclover	100	0.1
Small Burnet 'Delar'	1450	1.0
Alfalfa 'Ladak+'	1500	1.0
Bitterbrush--Ada/Boise ID	375	0.3
<b>Total</b>	<b>14,430</b>	<b>9.6</b>
<b>PLS lbs/acre</b>		<b>8.7</b>

<b>Greenville Bench Aerial Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Sagebrush, Wyoming	400	0.3
<b>Total</b>	<b>400</b>	<b>0.3</b>
<b>PLS lbs/acre</b>		<b>0.03</b>

HERBACEOUS TRENDS --  
Management unit 22R, Study no: 6

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	15	-	.28
G	Agropyron spicatum	-	9	-	.24
G	Agropyron trichoporum	-	54	-	1.20
G	Bromus tectorum (a)	<sub>a</sub> 10	<sub>b</sub> 372	.02	9.54
G	Elymus junceus	-	10	-	.66
G	Elymus wawawaiensis	-	73	-	2.57
G	Oryzopsis hymenoides	-	5	-	.01
G	Sitanion hystrix	<sub>a</sub> 6	<sub>b</sub> 66	.01	1.88
Total for Annual Grasses		10	372	0.02	9.54
Total for Perennial Grasses		6	232	0.00	6.86
Total for Grasses		16	604	0.03	16.40
F	Astragalus sp.	<sub>a</sub> 8	<sub>a</sub> 6	.01	.01
F	Chaenactis douglasii	-	10	-	.16
F	Descurainia pinnata (a)	-	8	-	.04
F	Eriogonum cernuum (a)	24	-	.18	-
F	Eriogonum ovalifolium	1	-	.03	-



Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Euphorbia sp.	<sub>a</sub> 1	<sub>a</sub> 4	.00	.01
F	Gayophytum ramosissimum(a)	1	-	.00	-
F	Gilia sp. (a)	<sub>a</sub> 1	<sub>a</sub> 4	.00	.01
F	Lappula occidentalis (a)	<sub>a</sub> -	<sub>a</sub> 2	.00	.03
F	Lactuca serriola	-	12	-	.10
F	Linum lewisii	-	19	-	.59
F	Medicago sativa	-	5	-	.06
F	Penstemon sp.	-	2	-	.15
F	Salsola iberica (a)	-	4	-	.03
F	Sanguisorba minor	-	22	-	.45
F	Sisymbrium altissimum (a)	-	10	-	.10
F	Streptanthus cordatus	<sub>a</sub> 4	<sub>a</sub> -	.01	.00
F	Tragopogon dubius	-	4	-	.00
Total for Annual Forbs		26	28	0.19	0.22
Total for Perennial Forbs		14	84	0.06	1.56
Total for Forbs		40	112	0.25	1.79

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 22R, Study no: 6

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	8	13	.15	.03
B	Eriogonum microthecum	7	2	.03	.00
B	Gutierrezia sarothrae	55	59	1.30	6.53
B	Juniperus osteosperma	8	0	11.60	1.54
B	Opuntia sp.	1	0	-	-
B	Pinus edulis	4	1	7.80	.15
B	Polygala subspinosa subspinosa	9	0	.02	-
B	Purshia tridentata	0	27	-	.35
Total for Browse		92	102	20.93	8.61

CANOPY COVER, LINE INTERCEPT --  
 Management unit 22R, Study no: 6

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	-	.05
Chrysothamnus depressus	-	.26
Gutierrezia sarothrae	1.04	5.73
Juniperus osteosperma	18.79	2.91
Pinus edulis	13.44	-
Purshia tridentata	-	.15

KEY BROWSE ANNUAL LEADER GROWTH --  
 Management unit 22R, Study no: 6

Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	2.6	2.8
Purshia tridentata	-	2.7

POINT-QUARTER TREE DATA --  
 Management unit 22R, Study no: 6

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	133	34
Pinus edulis	102	27

Average diameter (in)	
'04	'07
8.8	5.3
5.2	1.9

BASIC COVER --  
 Management unit 22R, Study no: 6

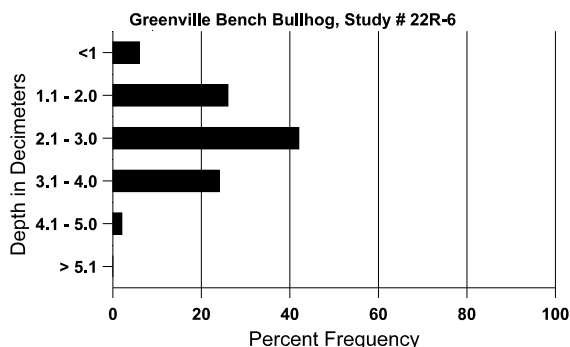
Cover Type	Average Cover %	
	'04	'07
Vegetation	21.37	29.67
Rock	7.48	5.42
Pavement	31.97	6.39
Litter	39.84	46.12
Cryptogams	.96	.33
Bare Ground	24.25	23.03

SOIL ANALYSIS DATA --

Management unit 22R, Study no: 6, Study Name: Greenville Bench Bullhog

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
13.6	67.0 (15.9)	7.3	61.7	20.4	17.8	2.5	6.8	99.2	0.6

### Stoniness Index



PELLET GROUP DATA --

Management unit 22R, Study no: 6

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	10	75	-	-
Elk	-	1	-	-
Deer	4	7	8 (20)	(15) 38

BROWSE CHARACTERISTICS --

Management unit 22R, Study no: 6

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<b>Artemisia tridentata wyomingensis</b>												
04	<b>180</b>	20	-	20	160	1740	33	22	89	78	78	19/23
07	<b>500</b>	60	380	120	-	220	4	4	0	-	4	13/14
<b>Eriogonum microthecum</b>												
04	<b>360</b>	-	-	360	-	-	39	28	-	-	0	3/4
07	<b>40</b>	-	20	20	-	-	50	50	-	-	0	6/6
<b>Gutierrezia sarothrae</b>												
04	<b>4000</b>	20	660	3340	-	780	0	0	0	-	0	6/8
07	<b>2840</b>	440	120	2680	40	200	0	0	1	1	1	11/16

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Juniperus osteosperma</i>												
04	<b>180</b>	-	100	80	-	-	0	0	-	-	0	-/-
07	<b>0</b>	40	-	-	-	40	0	0	-	-	0	-/-
<i>Opuntia sp.</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	5/10
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	4/13
<i>Pinus edulis</i>												
04	<b>80</b>	-	20	60	-	-	0	0	-	-	0	-/-
07	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-
<i>Polygala subspinoso subspinoso</i>												
04	<b>260</b>	-	-	260	-	-	8	0	-	-	0	2/3
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Purshia tridentata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>1320</b>	100	1320	-	-	-	42	48	-	-	0	4/5

Trend Study 23R-7-07

Study site name: South Narrows .

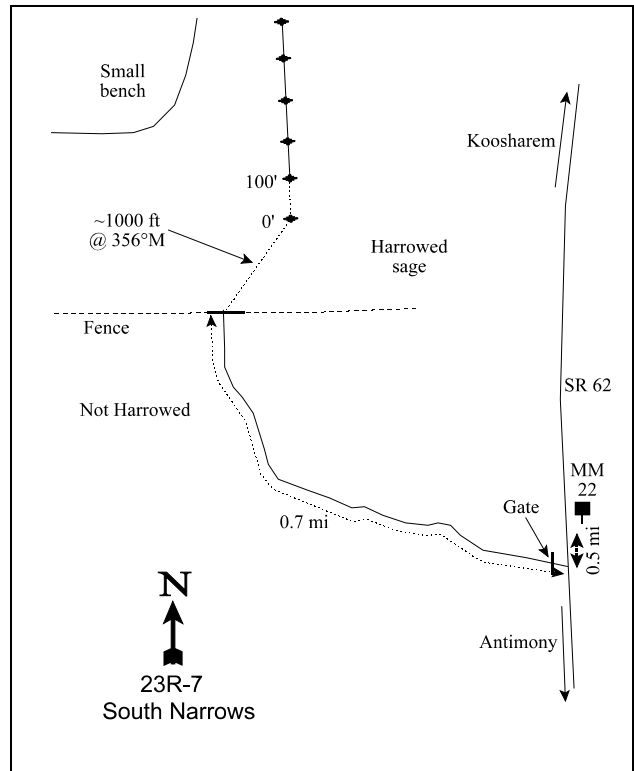
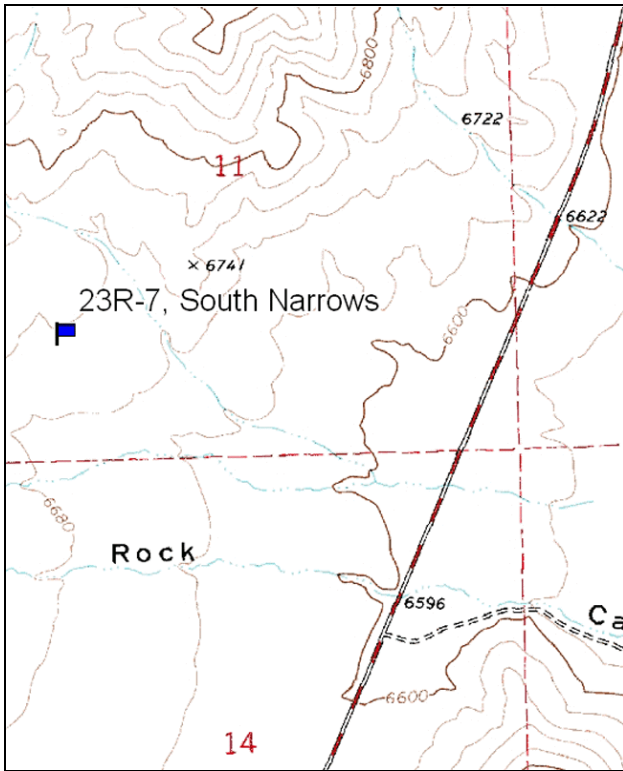
Vegetation type: Annual Forb .

Compass bearing: frequency baseline 336 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From State Route 62, south of Koosharem, there will be a road coming in from the west 0.5 mile south of mile marker 22. Turn onto this road, passing through a gate, and travel 0.7 miles to another fence with a gate. From here walk about 1,000 feet at 356°M to the 0-foot stake with browse tag #191.



Map name: Parker Knoll

Diagrammatic Sketch

Township 29S , Range 2W , Section 11

GPS: NAD 83, UTM 12S 413606 E 4239186 N

## DISCUSSION

### South Narrows - Trend Study No. 23R-7

#### Study Information

This study is located on land administered by the Bureau of Land Management just north of the Otter Creek Reservoir [elevation: 6,700 feet (2,042 m), slope: 4%-5%, aspect: south]. It is within the South Narrows livestock allotment. The range type is a Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) community that was two-way harrowed and seeded in 1996. Most of the seed did not establish, much like the Greenwich sites to the north. In December 2005, 2,300 acres (931 ha) were reseeded and two-way harrowed. The seeder was attached to the back of the tractor and the Dixie harrow was pulled behind. The second swath was to seed the shrub species. The study is located in an 8-10 inch (203-254 mm) precipitation zone (USDA et al. 1999). Data collected in Angle and Koosharem, which are 3 miles (4.8 km) and 16 miles (25.7 km) from the study, respectively, indicate that annual precipitation was normal or above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005, normal in 2006, and 65% of normal in 2007 (Utah Climate Center 2007). Pellet group data from 2004 estimated 3 elk days use/acre (8 edu/ha), 5 deer days use/acre (12 ddu/ha), and 2 cattle days use/acre (4 cdu/ha). There was no big game or cattle use in 2007. Rabbit pellet quadrat frequency was 70% in 2004 and 97% in 2007.

#### Soil

The soil is a sandy loam with a slightly alkaline reaction (pH 7.5). Soil phosphorus and potassium are both high at 13 ppm and 605 ppm, respectively (Tiedemann and Lopez 2004). A hardpan exists at a depth of approximately 15 inches (38.1 cm), and several rocks were coated with calcium carbonate at this depth. Relative rock cover was 5%-7% in 2004 and 2007, and relative pavement cover was 20% in 2004 and 7% in 2007. Relative vegetation cover was 13% in 2004 and 2007, and relative litter cover was 20% in 2004 and 42% in 2007. Relative bare ground cover was high at 40% in 2004 and 32% in 2007. The erosion condition was classified as stable in 2004 and 2007.

#### Browse

Preferred browse is very limited on the study, and provides almost no cover. Wyoming big sagebrush density was estimated at 40 plants/acre (99 plants/ha) in 2004 and 20 plants/acre (49 plants/ha) in 2007. Fifty percent of the sampled plants were decadent and classified as dying in 2004, and the only sampled plant in 2007 was dying after being hit with the harrow. No seedlings or young plants have been sampled. Dead plants were sampled at a density of 100 plants/acre (247 plants/ha) in 2004, which increased to 580 plants/acre (1,433 plants/ha) in 2007 due to the treatment. Browse use was light in both sample years. Forage kochia (*Kochia prostrata*) was also present at a density of 20 plants/acre (49 plants/ha) in 2007. Seedlings were sampled at a density of 200 plants/acre (494 plants/ha).

#### Herbaceous Understory

The understory provides little quality forage, and diversity is low. Bottlebrush squirreltail (*Sitanion hystrix*) is the only grass species that has been sampled on the study, and has provided almost no cover.

Annual forbs are dominant. They provided 8% cover in 2004 and 15% cover in 2007, while perennial species provided 5% cover in 2004 and almost no cover in 2007. Slimleaf goosefoot (*Chenopodium leptophyllum*), tansymustard (*Descurainia pinnata*), annual stickseed (*Lappula occidentalis*), Russian thistle (*Salsola iberica*), and cutleaf nightshade (*Solanum triflorum*) have been the most abundant annuals, although slimleaf goosefoot was not sampled in 2007. Milkvetch (*Astragalus* sp.) has been the most abundant perennial. Lewis flax (*Linum lewisii*) was the only seeded herbaceous species sampled in 2007, but was only found in three quadrats.

2007 Post-treatment Assessment

This treatment did not appear to be very successful, and may need to be re-treated in the future. Preferred browse cover was very low. It appears as though spring precipitation was adequate every year since the treatment, except 2007. The herbaceous understory composition was poor and dominated by weedy species. Tansymustard, nodding eriogonum (*Eriogonum cernuum*), annual stickseed, and Russian thistle increased significantly in nested frequency. Of the 12 seeded species, only Lewis flax established, but provided very little cover. Only one perennial grass species was sampled, and provided almost no cover. The 2004 Desirable Components Index (DCI) was rated as very poor-poor due to very little browse and perennial herbaceous cover. The DCI rating declined to very poor in 2007 due to the decrease in perennial forb cover.

2004 winter range condition (DCI) - very poor-poor (10) Low potential scale

2007 winter range condition (DCI) - very poor (0) Low potential scale

South Narrows Seed Mix	Bulk lbs in mix	Bulk lbs/acre
Crested Wheatgrass 'Douglas'	1150	0.50
Crested Wheatgrass 'Hycrest'	1150	0.50
Pubescent Wheatgrass	4600	2.00
Great Basin Wildrye 'Trailhead'	1750	0.76
Russian Wildrye	2300	1.00
Sandberg Bluegrass 'SID OR'	930	0.40
Sheep Fescue 'Covar'	2300	1.00
Yellow Sweetclover	1300	0.57
Alfalfa 'Ladak+'	2300	1.00
Sainfoin 'Eski'	3450	1.50
Small Burnet 'Delar'	4600	2.00
Blue Flax	545	0.24
Annual Sunflower	750	0.33
Fourwing Saltbush--Juab UT	735	0.32
Fourwing Saltbush--Juab UT	550	0.24
Blue Flax	500	0.22
<b>Total</b>	<b>28,910</b>	<b>12.57</b>
<b>PLS lbs/acre</b>	<b>10.77</b>	

HERBACEOUS TRENDS --

Management unit 23R, Study no: 7

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Sitanion hystrix	<sub>a</sub> 16	<sub>a</sub> 8	.09	.01
	Total for Annual Grasses	0	0	0	0
	Total for Perennial Grasses	16	8	0.08	0.01
	Total for Grasses	16	8	0.08	0.01
F	Astragalus lentiginosus	-	13	-	.03
F	Astragalus sp.	38	-	3.97	-
F	Chenopodium leptophyllum(a)	11	-	2.53	-

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Descurainia pinnata</i> (a)	<sub>a</sub> 4	<sub>b</sub> 115	.06	4.25
F	<i>Eriogonum cernuum</i> (a)	<sub>a</sub> 3	<sub>b</sub> 45	.06	.23
F	<i>Lappula occidentalis</i> (a)	<sub>a</sub> 5	<sub>b</sub> 230	.51	9.00
F	<i>Lactuca serriola</i>	-	3	-	.01
F	<i>Linum lewisii</i>	-	6	-	.01
F	<i>Nicotiana attenuata</i> (a)	-	-	.19	-
F	<i>Salsola iberica</i> (a)	<sub>a</sub> 22	<sub>b</sub> 262	3.57	.91
F	<i>Sisymbrium altissimum</i> (a)	-	3	-	.15
F	<i>Solanum triflorum</i> (a)	<sub>a</sub> 14	<sub>a</sub> 4	1.25	.01
F	<i>Sphaeralcea grossulariifolia</i>	-	-	.79	-
Total for Annual Forbs		59	659	8.19	14.56
Total for Perennial Forbs		38	22	4.76	0.06
Total for Forbs		97	681	12.96	14.62

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 23R, Study no: 7

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	1	1	.15	-
B	<i>Kochia prostrata</i>	0	1	-	.02
Total for Browse		1	2	0.15	0.01

BROWSE TRENDS--

Management unit 23R, Study no: 7

Species	Strip Frequency	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	1	1
<i>Kochia prostrata</i>	0	1



**BASIC COVER --**

Management unit 23R, Study no: 7

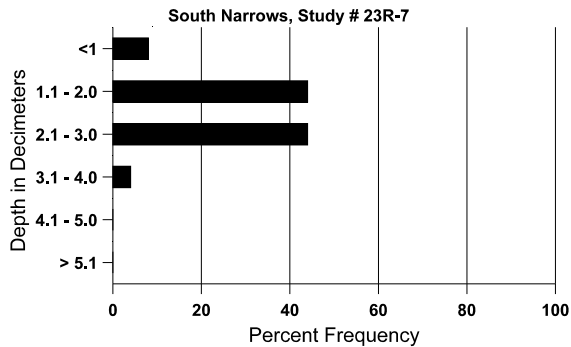
Cover Type	Average Cover %	
	'04	'07
Vegetation	14.13	14.36
Rock	7.82	5.38
Pavement	21.52	7.98
Litter	22.57	45.67
Cryptogams	.34	.20
Bare Ground	44.05	35.06

**SOIL ANALYSIS DATA --**

Management unit 23R, Study no: 7, Study Name: South Narrows

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
14.4	65.4 (13.4)	7.5	55.0	27.5	17.5	1.1	12.5	604.8	0.7

**Stoniness Index**



**PELLET GROUP DATA --**

Management unit 23R, Study no: 7

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	70	97	-	-
Elk	1	-	3 (8)	-
Deer	1	-	5 (12)	-
Cattle	1	2	1 (4)	-

BROWSE CHARACTERISTICS --  
 Management unit 23R, Study no: 7

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>40</b>	-	-	20	20	100	0	0	50	50	50	18/26
07	<b>20</b>	-	-	-	20	580	0	0	100	100	100	-/-
<i>Kochia prostrata</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>20</b>	200	-	20	-	-	0	0	-	-	0	-/-

Trend Study 23R-8-07

Study site name: Browns Canyon Drill .

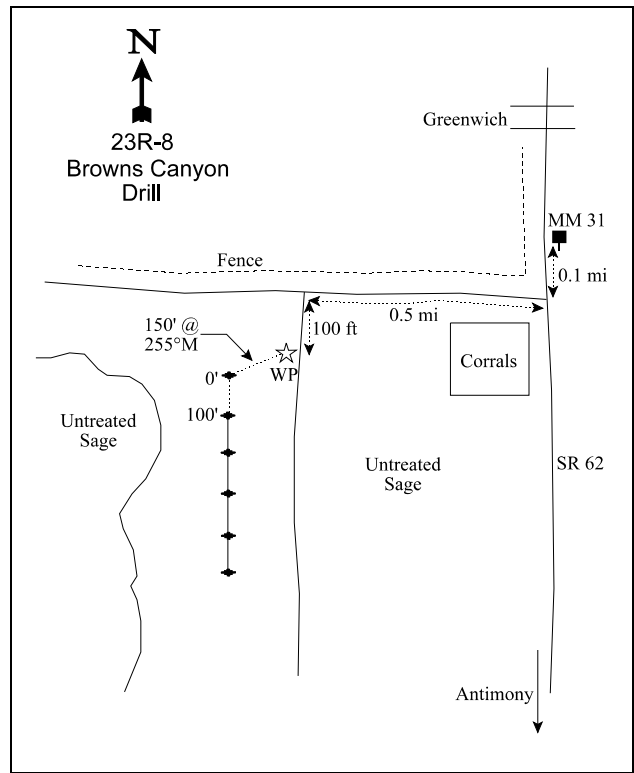
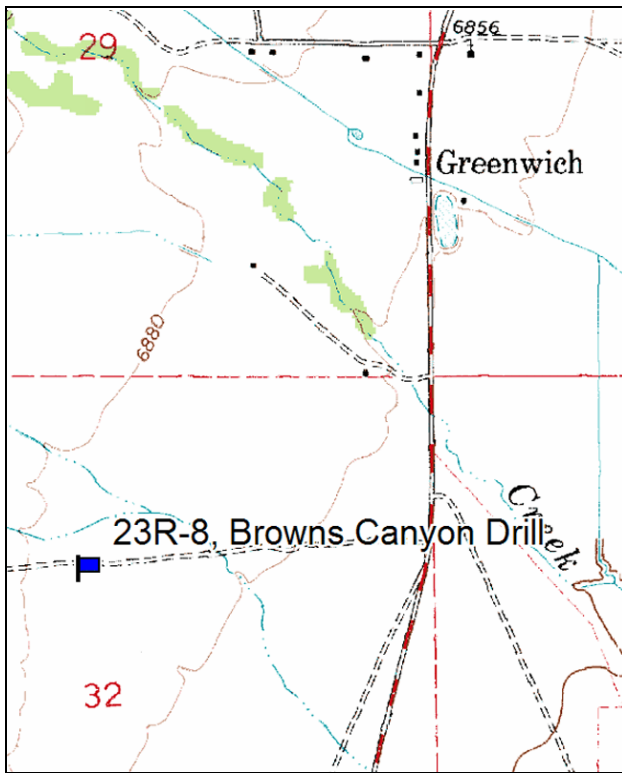
Vegetation type: Annual Forb .

Compass bearing: frequency baseline 170 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Travel south of Greenwich on State Route 62. From mile marker 31 travel 0.1 miles north to a road that will come in from the west. Turn onto this road and travel 0.5 miles to a road that will come in from the left (south). Turn onto this road and drive 100 feet to a witness post on the right side of the road. From the witness post walk 150 feet at 255°M to the 0-foot stake that is marked with browse tag #54.



Map name: Greenwich

Diagrammatic Sketch

Township 27S , Range 1W , Section 32

GPS: NAD 83, UTM 12S 418604 E 4253012 N

## DISCUSSION

### Browns Canyon Drill - Trend Study No. 23R-8

#### Study Information

This study is located on land managed by the state of Utah (SITLA), just south of Greenwich [elevation: 6,870 feet (2,094 m), slope: 2%, aspect: east]. The area was previously disked and seeded to remove Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), but the vegetation composition after the treatment consisted of only annual weeds. In October 2003, 275 acres (111 ha) were seeded with grasses, forbs, forage kochia (*Kochia prostrata*), and Wyoming big sagebrush using a Truax drill. The project title was Greenwich Disking, but the study was not named this due to other range trend studies in the area with the same name. The study is located in an 8-10 inch (203-254 mm) precipitation zone (USDA et al. 1999). Data collected in Koosharem and Angle, which are 8 miles (12.9 km) and 12 miles (19.3 km) from the study, respectively, indicate that annual precipitation was normal or above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005, normal in 2006, and 65% of normal in 2007 (Utah Climate Center 2007). Pellet group data estimated 7 elk days use/acre (17 edu/ha) and 3 deer days use/acre (8 ddu/ha) in 2004. Cattle use was estimated at 15 days use/acre (38 cdu/ha) in 2007. Rabbit pellet quadrat frequency was 55% in 2004 and 98% in 2007.

#### Soil

The soil is a sandy clay loam with a slightly alkaline reaction (pH 7.4). Soil phosphorus and potassium are both high at 16 ppm and 250 ppm, respectively (Tiedemann and Lopez 2004). A clay hardpan exists in the profile at a depth of 11 inches (27.9 cm). Relative combined rock and pavement cover was 7% in 2004 and 10% in 2007. Relative bare ground cover was high at 40%-46% in both sample years. Relative combined vegetation and litter cover was 53% in 2004 and 44% in 2007. The soil erosion condition was classified as stable in 2004 and 2007.

#### Browse

The historic key browse species was Wyoming big sagebrush, though only dead plants have been sampled. In 2007, there were 320 dead plants/acre (791 plants/ha), and all of these appeared to have been killed by the treatment. The live key browse species that were sampled in 2004 and 2007 were forage kochia and fourwing saltbush (*Atriplex canescens*). Forage kochia canopy cover was 31% in 2004 and 17% in 2007. Its density was 27,700 plants/acre (68,446 plants/ha) in 2004 and 53,720 plants/ha (132,740 plants/ha) in 2007. The population has been largely mature, with young plants comprising less than 1% of the population in 2004 and 31% in 2007. Seedlings were also present in 2007, but were not counted because of their high density. Vigor was good, and browse use was light in 2004 and heavy in 2007. The heavy browse use in 2007 was almost entirely from rabbits and explains the decrease in canopy cover and increase in density. There were more, smaller, plants. Average annual leader growth on forage kochia was 1.5 inches (3.9 cm) in 2007. Fourwing saltbush provided little cover. Its density was estimated at 20 plants/acre (49 plants/ha) in 2004, and it was not sampled in 2007.

#### Herbaceous Understory

The understory provides little quality forage, and diversity is low. Bottlebrush squirreltail (*Sitanion hystrix*) and orchardgrass (*Dactylis glomerata*) are the only grass species that have been sampled on the study, and have provided almost no cover. Orchardgrass was seeded, but was only sampled in 2004.

Annual forbs are dominant. They provided 14% cover in 2004 and 2% cover in 2007, while perennial species provided 1% cover or less both sample years. Tansymustard (*Descurainia pinnata*), annual stickseed (*Lappula occidentalis*), Russian thistle (*Salsola iberica*), and cutleaf nightshade (*Solanum triflorum*) have been the most abundant annuals. Milkvetch (*Astragalus* sp.) has been the most abundant perennial.

2007 Post-treatment Assessment

This treatment was successful in increasing forage kochia density, but did not improve the herbaceous understory. Kochia density increased 48%. Wyoming big sagebrush was also seeded, but did not establish. The herbaceous understory composition remained poor and was dominated by weedy species. Tansymustard and annual stickseed increased significantly in nested frequency, while Russian thistle and milkvetch decreased significantly in nested frequency. Of the 11 seeded herbaceous species, only orchardgrass established, and provided very little cover in 2004. The 2004 Desirable Components Index (DCI) was good due to high preferred browse cover with low decadence, as well as low browse recruitment and perennial herbaceous cover. The DCI rating remained good in 2007.

2004 winter range condition (DCI) - good (48) Low potential scale

2007 winter range condition (DCI) - good (59) Low potential scale

<b>Brown's Canyon Drill Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Pubescent Wheatgrass	550	2.00
Crested WG, "Douglas"	550	2.00
Great Basin Wildrye "Trailhead"	300	1.09
Western Wheatgrass "Arriba"	400	1.45
Snake River Wheatgrass "Secar"	300	1.09
Russian Wildrye "Bozoisky"	550	2.00
Orchardgrass "Paiute"	150	0.55
Blue Flax "Appar"	100	0.36
Alfalfa "Ladak+"	300	1.09
Yellow Sweetclover	100	0.36
Sagebrush, Wyoming	280	1.02
Forage Kochia	300	1.09
Rice Hulls	250	0.91
<b>Total</b>	<b>4,130</b>	<b>15.02</b>
<b>PLS lbs/acre</b>	<b>15.02</b>	
<b>PLS/ft<sup>2</sup></b>	<b>39.75</b>	

HERBACEOUS TRENDS --

Management unit 23R, Study no: 8

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Dactylis glomerata	2	-	.00	-
G	Sitanion hystrix	<sub>a</sub> 1	<sub>a</sub> 7	.00	.02
Total for Annual Grasses		0	0	0	0
Total for Perennial Grasses		3	7	0.00	0.01
Total for Grasses		3	7	0.00	0.01
F	Astragalus sp.	<sub>b</sub> 57	<sub>a</sub> 2	.89	.01
F	Cirsium sp.	-	1	-	.00
F	Cleome serrulata (a)	4	-	.83	-

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	<i>Descurainia pinnata</i> (a)	a-	b74	.03	.21
F	<i>Lappula occidentalis</i> (a)	a5	b270	.08	1.53
F	<i>Lactuca serriola</i>	-	4	-	.00
F	<i>Marrubium vulgare</i>	b15	a1	.26	.15
F	<i>Nicotiana attenuata</i> (a)	16	-	.12	-
F	<i>Salsola iberica</i> (a)	b90	a11	9.09	.03
F	<i>Sisymbrium altissimum</i> (a)	-	21	-	.21
F	<i>Solanum triflorum</i> (a)	157	-	3.85	-
F	<i>Sphaeralcea grossulariifolia</i>	-	3	-	.00
F	Unknown forb-perennial	21	-	.18	-
Total for Annual Forbs		272	376	14.01	2.00
Total for Perennial Forbs		93	11	1.33	0.17
Total for Forbs		365	387	15.35	2.17

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 23R, Study no: 8

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	0	0	-	-
B	<i>Atriplex canescens</i>	1	0	.15	-
B	<i>Kochia prostrata</i>	100	100	21.04	18.89
B	<i>Opuntia</i> sp.	3	1	.00	-
Total for Browse		104	101	21.20	18.89

#### CANOPY COVER, LINE INTERCEPT --

Management unit 23R, Study no: 8

Species	Percent Cover	
	'04	'07
<i>Kochia prostrata</i>	30.91	16.53
<i>Opuntia</i> sp.	.01	-

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 24R, Study no: 6

Species	Average leader growth (in)	
	'04	'07
Kochia prostrata	-	1.5

BASIC COVER --

Management unit 23R, Study no: 8

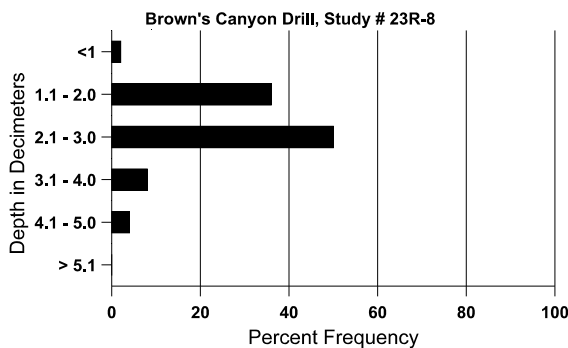
Cover Type	Average Cover %	
	'04	'07
Vegetation	38.31	19.50
Rock	4.68	5.84
Pavement	3.91	5.39
Litter	21.70	28.97
Cryptogams	.06	.03
Bare Ground	45.29	51.26

SOIL ANALYSIS DATA --

Management unit 23R, Study no: 8, Study Name: Browns Canyon Drill

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.8	63.4 (11.8)	7.4	51.0	26.8	22.2	1.1	15.7	249.6	0.7

Stoniness Index



PELLET GROUP DATA --

Management unit 23R, Study no: 8

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	55	98	-	-
Elk	3	-	7 (17)	-
Cattle	-	3	3 (8)	15 (38)

BROWSE CHARACTERISTICS --  
 Management unit 23R, Study no: 8

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	340	0	0	-	-	0	-/-
<i>Atriplex canescens</i>												
04	<b>20</b>	-	20	-	-	-	0	0	-	-	0	-/-
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Kochia prostrata</i>												
04	<b>27700</b>	-	40	27660	-	-	5	0	0	-	0	13/15
07	<b>53720</b>	-	16540	37140	40	-	1	98	0	.07	.07	4/9
<i>Opuntia sp.</i>												
04	<b>80</b>	-	-	60	20	-	0	0	25	-	0	4/12
07	<b>20</b>	-	-	-	20	-	0	0	100	100	100	5/17



Trend Study 24R-6-07

Study site name: Panguitch East Bench Harrow .

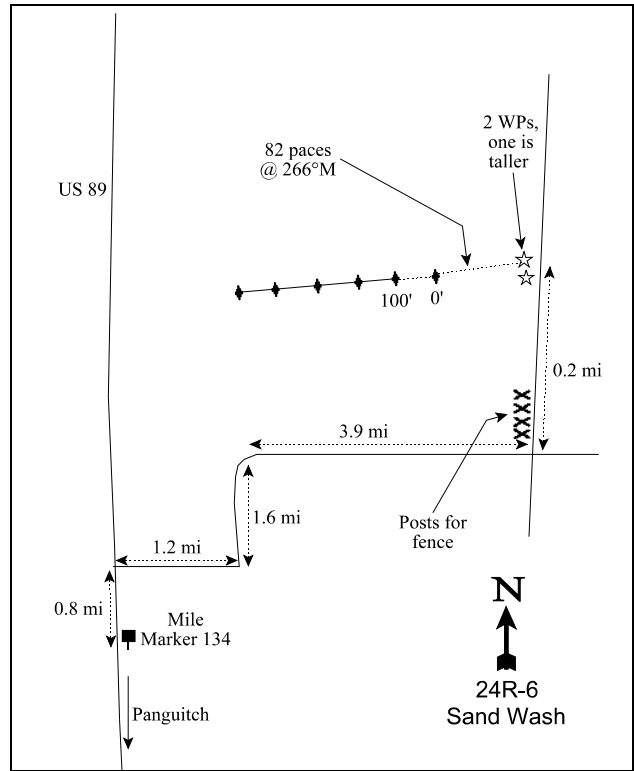
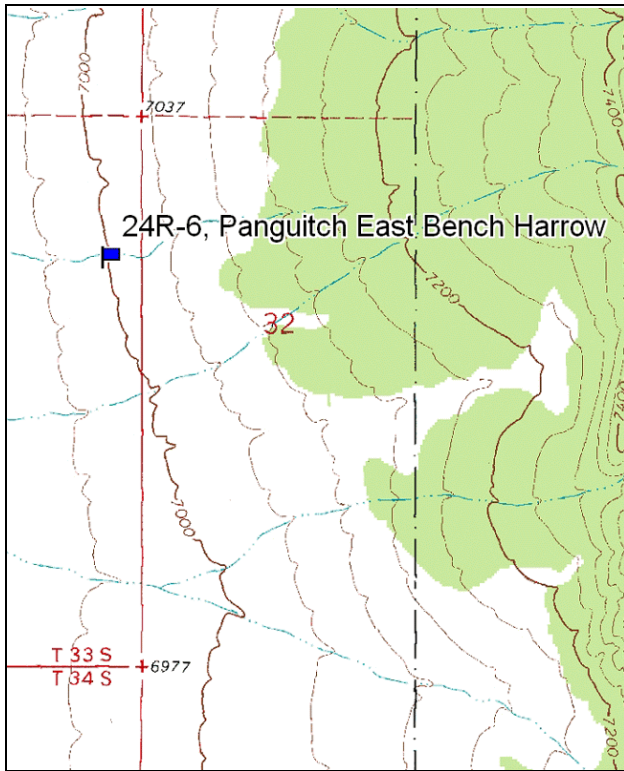
Vegetation type: Wyoming Big Sagebrush .

Compass bearing: frequency baseline 255 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

Travel north of Panguitch on US 89 to mile marker 134. Continue 0.8 miles north of the mile marker to a road that comes in from the right (east). Turn onto this road and travel 1.2 miles to an intersection. Turn left and travel 1.6 miles to a 90° turn. Continue 3.9 miles to a road that comes in from the left (north). Turn here and travel 0.2 miles to two witness posts that are right next to each other. From the witness posts walk 82 paces at 266°M to the 0-foot stake that is marked with browse tag #41.



Map name: Blind Spring Mountain

Diagrammatic Sketch

Township 33S , Range 4½W , Section 31

GPS: NAD 83, UTM 12S 382047 E 4195730 N

## DISCUSSION

### Panguitch East Bench Harrow - Trend Study No. 24R-6

#### Study Information

This study was established to monitor the Panguitch East Bench treatment, near sage-grouse habitat approximately 7.5 miles (12.1 km) northeast of Panguitch [elevation: 7,000 feet (2,134 m), slope: 7%, aspect: west]. This 300-acre (121-ha) area was treated with a 30-foot (9.1-m) wide Dixie harrow in a single direction in October 2004. Seed was applied to the treatment with a broadcast spreader attached to the tractor pulling the harrow. Forage kochia (*Kochia prostrata*) was seeded in December. The study is located in a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Data collected in Hatch, 18 miles (29 km) south of the study, indicate that annual precipitation was above normal in 2004, 2005, and 2006. Spring precipitation was above normal in 2005 and 2006, but was 65% of normal in 2007 (Utah Climate Center 2007). Pellet group transect data estimated use at 1 antelope day use/acre (3 adu/ha) in 2004, which was from late winter or early spring, and 4 antelope days use/acre (10 adu/ha) in 2007.

#### Soil

The soil is classified within the Notter series (USDA-NRCS 2007). The soils in this series are deep, well-drained, and moderately permeable. They formed in alluvium from intermediate and basic igneous rocks. The soil is a shallow sandy clay loam with a slightly alkaline reaction (pH 7.6). The concentration of phosphorus in the soil is marginal at 7.8 ppm (Tiedemann and Lopez 2004). Rock and pavement are scattered throughout the profile, with a distinct layer of rock at 12 inches (30.5 cm). Relative rock cover was 4%-5% both sample years, while pavement cover was 20% in 2004 and 8% in 2007. Relative bare ground cover was 32% in 2004 and 46% in 2007. Relative combined vegetation and litter cover was 41% in 2004 and 2007. The soil erosion condition was classified as slight in 2004 due moderate-high pedestalling and moderate-sized gullies. In 2007, the erosion condition was classified as stable.

#### Browse

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is the only key browse species on the study. It provided 19% canopy cover in 2004 and 5% in 2007 following the harrow treatment. Sagebrush density was 6,960 plants/acre (17,198 plants/ha) in 2004 and 2,460 plants/acre (6,079 plants/ha) in 2007. Population decadence was 45% in 2004 and 23% in 2007. Young plants comprised 7% of the population in 2004 and 10% in 2007. Seedlings were sampled in low densities in both sample years. Dead plant density was 1,840 plants/acre (4,547 plants/ha) in 2004 and 1,380 plants/acre (3,410 plants/ha) in 2007. Plants classified as dying comprised 26% of the population in 2004 and 5% in 2007. Another 10% of the population in 2007 displayed poor vigor due to the treatment. Forty-three percent of the sampled sagebrush were infested with the sagebrush defoliator moth (*Aroga websteri*). Browse use was light in 2004 and light-moderate in 2007. Annual leader growth averaged 0.4 inches (1 cm) in 2004 and 1.7 inches (4.2 cm) in 2007.

#### Herbaceous Understory

Total grass cover was 5% in 2004 and 6% in 2007, and was composed entirely of perennials. Three grass species were sampled in 2004, and eight were sampled in 2007. Blue grama (*Bouteloua gracilis*) was the most abundant grass in both sample years, comprising 81% and 97% of the total grass cover in 2004 and 2007, respectively. Bottlebrush squirreltail (*Sitanion hystrix*) was also abundant in 2004. Six seeded species, including crested wheatgrass (*Agropyron cristatum*), intermediate wheatgrass (*Agropyron intermedium*), Russian wildrye (*Elymus junceus*), Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread (*Stipa comata*), and bottlebrush squirreltail, were sampled in 2007. The seeded species, however, were all sampled at quadrat frequencies of 5% or less.

Total forb cover was nearly 0% in 2004 and 1% in 2007. Two forb species, milkvetch (*Astragalus* sp.) and tansymustard (*Descurainia pinnata*), were sampled in 2004. In 2007, 10 species were sampled, six of which

were annuals. Tansymustard was the most common forb in both sample years. Two seeded species, Rocky Mountain beeplant (*Cleome serrulata*) and small burnet (*Sanguisorba minor*), were sampled at low frequencies in 2007.

#### 2007 Post-treatment Assessment

The harrow treatment was successful in reducing sagebrush density, cover, and decadence. The remaining sagebrush plants appeared more vigorous in 2007 than in 2004. However, the seeding did not seem to be successful. Although the diversity of herbaceous species improved, cover did not increase substantially. Six of the eight seeded grass species were sampled in 2007. Bottlebrush squirreltail was seeded although it was present prior to the treatment, but decreased significantly in nested frequency. Two of the seven seeded forb species were sampled in 2007, but at low frequencies. Tansymustard increased significantly in nested frequency. The 2004 Desirable Components Index (DCI) score was fair due to excellent preferred browse cover and moderate perennial grass cover, but high browse decadence. In 2007, the DCI rating remained fair. Although preferred browse cover decreased, recruitment and decadence both improved, while perennial grass cover also slightly increased.

2004 winter range condition (DCI) - fair (39) Low potential scale

2007 winter range condition (DCI) - fair (36) Low potential scale

<b>Panguitch East Bench Harrow Seed Mix</b>	<b>Bulk lbs in mix</b>	<b>Bulk lbs/acre</b>
Crested Wheatgrass 'Douglas'	150	0.5
Crested Wheatgrass 'Hycrest'	150	0.5
Indian Ricegrass 'Rimrock'	150	0.5
Needle and Threadgrass	35	0.1
Bottlebrush Squirreltail	40	0.1
Intermediate Wheatgrass	150	0.5
Newhy WG	150	0.5
Hard Fescue	150	0.5
Russian Wildrye 'Bozoisky'	150	0.5
Yellow Sweetclover	13	0.0
Alfalfa 'Ladak+'	300	1.0
Sainfoin	800	2.7
Small Burnet 'Delar'	500	1.7
Blue Flax 'Appar'	50	0.2
Western Yarrow	20	0.1
Rocky Mountain Beeplant--Sanpete UT	150	0.5
Snake River Wheatgrass 'Secar'	350	1.2
<b>Total</b>	<b>3,308</b>	<b>11.0</b>
<b>PLS lbs/acre</b>		<b>10.3</b>

HERBACEOUS TRENDS --

Management unit 24R, Study no: 6

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Agropyron cristatum	-	7	-	.04
G	Agropyron intermedium	-	1	-	.00
G	Bouteloua gracilis	<sub>a</sub> 148	<sub>a</sub> 148	4.30	6.22
G	Elymus junceus	-	2	-	.03
G	Oryzopsis hymenoides	-	3	-	.03
G	Poa secunda	<sub>a</sub> 5	<sub>a</sub> 3	.01	.00
G	Sitanion hystrix	<sub>b</sub> 38	<sub>a</sub> 8	1.02	.07
G	Stipa comata	-	2	-	.00
Total for Annual Grasses		0	0	0	0
Total for Perennial Grasses		191	174	5.34	6.42
Total for Grasses		191	174	5.34	6.42
F	Arabis sp.	-	4	-	.00
F	Astragalus sp.	<sub>a</sub> 3	<sub>a</sub> 7	.03	.01
F	Chenopodium fremontii (a)	-	4	-	.00
F	Cleome serrulata (a)	-	9	-	.20
F	Descurainia pinnata (a)	<sub>a</sub> 16	<sub>b</sub> 60	.10	.87

Type	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
F	Eriogonum cernuum (a)	-	22	-	.04
F	Gilia sp. (a)	-	1	-	.00
F	Lappula occidentalis (a)	-	2	-	.01
F	Lactuca serriola	-	4	-	.00
F	Sanguisorba minor	-	1	-	.03
Total for Annual Forbs		16	98	0.10	1.13
Total for Perennial Forbs		3	16	0.02	0.04
Total for Forbs		19	114	0.13	1.18

Values with different subscript letters are significantly different at alpha = 0.10

#### BROWSE TRENDS --

Management unit 24R, Study no: 6

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	98	55	18.24	7.73
B	Chrysothamnus viscidiflorus	0	0	-	.15
B	Gutierrezia sarothrae	2	0	.06	-
B	Opuntia sp.	2	1	-	.00
Total for Browse		102	56	18.30	7.88

#### CANOPY COVER, LINE INTERCEPT --

Management unit 24R, Study no: 6

Species	Percent Cover	
	'04	'07
Artemisia tridentata wyomingensis	19.46	4.66

#### KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 24R, Study no: 6

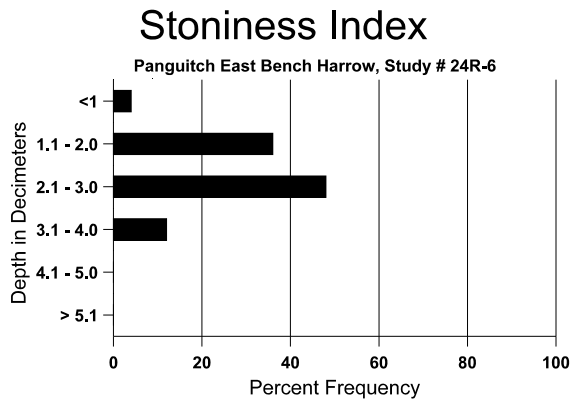
Species	Average leader growth (in)	
	'04	'07
Artemisia tridentata wyomingensis	0.4	1.7

BASIC COVER –  
Management unit 24R, Study no: 6

Cover Type	Average Cover %	
	'04	'07
Vegetation	23.30	16.06
Rock	4.09	5.02
Pavement	22.95	9.11
Litter	23.92	28.44
Cryptogams	3.37	.07
Bare Ground	36.83	50.06

SOIL ANALYSIS DATA --  
Management unit 24R, Study no: 6, Study Name: Panguitch East Bench Harrow

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
13.2	63.0 (15.3)	7.6	55.0	23.4	21.6	1.4	7.8	611.2	0.7



PELLET GROUP DATA --  
Management unit 24R, Study no: 6

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	26	91	-	-
Antelope	1	1	1 (3)	4 (10)

BROWSE CHARACTERISTICS --  
 Management unit 24R, Study no: 6

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>6960</b>	60	500	3320	3140	1840	3	0	45	26	26	17/26
07	<b>2460</b>	80	240	1660	560	1380	22	7	23	5	15	15/22
<i>Gutierrezia sarothrae</i>												
04	<b>320</b>	-	100	220	-	-	0	0	-	-	0	5/7
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
<i>Opuntia sp.</i>												
04	<b>40</b>	-	-	40	-	-	0	0	-	-	0	4/9
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	½

Trend Study 25R-5-07

Study site name: Lamp Stand.

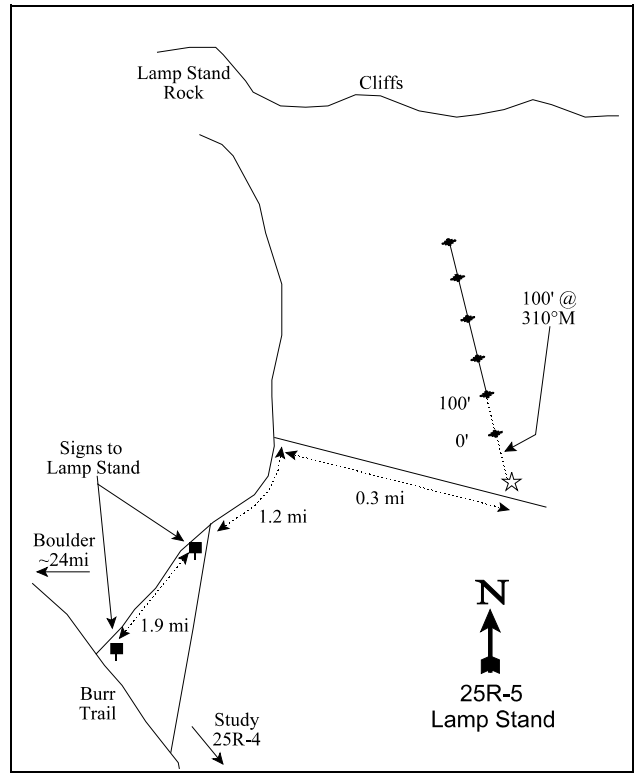
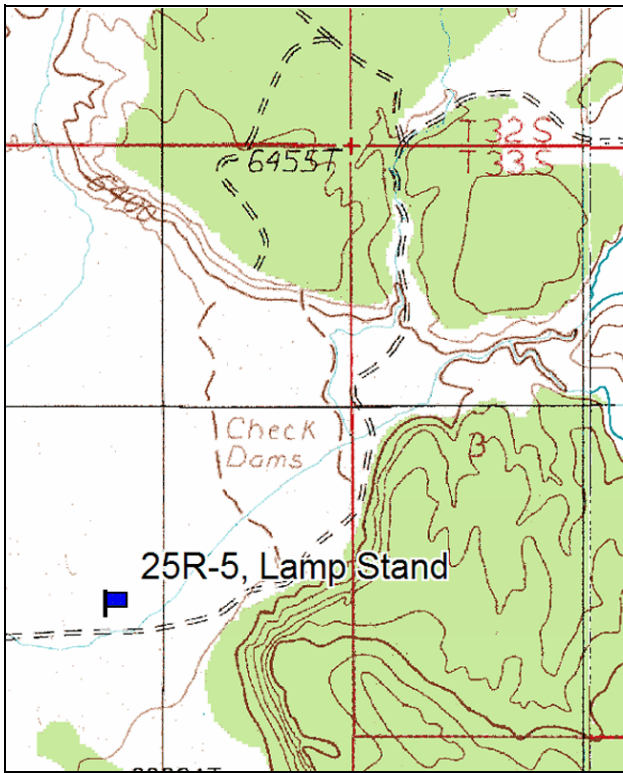
Vegetation type: Annuals.

Compass bearing: frequency baseline 310 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Burr Trail take the turnoff to Lamp Stand. Travel 1.9 miles to another sign for Lamp Stand. Continue north 1.2 miles to a road on the right. Turn onto this road and travel 0.3 miles to a witness post on the left side of the road. From here the 0-foot stake is 100 feet away at 310°M and is marked with browse tag #53.



Map name: Lamp Stand.

Diagrammatic Sketch

Township 33S, Range 7E, Section Unsurveyed

GPS: NAD 83, UTM 12S 487803 E 4201695 N



## DISCUSSION

### Lamp Stand - Trend Study No. 25R-5

#### Study Information

This study is part of the Circle Cliffs range seeding project, and is located approximately 27 miles (43 km) east of Boulder, north of the Burr Trail [elevation: 6,360 feet (1,939 m), slope: 1%, aspect: northwest]. It was established prior to treatment in 2004 to monitor an open flat in the Grand Staircase Escalante National Monument managed by the BLM. The area was dominated by weedy annual forbs, and was drill seeded with a Truax no-till drill in November of 2004. The goal of the seeding project was to establish perennial grasses, forbs, and shrubs to improve this rangeland for wildlife and livestock use. The study is within a 10-12 inch (254-305 mm) precipitation zone (USDA et al. 1999). Data collected in Boulder, 16 miles (25.7 km) from the study, indicated that annual precipitation was above normal in 2004, 2005, and 2006. Spring precipitation was also above average in 2005 and 2006, but was 51% of normal in 2007. A stockpond is located approximately 1,000 feet (305 m) west of the study. A pellet group transect found no wildlife use in 2004. In 2007, elk use was estimated at 16 days use/acre (40 edu/ha), and was in the winter and spring. Older cattle pats were sampled in 6% of the quadrats in 2004 and 2% in 2007. Four cattle days use/acre (10 cdu/ha) were estimated in 2007. Rabbit pellet quadrat frequency increased from 46% in 2004 to 86% in 2007. Coyote scat was also noted in 2007.

#### Soil

The soil is classified as a Barx-Radnik complex (USDA-NRCS 2007). Soils in the Barx series are very deep and well-drained, and formed in alluvium and reworked eolian material derived from sandstone. The Radnik series consists of very deep, well-drained soils that formed in alluvium from sandstone and mudstone. The soil is a sandy clay loam with a moderately alkaline reaction (pH 7.9). Soil phosphorus is marginal at 10.9 ppm (Tiedemann and Lopez 2004). No rock was found in the soil profile or on the surface, and there was little pavement. Relative bare ground cover is high, but decreased from 59% in 2004 to 37% in 2007 following the treatment, while relative combined vegetation and litter cover increased from 38% to 62%. The soil erosion condition was classified as stable in 2004 and 2007, despite some evidence of overland flow.

#### Browse

The only preferred browse species present when the study was sampled in 2004 was fourwing saltbush (*Atriplex canescens*), which was found at a very low density. Five browse species were seeded, including fourwing saltbush, Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), antelope bitterbrush (*Purshia tridentata*), green ephedra (*Ephedra viridis*), and winterfat (*Ceratoides lanata*). Sagebrush and fourwing saltbush were present in 2007. Young sagebrush density was estimated at 40 plants/acre (99 plants/ha), and one seedling was sampled. Fourwing saltbush was not sampled within the density strips.

#### Herbaceous Understory

The herbaceous understory was poor prior to treatment. Only three grass species were sampled, which provided almost no cover. In 2007, six grass species were sampled and provided 14% cover. Crested wheatgrass (*Agropyron cristatum*), which was seeded, was the dominant grass and comprised 77% of the total grass cover. Blue grama (*Bouteloua gracilis*), Indian ricegrass (*Oryzopsis hymenoides*), and bottlebrush squirreltail (*Sitanion hystrix*) were also present at lower frequencies. Cheatgrass (*Bromus tectorum*) was present in both sample years, but increased from providing almost no cover in 2004 to 2% cover in 2007.

Annual forbs dominated the understory in 2004, and provided 28% cover. Eighty-one percent of the total forb cover was comprised of Russian thistle (*Salsola iberica*). Annual stickseed (*Lappula occidentalis*) was also abundant. Six forb species were seeded, but none were sampled in 2007. Annuals continued to dominate the understory, although cover slightly decreased to 26%. Woolly plantain (*Plantago patagonica*), blue mustard (*Chorispora tenella*), tansymustard (*Descurainia pinnata*), and annual stickseed were the most abundant forbs

in 2007. Gooseberryleaf globemallow (*Sphaeralcea grossulariifolia*) and hoary aster (*Machaeranthera canescens*) were the most abundant perennial forbs, and provided 1% combined cover in 2007.

#### 2007 Post-treatment Assessment

Eighteen total species were seeded, and only four were sampled following the treatment: Wyoming big sagebrush, fourwing saltbush, crested wheatgrass, and Indian ricegrass. However, fourwing saltbush and Indian ricegrass were also present before the seeding, and Indian ricegrass increased slightly in cover. Preferred browse density and cover remained very low. Perennial grass cover increased from less than 1% in 2004 to 12% in 2007. Blue grama, Indian ricegrass, and cheatgrass increased significantly in nested frequency, and crested wheatgrass became the dominant grass. However, annual forb cover remained high at 26% following the treatment. Blue mustard, tansymustard, annual stickseed, woolly plantain, and gooseberryleaf globemallow all increased significantly in nested frequency, while Russian thistle and Fremont goosefoot (*Chenopodium fremontii*) decreased significantly in nested frequency. The 2004 Desirable Components Index (DCI) was rated as very poor due to low preferred browse and perennial herbaceous cover. In 2007, the DCI rating improved to poor-fair due to the increase in perennial grass cover.

2004 winter range condition (DCI) - very poor (2) Low potential scale

2007 winter range condition (DCI) - poor-fair (25) Low potential scale

<b>Circle Cliffs Seed Mix</b>	<b>Bulk lbs/ac</b>
*Crested WG 'Nordan'	2.5
*Sand Dropseed	0.6
*Thickspike WG 'Schwendimar'	0.1
*Siberian WG P27	2.5
*Thickspike WG 'Critana'	0.1
*Western WG 'Ariba'	3.7
*Alfalfa 'Ladak+'	0.3
*Yellow Sweetclover 'Madrid'	0.5
*Small Burnet 'Delar'	0.1
*Fourwing Saltbush	0.1
*Fourwing Saltbush	1.1
*Indian Ricegrass 'Rimrock'	1.2
*Great Basin Wildrye 'Megnar'	0.3
*Antelope Bitterbrush	0.1
Alfalfa 'Nomad'	0.3
Blue Flax 'Appar'	0.1
Palmer Penstemon 'Washington, UT'	0.0
Green Ephedra	0.0
Bitterbrush--Ada/Boise ID	0.1
Munroe Globemallow 'Elbow Ranch'	0.1
Green Ephedra	0.0
<b>Total Bulk lbs/acre</b>	<b>13.7</b>

\*Seed provided by BLM

<b>Circle Cliffs Shrub Seed Mix</b>	<b>Bulk lbs/ac</b>
*Winterfat	0.0
*Big Sagebrush, Wyoming	0.3
*Winterfat	0.3
Sagebrush, Wyoming--Beaver UT	0.3
<b>Total Bulk lbs/acre</b>	<b>0.8</b>
<b>Total PLS lbs/acre</b>	<b>0.08</b>

\*Seed provided by BLM

HERBACEOUS TRENDS --  
Management unit 25R, Study no: 5

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	<i>Agropyron cristatum</i>	-	228	-	10.53
G	<i>Bouteloua gracilis</i>	<sub>a</sub> 10	<sub>b</sub> 30	.24	.60
G	<i>Bromus tectorum</i> (a)	<sub>a</sub> -	<sub>b</sub> 106	.00	1.67
G	<i>Oryzopsis hymenoides</i>	<sub>a</sub> 4	<sub>b</sub> 17	.00	.65
G	<i>Sitanion hystrix</i>	-	2	-	.15
G	<i>Vulpia octoflora</i> (a)	-	13	-	.07
Total for Annual Grasses		0	119	0.00	1.75
Total for Perennial Grasses		14	277	0.24	11.94
Total for Grasses		14	396	0.25	13.69
F	<i>Alyssum alyssoides</i> (a)	-	2	-	.00
F	<i>Calochortus nuttallii</i>	-	-	-	.00
F	<i>Chenopodium fremontii</i> (a)	<sub>b</sub> 33	<sub>a</sub> 2	.22	.00
F	<i>Chenopodium leptophyllum</i> (a)	7	-	.04	-
F	<i>Chorispora tenella</i> (a)	<sub>a</sub> 44	<sub>b</sub> 187	.91	6.71
F	<i>Descurainia pinnata</i> (a)	<sub>a</sub> 4	<sub>b</sub> 211	.01	3.04
F	<i>Gilia</i> sp. (a)	<sub>a</sub> 2	<sub>a</sub> 3	.03	.00
F	<i>Helianthus annuus</i> (a)	24	-	.14	-
F	<i>Lappula occidentalis</i> (a)	<sub>a</sub> 195	<sub>b</sub> 338	3.09	6.28
F	<i>Lactuca serriola</i>	-	3	-	.00
F	<i>Machaeranthera canescens</i>	-	159	-	.75
F	<i>Mentzelia albicaulis</i> (a)	34	-	.27	-
F	<i>Plantago patagonica</i> (a)	<sub>a</sub> 23	<sub>b</sub> 380	.07	9.32
F	<i>Ranunculus testiculatus</i> (a)	-	2	-	.00
F	<i>Salsola iberica</i> (a)	<sub>b</sub> 404	<sub>a</sub> 177	23.60	.56
F	<i>Sphaeralcea grossulariifolia</i>	<sub>a</sub> 44	<sub>b</sub> 74	.67	.67
Total for Annual Forbs		770	1302	28.41	25.95
Total for Perennial Forbs		44	236	0.67	1.43
Total for Forbs		814	1538	29.09	27.39

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 25R, Study no: 5

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	Artemisia tridentata wyomingensis	0	2	-	.00
B	Atriplex canescens	0	0	-	-
B	Chrysothamnus viscidiflorus	1	1	.15	.38
B	Opuntia sp.	1	0	-	-
Total for Browse		2	3	0.15	0.38

BASIC COVER --

Management unit 25R, Study no: 5

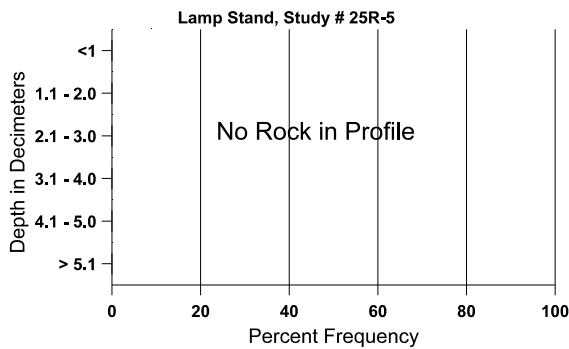
Cover Type	Average Cover %	
	'04	'07
Vegetation	30.74	37.92
Rock	.03	.03
Pavement	3.42	1.09
Litter	10.06	30.88
Bare Ground	63.43	41.93

SOIL ANALYSIS DATA --

Management unit 25R, Study no: 5, Study Name: Lamp Stand

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
11.7	66.2 (14.3)	7.9	54.3	23.5	22.2	0.8	10.9	534.4	1.0

### Stoniness Index



PELLET GROUP DATA --  
 Management unit 25R, Study no: 5

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	46	86	-	-
Elk	-	17	-	16 (40)
Cattle	6	2	-	4 (10)

BROWSE CHARACTERISTICS --  
 Management unit 25R, Study no: 5

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	-/-
07	<b>40</b>	20	40	-	-	-	0	0	-	-	0	-/-
<i>Atriplex canescens</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	33/30
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	29/29
<i>Chrysothamnus viscidiflorus</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	13/14
07	<b>20</b>	-	-	20	-	-	0	0	-	-	0	33/40
<i>Opuntia sp.</i>												
04	<b>20</b>	-	-	20	-	-	0	0	-	-	0	4/22
07	<b>0</b>	-	-	-	-	-	0	0	-	-	0	4/23

Trend Study 30R-1-07

Study site name: Newcastle Bullhog .

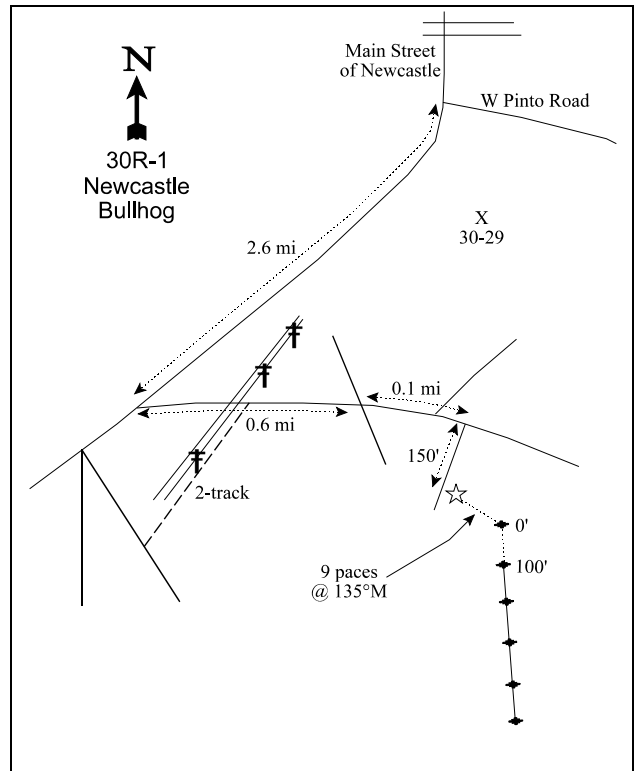
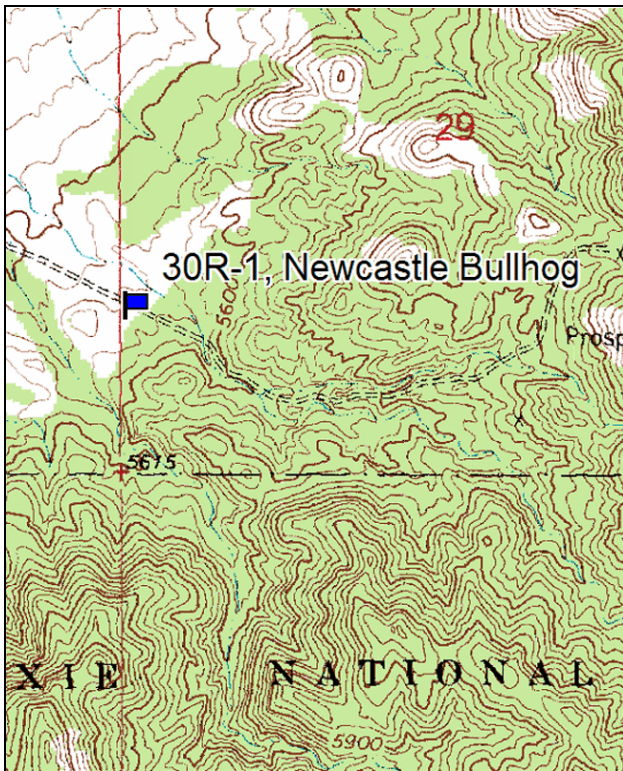
Vegetation type: Pinyon-Juniper .

Compass bearing: frequency baseline 174 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft).

LOCATION DESCRIPTION

From Pinto Canyon Road in Newcastle travel south on Main Street, which turns into Bench Road, for 2.6 miles to a road that comes in from the left (east). Turn onto this road and drive 0.6 miles to and intersection. Continue through the intersection to a road that comes in from the right (south). Turn onto this road and drive 150 feet to a witness post on the left side of the road. From the witness post walk 9 paces at 135°M to the 0-foot stake that is marked with browse tag #44.



Map name: Newcastle

Diagrammatic Sketch

Township 36S , Range 15W , Section 29

GPS: NAD 83, UTM 12S 273534 E 4168516 N

## DISCUSSION

### Newcastle Bullhog - Trend Study No. 30R-1

#### Study Information

This study is located on land managed by the Bureau of Land Management just south of Newcastle, and is part of the Pinto Creek grazing allotment [elevation: 5,560 feet (1,695 m), slope: 5%-10%, aspect: northwest]. The range type is an association of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), Utah juniper (*Juniperus osteosperma*), and pinyon pine (*Pinus edulis*). Over the years, pinyon and juniper have encroached to the point of outcompeting important forage species for wintering mule deer. In October 2004, a bullhog was used to thin and remove the pinyon and junipers on 900 acres (364 ha). The area was not seeded previous to or following the bullhog treatment. The study is within a 14-16 inch (356-406 mm) precipitation zone (USDA et al. 1999). Data collected in Enterprise, 9 miles (14.5 km) from the study, indicated that annual precipitation was above normal in 2004 and 2005. Precipitation data were incomplete in 2006, but average annual precipitation for Wildlife Management Unit 30 was above normal in 2006. Spring precipitation in Enterprise was above average in 2005 and 2006, but was 75% of normal in 2007 (Utah Climate Summaries 2007). Pellet group data estimated 72 deer days use/acre (177 ddu/ha) in 2004 and 23 deer days use/acre (56 ddu/ha) in 2007. All of the deer pellet groups sampled in 2007 were from winter use. Rabbit pellet quadrat frequency was 47% in 2004 and 80% in 2007. Deer and old cattle bones were found on the study in 2007.

#### Soil

The soil is classified within the Checkett series (USDA-NRCS 2007). The soils in this series are shallow, well-drained, and moderately permeable, and formed in residuum and colluvium derived dominantly from igneous and metamorphic rocks. The soil is a sandy loam with a neutral reaction (pH 7.3). Soil phosphorus is marginal at 7.8 ppm (Tiedemann and Lopez 2004). A coarse rock layer exists at a depth of approximately 10-12 inches (25-30 cm), which may be a barrier to roots. Relative rock cover was 2%-3% in both sample years, and relative pavement cover was 33% in 2004 and 16% in 2007. Relative bare ground cover was moderate at 16% in 2004 and 12% in 2007. Relative combined vegetative and litter cover was 47% in 2004 and 70% in 2007. The erosion condition was classified as slight in both sample years due to evidence of surface litter and soil movement, and the presence of flow patterns, rills, and gullies.

#### Browse

The preferred browse species present are Wyoming big sagebrush, Stansbury cliffrose (*Cowania mexicana* ssp. *stansburiana*), and green ephedra (*Ephedra viridis*). Some of the sagebrush appeared to be a hybrid of Wyoming big sagebrush and black sagebrush. Wyoming big sagebrush canopy cover was 4% in 2004 and 10% in 2007. Its density was 2,580 plants/acre (6,375 plants/ha) in 2004 and 2,480 plants/acre (6,128 plants/ha) in 2007. Decadent plants comprised 40% of the population in 2004 and 23% in 2007. Young plants were sampled for the first time in 2007, and made up 12% of the population. Seedlings were sampled at a density of 1,480 plants/acre (3,657 plants/ha) in 2007. The density of dead sagebrush was 1,440 plants/acre (3,558 plants/ha) in 2004 and 1,060 plants/acre (2,619 plants/ha) in 2007. Twenty-nine percent of the population was classified as dying in 2004, which decreased to 13% by 2007. An additional 4% of the population showed poor vigor in 2007 due to the treatment. Browse use was moderate-heavy in both sample years. Annual leader growth averaged 1.6 inches (3.8 cm) in 2004 and 2.3 inches (5.7 cm) in 2007. Several plants had only seedstalks and no leaders in 2004 due to late stages of decadence. In 2007, the sagebrush located near chipped trees had excellent vigor, whereas those farther away from the bullhogged trees showed more normal vigor.

A few Stansbury cliffrose plants were scattered throughout the area, but provided little cover. They were tall and only partially available to wildlife, but the available areas were heavily hedged. Green ephedra was also present and had a density of 100 plants/acre (247 plants/ha) in 2004 and 160 plants/acre (395 plants/ha) in 2007. The population was largely mature, with 20% decadence in 2004 and 25% in 2007. Young plants were



sampled for the first time in 2007 and comprised 12% of the population. Vigor was good in 2004, but in 2007, 25% of the sampled plants were classified as dying. Browse use was heavy in 2004 and light in 2007.

Combined pinyon and juniper canopy cover was 23% in 2004, and 6% in 2007 following the treatment. From the point-centered quarter data, juniper density was estimated at 116 trees/acre (287 trees/ha) in 2004 and 26 trees/acre (64 trees/ha) in 2007. Average trunk diameter was 8.2 inches (20.8 cm) in 2004 and 1 inch (2.5 cm) in 2007. Pinyon density was estimated at 64 trees/acre (158 trees/ha) in 2004 and 25 trees/acre (62 trees/ha) in 2007. Average trunk diameter was 2.8 inches (7.1 cm) in 2004 and 1.1 inches (2.8 cm) in 2007. Pinyon and juniper trees ranged from 1 foot (0.3 m) to over 12 feet (3.7 m) tall in 2004, but in 2007, nearly all of the sampled trees were less than 4 feet (1.2 m) tall.

#### Herbaceous Understory

The herbaceous understory was dominated by perennial grasses in 2004, which provided 6% cover. Galleta (*Hilaria jamesii*) and Indian ricegrass (*Oryzopsis hymenoides*) were the most abundant species. Cheatgrass was present in 2004, but was only sampled in 14% of the quadrats and provided almost no cover. By 2007, cheatgrass was found in 95% of the quadrats and provided 16% cover. Perennial grass cover increased to 9% in 2007, and galleta and Indian ricegrass remained the most common perennials. Other sampled grasses include bottlebrush squirreltail (*Sitanion hystrix*) and needle-and-thread (*Stipa comata*). Eight forb species were sampled in 2004, and 15 were sampled in 2007. No species were particularly common. Total forb cover was nearly 0% in 2004 and 1% in 2007.

#### 2007 Post-treatment Assessment

The treatment successfully thinned the pinyon and juniper canopy, and the sagebrush population improved in reproduction, recruitment, and vigor. However, cheatgrass increased significantly in nested frequency and dominated the understory due to the lack of competition from the trees for water. The cheatgrass did not grow well in the areas of tree chippings, but had spread in the intercanopy areas. Bottlebrush squirreltail and Indian ricegrass also increased significantly in nested frequency. Forb diversity increased with nine new forb species present, however, six of these species were annuals and provided little forage. The 2004 Desirable Components Index (DCI) score was poor due to low preferred browse cover with high decadence and low recruitment, moderate perennial grass cover, and low perennial forb cover. In 2007, the DCI rating improved to fair with an increase in preferred browse cover and recruitment, a decrease in browse decadence, and an increase in perennial herbaceous cover. However, the large increase in cheatgrass cover prevented the score from being higher.

2004 winter range condition (DCI) - poor (21) Low potential scale

2007 winter range condition (DCI) - fair (31) Low potential scale

HERBACEOUS TRENDS --  
Management unit 30R, Study no: 1

T y p e	Species	Nested Frequency		Average Cover %	
		'04	'07	'04	'07
G	Bromus tectorum (a)	<sub>a</sub> 33	<sub>b</sub> 415	.12	16.14
G	Hilaria jamesii	<sub>a</sub> 112	<sub>a</sub> 135	3.89	6.34
G	Oryzopsis hymenoides	<sub>a</sub> 35	<sub>b</sub> 58	1.58	2.00
G	Sitanion hystrix	<sub>a</sub> 8	<sub>b</sub> 26	.04	.46
G	Sporobolus cryptandrus	2	-	.03	-
G	Stipa comata	<sub>a</sub> 3	<sub>a</sub> 3	.00	.03
G	Vulpia octoflora (a)	-	59	-	.27
Total for Annual Grasses		33	474	0.12	16.41
Total for Perennial Grasses		160	222	5.55	8.85
Total for Grasses		193	696	5.68	25.26
F	Arabis sp.	<sub>a</sub> 1	<sub>a</sub> 3	.00	.00
F	Astragalus sp.	-	4	-	.03
F	Castilleja sp.	-	1	-	.00
F	Cordylanthus sp. (a)	-	17	-	.14
F	Cryptantha sp.	-	5	-	.03
F	Descurainia pinnata (a)	-	10	-	.10
F	Draba sp. (a)	-	16	-	.03
F	Eriogonum cernuum (a)	<sub>a</sub> 5	<sub>a</sub> 2	.01	.00
F	Gilia sp. (a)	-	2	-	.00
F	Holosteum umbellatum (a)	-	1	-	.00
F	Lupinus sp.	2	-	.00	-
F	Penstemon sp.	<sub>a</sub> 1	<sub>a</sub> 3	.00	.01
F	Penstemon pachyphyllus	1	-	.01	-
F	Phlox longifolia	<sub>a</sub> 3	<sub>a</sub> 7	.00	.02
F	Sisymbrium altissimum (a)	-	4	-	.04
F	Streptanthus cordatus	<sub>a</sub> 7	<sub>a</sub> 14	.01	.10
F	Swertia albomarginata	<sub>a</sub> 1	<sub>a</sub> 11	.00	.40
Total for Annual Forbs		5	52	0.00	0.32
Total for Perennial Forbs		16	48	0.04	0.61
Total for Forbs		21	100	0.05	0.94

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 30R, Study no: 1

Type	Species	Strip Frequency		Average Cover %	
		'04	'07	'04	'07
B	<i>Artemisia tridentata wyomingensis</i>	57	62	5.91	7.25
B	<i>Chrysothamnus viscidiflorus stenophyllus</i>	6	3	.41	-
B	<i>Cowania mexicana stansburiana</i>	1	2	.18	.18
B	<i>Ephedra viridis</i>	3	6	-	.45
B	<i>Gutierrezia sarothrae</i>	0	2	-	-
B	<i>Juniperus osteosperma</i>	7	2	6.78	.06
B	<i>Opuntia sp.</i>	4	0	.18	-
B	<i>Pinus edulis</i>	7	1	3.37	.63
Total for Browse		85	78	16.84	8.59

CANOPY COVER, LINE INTERCEPT --

Management unit 30R, Study no: 1

Species	Percent Cover	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	4.36	9.85
<i>Cowania mexicana stansburiana</i>	.08	.15
<i>Ephedra viridis</i>	-	.28
<i>Juniperus osteosperma</i>	15.91	4.34
<i>Opuntia sp.</i>	.08	-
<i>Pinus edulis</i>	7.18	1.79

KEY BROWSE ANNUAL LEADER GROWTH --

Management unit 30R, Study no: 1

Species	Average leader growth (in)	
	'04	'07
<i>Artemisia tridentata wyomingensis</i>	1.6	2.3

POINT-QUARTER TREE DATA –  
Management unit 30R, Study no: 1

Species	Trees per Acre	
	'04	'07
Juniperus osteosperma	116	26
Pinus edulis	64	25

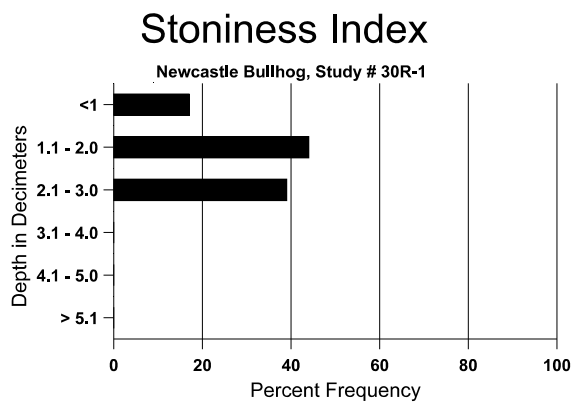
Average diameter (in)	
'04	'07
8.2	1.0
2.8	1.1

BASIC COVER --  
Management unit 30R, Study no: 1

Cover Type	Average Cover %	
	'04	'07
Vegetation	21.56	35.62
Rock	3.05	2.47
Pavement	38.31	17.81
Litter	32.65	41.47
Cryptogams	.66	.12
Bare Ground	18.23	12.91

SOIL ANALYSIS DATA --  
Management unit 30R, Study no: 1, Study Name: New Castle Bullhog

Effective rooting depth (in)	Temp °F (depth)	pH	%sand	%silt	%clay	%OM	PPM P	PPM K	ds/m
12.9	71.8 (13.9)	7.3	63.0	18.8	18.2	2.3	7.8	182.4	0.8



PELLET GROUP DATA --  
 Management unit 30R, Study no: 1

Type	Quadrat Frequency		Days use per acre (ha)	
	'04	'07	'04	'07
Rabbit	47	80	-	-
Deer	23	12	72 (177)	23 (56)

BROWSE CHARACTERISTICS --  
 Management unit 30R, Study no: 1

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata wyomingensis</i>												
04	<b>2580</b>	-	-	1560	1020	1440	41	26	40	29	29	16/24
07	<b>2480</b>	1480	300	1600	580	1060	23	27	23	13	17	16/24
<i>Chrysothamnus viscidiflorus stenophyllus</i>												
04	<b>120</b>	-	-	120	-	-	17	33	0	-	0	8/10
07	<b>60</b>	-	-	40	20	-	67	33	33	33	67	12/20
<i>Cowania mexicana stansburiana</i>												
04	<b>20</b>	-	-	-	20	-	0	100	100	-	0	71/75
07	<b>40</b>	-	-	40	-	-	0	100	0	-	0	40/43
<i>Ephedra viridis</i>												
04	<b>100</b>	-	-	80	20	20	0	100	20	-	0	18/25
07	<b>160</b>	-	20	100	40	-	13	13	25	25	25	16/27
<i>Gutierrezia sarothrae</i>												
04	<b>0</b>	-	-	-	-	-	0	0	-	-	0	9/9
07	<b>40</b>	-	-	40	-	-	0	0	-	-	0	12/18
<i>Juniperus osteosperma</i>												
04	<b>140</b>	-	40	100	-	40	0	0	-	-	0	-/-
07	<b>40</b>	40	20	20	-	60	0	0	-	-	0	-/-
<i>Opuntia sp.</i>												
04	<b>80</b>	-	-	80	-	-	0	0	-	-	0	5/10
07	<b>0</b>	-	-	-	-	20	0	0	-	-	0	-/-
<i>Pinus edulis</i>												
04	<b>140</b>	-	80	60	-	-	0	0	-	-	0	-/-
07	<b>20</b>	40	20	-	-	-	0	0	-	-	0	-/-

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