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 vegetation 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 has 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 crucial 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 "0 foot baseline stake", is marked with a metal tag for proper identification of the transect.

Vegetation Composition

Determining vegetation characteristics for each "key" area is determined by setting up five 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^2 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. However, prior to 1992 no data was collected for annual species.

Percent Cover: Cover is determined using an ocular cover estimation procedure using 7 cover classes (Bailey and Poulton 1968, Daubenmire 1959). 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% (Figure 1). For example, to estimate vegetation 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.

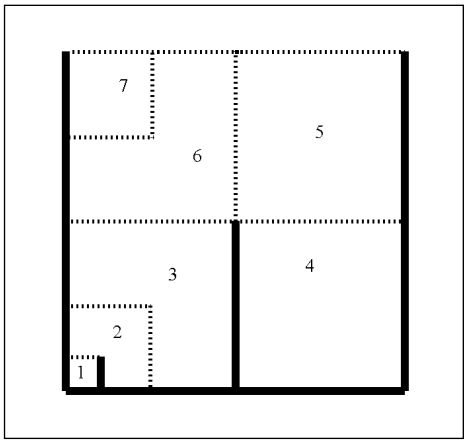

Figure 1. Cover classes of the 1/4 m^2 sampling quadrat.

Total canopy cover of shrubs or trees is also estimated using the line- intercept method ([1]U.S. Department of Interior Bureau of Land Management 1999). 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. After 2002 all canopy cover both above and below eye level was estimated.

Nested Frequency: 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 (Figure 2).
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 and composition 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 and density values are not reliable indicators of trend for herbaceous species and can fluctuate greatly with precipitation and time of season sampled. Therefore, plant cover and density values can be misleading if used independently and do not necessarily indicate changes in composition and/or distribution of key plant species.

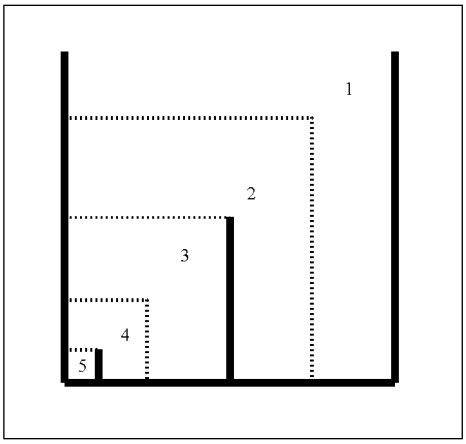

Figure 2. Nested frequency sub-quadrats of the 1/4 m^2 sampling quadrat.

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

Shrub Density & Characterization: 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 categorized using a modified Cole Browse Method ([2]U.S. Department of Interior Bureau of Land Management 1999):

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 nine 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.
Unavailable: 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 four 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 (Mitchell 2007, Dahdouh-Guebas and Koedam 2006, Pollard 1971, Cottam and Curtis 1956) at 100 foot intervals along the baseline measuring to a maximum of 15 meters. If trees are rare due to a treatment or wildfire, the sampling area is extended to 200 foot intervals measuring to a maximum of 30 meters, and 300 feet is 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 or high 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 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, average height and crown diameter, form class, and age class are utilized to characterize shrub populations.

Browse: Particular attention is given to woody plants and their important role as indicators on crucial big game 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 cover contributed by key species
3) recruitment or proportion of young plants in population
4) proportion of decadent plants
5) proportion of plants in poor vigor
6) changes in height and crown diameter measurements for mature age class
7) changes in browse species composition
8) strip frequency values

Herbaceous Understory: Trends in herbaceous plants as a group or as a single "key" species are 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, the Friedman test (analogous to analysis of variance) (Conover 1980), is conducted on nested frequencies of each species to determine significant changes at alpha = 0.10.

Soil: Ground cover parameters are analyzed and compared in the discussions of the reread studies, but no actual trend is determined. Beginning in 2002, an erosion condition class assessment adapted from the Bureau of Land Management was also completed on each study site to provide additional qualitative information on soil condition (Clark 1980).

Data Interpretation

The following tables and partial tables are taken from study number 13A-1 to help illustrate how to read the data and some basic comparisons that can be made with the data.

Herbaceous Understory: The "Herbaceous Trends" table summarizes the 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 13A-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, trend is determined using the change in the sum of nested frequency and cover of perennial grasses, and the change in composition of grasses determined by each species nested frequency and cover.

As shown in the "Herbaceous Trends" table, the undesirable species bulbous bluegrass (*Poa bulbosa*) was the most common species in nested frequency on the site in all sample years. The subscript letters indicate that the nested frequency value for *P. bulbosa* declined significantly between 1999 and 2004. Cover of *P. bulbosa* was estimated at a high of 8.01% in 1999 to a low of 2.43% in 2004. Trend for this grass species is down over the life of the study due to a significant decline in sum of nested frequency and a decrease in cover, though the decrease in this species is desirable for the grass trend of the site. The more desirable species crested wheatgrass (*A. cristatum*) has also decreased in nested frequency over the life of the study, but the decrease was only significant between the 1987 and 2009 sample years. Grasses had a combined total cover value of 11.52% in 1994, 13.89% in 1999, 11.35% in 2004 and 7.32% in 2009. These changes would indicate a slightly downward perennial grass trend over the life of the study. The forb trend can be determined in a similar manner.

HERBACEOUS TRENDS--
Management unit 13A, Study no: 1

Type	Species	Nested Frequency					Average Cover %			
		'87	'94	'99	'04	'09	'94	'99	'04	'09
G	Agropyron cristatum	$_{b}$135	$_{ab}$106	$_{ab}$100	$_{ab}$112	$_{a}$81	2.46	2.50	4.81	2.00
G	Agropyron intermedium	-	-	3	2	3	-	.03	.00	.03
G	Bouteloua gracilis	15	19	17	13	17	1.07	.14	.53	.30
G	Bromus inermis	75	67	63	68	92	.63	2.40	1.00	1.35
G	Bromus tectorum (a)	-	-	3	-	-	-	.00	-	-
G	Hilaria jamesii	-	-	-	2	-	-	-	.03	-
G	Koeleria cristata	$_{b}$61	$_{a}$3	$_{a}$19	$_{a}$3	$_{a}$-	.03	.18	.01	-
G	Oryzopsis hymenoides	-	3	3	3	8	.00	.00	.03	.07
G	Poa bulbosa	$_{b}$220	$_{b}$256	$_{b}$250	$_{a}$129	$_{a}$136	7.14	8.01	2.43	2.86
G	Poa fendleriana	$_{a}$-	$_{b}$16	$_{d}$53	$_{cd}$55	$_{bc}$24	.06	.38	1.24	.33
G	Sitanion hystrix	6	1	-	-	-	.00	-	-	-
G	Stipa comata	$_{b}$48	$_{a}$14	$_{bc}$24	$_{bc}$30	$_{a}$21	.11	.23	1.24	.36
Total for Annual Grasses		0	0	3	0	0	0	0.00	0	0
Total for Perennial Grasses		560	485	532	417	382	11.52	13.89	11.35	7.32
Total for Grasses		560	485	535	417	382	11.52	13.90	11.35	7.32
F	Astragalus convallarius	$_{b}$40	$_{bc}$17	$_{ab}$25	$_{b}$37	$_{a}$9	.10	.42	.99	.10
F	Calochortus nuttallii	8	-	-	1	-	-	-	.00	-
F	Castilleja chromosa	$_{b}$38	$_{a}$4	$_{a}$-	$_{a}$-	$_{a}$-	.01	-	-	-
F	Castilleja linariaefolia	-	2	1	-	-	.01	.03	-	-
F	Comandra pallida	-	-	-	3	-	-	-	.01	-
F	Cordylanthus sp. (a)	-	-	-	5	5	-	-	.16	.01
F	Crepis acuminata	$_{b}$14	$_{a}$6	$_{a}$-	$_{a}$-	$_{a}$-	.03	-	-	-
F	Erigeron flagellaris	-	-	3	-	1	-	.15	-	.00
F	Erigeron pumilus	$_{b}$111	$_{a}$21	$_{a}$43	$_{a}$20	$_{a}$12	.07	.51	.53	.08
F	Eriogonum racemosum	$_{b}$63	$_{a}$30	$_{a}$34	$_{a}$25	$_{a}$28	.14	.30	.35	.21
F	Hymenoxys acaulis	3	-	3	1	-	-	.00	.03	-
F	Lomatium triternatum	$_{b}$31	$_{a}$-	$_{a}$-	$_{a}$-	$_{a}$-	-	-	-	-
F	Lupinus argenteus	$_{d}$162	$_{c}$57	$_{b}$20	$_{a}$-	$_{a}$-	3.64	.14	-	-
F	Machaeranthera canescens	1	-	2	-	-	-	.01	-	-
F	Penstemon caespitosus	85	2	6	6	5	.01	.03	.07	.02
F	Petradoria pumila	-	-	5	-	-	-	.06	-	-
F	Phlox longifolia	$_{c}$67	$_{bc}$53	$_{ab}$31	$_{a}$7	$_{a}$17	.14	.06	.05	.10
F	Polygonum douglasii (a)	-	-	-	-	6	-	-	-	.01
F	Senecio multilobatus	-	1	1	-	-	.00	.00	-	-
F	Sphaeralcea coccinea	58	55	52	49	48	1.24	.38	.60	.59
F	Tragopogon dubius	6	-	-	-	-	-	-	-	-
F	Trifolium gymnocarpon	-	3	3	2	-	.00	.00	.00	-
F	Zigadenus paniculatus	-	-	3	-	1	-	.00	.00	.03
Total for Annual Forbs		0	0	0	5	11	0	0	0.15	0.01
Total for Perennial Forbs		693	251	232	151	121	5.43	2.15	2.66	1.15
Total for Forbs		693	251	232	156	132	5.43	2.15	2.82	1.17

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

Browse: 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 13A-1 are listed. For example, mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) had a strip frequency of 86 out of a possible 100 in 1994, 82 in 1999 and 85 in 2004 and 2009. Average cover is determined using cover classes in conjunction with the 1/4m^2 quadrat and estimating the percent of the quadrat covered. In this case, mountain big sagebrush cover was estimated to be 16.28% in 1994, 9.40% in 1999, 10.65% in 2004 and 9.94% in 2009.

BROWSE TRENDS--
Management unit 13A, Study no: 1

Type	Species	Strip Frequency				Average Cover %			
		'94	'99	'04	'09	'94	'99	'04	'09
B	Amelanchier utahensis	18	18	16	20	2.25	3.74	6.50	5.30
B	Artemisia tridentata vaseyana	86	82	85	85	16.28	9.40	10.65	9.94
B	Chrysothamnus depressus	12	26	23	23	.66	.72	1.46	.87
B	Chrysothamnus viscidiflorus viscidiflorus	86	81	72	72	3.62	4.96	5.00	6.14
B	Coryphantha vivipara arizonica	0	2	5	5	-	.00	.00	.00
B	Eriogonum microthecum	10	16	10	9	.01	.53	.12	.12
B	Gutierrezia sarothrae	0	4	8	4	.01	.04	.15	.03
B	Juniperus osteosperma	0	0	0	0	-	-	-	.15
B	Opuntia sp.	36	35	41	45	.32	.56	1.12	1.33
B	Pinus edulis	0	16	14	10	2.92	3.53	7.21	8.53
B	Purshia tridentata	0	1	1	1	-	.00	.00	.00
B	Quercus gambelii	0	3	3	2	.76	.63	1.48	.76
B	Symphoricarpos oreophilus	3	2	4	2	.00	.00	.00	.00
Total for Browse		251	286	282	278	26.86	24.13	33.72	33.20

To more accurately 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, mountain big sagebrush had a cover of 13.21% in 2004 and 13.93% in 2009. Compare this to the cover determined using the 1/4m^2 quadrat cover class method. Prior to 2002, only trees species were sampled in the line-intercept transect above eye level. Beginning in 2002, all woody species were included in the line-intercept transect and a total canopy cover (above and below eye level) value for each was determined.

CANOPY COVER, LINE INTERCEPT--
Management unit 13A, Study no: 1

Species	Percent Cover		
	'99	'04	'09
Amelanchier utahensis	.80	7.25	9.48
Artemisia tridentata vaseyana	-	13.21	13.93
Chrysothamnus depressus	-	1.04	.58
Chrysothamnus viscidiflorus viscidiflorus	-	4.73	7.25
Eriogonum microthecum	-	.11	.06
Opuntia sp.	-	.65	.71
Pinus edulis	3.59	11.86	13.43
Quercus gambelii	-	1.23	1.43
Symphoricarpos oreophilus	-	-	.08

Beginning in 2002, annual leader growth of the key browse species was 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 serviceberry (Amelanchier utahensis) averaged 1.8 inches and 1.7 inches in length in 2004 and 2009, respectively, while mountain big sagebrush leaders averaged 1.3 inches in both sample years.

KEY BROWSE ANNUAL LEADER GROWTH--
Management unit 13A, Study no: 1

Species	Average leader growth (in)	
	'04	'09
Amelanchier utahensis	1.8	1.7
Artemisia tridentata vaseyana	1.3	1.3

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. Point-quarter tree data for pinyon estimated 201 trees/acre in 1999, 175 tree/acre in 2004 and 213 trees/acre in 2009, with average basal diameters of 2.1 inches, 2.8 inches and 3.2 inches, respectively.

POINT-QUARTER TREE DATA--
Management unit 13A, Study no: 1

Species	Trees per Acre			Average diameter (in)		
	'99	'04	'09	'99	'04	'09
Pinus edulis	201	175	213	2.1	2.8	3.2

The "Browse Characteristics" table summarizes characteristics of the shrub community. 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 3,198 plants/acre in 1987, 4,800 plants/acre in 1994, 4,080 plants/acre in 1999, 3,800 plants/acre in 2004 and 3,820 plants/acre in 2009. 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 area (more than three times larger) was 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 decadence, percent of the population displaying poor vigor, percent heavy hedging, young recruitment, etc., are given more weight in determining shrub trend when comparing survey years where sample sizes are different.

The data for mountain big sagebrush from study 13A-1 shows the proportion of decadent shrubs in the population was highest in 1994 at 42%, but has been more moderate at an average of 24% since 1999. More seedlings were also encountered in 1994, but recruitment of young plants has been low (< 10%) in all sample years except for 1999. The percentage of plants displaying poor vigor was low in most sample years, but increased to 22% in 2009. Considering all these factors, trend for sagebrush over the life of the study is stable.

BROWSE CHARACTERISTICS--
Management unit 13A, Study no: 1

		Age class distribution				Utilization			
Year	Plants per Acre (excluding seedlings)	% Young	% Mature	% Decadent	Seedling (plants/acre)	% moderate	% heavy	% poor vigor	Average Height Crown (in)
Artemisia tridentata vaseyana									
87	**3198**	8	79	12	-	42	8	2	13/17
94	**4800**	4	54	42	940	13	2	10	18/32
99	**4080**	13	63	24	360	41	3	3	21/31
04	**3800**	5	73	22	-	33	10	9	15/24
09	**3820**	6	68	26	60	34	17	22	17/25

Soil: 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 vegetation cover (15.25% in 1987), while the new method estimates the vertical projection of the crown, or aerial cover (33.38% in 1994, 39.61% in 1999, 42.08% in 2004 and 42.20% in 2009). Therefore, comparisons can be made for all cover measurements except for general vegetation cover.

BASIC COVER--
Management unit 13A, Study no: 1

Cover Type	Average Cover %				
	'87	'94	'99	'04	'09
Vegetation	15.25	33.38	39.61	42.08	42.20
Rock	0	.02	.00	.00	.00
Pavement	0	.03	.04	.05	.03
Litter	61.00	46.05	40.37	45.25	50.69
Cryptogams	3.50	1.50	8.07	2.74	2.00
Bare Ground	20.25	32.20	29.56	34.09	22.93

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, and abundance. 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 (Allison and Moode 1965, Day 1965, Kenney and Nelson 1982, Normandin et. al. 1998, Olsen et. al. 1954, Rhodes 1982, Schoenau and Karamonos 1993, Sims and Jackson 1934, Walkley and Black 1971).

SOIL ANALYSIS DATA --
Management unit 13A, Study no: 1, Study Name: Two Mile Chaining

Effective rooting depth (in)	pH	loam			%0M	PPM P	PPM K	ds/m
		%sand	%silt	%clay				
11	6.5	48.2	30.6	21.3	2	8	105.6	0.4

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

Ultra acidic	< 3.5
Extremely Acidic	3.5-4.4
Very Strong Acidic	4.5-5.0
Strongly Acidic	5.1-5.5
Moderately Acidic	5.6-6.0
Slightly Acidic	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 6 ppm and 60 ppm, respectively, are considered to have low availability for 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

Utilization: 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 1994, rabbit pellets were found in 44% of the quadrats placed on study 13A-1, decreasing to just 6% in 1999 and 2004, then increasing again to 34% in 2009. Quadrat frequency of rabbit or big game pellets indicates a relative amount of use by that particular animal. This data can help characterize changes in wildlife use patterns on the site.

It was determined that additional information on pellet groups was necessary. Therefore, a pellet group transect is now sampled in conjunction with the vegetation transects. The pellet group transect utilizes 50, $100ft^2$ circular plots which are placed through the study area. These are usually two parallel transects of 25 plots on each side of the vegetation transect which runs 400 feet to 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 (hectare) (Neff 1968). Rabbit pellet groups are not included in this sample. In the example, elk days use/acre was estimated at 70 in 1999 and decreased steadily to 4 elk days use/acre in 2009.

PELLET GROUP DATA--
Management unit 13A, Study no: 1

Type	Quadrat Frequency			
	'94	'99	'04	'09
Rabbit	44	6	6	34
Elk	28	26	11	3
Deer	14	28	15	9
Cattle	-	2	-	1

Days use per acre (ha)		
'99	'04	'09
-	-	-
70 (173)	27 (68)	4 (10)
32 (79)	16 (40)	25 (63)
6 (14)	4 (11)	4 (9)

Other Information: 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 spp.* and *Purshia spp.*, the species names used by the Range Trend Study Plant Species List (Giunta 1983), Intermountain Flora (Cronquist et al. 1977) and the Intermountain Range Plant Names and Symbols (Plummer et al. 1977) are retained to maintain continuity and alleviate confusion with earlier published reports.

REFERENCES

Allison L. E. and C. C. Moode. Carbonate. pp. 1387-1388. In C. A. Black (ed.), Methods of Soil Analysis Part 2. 1965. American Society of Agronomy, Inc. Madison, WI.

Bailey, A. W. & C. E. Poulton. 1968. Plant communities and environmental interrelationships in a portion of the Tillamook burn, Northwest Oregon. Ecology. 49(1):1-13.

Clark, R. 1980. Erosion condition classification system. Technical Note Number 346. USDI-BLM. Denver, Colorado.

Cottom, G. and Curtis, J. T. 1956. The use of distance methods in phytosociological sampling. Ecology 37:451-460.

Conover, W. J. 1980. Practical Nonparametric Statistics (second edition). John Wiley & Sons, New York. 493pp.

Cronquist, A., A. H. Holmgren, N. H. Holmgren, J. Reveal and P. Holmgren. 1977. Intermountain Flora (volume six). Columbia University Press, New York. 584pp.

Dahdouh-Guebas, F. & N. Koedam. 2006. Empirical estimate of the reliability of the use of the point-centred quarter method (PCQM): solutions to ambiguous field situations and description of the PCQM+ protocol. Forest Ecology and Management. 228:1-18

Daubenmire, R. 1959. A canopy coverage method of vegetational analysis. Northwest Science 33:43-66.

Day P. R. Particle fractionation and particle-size analysis. pp. 562-566. In: C. A. Black (ed.), Methods of Soil Analysis Part 1. 1965. American Society of Agronomy, Inc. Madison, WI.

Giunta, B. C. 1983. Utah interagency big game range trend plant species list. Utah Dept. Of Natural Resources, Division of Wildlife Resources. Salt Lake City, Utah. 281pp.

Kenney, D. R. and D. W. Nelson. Nitrogen - Inorganic forms. Pp. 643-698. In: A. L. Page (ed.), Methods of Soil Analysis Part 2. 1982. American Society of Agronomy, Inc. Madison, WI.

Mitchell, K. 2007. Quantitive Analysis by the Point-Centered Quarter Method. Department of Mathematics and Computer Science Hobart and William Smith Colleges. Geneva, New York. 33pp. <http://people.hws.edu/mitchell/PCQM.pdf>

Mosley, J. C., S. C. Bunting, and M. Hironaka. 1986. Determining range condition from frequency data in mountain meadows of central Idaho. J. Range Manage. 39:561-565.

Neff, D. J. 1968. The Pellet-Group Count Technique for Big Game Trend, Census, and Distribution: A Review. Journal of Wildlife Management. 32(3):597-614

Normandin, V., J. Kotuby-Amacher, and R. O. Miller. 1998. Modification of the ammonium acetate extractant for the determination of exchangeable cation in calcareous soils. Commun. Soil Sci. Plant Anal. 29(11-14):1785-1791.

Olsen, S. R., C. V. Cole, F. S. Watanabe, and L. A. Dean. 1954. Estimation of Available phosphorous in soil by extraction with sodium bicarbonate. USDA Cir. No. 939.

Plummer, A. P., S. B. Monsen and R. Stevens. 1977. Intermountain Range Plant Names and Symbols. USDA Forest Service, General Technical Report INT-38. Ogden, Utah.

Pollard, J. H. 1971. On distance estimators of density in randomly distributed forests. Biometrics. 27(4):991-1002.

Schoenau, J. J. and R. E. Karamonos. Sodium Bicarbonate Extractable P, K, and N. pp. 51-58. In: M. R. Carter (ed.), Soil Sampling and Methods of Analysis. 1993. Canadian Society of Soil Science. Ottawa, Ontario, Canada.

Sims, J. R. and G. D. Jackson. 1971. Rapid analysis of soil nitrate with chromotropic acid. Soil Sci. Soc. Amer. Proc. 35:603-606.

Smith, S. D., S. C. Bunting, and M. Hironaka. 1987. Evaluation of the improvement in sensitivity of nested frequency plots to vegetational change by summation. Great Basin Naturalist. 47(2): 299-307.

Smith, S. D., S. C. Bunting, and M. Hironaka. 1986. Sensitivity of frequency plots for detecting vegetation change. Northwest Science. 60: 279-286.

Rhodes, J. D. Soluble Salts. pp. 167-179. In: A. L. Page (ed.), Methods of Soil Analysis Part 2. 1982. American Society of Agronomy, Inc. Madison, WI.

Tiedemann, A. R. and C. F. Lopez. 2004. Assessing Soil Factors in Wildland Improvement Programs. In: S. B. Monsen, R. Stevens, and N. Shaw (compilers) Restoring Western Ranges and Wildlands. Gen. Tech. Rep. RMRS-GTR-136-vol 1. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. pp. 39-56. U. S. Dept. of Agriculture - Soil Conservation Service. 1972. Soil survey of Utah County, Utah - central part. U. S. Govt. Printing Office, Wash. D. C. 161 pp.

[1]U.S. Department of Interior Bureau of Land Management. 1999. Sampling vegetation attributes, Interagency Technical Reference, BLM/RS/ST-96/002+1730.

[2]U.S. Department of Interior Bureau of Land Management. 1999. Utilization Studies and Residual Measurements, Interagency Technical Reference, BLM/RS/ST-96/004+1730.

Walkley, A. and I. A. Black. 1934. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science 37:29-38.

Welsh, S. L., N. D. Atwood, S. Goodrich and L. C. Higgins. 2003. A Utah Flora (Third Edition, revised). Brigham Young University. Provo, Utah. 912 pp.