2009 Range Vegetation Assessment in the Big Desert, Upper Snake River Plain, Idaho

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Abstract
Vegetation data were collected at 60 randomly located sample points during June 2009. Data were collected using both ocular estimation, line-point intercept transects, and hoop sampling to describe fuel load, percent cover of grasses, forbs, shrubs, litter, microbial crust, bare ground, and weeds, and to assess forage availability. Due to the increased precipitation that fell in 2009, percent bare ground was reduced in comparison to all other years while forage availability increased substantially. Precipitation is the limiting factor in semiarid rangelands and the relationship between forage availability and precipitation was never illustrated better than it was in 2009. Linear regression analysis using precipitation as the independent variable and forage (kg/ha) as the dependent variable resulted in a strong coefficient of determination ($R^2 = 0.93$). Additional data will be collected in subsequent years to continue monitoring the condition of the Big Desert.

Keywords: vegetation, transects, land cover

Introduction
The study area, known as the Big Desert (Figure 1), is located in southeast Idaho, northwest of the American Falls Reservoir, and bordered on the west by the Craters of the Moon National Monument. The area is managed by the Bureau of Land Management (BLM), with current and historic livestock grazing.

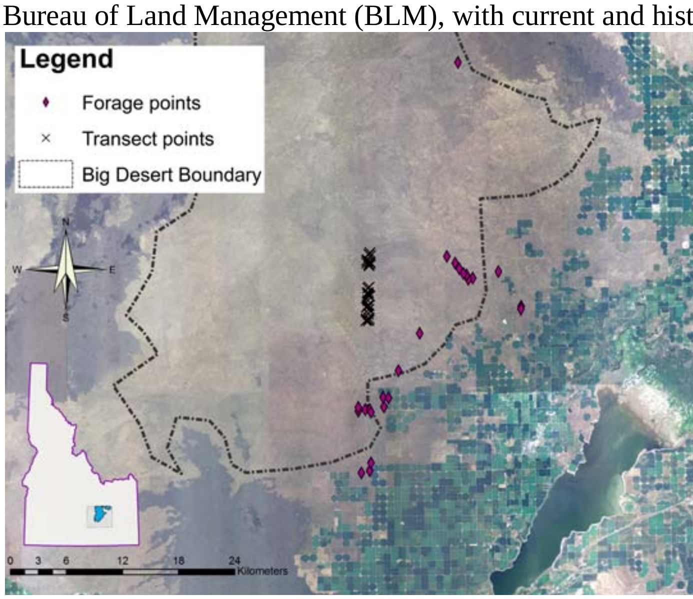

Figure 1. The Big Desert region of southeastern Idaho. The boundary of the Big Desert is shown, as are the collection points for both forage and land cover sample sites.

The Big Desert is a semiarid sagebrush-steppe ecosystem, surrounded to the north, south, and east by agricultural lands. The dominant shrub is sagebrush, with big sagebrush (*Artemisia tridentata*) and three-tip sagebrush (*A. tripartita*) being the most common. The herbaceous understory is comprised mostly of a mixture of grasses such as Cheatgrass (*Bromus tectorum*), native grasses, and forbs. Cheatgrass is an invasive weed that contributes to a decreased fire return interval and increased fire severity. Areas dominated by Cheatgrass tend to show decreased species diversity and increased susceptibility to severe soil erosion (Knapp, 1996).

The purpose of data collection at the Big Desert was to support the continued studies of the area (2000 to 2008) for use in the rangeland research program at Idaho State University's GIS Training and Research Center (Anderson et al, 2008; Gregory et al., 2008; Russell and Weber, 2003; Sander and Weber, 2004; Tedrow, Davis, and Weber, 2008; Underwood et al, 2008; Weber and McMahan, 2005). In this study, land cover was estimated using line transects. and forage biomass was measured using hoop sampling.

Materials and Methods

Land cover estimation

Thirty random points were generated for line transect data collection using Hawth's Analysis Tools within ArcGIS 9.3.1. Parameters constraining the location of the random points included being 1) within the flight line of a concurrently acquired 0.05 m aerial photography mission (located within WRS path 39 and row 30), 2) at least 70 m from anything that could be defined as an "edge" (fences, roads, permanent trails, etc), and 3) within 750 m of a road to aid in access. Transects were designated as either running to the east or to the west from the plot center point, based upon which side of the flight line each point was located (e.g., if a random sample point was located to the east of the center of the flight line then the transect would be read directly to the west). This was done to ensure the entire transect would be acquired by the aerial photography mission.

Sample points were navigated to using a Trimble GeoXH GPS receiver. A 20 m flexible tape was laid out on the ground from the starting point and in the designated direction (directly east or west) with the aid of a compass. Photographs were taken using a Sony digital camera in each cardinal direction, starting at north and proceeding to photographs viewing east, south, and west. Land cover type was determined by looking straight down at the transect tape and recording the land cover feature in the upper most canopy and directly above the designated observation point. Observation points began at 10 cm from the sample point (observation point one) and continued every 20 cm thereafter (observation points 2-100). Land cover at each observation point was classified as either shrub, rock (if the rock was over 7.5 cm in surface diameter), bare ground, invasive weed (e.g., Cheatgrass or Canadian thistle (*Cirsium arvense*)), grass, forb, litter, standing dead herbaceous material, standing dead woody material (e.g., a dead tree or sagebrush shrub still intact at the ground), or microbiotic crust. A total of 100 point observations were made and recorded in the GPS-based field form.

Fuel load was determined by visually estimating the vegetation type and quantity in the immediate vicinity (approximately 20 meters) of the sample point. Anderson's (1982) fuel load classes were used (Table 1).

Table 1 –Fuel load classes used in this study

Fuel Load Class	(Tons/Acre)	General Description
1	0.74	Almost bare ground, very little vegetation
2	1.00	Grasses, some bare ground, few shrubs
3	2.00	Mixture of shrubs and grasses
4	4.00	Predominantly shrubs
5	>6.00	Shrubs to trees

Forage Biomass Estimation

Forage biomass was estimated at 30 sample points. These data were collected to support an herbaceous biomass study using remotely-sensed imagery. That study required entire pixels (20m x 20m) be covered by herbaceous vegetation and so a directed method of sampling involving travelling across the Big Desert study area to locate suitable collection sites was employed. Sites needed to be at least 20 x 20 meters in size, more than 70 meters from “edges” (roads, fences, powerlines, etc), and with less than 20% shrub cover. Adjacent sites also needed to be located at least 100 meters between site perimeters, with preference given to locations where perimeters were >250 meters apart.

Once a suitable site had been located, a Trimble GeoXH GPS receiver was used to record the approximate perimeter of the site. A location near the center of each site was chosen from which forage biomass data were collected as well as photographs which followed the protocol described above. Forage was measured following methods described by Sheley et al. (1995) and entailed the use of a hoop with a circumference of 2.36 meters (0.44 m^2) which was randomly tossed into each of four quadrants (northeast, southeast, southwest, and northwest) from the plot center location. All herbaceous plant material rooted within the hoop was clipped as close to the ground as possible (approximately 6 mm), placed in an ordinary paper bag, and weighed using a Pesola scale (+/- 1g) tared to the weight of the bag. The phenological stage of grasses within each quadrant was noted as either “Before initial growth-boot stage”, “Headed-out boot stage to flowering”, “Seed ripe/leaf tips drying”, “Leaves dry/ stems partly dry”, or “Apparent dormancy” (Sheley et al., 1995). Sample bags were noted with sample ID, date, and quadrant information and retained for further processing.

Forage biomass was dried in an oven for 48 hours at 75° C and re-weighed. The total, dry-weight of forage at each sample point was converted to an estimate of forage expressed in kg/ha by multiplying the forage weight (in grams) by 5.0262 to arrive at an estimate in lbs/acre (note: the value of 5.0262 was derived from Sheley's "AUM Analyzer" software and is considered accurate for grasses in this region and for the phenological stages observed during this sampling period). This value was then converted to kg/ha by multiplying lbs/acre by 1.121 (Equation 1).

$$kg/ha = 1.121*(5.0262*(g)) \quad \text{[Eq 1]}$$

A Trimble GeoXH GPS receiver (+/-0.20 m @ 95% CI after post processing) was used to record the location of each sample point (Serr et al., 2006) in latitude-longitude (WGS 84). Points were occupied until a minimum of 60 positions were acquired and WAAS was used whenever available. All points were post-process differentially corrected using a constellation of GPS base stations each located <80 km from the Big Desert study area. This technique used Trimble's H-star technology to achieve improved horizontal positional accuracy. The sample points were projected into Idaho Transverse Mercator NAD 83 using ESRI's ArcGIS 9.3.1 for datum transformation and projection (Gneiting, et al., 2005).

Results and Discussion

Land cover

Transect data were collected June 23-24, 2009. On average, grass was the most common cover type, being found 22% of the time. Grass was also one of only four cover types to be found at every site; the others being forbs, litter, or patches of bare ground with no cover. Areas of bare ground with no other cover composed about 18% of the area in the Big Desert. Weeds comprised about 16% of the land cover. Shrubs, litter, and forbs were commonly encountered as well. The least common cover type was microbiotic crust, which was found to cover an average of 0.2% of the Big Desert study area (Table 2).

Table 2 – Percent cover by cover type. All values are the percent total across all sites (n=30). "Dead herb." and "Dead wood" refer to standing dead herbaceous material and standing dead wood, respectively. "Missing" refers to the number of times a cover type was not found in any of the transects.

	Shrub	Bare ground	Weed	Grass	Forb	Rock	Litter	Dead herb.	Dead wood	Micro crust
Min	0	1	0	6	1	0	4	0	0	0
Max	47	37	52	42	30	7	25	6	4	1
Mean	14.5	17.8	16.2	22.0	10.8	1.7	14.4	1.8	0.6	0.2
Missing	4	14	7	0	0	14	0	11	20	25

Land cover data from 2009 were compared with cover data from previous years by cover type. Data for all cover types were not available for all years, so focus was placed on weed, grass, bare ground, and shrub cover types, as data for these cover types were available over the past several years.

Based upon results from 2009 transect data (n=30) weed cover has increased since 2002. Data collected from 2002 through 2006 showed that approximately half of the time, weeds contributed < 5% of total cover. In 2007 and 2008, more instances of weeds covering up to 25% of the landscape were reported. In 2009 very few sites had <5% weed cover, and approximately one fifth of the sites had weeds contributing 26-35% of total cover. This suggests that weeds are becoming more common in the Big Desert study area (Figure 2).

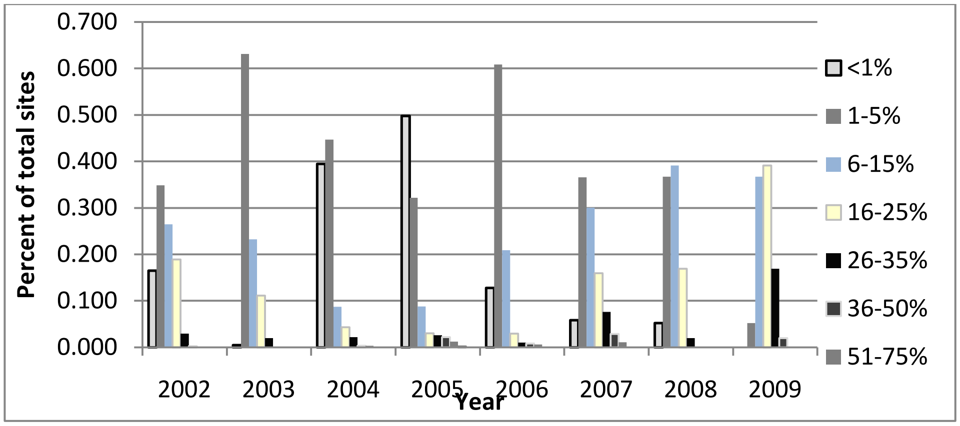

Figure 2 – Percent cover of weeds from 2002 to 2009, divided into percent cover categories to better enable comparison with other years**.**

Bare ground was lower in 2009 than in previous years, with most sites having <25% bare ground. In previous years bare ground had contributed 25-75% of total land cover (Figure 3).

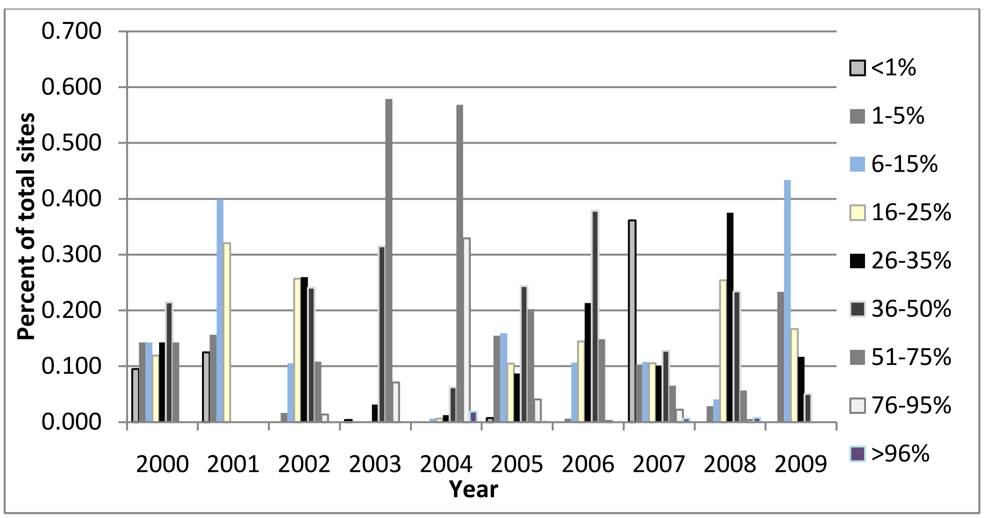

Figure 3 – Percentage of bare ground from 2000 to 2009, divided into percent cover categories to better enable comparison with other years.

Both grass and shrub cover in 2009 appeared similar to past years, with grass averaging between 6-35% cover and shrubs contributing to 1-25% cover. A slight, negative correlation existed between shrub cover and weed cover, suggesting areas with higher percentages of shrub cover have less weed cover. While the correlation was weak (R^2 = 0.525), it is supported by research reported by Anderson and Inouye (2001) from the nearby US DOE Idaho National Laboratory.

Forage

Forage biomass samples were collected July 1-9, 2009. These data were collected later in the season because unusually heavy June rains made road travel hazardous in the study area. Most sites (60%) found to be suitable for forage collection were dominated by Crested wheatgrass

(*Agropyron cristatum*). Most of these sites appeared to have been reclaimed farm land, though some were the result of reseeding following wildfire. One-third of the sites were dominated by Cheatgrass (*Bromus tectorum*) and/or tumbling mustard (*Sisymbrium altissimum*) while only one site was dominated by a native grass, western wheatgrass (*Pascoypyrum smithii*).

Average forage weight in 2009 (1386 kg/ha) was very different compared to previous years (Table 3). This may be attributed to a variety of interrelated factors. First, southeast Idaho experienced an unusually high amount of rain in June of 2009. According to the Western Regional Climate Center (WRCC), the total monthly precipitation for June at the Craters of the Moon National Monument was 16.8 cm, almost 10 times the average of the previous eight years (WRCC 2009). Another factor was how forage data was collected in 2009. In previous years, collection points were selected randomly. In 2009, forage sample sites were selected using a directed method with sites selected because they had high percent cover of homogeneous grasses and low percent cover of shrubs. As a result, higher forage weights were anticipated. Finally, forage collections this year included forbs such as tumbling mustard, where as in past years it was principally composed of grasses.

Table 3 – Comparison of mean forage weight (kg/ha) with total precipitation for the month of June by year (note: 2002 was omitted as no forage data was collected for that year).

Year	Mean Forage Weight (kg/ha)	June Precipitation (cm)
2000	290	0.2
2001	320	0.3
2002	*unk*	*unk*
2003	191	0.9
2004	290	2.2
2005	488	3.6
2006	263	1.5
2007	590	2.1
2008	365	2.2
2009	1386	16.8

Note: Other factors besides precipitation, such as forage collection methodology, may have contributed to the high forage weights collected in 2009.

When forage weights were compared with June precipitation from 2000 to 2008, only a slight correlation was found to exist ($R^2 = 0.34$) (Figure 4). Based upon this relationship, the actual precipitation recorded for June, 2009 was applied to the linear regression equation derived for the line of best fit ($y = 67.698x + 239.59$). The result of this computation predicted that the forage weight for 2009 would be 1,377 kg/ha, which is very close to the actual weight of 1,386 kg/ha. This relationship illustrates the import role precipitation plays in the vegetation characteristics of semiarid rangelands. The resulting coefficient of determination (R^2)for the relationship between precipitation (2000-2009) and mean weight of forage was 0.93.

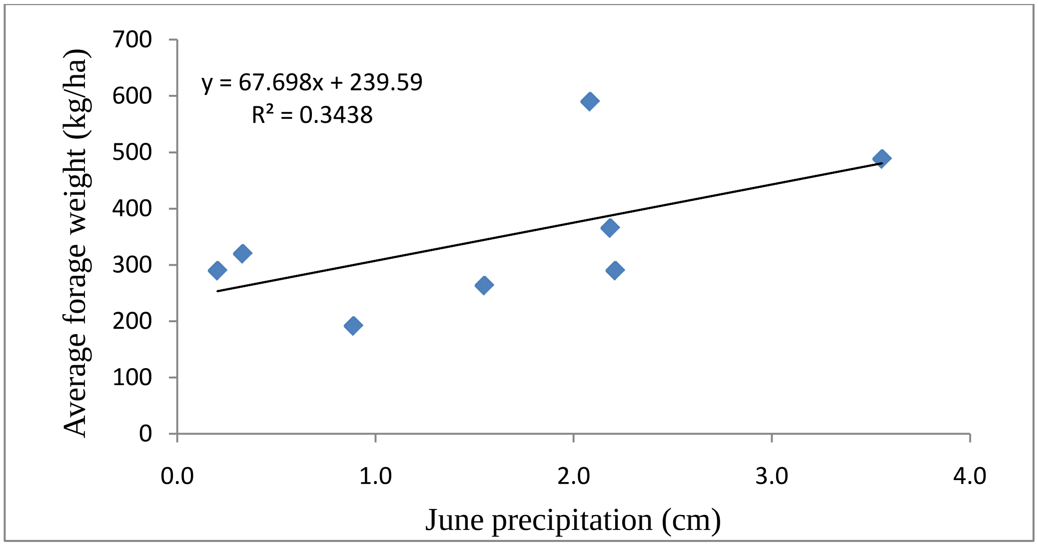

Figure 4 – Comparison of June precipitation (cm) with forage weight (kg/ha) 2000-2008 (2002 was omitted as no forage data were collected in that year.

Conclusions

Transect data collected for the Big Desert study area showed that grass was the most common land cover type. Comparisons with previous years' data show an overall increase in weed cover, as well as a decrease in bare ground. A slight negative correlation between shrub cover and weed cover was observed and suggests an area of future research. Most sites used for forage collection were dominated by Crested wheatgrass, although Cheatgrass and tumbling mustards also contributed to overall forage availability in 2009. High June rains may have had an impact on available forage in the Big Desert study area, with weights being the highest recorded since 2000. While changes in forage collection methodology made it difficult to directly compare 2009 results with those collected in the past, a strong relationship ($R^2 = 0.93$) between forage availability (dependent variable) and precipitation (independent, driver variable) was observed and validated, suggesting the primary factor controlling vegetation characteristics in the Big Desert study area is precipitation. This relationship is likely true of all semiarid rangeland ecosystems as similar results have been reported in other studies (Niamir-Fuller and Turner 1999; Gregory et al. 2008).

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Literature Cited

Anderson, H. E. 1982. Aids to Determining Fuel Models For Estimating Fire Behavior. USDA For. Serv. Gen. Tech. Rep. INT-122. Ogden, UT.

Anderson, J., and Inouye, R. 2001. Landscape-scale changes in plant species abundance and biodiversity of a sagebrush steppe over 45 years. Ecological Monographs: vol. 71, No. 4, pp. 531-556.

Anderson, J., J Tibbits, and K. T. Weber, 2008, Range Vegetation Assessment in the Big Desert, Upper Snake River Plain, Idaho 2007. Pages 16-26 in K.T. Weber (ED), Final Report: Impact of Temporal Landcover Changes in Southeastern Idaho Rangelands (NNG05GB05G). 345pp.

Beyer, H. L. 2004. Hawth's Analysis Tools for ArcGIS. Accessed: May 2009. http://www.spatialecology.com/htools

Gnieting, P., J. Gregory, and K. T. Weber, 2005, Datum Transforms Involving WGS84. Idaho State University, GIS Training and Research Center. Accessed: October 29, 2008 http://giscenter.isu.edu/research/techpg/nasa_tlcc/to_pdf/wgs84_nad83-27_datumtransform.pdf

Gregory, J., L. Sander, and K. T. Weber, 2008, Range Vegetation Assessment in the Big Desert, Upper Snake River Plain, Idaho 2005. Pages 3-8 in K.T. Weber (ED), Final Report: Impact of Temporal Landcover Changes in Southeastern Idaho Rangelands (NNG05GB05G). 345pp.

Knapp, P. 1996. Cheatgrass (*Bromus tectorum L*) dominance in the Great Basin Desert: History, persistence, and influences to human activities. Global Environmental Change: Vol. 6, No. 1, pp. 37-52.

Niamir-Fuller, M. and M. D. Turner. 1999. A Review of Recent Literature on Pastoralism and Transhumance in Africa. Pages 18-46 in M. Niamir-Fuller [Eds.], *Managing Mobility in African Rangelands: The Legitimization of Transhumance*. FAO: IT Publications. 314 pp.

Russell, G. and K. T. Weber. 2003. Field Collection of Fuel Load, Vegetation Characteristics, and Forage Measurements on Rangelands of the Upper Snake River Plain, ID for Wildfire Fuel and Risk Assessment Models. In K. Weber (Ed.), Final Report: Wildfire Effects on Rangeland Ecosystems and Livestock Grazing in Idaho. Chapter 1. pp. 4-11. Idaho State University. Accessed: October 29, 2008. http://giscenter.isu.edu/research/techpg/nasa_wildfire/template.htm

Sander L. and K. T. Weber. 2005. Range Vegetation Assessment in the Big Desert, Upper Snake River Plain, Idaho, GIS Training and Research Center. Accessed: October 29, 2008 http://giscenter.isu.edu/Research/techpg/nasa_weeds/to_pdf/fieldreport_2003-2004.pdf

Sheley, R., S. Saunders, and S. Henry, 1995, AUM Analyzer: A Tool to Determine Forage and Production and Stocking Rates as a Result of Managing Rangeland Weeds or Making Other Improvements. Montana State University Extension Service, EB 133.

Serr, K., T. Windholz, and K. T. Weber. 2006, Comparing GPS Receivers: A Field Study. Journal of the Urban and Regional Information Systems Association: Vol. 18, No. 2. p 19-23.

Tedrow, L., Davis, K., and Weber, K. 2008. Range Vegetation Assessment in the Big Desert Upper Snake River Plain, Idaho 2008. Pages 41-50 in K. T. Weber (Ed.), Final Report: Comparing Effects of Management Practices on Rangeland Health with Geospatial Technologies.

Underwood, J., J Tibbits, and K. T. Weber, 2008, Range Vegetation Assessment in the Big Desert, Upper Snake River Plain, Idaho 2006. Pages 9-15 in K.T. Weber (ED), Final Report: Impact of Temporal Landcover Changes in Southeastern Idaho Rangelands (NNG05GB05G). 345pp.

Weber, K. T. and J. B. McMahan. 2003. Field Collection of Fuel Load and Vegetation Characteristics for Wildfire Risk Assessment Modeling: 2002 Field Sampling Report. In: K. T. Weber [ED.]. Final report: Wildfire Effects on Rangeland Ecosystems and Livestock Grazing in Idaho. 209 p. Accessed: October 29, 2008. http://giscenter.isu.edu/research/techpg/nasa_wildfire/Final_Report/Documents/Chapter2.pdf.

Western Regional Climate Center (WRCC). 2009. Accessed September 3, 2009.
http://www.wrcc.dri.edu/cgi-bin/cliMONtpre.pl?id2260