MERLIN RANCH:

2013 Rangeland Health Monitoring in Hall Homestead, Pigpen, and Lawrence Trap Pastures

Prepared for Merlin Ranch Management

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INTRODUCTION

This document presents the findings of three rangeland health monitoring transects examined on Merlin Ranch in August 2013. These sites were located in the Hall Homestead, Pigpen, and Lawrence Trap Pastures. The Hall Homestead and Pigpen transects had been established in prior years, so data presented here will be displayed side-by-side with prior years' data. The Lawrence Trap transect was a new transect established in 2013.

Merlin began a monitoring effort in 2006 to track changes in land health through time. Using permanently marked study sites within pastures, data gathered through the years provides a permanent record of changes on the land. Data presented will show how the land has responded to changes in management, changes in precipitation, and natural phenomena such as grasshopper outbreaks. The data will also be the basis for making management recommendations to improve land health and overall performance of pastures.

Much discussion will be made concerning the function of four fundamental ecosystem processes. These are the water cycle, mineral cycle, energy flow, and successional process. These are reviewed graphically in the Methods section. Management may influence the function of these processes by altering such variables as stocking rate, stock density, grazing duration, recovery times between grazings, utilization rate, and timing of grazings. Data presented in this report will show how these variables interact with function of ecosystem processes, and how management may improve their interaction for the improvement of pasture performance, wildlife habitat, and profitability.

Since 2006, the pastures that have been studied at Merlin Ranch are as follows:

Merlin Ranch Transect Readings

Year	*Site Name*
2006	Hall Pasture Hall Homestead
2007	Three Section Tipperary
2008	Pigpen Lower M&M #1
2009	Hall Homestead Tipperary
2010	Hall Pasture Three Section Lower Hepp
2011	Lower M&M #1 Lawrence
2012	Tipperary Three Section Lower Hepp
2013	Hall Homestead Pigpen Lawrence Trap

Findings will be presented with a combination of qualitative rangeland health indicators and quantitative data. Quantitative data will be used to track changes on the land as they occur through time. Qualitative indicators will provide a snapshot of land health on the day the site was sampled. Both will be used to provide the management recommendations contained herein.

SUMMARY OF FINDINGS AND MANAGEMENT RECOMMENDATIONS MADE IN THIS DOCUMENT

Summary findings from each of the three 2013 transect sites are displayed here, along with management recommendations for continued improvement of the resource base. See the individual site summaries later in this document for added detail.

Hall Homestead – MRT06

This site was established in 2006 as an area to be treated by the Lawson Renovator. It also served as an area of concern, for plants did not display desired vigorous growth. Unfortunately, the Lawson Renovator missed the study site, so the area remained as intact rangeland.

Highlights of changes since 2005 include:

- Bare ground fell by 59%.
- A slight loss in live cover occurred, likely due to the reduced presence of the undesired species blue grama.
- Mid-seral grasses were the predominant species as measured by basal abundance and production. The highly desired grass species were not found here in the abundance sought.
- The site was producing well below its potential.

This pasture appeared to change minimally since it was first examined in 2005. The strong reduction in bare ground was a positive sign, but changes in live plant cover, distance between perennial plants, and species composition appeared to be changing slowly. Such slow changes represent an outlier from other Merlin Ranch pastures, which have often displayed rapid signs of

improvement (whether treated by the Lawson Renovator or not). No indications of poor grazing management were revealed in at least the last two years, since grazing durations were short (usually less than 5 days), stocking rate was low (around 2 animal days per acre), and recovery periods between grazings were lengthy. The pasture simply appeared to be changing slowly. Grazing managers should attempt to jumpstart this area with more abundant and frequent placement of salt to increase hoof action and speed the mineral cycle.

Pigpen – MRT12

The Pigpen Pasture site was established in 2008 and was located toward the northwestern end of the pasture in the pasture's main draw. The boundary fence lies roughly 250 yards to the northwest. The nearest water was between 0.25 and 0.5 miles away. The site was placed on a slope that contained a mixture of grass, forbs, and shrubs. The site was chosen to represent the area.

Highlights of changes since 2008 include:

- Bare ground fell by 52%.
- Live plant cover increased from 5% to 7%.
- Two desired grass species displayed contrasting tendencies: needleandthread's contribution greatly declined, while bluebunch wheatgrass's contribution greatly increased (as measured by basal cover and production).
- Plant productivity was well below the site's potential.
- The desired grass Idaho fescue was found in 2013, which was a positive addition to the plant community.

No major course corrections in grazing management were required in this pasture, for improvement in rangeland health was evident. Continue the practice of utilizing short grazing durations and lengthy plant recovery periods between grazings.

Lawrence Trap – MRT22

This site was established in 2013 in the center of the Lawrence Trap Pasture. The site lies on a mild slope in a sagebrush/grass plant community with a slight northward aspect. The Trap was used for cattle sorting in mid-summer 2013, where utilization rates on pasture grasses were quite high (in excess of 70%), but the grazing duration was quite low (a few hours). The pasture received a high amount of animal impact during the sort, so little bare ground was evident.

Highlights of findings include:

- Only 5% bare ground was found, reflecting the effectiveness of hoof action during the 2013 sort.
- No live plant cover was found, suggesting desired perennial bunchgrasses were not numerous in the pasture.
- The desired species needleandthread was the site's predominant grass. More of it should be found here.
- Distance between perennial grasses exceeded 2 inches, which was high for Merlin Ranch pastures. Ideally, that figure should fall below one inch to optimal.

Animal impact that occurred during the 2013 livestock sort was beneficial to the soil surface and will help speed the

mineral cycle in coming years. That being said, grazing managers should strive to prevent such heavy utilization rates in the future, for high use may enable growth of invasive species like cheatgrass. Ensure the Trap is provided ample regrowth time in spring/summer 2014, and, if possible, try not to use the trap until later in the growing season.

Detailed summaries of the three transect sites may be seen in the pages that follow.

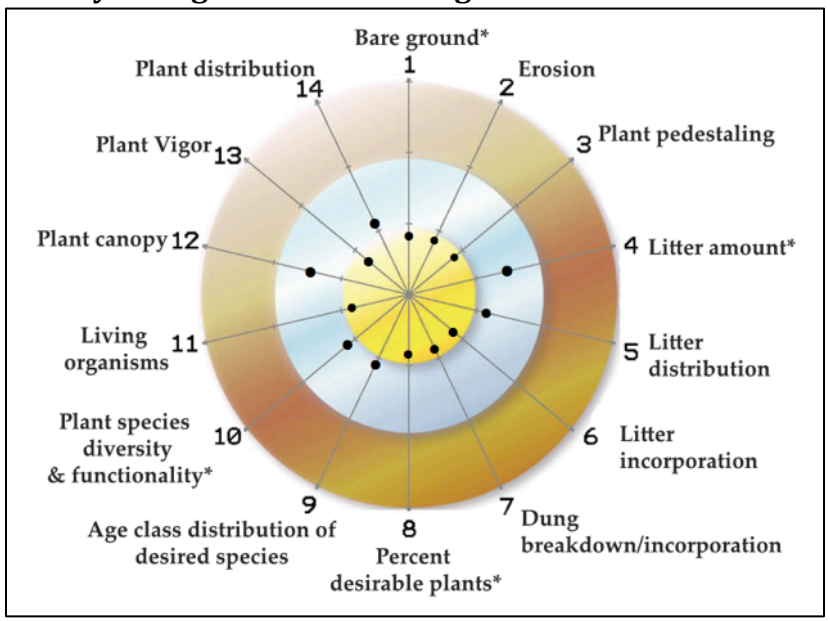
Hall Homestead Pasture

MRT06

Data Comparisons

Ecological Site: Loamy; 10 – 14” Precipitation Zone

Bullseye Rangeland Health Target



This site was established in 2006 as an area to be treated by the Lawson Renovator. It also served as an area of concern, for plants did not display desired vigorous growth. Unfortunately, the Lawson Renovator missed the study site, so the area remained as intact rangeland.

A glance at the Rangeland Target above shows how the 14 indicators of rangeland health were performing on sample day. Using the colors of the Olympics, those indicators falling in the gold (or bull's eye) were functioning optimally; those in the silver were at mid-level function and displayed room for improvement; and those falling in the bronze area require more urgent management attention.

The **water cycle** was mostly effective at this site. Some **bare ground** was found, which should ideally be covered by litter or live plants. No signs of **erosion** were observed, and only minor **plant pedestals** were found.

The **mineral cycle** was moderately rapid, where a greater **litter amount** was desired to help cover the soil surface. Litter was not well **distributed** across the soil and tended to be clumped around prominent area plants as if it had been blown there by wind. Litter was not **incorporating** as well as desired and tended to be lying idly on the soil surface, rather than contacting soil where it could be more readily broken down by microorganisms of decay. Conversely, area **dung piles** appeared to be less than one year old, suggesting rapid biological decay. These indicators suggest the mineral cycle was functioning at a moderate rate.

Within the successional process, the **percent desired plants** was high, with only threadleaf sedge as a less-than-desired species. Obvious **age classes** of big sagebrush were observed, suggesting this species was replacing itself in the community. Some younger desired needleandthread grasses were observed here as well, which was a positive sign. **Plant species diversity** was also high with over 20 species found whose varied root structures will elevate nutrients stored at different levels of the soil profile.

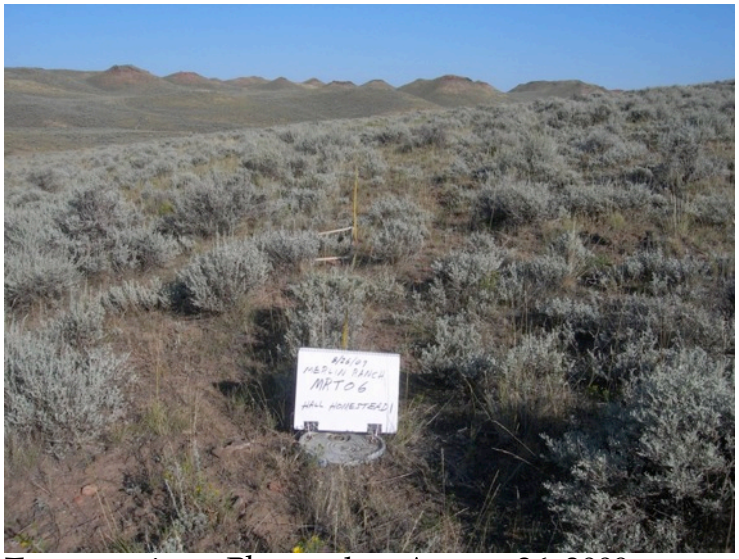
Energy flow as reduced. The **plant canopy** was small, allowing much sunlight energy to strike the soil surface. **Plant vigor** also appeared reduced, with most little leader growth on shrubs and short-statured grasses. Plants were not well **distributed** across the soil surface.

Transect view. Photo taken September 3, 2005.

Quadrat view. Photo taken September 3, 2005.

Transect view. Photo taken September 16, 2006.

Quadrat view. Photo taken September 16, 2006.



Transect view. Photo taken August 26, 2009.

Quadrat view. Photo taken August 26, 2009.

Transect view. Photo taken August 23, 2013.

Quadrat view. Photo taken August 23, 2013.

BASAL COVER

2005	2006	2009	2013	
49%	44%	40%	20%	Bare
43%	49%	54%	74%	Litter
8%	7%	6%	6%	Live

ADDITIONAL INFORMATION

Site sampled September 3, 2005.
Site sampled September 16, 2006.
Site sampled August 26, 2009.
Site sampled August 23, 2013

RELATIVE BASAL PLANT SPACING - inches

2005	2006	2009	2013
1.1	1.6	1.3	1.3

RELATIVE BASAL PLANT SPACING BY SPECIES (TOP 7 SPECIES)

2005		2006		2009		2013	
Threadleaf sedge	22%	Sandberg bluegrass	36%	Western wheatgrass	15%	Western wheatgrass	28%
Western wheatgrass	16%	Western wheatgrass	23%	Prairie junegrass	15%	Threadleaf sedge	23%
Needleandthread	14%	Prairie junegrass	12%	Threadleaf sedge	14%	Prairie junegrass	17%
Prairie junegrass	11%	Big sagebrush	12%	Sandberg bluegrass	13%	Hoods phlox	9%
Big sagebrush	11%	Hood's phlox	7%	Big sagebrush	8%	Big sagebrush	8%
Bluebunch wheat	9%	Fringed sage	4%	Bluebunch wheat	7%	Bluebunch wheat	4%
Blue grama	6%	Bluebunch wheat	3%	Green needlegrass	6%	Fringed sage	4%

RELATIVE PLANT SPECIES COMPOSITION BY WEIGHT RANKING (TOP 5 SPECIES)

2005		2006		2009		2013	
Big sagebrush	30%	Big sagebrush	22%	Big sagebrush	35%	Big sagebrush	27%
Bluebunch wheat	17%	Western wheatgrass	20%	Sandberg bluegrass	14%	Western wheatgrass	14%
Fringed sage	11%	Sandberg bluegrass	17%	Western wheatgrass	13%	Threadleaf sedge	11%
Prairie junegrass	9%	Bluebunch wheat	16%	Prairie junegrass	13%	Prairie junegrass	9%
Broom snakeweeed	8%	Prairie junegrass	8%	Vetch species	12%	Needleandthread	7%

PRODUCTION: Lbs per acre

2005	2006	2009	2013	Potential (avg yr.)
760	230	260	140	1100

PLANT SPECIES FOUND IN TRANSECT AREA

2005	2006	2009	2013	
23	*19*	*29*	*24*	***Total count***
X	X	X	X	Bluebunch wheatgrass
X	X	X	X	Western wheatgrass
X	X	X	X	Prairie junegrass
X		X		Japanese brome
X	X	X		Blue grama
X		X	X	Green needlegrass
X	X	X	X	Threadleaf sedge
X		X	X	Needleandthread
X	X	X	X	Big sagebrush
X	X	X	X	Fringed sage
X	X	X	X	Silver sagebrush
X	X	X	X	Broom snakeweed
X	X	X	X	Rubber rabbitbrush
X	X	X	X	Western yarrow
X		X	X	Vetch species
X	X	X	X	Hood's phlox
X	X	X		Pricklypear cactus
X		X	X	Curlycup gumweed
X		X		Lepidium (white alyssum)
X	X	X	X	Vagrant lichen
X				Plains daisy
X			X	Musk thistle
	X	X	X	Sandberg bluegrass
	X			Smooth brome
	X			Sixweeksgrass
	X			Moss species
	X			Longleaf phlox
			X	Alfalfa

PLANT SPECIES CONTINUED

2005	2006	2009	2013	
			X	Golden pea
		X		Cheatgrass
		X		Salsify
		X		Clover species
		X		Showy fleabane
		X	X	Scarlet globemallow
		X	X	Sego lily
			X	Penstemon
			X	Goldenweed
		2		Additional vetch species
1	1	2		Unknown perennial forb

Hall Homestead – MRT06

BIG SAGEBRUSH DATA

2005	2006	2009	2013	*Line intercept:*
38	32	29	49	*Number of big sage plants encountered*
				Line Intercept: Age Class Distribution
0%	0%	0%	0%	seedling
18%	3%	8%	0%	young
82%	81%	79%	90%	mature
0%	16%	13%	10%	decadent
11.5	12.5	9	8	*Average plant height - inches*
16%	9%	15%	18%	*Percent canopy intercept*
186	211	206	233	*Density per 1000 square feet*

Photos
Each year's photos display a site with low-vigor, low-producing plants, which is why it was scheduled to be treated with the Lawson Renovator. This loamy ecological site has potential production of 1100 pounds per acre, a level that was well above the actual production found each year (although the pasture had been grazed each year prior to when the site was examined, so forage plants here had been grazed.) Note that 2006 was a dry year, and the site displayed especially low vigor that year. As may be seen in the transect view photos, vigor appeared much higher in 2009 and 2013, but much bare ground was still evident.

Basal cover
The percent ground declined steadily each time the site was sampled, beginning with 49% bare ground in 2005 and ending at 20% bare ground in 2013. While this improvement was desirable, the amount of bare soil should fall below 10% here to be optimal. Ideally, bare ground will be covered by living plants, and this new growth will be measured by the live cover figure. No improvements were recorded in live cover since 2005 (although 6% live cover represents a good figure for this site using the point intercept method).

Relative basal plant spacing
Relative basal plant spacing is a measure of the distance between perennial plants. The shorter the distance, the tighter the spacing between perennial plants. Ideally, that distance between perennial plants decreases through time as new plants germinate. At Hall Homestead, this distance did not change since 2009. Ideally, this measure would fall below one inch to be optimal.

Relative basal plant spacing by species
The relative basal plant spacing data set displays the seven most basally abundant species found a the transect site. These data have changed substantially through the years. In particular, note the fluctuations of threadleaf sedge: It was the most basally abundant species in 2005, was minimally found in 2006, and was basally abundant in 2009 and 2013. Needleandthread and green needlegrass, both desired species, also appeared on the list, but then were absent in subsequent readings. The less-than-desired species blue grama first appeared in 2005, but did not make the list of the top seven most basally abundant species after that.

Overall, this was a site whose basal composition has been predominantly mid-seral species like western wheatgrass, threadleaf sedge, and prairie junegrass. The relative composition of these species has changed through time, but the mid-seral species were the predominant species at the site, and little appears to have changed. Ideally, the later-seral species like bluebunch wheatgrass and green needlegrass would increase their presence, which had not yet happened.

Relative plant species composition by weight
The composition by weight data sets display the five most productive plant species found each sample year. Big sagebrush maintained its position atop the list each year, and species like the desired bluebunch wheatgrass have fluctuated. The contribution of this species at other Merlin Ranch sites has often fallen, while being replaced by other desired species, such as needleandthread and green needlegrass. Note that needleandthread made an

appearance on this list for the first time in 2013. The possibility exists that such change (where one desired species replaces another) was occurring at Hall Homestead in 2013. Overall, however, mid-seral species like western wheatgrass and prairie junegrass were the predominant species at this site.

Production

As previously stated, potential production in an average precipitation year for this loamy ecological site is 1100 pounds per acre. The Hall Homestead site has never reached this productivity level. Note that the pasture had been grazed each time prior to the transect reading, and the harvest of forage will greatly affect the data results. Overall, the level of production at this site appears to be well short of 1100 pounds.

Plant species

Twenty-four plant species were found at this site, which was a high figure for this arid pasture (but below the high of 29 set in 2009). Two undesired species fell from the list in 2013: Japanese brome and blue grama. Note that blue grama was one of the most basally abundant species in 2005, so its absence signals positive change. 2009 appears to have been a wet year, judging by the number of forbs growing there. Some of those forbs were found in 2013, but several dropped from the list. Note that the additions of alfalfa, penstemon, and goldenweed were welcome in 2013. The movement of various species on and off the list is a good indicator that change was occurring within the pasture.

Big sagebrush data

The big sagebrush community appears to slowly be replacing itself within this pasture. Several decadent big sage plants were found along the transect line (and multiple younger plants were observed in the area). Note that big sagebrush canopy cover was 18%. As a rule of thumb, 30% big sagebrush cover becomes hard to walk through, and it is at this point when managers should consider treating a big sagebrush stand. At Hall Homestead, the canopy was open enough to not require a treatment.

Range trend

Trend here was undetermined. Positive change was occurring, such as the reduction in bare ground and loss of species like Japanese brome, but positive shifts in species composition were not evident. The site appears to be changing slowly through time, but positive gains as measured by production and species composition have not been seen here.

Management recommendations

Change was occurring in this pasture, but it appeared to be quite slow. Given recent grazing history of the pasture, such findings are difficult to explain.

A review of the 2013 grazing program shows that the pasture was grazed for four days in mid June, representing a short (and desirable) grazing duration. Further, the stocking rate was just above 2 animal days per acre, which was again low. A similar program was practiced in 2012. These figures show no problems with grazing management. By contrast, grazing in both years should have enabled

improvement in this pasture (even in the dry summer of 2012), but such improvements were not found.
We cannot explain why the pasture did not display more rapid improvement, given its grazing history.

That portion of the Hall Homestead Pasture receiving the Lawson Renovator in 2007 displayed improvement by 2013, through plant vigor, plant productivity, and desired shifts in species composition. This would suggest running the renovator over the transect area would be a good move. However, the compelling reasons for using the Lawson Renovator (excessive big sagebrush canopy cover and a capped soil surface) were not present. No quantitative argument can be given for mechanically treating this part of the pasture.

That being said, grazing managers should capitalize on the area's buildup of litter, which has increased markedly since the transect was established. Cattle should be salted in this area in an effort to speed the mineral cycle by improving litter to soil contact. The extra hoof action will introduce extra energy into the system, which should speed the mineral cycle and make the water cycle more effective. The affect of this should be improved plant productivity. In time, desired shifts in species composition should result (four or five years). Simultaneously, the current practice of short grazing durations should be maintained.

Early-warning indicators

Early-warning indicators provide those first signals that something is amiss on the land. They are the first signs that a grazing strategy is being improperly implemented, and changes should be made. Early-warning indicators tend to be cheaper to implement than those later-in-time indicators, so should be heeded. Early-warning indicators are often qualitative in nature and can be observed when out checking pasture.

If management actions are improperly applied at Hall Homestead, look first shifts in species composition that favor less desired species, such as cheatgrass, Japanese brome, and blue grama.

Conversely, if management actions are properly applied, look first for improving plant vigor (even in dry years). Look for continued declines in bare ground, increased litter amount, and reduced spacing between plants. These all suggest positive change is occurring. With continued good management, increases in the desired species will be apparent in the next three to five years.

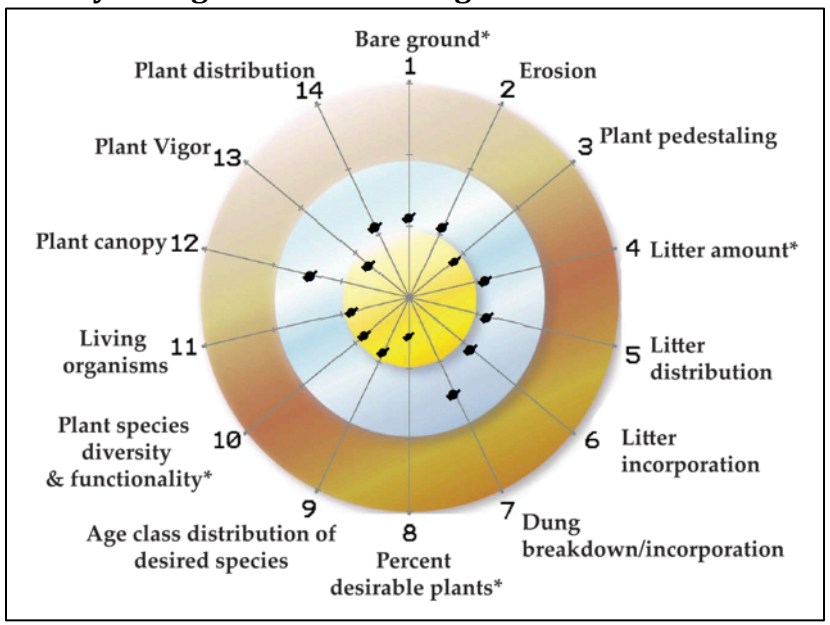
Pigpen

MRT12

Data Comparisons

Ecological Site: Shallow Loamy; 10 – 14” Precipitation Zone

Bullseye Rangeland Health Target



The Pigpen Pasture site was established in 2008 and was located toward the northwestern end of the pasture in the pasture's main draw. The boundary fence lies roughly 250 yards to the northwest. The nearest water was between 0.25 and 0.5 miles away. The site was placed on a slope that contained a mixture of grass, forbs, and shrubs. The site was chosen to represent the area.

The **water cycle** was moderately effective at this site. In some areas, too much **bare ground** was found that should be covered by litter and/or live plants. Signs of wind **erosion** were evident, where wind removed finer soil particles, leaving coarser materials behind. The affect produced minor **plant pedestals** observable on the soil surface.

The **mineral cycle** was not functioning as rapidly as desired. A higher **litter amount** was sought to help cover some of those bare patches previously mentioned. Likewise, improved litter **distribution** would help cover the bare patches and help prevent erosive forces. Some litter was **incorporating** well with soil, but much of it was lying idly on the soil surface, an affect that slowed the mineral cycle. Further, area **dung piles** appeared to be roughly 2 years old, and an increased decay rate was desired.

Within the successional process, the **percent desired plants** was high, with only a few invasive Japanese brome plants found and most species being desired. Different **age classes** of desired species such as green needlegrass, bluebunch wheatgrass, and needleandthread were all readily apparent, suggesting positive shifts in species composition were occurring. The big sagebrush community appeared to be continuing its decline, with multiple decadent members present. The species appeared to be slow in replacing itself in the community. Twenty-seven plant species were found in the area, resulting in high **plant species diversity.**

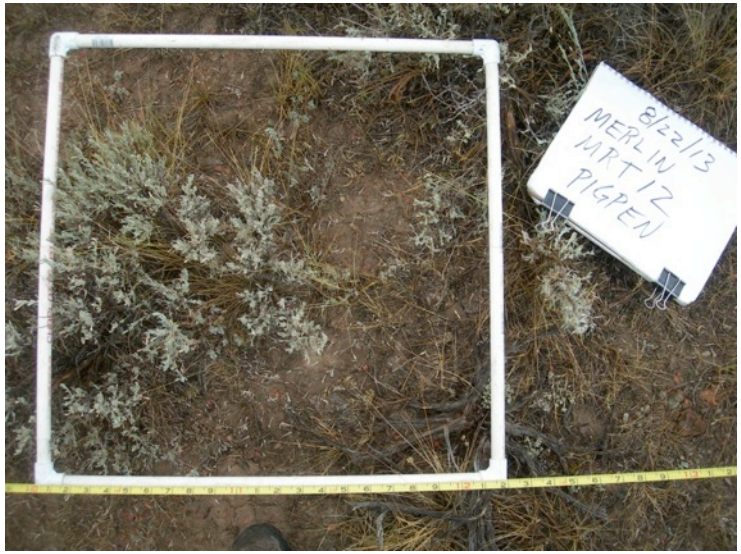
Energy flow functioned at mixed levels. The **plant canopy** was too minimal, resulting in much sunlight energy striking the soil surface, rather than being intercepted by living plants. **Plant vigor** of desired grasses (green needlegrass, Idaho fescue) was high, but was lacking for sagebrush and western wheatgrass. Improved **plant distribution** was desired to help cover the area's bare patches and improve plant productivity.

Pigpen – MRT12

Transect view. Photo taken August 27, 2008.

Transect view. Photo taken August 22, 2013.

Transect view. Photo taken August 27, 2008.



Quadrat view. Photo taken August 22, 2013.

Pigpen – MRT12

BASAL COVER

2008	2013	
23%	11%	Bare
72%	82%	Litter
5%	7%	Live

RELATIVE BASAL PLANT SPACING - inches

2008	2013
1.8	1.1

RELATIVE BASAL PLANT SPACING BY SPECIES (TOP 7 SPECIES)

2008		2013	
Western wheatgrass	32%	Western wheatgrass	39%
Green needlegrass	19%	Bluebunch wheatgra	18%
Big sagebrush	18%	Hood's phlox	11%
Fringed sage	7%	Western yarrow	7%
Bluebunch wheatgra	6%	Big sagebrush	6%
Prairie junegrass	4%	Sandberg bluegrass	5%
Hood's phlox	4%	Green needlegrass	5%

RELATIVE PLANT SPECIES COMP. BY WEIGHT RANKING (TOP 5 SPECIES)

2008		2013	
Big sagebrush	31%	Big sagebrush	30%
Green needlegrass	19%	Bluebunch wheatgra	20%
Western wheatgrass	19%	Western wheatgrass	15%
Japanese brome	18%	Fringed sage	9%
Bluebunch wheatgra	5%	Green needlegrass	7%

PRODUCTION: Lbs per acre

2009	2013	Potential (avg yr.)
960	320	900

ADDITIONAL INFORMATION

Site sampled August 27, 2008
Site sampled August 23, 2013

Pigpen – MRT12

PLANT SPECIES FOUND IN TRANSECT AREA

2008	2013	
28	*27*	***Total count***
X	X	Big sagebrush
X	X	Western wheatgrass
X	X	Broom snakeweed
X	X	Hoods phlox
X	X	Silver sagebrush
X	X	Winterfat
X	X	Bluebunch wheatgrass
X	X	Fringed sage
X	X	Sandberg bluegrass
X	X	Western yarrow
X	X	Prairie junegrass
X	X	Japanese brome
X	X	Needleandthread
	X	Idaho fescue
X	X	Crested wheatgrass
X	X	Salsify
X	X	Green needlegrass
X	X	Sego lily
	X	Alpine pussytoes
X	X	Clover species
X	X	Pricklypear cactus
	X	Vetch sp
	X	Plains daisy
	X	Blue grama
	X	Thread leaf sedge
	X	Smooth brome
	X	Peppergrass
X		Cheatgrass

PLANT SPECIES CONT'D

2008	2013	
X		Arabis mustard
X		Scarlet globemallow
X		Showy fleabane
X		Curlycup gumweed
X		White alyssum
X		Lupine
1		unknown perennial forb
1		unknown annual forb

BIG SAGEBRUSH DATA

2008	2013	*Line intercept:*
45	44	*Number of big sage plants encountered*
		Line Intercept: Age Class Distribution
0%	0%	seedling
0%	0%	young
76%	80%	mature
24%	20%	decadent
15.6	10.3	*Average plant height - inches*
23%	19%	*Percent canopy intercept*
175	238	*Density per 1000 square feet*

Photos
Photos from the site display reduced vigor of big sagebrush in both sample years. Sagebrush data will show the continued decline of this species. Further, improved vigor of perennial grasses may be seen, and such grasses appear much more prominently in the 2013 photos than the 2008 photos. (Note that 2008 exceeded the region's average precipitation; whereas 2013 contained a wet spring (Source: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy1165).)

Basal cover
The percent bare ground declined by 12 percentage points between the two sample years, which was positive change. Further, the percent live cover increased by two percentage points, which was also desired.

Relative basal plant spacing
Relative basal plant spacing is a measure of the distance between perennial plants. The lower the figure, the tighter the spacing. Conversely, the higher the figure, the looser the spacing. Through time, if this distance falls, then new perennial plants have been recruited the soil surface. At Pigpen, the distance between perennial plants fell by 0.7 inches, which was a positive change that occurred quickly.

Relative basal plant spacing by species
The relative basal plant spacing by species data set displays the seven most basally abundant plant species at the site. As may be seen in the table, the desired grass western wheatgrass maintained its basal prominence in the community. Green needlegrass, another desired species, reduced its relative contribution. Conversely, the desired grass bluebunch wheatgrass increased its basal abundance. In this instance, two desired grasses replaced each other. The less-than-desired fringed sage fell from the community, and the desired forb western yarrow was added to the list, both of which were positive signs. Note also the fall of big sagebrush (from 18% in 2008 to 6% in 2013). This again illustrated the decline of this species in the community. Overall, this data set displays the occurrence of positive changes

Relative plant species composition by weight
This data set displays the five most productive plant species. Big sagebrush remained unchanged as the most productive species. Again, bluebunch wheatgrass and green needlegrass, two desired grasses, replaced each other in terms of most productive grasses. Watch for further changes in these species in coming years. The undesired species Japanese brome composed 18% of the site's productive capacity in 2008, and this species was barely found at the site in 2013, which was a positive finding.

Production
Potential production for this site is 900 pounds per acre in an average precipitation year (USDA, 1990). Production in the wet year of 2008 surpassed this figure, but was well below it in 2013. Much of the productive contribution in 2008 was from Japanese brome, and the lack of this species in 2013 affected overall production. Ideally, the more productive species like Idaho fescue, green needlegrass, and bluebunch wheatgrass will increase their composition of the community in time, which will increase overall production.

Plant species
The total number of plant species fell by one between the sample years, which was not a bad finding, given the discrepancy in precipitation between the two years (wetter years tend to produce more forbs). New desired species were found in 2013, including Idaho fescue, vetch, and daisy, whereas less-desired species were also added, including threadleaf sedge and blue grama. The multiple forbs found in 2008 (mustard, globemallow, lupine) likely did not produce well in 2013 due to the reduction in precipitation.

Big sagebrush data
The big sagebrush data table displayed decline of this species in the community. Age class distribution data, in particular, portray rapid change in the species with many decadent (dying) members. Further, the percent canopy cover declined by four percentage points, showing further decline. Conversely, density data displayed an increase, suggesting some big sage plants germinated between the two sample years. Such younger plants, while counted and displayed in this data set, were not obvious on the soil surface.

Range trend
Range trend here was upward. The decline in bare ground, increase in live cover, reduced basal spacing, and improved species composition all signal a pasture whose overall rangeland health was improving.

Management recommendations
The site was grazed lightly in 2013, and cattle grazed species such as bluebunch wheatgrass and green needlegrass. Overall utilization was light.

The site required additional hoof action to help knock down some of the area's standing, dead big sagebrush plants. This same action should also help improve litter incorporation and litter distribution, which should help speed the mineral cycle. Grazing managers should consider spreading salt to be consumed by cattle in this area to help improve the mineral cycle and overall plant production.

Continue the short grazing durations and lengthy recovery periods coupled with light-to-moderate utilization rates as has been done in the past.

Overall, no major course corrections to grazing management were warranted here.

Early-warning indicators
If management actions are improperly applied, look first for reductions in plant vigor, more bare soil, and signs of erosion. These would indicate that utilization rates have been too high, and spring grazing durations have been too long. Should more undesired plant species increase and the desired plant species decline, then more issues with recovery period between grazings and timing of grazings are evident.

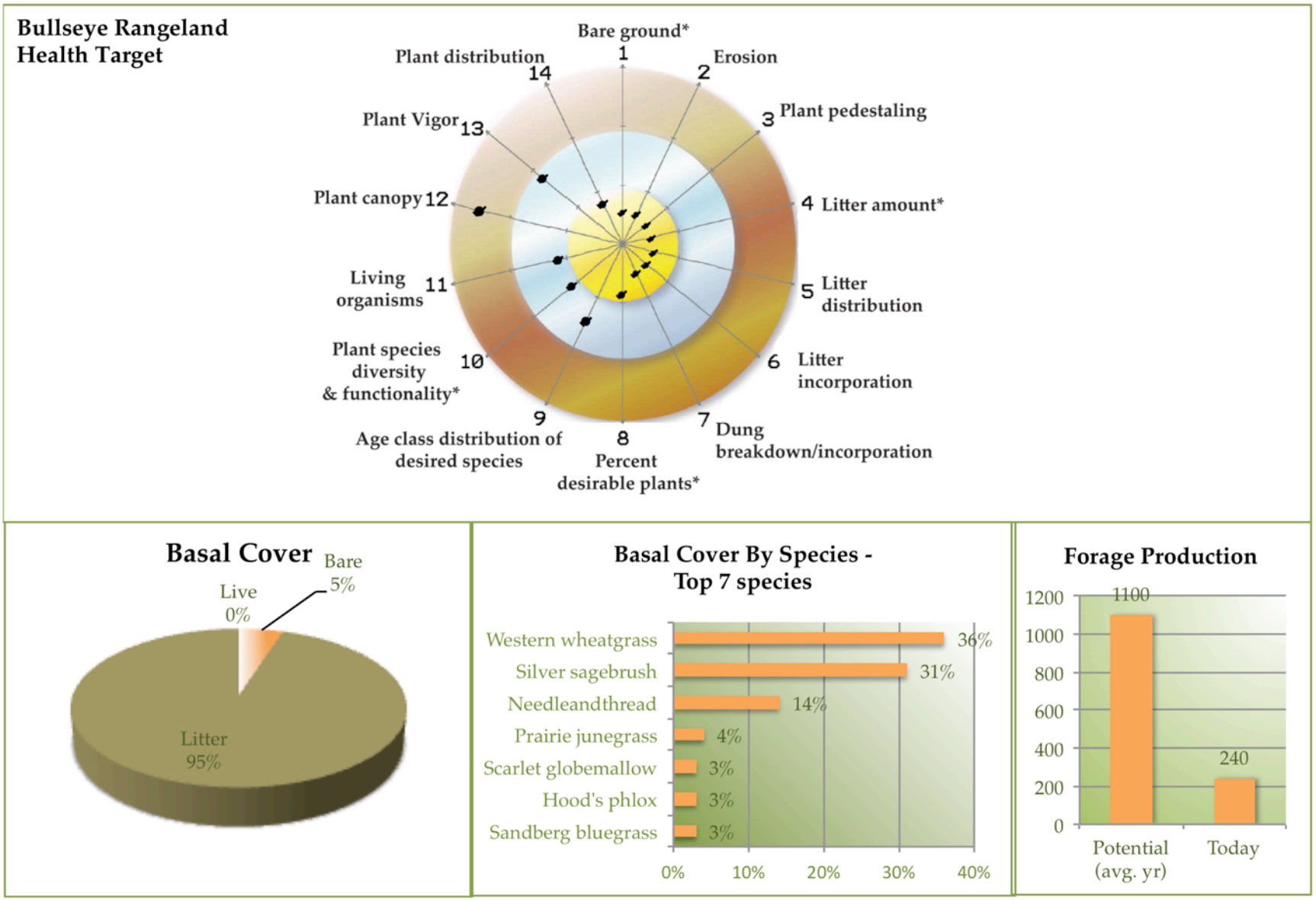
If management actions are properly applied, look for elevated plant vigor, even in dry years. Look for increased

presence in desired species like bluebunch wheatgrass, Idaho fescue, and green needlegrass. Such positive shifts in species composition suggest a good balance among grazing duration, recovery period, intensity, and frequency of grazing variables.

Lawrence Trap

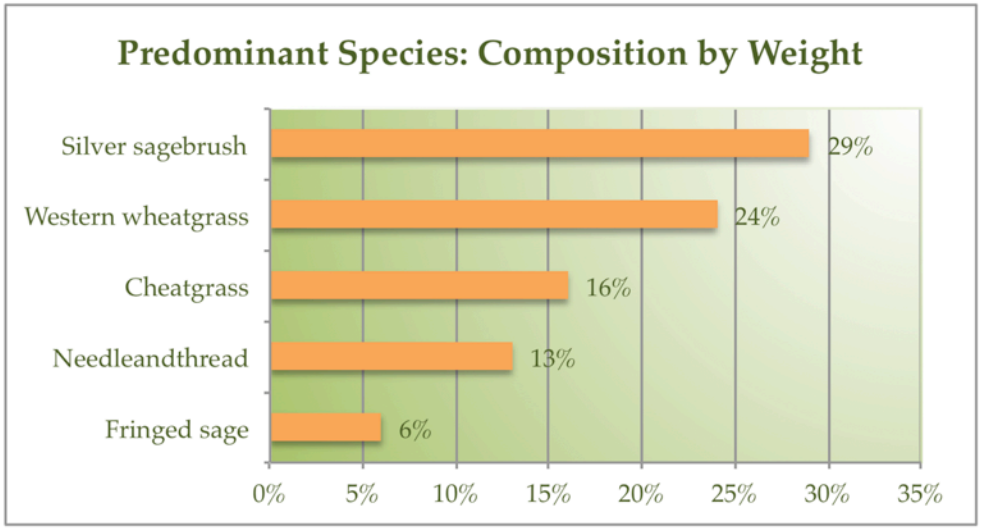
MRT22

Ecological Site: Loamy; 10 – 14" Precipitation Zone


Bullseye Rangeland Health Target
Bare ground*
1
Erosion
2
Plant pedestaling
3
Litter amount*
4
Litter distribution
5
Litter incorporation
6
Dung breakdown/incorporation
7
Percent desirable plants*
8
Age class distribution of desired species
9
Plant species diversity & functionality*
10
Living organisms
11
Plant canopy
12
Plant Vigor
13
Plant distribution
14
Basal Cover
Bare 5%
Live 0%
Litter 95%
Basal Cover By Species - Top 7 species
Western wheatgrass 36%
Silver sagebrush 31%
Needleandthread 14%
Prairie junegrass 4%
Scarlet globemallow 3%
Hood's phlox 3%
Sandberg bluegrass 3%
0% 10% 20% 30% 40%
Forage Production
1200 1000 800 600 400 200 0
1100
240
Potential (avg. yr)
Today

Lawrence Trap – MRT22

Transect View



Quadrat View

Plant species at site: 16 total

Cheatgrass
Threadleaf sedge
Sandberg bluegrass
Needleandthread
Western wheatgrass
Prairie junegrass
Silver sagebrush
Big sagebrush
Fringed sage
Green rabbitbrush
Hood's phlox
Pricklypear cactus
Salsify
Scarlet globemallow
Dandelion
Curlycup gumweed

Basal Plant Spacing = 2.19"

Silver Sagebrush Data

54 Big sagebrush plants on line
Age class distribution
0% Seedling
5% Young
93% Mature
2% Decadent

10" Average Plant Height
19% Percent canopy intercept
358 Plants per 1000 square feet

Site Selection Notes
This site was established in 2013 in the center of the Lawrence Trap Pasture. The site lies on a mild slope in a sagebrush/grass plant community with a slight northward aspect. The Trap was used for cattle sorting in mid-summer 2013, where utilization rates on pasture grasses were quite high (in excess of 70%), but the grazing duration was quite low (a few hours). The pasture received a high amount of animal impact during the sort, so little bare ground was evident. This study site was intended to track changes in the pasture through time.

Bullseye Rangeland Health Target
The **water cycle** was effective at this site, with minimal **bare ground**, no signs of **erosion**, and no **plant pedestaling**.

The **mineral cycle** appeared to be functioning rapidly, with optimal **litter amount**. With the recent sorting and abundant hoof action, litter was well **distributed** across the soil surface, and appeared to be **incorporating** well with soil.

Within the **successional process**, the **percent desired plants** was high. Only cheatgrass was undesired, and many of the species found at the site were desired. Examining different **age classes** proved difficult given the high utilization rates (especially on grasses), but some younger silver sagebrush plants were evident. **Plant species diversity** was not as high as desired, where more desired perennial bunchgrasses such as bluebunch wheatgrass and green needlegrass were desired. Additional forbs, such as fleabane, gilia, and even lupine were desired here.

Energy flow was mixed. Due to the sorting event, much of the **plant canopy** had been removed, and much sunlight energy struck the soil surface, rather than being intercepted by living plant leaves (this indicator would have been scored differently had the site been examined prior to sorting). **Plant vigor** was also affected by the sorting action, but some regrowth was occurring, so this indicator received a mid-level score. Plants appeared to be well **distributed** across the soil surface.

Photos
The photos display the site after cattle had been sorted here. Silver sagebrush appears as the most prominent standing plant in the photos, and most grass had been removed (utilization rates reached 70% in many places). Regrowth was occurring on the grass plants, which does not appear in the photos.

Basal cover
The basal cover pie charts displays the relationship among the various forms of cover (bare ground, litter, live plants, gravel, and rock). The 5% bare ground amount was a positive figure for this site, and it should be expected given the high level of animal impact the area received. Using the point intercept method, no live cover was recorded, which was not a desired finding. Ideally, more perennial bunchgrasses, such as Idaho fescue and green needlegrass, could be recruited to this site, whose large bases would be easily captured using the point intercept method.

Relative basal plant spacing
The relative basal plant spacing measure displays the average distance between bases of perennial plants on the

soil surface. When measured through time, this distance will ideally decrease, which suggests that new plants have been recruited to the soil surface. Since this was the first reading of the Lawrence Trap, no comparison between sample years could be made. However, the measure of 2.19 inches was too high for this pasture. Ideally, this figure should drop below 1 inch to be optimal, so room for improvement existed.

Relative basal plant spacing by species

The relative basal plant spacing data set displays the seven most basally abundant species on the soil surface. Species like western wheatgrass, silver sagebrush, and needleandthread were desired, as was scarlet globemallow. Hood's phlox is a low-producing, less-desired forb that does not present a problem, but should ideally be replaced by more desired species.

Note that this method of data collection is useful regardless of whether or not a site has been grazed. Since the pasture was grazed so heavily, measuring the basal species composition of a site may be performed irrespective of variables such as grazing and/or recent precipitation events. Thus, the technique is a useful means of tracking changes in a plant community, and the data would have appeared the same had this pasture not been grazed.

Relative plant species composition by weight

This data set displays the five most productive species found at the site. Note that most standing grass cover had been harvested, so this list of most productive species is highly affected by the occurrence of grazing. Silver sagebrush, western wheatgrass, and needleandthread were all desired species for this site, and the two grasses offer strong foraging opportunities for cattle. Ideally, cheatgrass and fringed sage will be replaced by other species through time.

Production

The pasture has a potential production of 1100 pounds per acre in an average year (USDA, 1990). In August 2013, 240 pounds per acre were clipped at the site, which was a figure that was highly influenced by the recent sorting of cattle in the pasture. All of the 240 pounds were from silver sagebrush, since no grass was left to be clipped at this site.

Note also that since no grass could be clipped here, no forage sample was sent to the lab for nutrient analysis. Thus, only two samples will be examined this year – Hall Homestead and Pigpen.

Plant species

Sixteen plant species were found at this site, which was low for this area (and low for most comparable Merlin Ranch pastures). Many desired species were found, including needleandthread, western wheatgrass, salsify, globemallow, and sagebrush. Ideally, additional bunchgrasses will be found, including bluebunch wheatgrass, green needlegrass, and Idaho fescue. The only true undesired species on the list was cheatgrass.

Silver sagebrush data

The silver sagebrush data reveal that the site was predominantly lower-growing and highly dense silver sage plants (which can also be seen in the site photos). 358 plants were found growing in 1000 square feet (which was

a lot), and these plants were 10 inches high. Grazing managers have little leverage influencing the density, canopy cover, and height of these plants, short of placing salt atop these plants, which was unnecessary here.

Range trend

Apparent range trend here was undetermined. Given the high degree of utilization in the pasture, no determination could be made regarding whether the pasture was improving or declining. The best that may be said for now was that the water cycle was effective and mineral cycle appeared to be rapid, which constitute strong building blocks for improving performance of this pasture in the future.

Management recommendations

The animal impact that occurred through the 2013 cattle sorting was beneficial to the soil surface. Little bare ground was seen, erosion was not observed, litter was abundant and well distributed across the soil surface, and incorporation appeared to be rapid. The event likely added much energy into the soil surface that can be beneficial in coming years.

That being said, grazing managers should strive to prevent such heavy utilization in the future in an effort to inhibit successful germination of undesired species like cheatgrass. This invasive species thrives when the more desired species are stressed, so preventing such heavy use in the future will help prevent cheatgrass from spreading.

Further, the Lawrence Trap should be given ample regrowth opportunity in summer 2014 in an effort to favor growth of those desired perennial grasses. They need a chance to grow back after the heavy use event of 2013. If possible, use the Trap later in the growing season.

Early-warning indicators

If management actions are improperly applied, look first for reduced plant vigor, more bare ground, and signs of erosion. These suggest grazing durations have been too lengthy, utilization rates have been too high, and grazing durations have been too long. If much bare ground becomes evident quickly, then use of animal impact with salt blocks has been too heavy.

If management actions are properly applied, look first for strong plant vigor, even in dry years. If animal impact has been successfully used, look for decreased silver sagebrush canopy cover, and increased presence of desired forbs. Lastly, look for shifts in species composition toward those more favorable desired grasses.

NUTRIENT ANALYSIS

At each of the three sites, a single plot of forage was clipped to determine above-ground productivity. The plant matter taken from this clipping was saved and used to determine nutrient content of the plants. The sample was first sorted to remove species like sagebrush that cattle would not graze, and then the samples were sent to Midwest Labs in Omaha, NE for nutrient analysis. The following table displays the dry-matter nutrient content of each of the samples in 2013.

	Hall Home	Pigpen
Crude Protein (%)	7.9	5.9
Acid Detergent Fiber (%)	37.6	3.92
Total Digestible Nutrients (%)	59.7	57.8
Net energy-lactation (Mcal/lb)	0.61	0.59
Net energy-maintenance (Mcal/lb)	0.59	0.56
Net energy-gain (Mcal/lb)	0.35	0.33
Sulfur (%)	0.14	0.13
Phosphorus (%)	0.13	0.08
Potassium (%)	0.97	0.73
Magnesium (%)	0.1	0.14
Calcium (%)	0.8	0.59
Sodium (%)	no test	no test
Iron (ppm)	533	527
Manganese (ppm)	52	55
Copper (ppm)	6	6
Zinc (ppm)	21	21

Since the Lawrence Trap contained no grass to be clipped, no sample was sent to the lab for nutrient analysis. Thus the table to the left contains only data from the Hall Homestead and Pigpen Pastures.

Note that no nutrients appeared in toxic levels, but some were low. Like usual, levels of trace minerals (zinc and copper) were low, and the Pigpen sample contained a reduced crude protein level. Further, much variation exists between the two samples (Hall Homestead was superior by nearly every measure), and no ready explanation exists for this difference.

Also note the iron levels of both samples. While the iron levels presented no problem (iron becomes toxic to cattle at levels above 1000 ppm), the high levels are worth considering. In 2012, speculation was made concerning the elevated levels of iron in low precipitation years. When reviewing past Merlin Ranch forage samples, iron levels tended to be higher when precipitation was lower. The reverse is also true: in wetter years, iron levels tended to fall, oftentimes below 100 ppm. 2013, with hits wetter spring, appears to present the first recorded instance when iron levels were elevated. No management action is required from this knowledge, but the correlation (or lack thereof) is worth noting.

As was done in previous years, the nutrients provided by the samples will be compared against the needs of an 1100-pound lactating cow. Using the Nutrient Requirements of Beef Cattle tables (NRC, 1984), the

requirements of an 1100-pound lactating cow of average milking ability are stated as follows:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	2#	12.1#	27g	22g

Assuming our sample cow meets here dry matter requirements, the **Hall Homestead** sample will return the following to her:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.7#	12.9#	78g	13g

Our sample cow in Hall Homestead will be short nearly 0.3 pounds of protein per day in mid August. Further, she is short 11 grams of phosphorus, another noteworthy issue. Fortunately, the calcium to phosphorus ratio was 6:1, which was below the recommended 7:1 range.

At **Pigpen**, the forage will return the following to our sample cow:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.3#	12.5#	58g	8g

This forage was short in both crude protein (by 0.7 pounds per day) and phosphorus (by 14 grams per day) for our sample cow grazing in August. Further, the calcium to phosphorus ratio was just beyond that 7:1 limit (7.25:1).

Management recommendations from nutrient analysis

Analysis of the sample nutrients on the preceding pages serves as a guide for management when considering nutritional factors as they relate to livestock performance. That being said, the analysis is intended to be a "shotgun" approach to livestock performance, rather than a precise science. Simply put, livestock have access to a variety of forage sources in each of these pastures, and not just forage from the sample sites. This provides variety in the diet and likely meets the cow's needs, including those critical crude protein levels.

The ranch also moves its livestock through a series of pastures during the growing season, providing cattle with fresh feed sources on a regular basis. This action in itself presents the best means of meeting the needs of the lactating cows.

If livestock performance is lacking, cows whose calves have been weaned may be placed on the ranch's irrigated hay meadows in fall and early winter. There, they should graze plants containing much higher nutrient content than the range grasses can provide. Once hay feeding begins, much of the cow's daily nutrient requirement should be met, and the cow will rebuild body condition.

Lastly, to meet the needs of the herd, management may take more aggressive actions, such as weaning calves earlier. If performance suffers and cow longevity is also an issue, then the calf may be weaned early so the body condition of the cow may be replenished more readily. Only pursue this option if cow performance is an issue. Finally, management should consider placing cattle on a trace mineral supplement with high levels of phosphorus, copper, and zinc to make up those missing nutrients. Some of the nutrients may be stored in the cow's body and utilized through time. Consider placing the herd on a trace mineral package during winter, or in the last 100 days before calving. This should help minimize costs, minimize labor/infrastructure/fuel required to put mineral out, and should help livestock performance in dry years. This will also help correct that calcium to phosphorus ratio imbalance.

MONITORING METHODS

On August 22, 2013, Todd Graham of Ranch Advisory Partners examined the three pastures to be monitored.

Graham read those transects over the next few days. He laid out a 200-foot tape measure along the soil surface that served as the basis of the monitoring protocol. A variety of methods were then conducted from this tape measure (Figures 1 and 2).

Figure 1: five-gallon bucket lids used to mark transect locations

Each location was photographed and described. This description included a list of plants, activities of animals, and type of soil and terrain. A background field form was used to record the following information:

1. Site name;
2. Date;
3. Investigators;
4. Location description;
5. Details of transect layout and orientation;
6. Production characteristics (from area soil survey);
7. Current weather conditions;
8. History of pasture use;
9. Wildlife observations;
10. Soil characteristics;
11. Vegetation characteristics; and
12. Reasons for site choice.

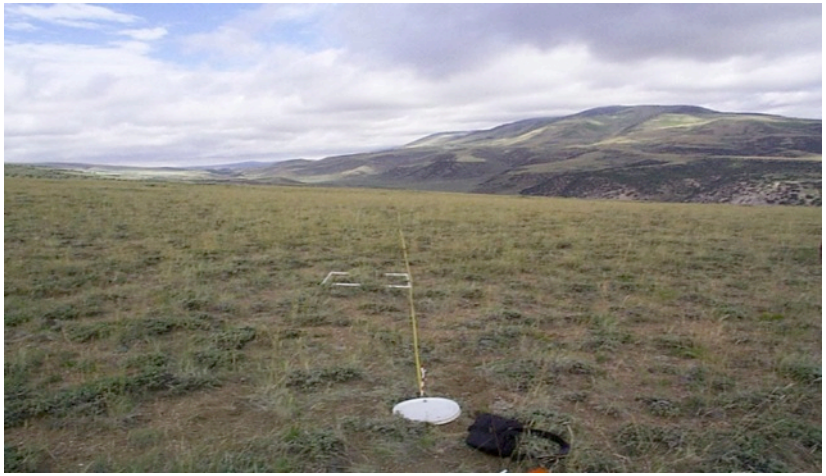


Figure 2: Permanent transects were 200 feet long and were permanently marked **on each end.**

Ten plots along the transect line were examined and 16 indicators of rangeland health were evaluated (Figure 3). The first plot lay at the 10-foot mark on the tape measure, and each successive plot was read at 20-foot intervals (10,

30, 50, 70 feet, etc.) Ocular utilization estimates were also recorded.

A rangeland health qualitative scoring guide accompanies this document that portrays how each of the 16 indicators was evaluated. Each indicator is assigned a score from one to five, with five being the score that best reflects achievement of the landscape goals for that site. As an example, consider the "litter distribution" indicator. If it was found that litter displayed "mostly uniform, slightly patchy" appearance, this indicator would be assigned a score of "4." Each of the 16 indicators was scored in this way at each of the 10 plots.

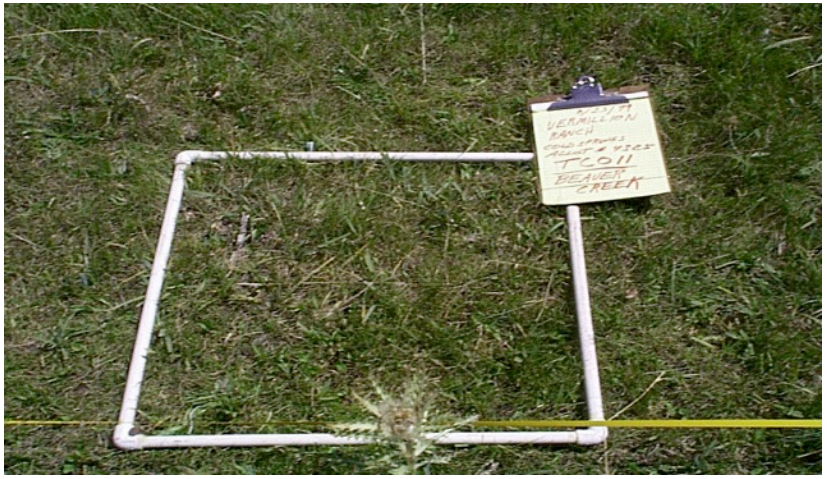


Figure 3: The first plot on a transect. [This sample plot lies in Colorado.]

When all 10 plots have been evaluated, the scores for each indicator are tallied. Using the litter distribution indicator example, the scores may read 4, 3, 5, 2, 4, etc. up to ten plots. Assume that this indicator's score totaled 36. (If all plots received a "5", a perfect score would be achieved at 50 points.) Then, multiply this score by two. This allows the indicator's score to be plotted on the target (Figure 4) for visual portrayal on a 100 point scale. In the example, litter distribution would receive a 72 for its score. This indicator would be plotted on the Web at the 72 mark, which lies in the silver target zone. Using the colors of the Olympics, gold is preferred, silver in the mid range, and bronze is least desired.

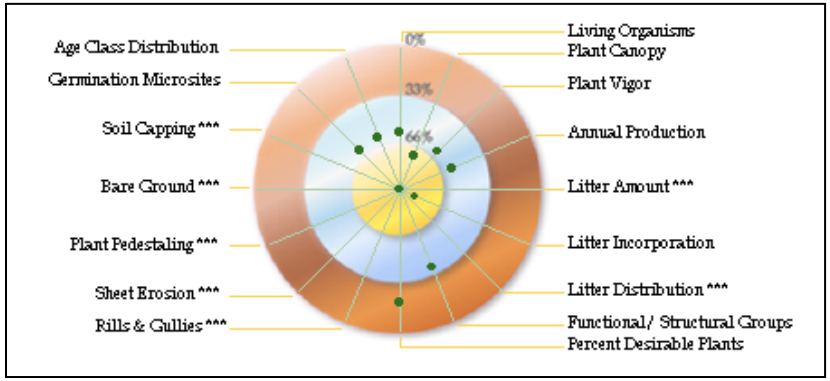


Figure 4: The target portrays results of each of the 16 indicators studied based on field scores.

An overall site score is then sought. This score is calculated by averaging the total score for each of the 16 indicators. For example, adding the scores for all 16 indicators together may produce a total of 1456. By

dividing this figure by 16, an overall site score of 91 is achieved. The overall site score will be displayed in the "Additional Information" box. This figure will change through time, and progress toward the stated landscape description goal can be tracked.

Additionally, the 14 indicators of rangeland health provide information for making management decisions. This report provides a brief narrative on how each indicator was evaluated and what management recommendations arose through their evaluation.

The Wyoming State Range Site Guide suggests potential production for each site. The site's average-year production figure was used to produce the bar graph featured in Figure 5 to the right. A single plot was clipped at each site. The clipped plants were dried, and then weighed. The resulting weight in pounds per acre is displayed as the "today" figure.

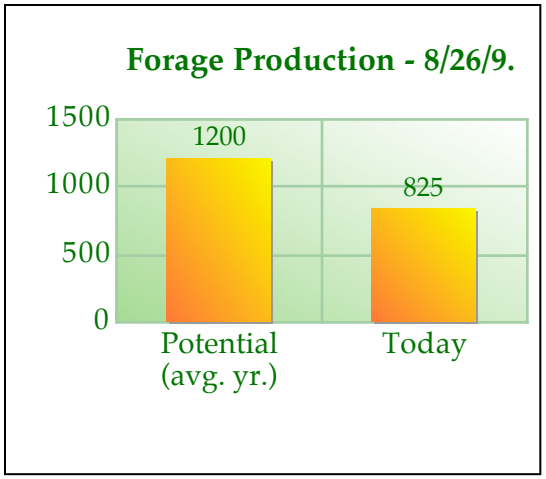


Figure 5: Plant production on sample day as compared with the site's potential from the soil survey.

While looking in each study plot, that species estimated to be most abundant by weight is evaluated. A value of "5" is then assigned for that species. The next most abundant by weight received a "4" and so on until the five most abundant species by weight have been recorded. The procedure is repeated for all 10 study plots. The percentage composition of each species is calculated based on its scoring versus other species encountered in the plots. The most abundant will have the highest scores and the highest percentage composition. A chart with the five heaviest species is then generated like the one featured in Figure 6 below.

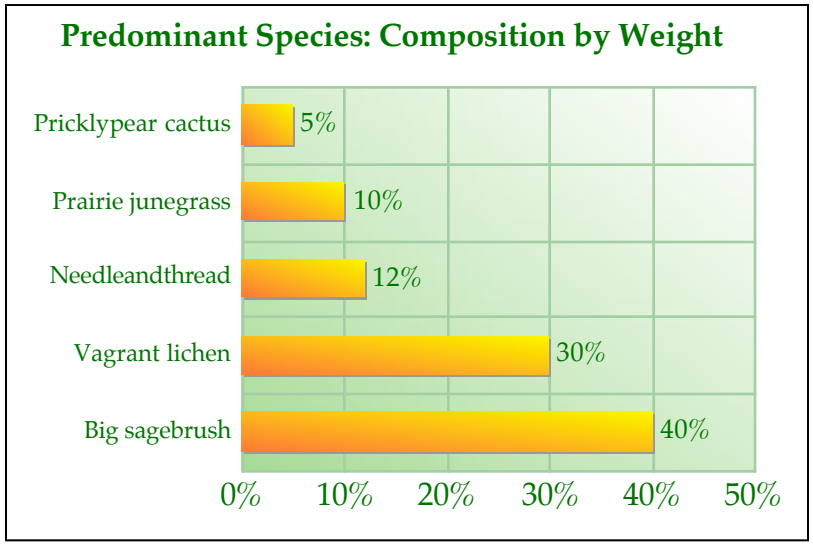


Figure 6: The most abundant species as composition by weight.

A sample of forage plants most likely to be selected by cattle is sent to Midwest Labs, Inc. in Omaha, Nebraska. The nutrient analysis returned is presented in the body of this report.

The procedure also uses the 200-foot tape measure as a base for collecting information such as ground cover and basal plant spacing. Using the point intercept method, a steel rod is lowered to the soil surface every other foot along the 200-foot tape measure. At each point, ground cover is classed as bare soil, litter, or live plant cover. After examining all 100 points, the percentage of each class is calculated. A pie chart is generated portraying the results (Figure 7).

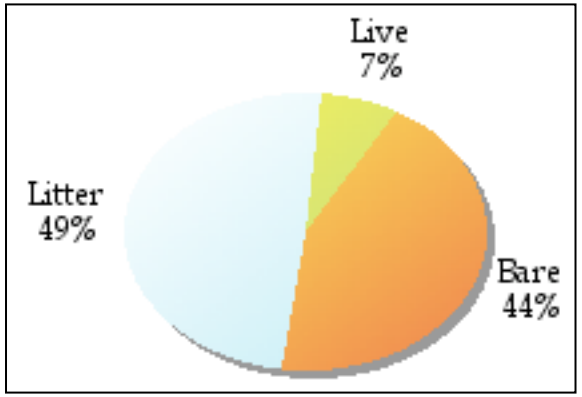


Figure 7: The ground cover chart generated by using the point intercept method.

At each point ground cover data was collected, data on basal cover by plant species was gathered. When the point intercept rod was lowered to the soil surface, the distance to the nearest perennial plant was measured (see photo in Figure 8). The average distance for all 100 points is calculated and the average distance to nearest perennial figure is found and displayed in the "Additional Information" box. Simultaneously, this nearest plant's species was recorded. The seven species representing the closest perennial plants are portrayed in the "Basal Cover by Species" bar graph (Figure 9).

Figure 8: This photo shows the point intercept method. A steel rod is lowered to the soil surface every other foot along the transect line. The tip of the rod may strike bare soil, litter, rock, or live plant cover, and this data point is collected. Additionally, the distance to the nearest perennial plant is measured. In this photo, the nearest plant from the yellow tape measure is 3 cm away from the steel rod. Averaging all data points along the transect generates the relative basal plant spacing figure shown in this document. Lastly, that nearest plant's species is recorded (Western wheatgrass is the stem seen growing at the 3 cm mark on the red ruler). This generates the basal cover by species graph shown in Figure 9.

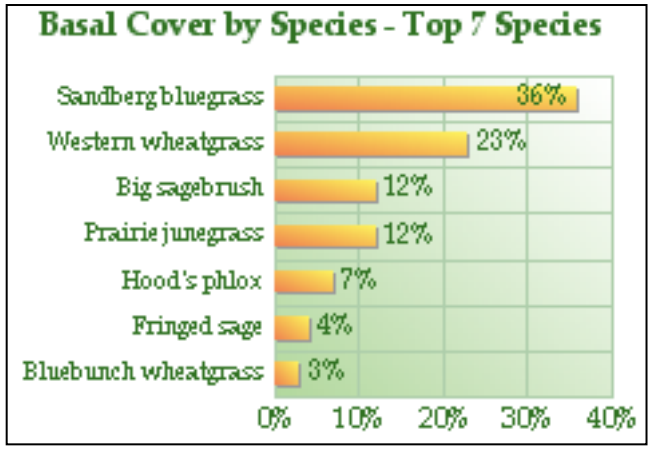


Figure 9: Basal cover by species bar graph created by measuring the distance to the nearest perennial plant using the point intercept method. The seven most numerous species are displayed here.

This means of collecting basal cover by species data was developed by Holistic Management International in Albuquerque, NM.

The scoring guides used to evaluate rangeland health indicators may be seen on the following pages.

SCORING GUIDE SIDE 1

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
1	Bare Ground*	Amount and size of bare areas nearly to totally match that expected/ desired for site.	Amount and size of bare areas higher and larger than expected/desired for site. Bare areas may be large and sporadically connected.	Amount and size of bare areas are much higher and larger than expected/desired for site. Bare areas are generally connected.
2	Erosion	Little to no evidence of wind or water erosion, including desert pavement, rills, and/or gullies.	Some signs of soil loss, including formation of desert pavement, rills, and/or gullies.	Soil is actively leaving the site. Advanced formation of desert pavement, rills, and/or gullies may be seen.
3	Plant Pedestaling	No to minimal plant pedestals present.	Some to moderate plant pedestals present. No signs of exposed roots.	Plant pedestaling obvious and tall. Root exposure seen.
4	Litter Amount*	Amount of litter nearly to totally matches that expected/ desired for site.	Amount of litter less than that expected/desired for site.	Amount of litter much lower than expected/desired for site.
5	Litter Distribution	Litter is uniformly distributed across plot.	Less uniformity of litter distribution. Litter may be becoming associated with prominent plants or other obstructions.	Litter distribution not uniform. This may be due to general lack of litter and/or obvious patchy appearance of litter amount.
6	Litter Incorporation	Litter mixing well with soil, resulting in more rapid mineral cycle.	Some mixing of litter with soil. Litter may be elevated and its amount may be reduced. Mineral cycle not as rapid.	Litter not mixing with soil. Litter may be elevated and/or amount too little. Mineral cycle slower.
7	Dung Breakdown/ Incorporation	Dung breaking down rapidly, less than one year old.	Some dung breakdown, with most being around 2 years old.	Dung breaking down slowly, older than 2 years old.

*Refer to ecological site descriptions available from NRCS

SCORING GUIDE SIDE 2

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
8	Percent Desirable Plants*	Greater than 66% of plants in the area are desired. Remainder of plants are intermediate species (neither desired, nor undesired).	33% to 66% of plants species in the area are desired. Intermediate species (neither desired, nor undesired) have strong presence. Potential presence of undesired species.	Less than 33% of plant species in the area are desired. Intermediate plant species (neither desired, nor undesired) dominate. Undesired species also present.
9	Age Class Distribution	Variety of age classes seen in the area (seedling, young, mature, decadent).	More mature age classes present, seedlings and young mostly lacking.	Primarily old and/or deteriorating plants present.
10	Plant Species Diversity & Functionality*	Number of plant species in the area matches that expected for site. Plant forms (grass, shrub, forb, tree) also match that expected for site. Plants serving different functions.	Number of plant species in the area below that expected for site plant forms (grass, forb, shrub) reduced. Reduced functionality.	Number of plant species the area minimal. Plant forms (grass, forb, shrub) much below that expected for site. Poor functionality.
11	Living Organisms	Abundant signs of non-plant life.	Few to moderate signs of non-plant life. Something is missing from community.	Next to no signs of non-plant life. Components of the ecosystem are clearly missing.
12	Plant Canopy	Strong photosynthetic activity in the area. Canopy may cover greater than 66% of area.	Moderate photosynthetic activity in the area. Canopy may cover 33-66% of area.	Reduced photosynthetic activity in the area. Canopy may cover less than 33% of area.
13	Plant Vigor/ Color	Capability to reproduce (seed or vegetatively) not limited relative to recent climatic conditions. Growing plant exhibits bright green color.	Capability to reproduce (seed or vegetatively) is somewhat limited relative to recent climatic conditions. Growing plant exhibits pale green or may be yellowing.	Capability to reproduce (seed or vegetatively) is severely reduced relative to recent climatic conditions. Growing plant exhibits sickly yellow coloration.
14	Plant Distribution	Plants uniformly distributed across soil surface.	Distribution becoming fragmented, but some areas of uniformity.	Distribution obviously fragmented.

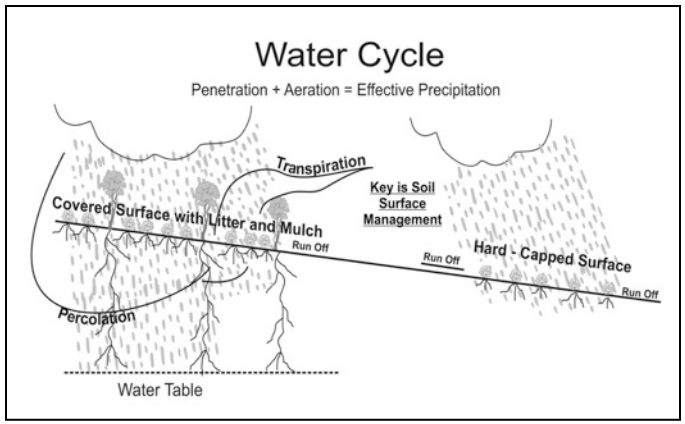
*Refer to ecological site descriptions available from NRCS

RANGELAND HEALTH

In its 1994 report Rangeland Health, the National Research Council defined rangeland health as the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained. Range in good health produces more forage and better wildlife habitat, while watershed condition is improved, resulting in more stable stream flows and higher water quality (NRC, 1994). Healthy range generally supports more plant and animal diversity and provides greater ecological stability in terms of productivity and population flux.

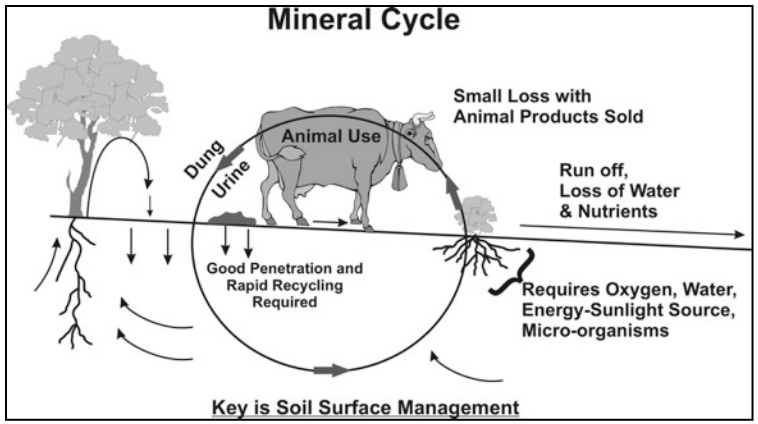
The monitoring methods used here were intended to observe changes in rangeland health through time. Both qualitative observations and quantitative methods were employed. Both are intended to provide decision-making information to land managers. Methods used in generation of this report are aligned with the findings with the Rangeland Health document.

The following pages visually describe the ecosystem process described in this report. They are the water cycle, mineral cycle, community dynamics (succession) and energy flow.



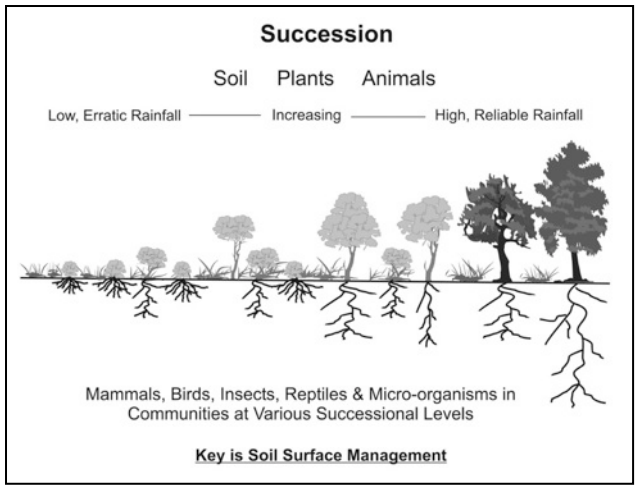
An effective water cycle requires covered soil and high biodiversity. When effective, most water soaks in quickly where it falls. Later, it's released slowly through plants that transpire it, or through rivers, springs, and aquifers that collect through seepage what the plants don't take. When biodiversity is reduced and soil exposed, much water runs off as floods. What little soaks in is released rapidly from evaporation which draws moisture back up through the soil surface (Savory, 1993).

The water cycle will be described as either being "effective," or "ineffective." If the water cycle is effective, then precipitation appeared to be moving into the soil. Conversely, an ineffective water cycle would display signs of water leaving the site, including signs of erosion, plant pedestaling, and soil capping.



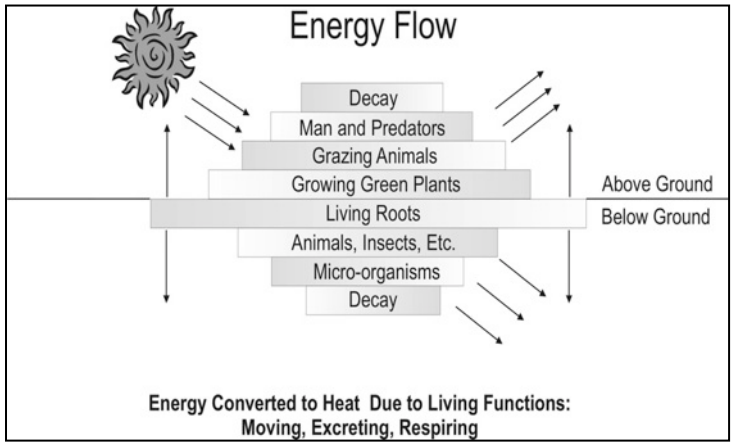
Like the water cycle, an effective and rapid mineral cycle requires covered soil and high biodiversity. When effective, many nutrients cycle between living plants and living soil continually. When soil is exposed and biodiversity low, nutrients become trapped at various points in the cycle, or are lost to wind and water erosion (Savory, 1993).

The *speed* of the mineral cycle will be described. If the cycle is moving slowly, then nutrients are not moving back into the system. An indicator of this would be past plant growth (known as "litter") either elevated above the soil surface or lying idly on the soil surface that is oxidizing rather than breaking down. Ideally, litter should contact the soil surface where soil-borne organisms of decay may begin decomposition and speed the re-utilization of nutrients in the system.



With few exceptions, communities strive to develop toward ever-greater complexity, and thus stability. From unstable bare ground, where biodiversity is low, stable complex range or forest communities, high in biodiversity develop over time (Savory, 1993). This is succession.

Monitoring will describe plant species found at each sample site, for plants help characterize past management actions and help shape expectations for both pasture and livestock performance. Plants will be classified as high seral, meaning desirable, mid seral, meaning neither really desired nor undesired, and low seral, meaning weedy or less desired species. Importantly, indicators like seedlings and young plants of different species portray expected changes in the plant community to be witnessed in coming years. These further shape management expectations.



Almost all life requires energy that flows daily from the sun. The basic conversion of this solar energy to useable form takes place through plant material on land and in water. Energy passes from plants to whatever eats them, and in turn eats the consumers of plants. Energy doesn't cycle, but flows through the ecosystem until it's consumed (Savory, 1993).

Energy flow will be described as functioning at "elevated," "moderate," or "reduced" levels. Energy flow at elevated levels suggests that much solar energy was being captured by living plants and that much photosynthesis was occurring. Conversely, reduced energy flow suggests that much sunlight energy was striking the soil surface and not being captured.

LITERATURE CITED

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