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MERLIN RANCH

2007 RANGELAND MONITORING REPORT

Prepared for
Merlin Ranch

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TABLE OF CONTENTS

INTRODUCTION

This document presents the findings of three rangeland health monitoring transects from data collected on Merlin Ranch in August 2007. The work presents a continuation of a monitoring effort Merlin began in 2005 to track changes in rangeland health through time. Further, Merlin Ranch will use these findings for directing management action toward improved rangeland health, wildlife habitat, and potential for profitability.

The three study sites were located in the Hall Pasture, Tipperary Pasture, and Three Section Pasture. The study in the Hall involved re-reading a transect established there in 2005, while the other two were new. Another transect also established in 2005 was located in the Hall Homestead Pasture.

Data collected at the Hall Pasture site will first be displayed and a narrative detailing the findings will be provided. Function of four fundamental ecosystem processes (water cycle, mineral cycle, succession, and energy flow) will be analyzed and discussed. See the methods section for a visual description of these four processes. Following that, data from both 2005 and 2007 will be displayed side-by-side and compared, along with site photos from both years. Range trend and management recommendations will conclude this site's analysis.

Next, information gathered at the Tipperary and Three Section sites will follow. An analysis of function of the four ecosystem processes will be included, along with management recommendations.

Clippings were taken at each site and results sent to a lab for nutrient analyses. Results for the forage tests will be compared with the needs of a lactating 1100-pound cow and management recommendations derived.

A methods section ends the report that details data collection techniques for further clarification.

This monitoring report is presented to Merlin Ranch for improved rangeland health and decision making.

SUMMARY OF FINDINGS AND MANAGEMENT RECOMMENDATIONS PRESENTED IN THIS REPORT

Hall Pasture

The amount of bare soil declined by a few percentage points between the two sample years, and both litter and live cover increased. These are all positive signs. Plant productivity climbed, but was well below the site's potential. Density of big sagebrush declined and overall canopy dropped. Simultaneously, the number of decadent big sage plants increased, suggesting that these more mature big sage plants may be failing in the plant community. The desired plant species were found in the area, but not in abundance. The undesired species of cheatgrass and Japanese brome grew prominently in both sample years. Other than slow decay of sagebrush, the community appeared to be in a stable state with minimal signs of change.

Management should consider a vegetative treatment of sagebrush in the area. Options should include herbicide or a traditional brush beater. Cost considerations should play heavily in the analysis of this decision. Management should not consider the Lawson Renovator used on other portions of the ranch. The Lawson machine was intended to disturb a soil crust and sod-bound soils. Crusted soils in the area were not so severe that they warrant mechanical disturbance, and the grass, forbs, and shrubs of the plant community were not sod bound. Such a vegetative treatment should result in improvements in plant vigor and species composition.

Tipperary

The Tipperary Pasture study site was located between water points in shallow, loamy soils. The site was also located on a mild slope. Fifty-two percent of the soil was bare at this site. This is a high number that can be reduced. Some signs of wind erosion were present. Plant production was well below the site's potential. Desired plant species were present in the area, but not in the abundance desired. The favored plant bluebunch wheatgrass was prominent, but the invasive Japanese brome was as well. Thirty-one plant species were found at the site, a high number for an arid site such as Tipperary.

Species such as blue grama and threadleaf sedge were encountered in abundance. These rhizomatous grasses thrive under conditions where other bunchgrasses cannot. These conditions are often associated with plant recovery periods that are too short. Bunchgrasses need lengthy recovery times to replenish reserves from being bitten. Lacking that, they are subject to competitive pressures from rhizomatous plants that favor shorter recovery periods. The greatest means of improving land health at this site is to lengthen recovery periods between grazings. In this way, the desired perennial bunchgrasses may become more prominent.

Three Section

This site was located near the middle of the Three Section Pasture on shallow loamy soils. The amount of bare soil was low at 16%. Age class of big sagebrush plants was 100% mature. Annual production was well below the site's potential. Desired perennial bunchgrasses such as needleandthread and green needlegrass were present, but not in abundance. Undesired species such as

Japanese brome and cheatgrass were prominent in the community. Leafy spurge was not found. Twenty-five total plant species were encountered at the site, which is a high number for this arid site.

As at the Tipperary site above, the greatest means for improving land health in this area is by increasing the recovery periods between grazings. See management discussion below.

Further Management Discussion

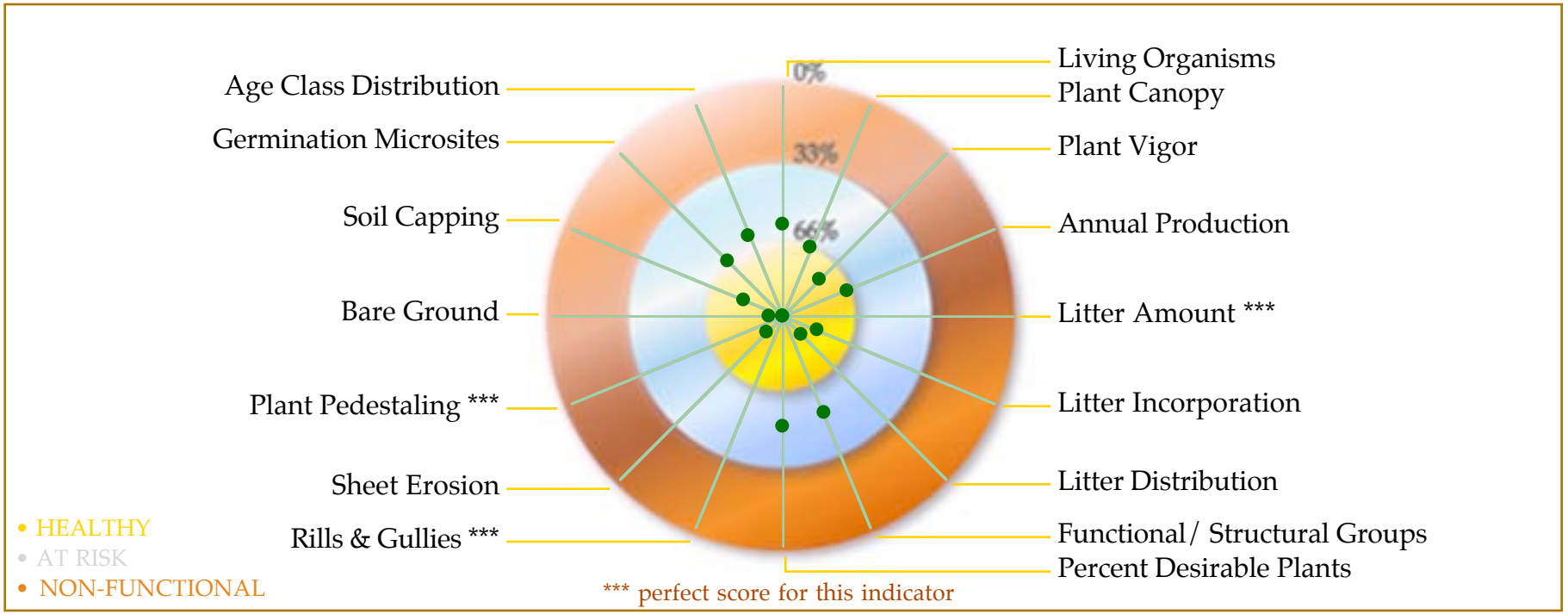
The best means of improving rangeland health in pastures such as Tipperary and Three Section lies in extending recovery periods between grazing events. Species such as threadleaf sedge and blue grama appear to have a competitive advantage over desired bunchgrasses such as bluebunch wheatgrass, green needlegrass, and needleandthread. The bunchgrasses are preferred due to their deeper root systems and productive capacity. They are also plants that need a long recovery period between grazings to replenish lost leaf material from a grazing event.

Management should consider extending recovery times between grazings even in excess of one year's time. This means that if a pasture plant is grazed in the early season one year, it may not be grazed again until later in the season of the following year. In a best-case scenario, plants in Pasture A would be grazed in the very early growing season, prior to the spring fast growth period. Cattle would move onto other pastures, and would not return to graze Pasture A until after fast growth the following year. The result for plants in Pasture A would be two uninterrupted fast growth periods where the desired perennial bunchgrasses would produce vigorous root structures and leaf material. They may then be grazed at moderate levels where livestock take a bite, but leave plenty of plant material that may then fall to the soil surface as litter. Litter will help cover remaining bare soil and trap rainfall and melting snow. More vigorous bunchgrasses may then have a competitive advantage over less desired plants like cheatgrass and Japanese brome.

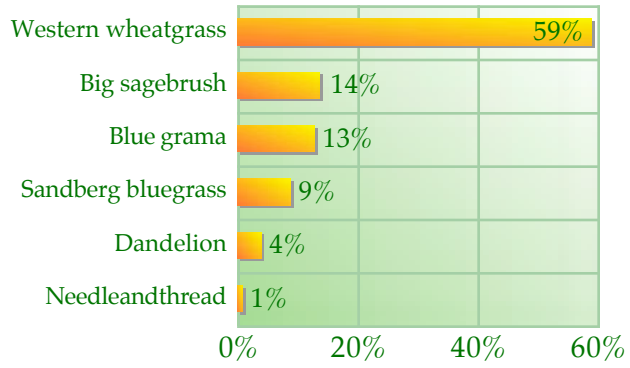
Adhering to this recommendation would mean grazing plants once per season. In light of the reduced precipitation levels the area has known since the late 1990s, plants may need the additional recovery time anyway. Management should provide this recovery time until the plants are displaying better vigor and species composition at the ranch's study sites moves toward a more favorable species mix. At that time, management may begin exploring additional grazing events in the same season, but not until the more desired plants become prominent in the community.

Stocking rates may also need to be adjusted while the perennial bunchgrasses improve in vigor. Management should seek a balance between grazing utilization (manage for moderate use) and lengthy recovery periods between grazings while grazing a pasture once per season. In time, as species composition improves, stocking rate may be able to be adjusted upward. Look to improved ground cover, plant vigor, and finally species composition as signals that improvement is being realized.

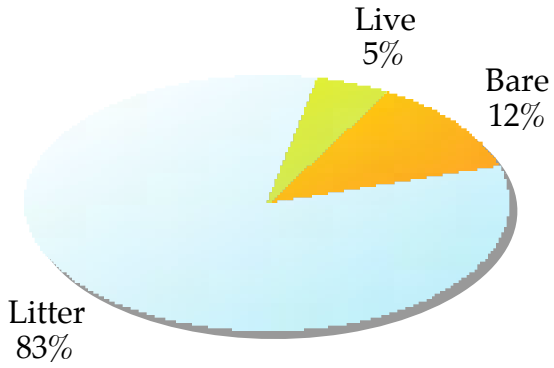
Hall Pasture **Transect MRT07** **Loamy range site;**



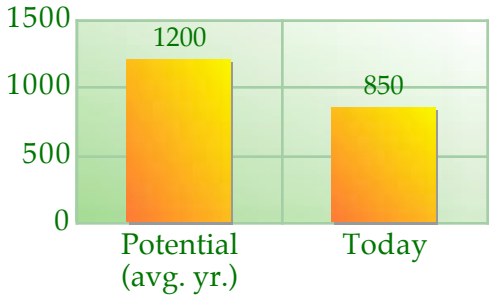
Basal Cover by Species - Top 6 Species



2007 Basal Cover



Forage Production



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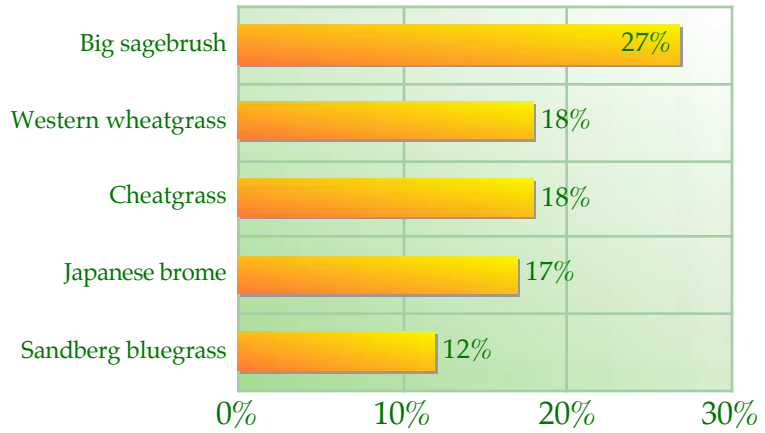
Hall Pasture **Transect MRT07** **Loamy range site;**

Predominant Species: Composition by Weight



Additional Info: Overall Site Score: **78**

Apparent range trend:

Site sampled August 17, 2007.

UTM Coordinates: 13T 00375390 4915369

24 plant species found at site.

Big sagebrush data:
Line intercept: 43 plants encountered, 32% canopy cover.
Average plant height: 28 inches.
93% mature plants, 7% decadent plants.
Belt transect: 99 big sage plants growing in 1000 square feet.

Relative basal plant spacing: 2.1 inches.

Plant species encountered at site:

Japanese brome
Cheatgrass
Western wheatgrass
Blue grama
Sandberg bluegrass
Cusick bluegrass
Prairie junegrass
Sixweeksgrass
Needleandthread
Lepidium species
Tansymustard
Dandelion
Clover species
Scarlet globemallow
Vagrant lichen
Pennycress
Woolly plantain
Winterfat
Pricklypear cactus
Western yarrow
Fringed sage
Big sagebrush
Silver sagebrush
1 unknown perennial forb

Merlin Ranch

Hall Pasture (Transect MRT07)

This transect was located in an area intended to be impacted with a Lawson Renovator, whose purpose was to disturb sagebrush in the area and invigorate other plants. The Renovator was not used in the pasture. This transect was originally located in an area in 2005 where sagebrush growth appeared to be heavier than in other parts of the pasture, and plant species diversity was reduced.

The first plot studied at the Hall Pasture site.

The first indicator studied was **living organisms**. At the site, we recorded either seeing, or seeing signs of the following: flies, ants, exoskeletons from insects, grasshoppers, meadow larks, golden eagle, various songbirds, badger, rabbits, and pronghorn. This indicator received an 80.

The site's **plant canopy** was composed largely of big sagebrush and cheatgrass. Much sunlight was captured by plant leaves, rather thank striking the soil surface. In some plots where sage and cheatgrass were more limited, sunlight readily struck the soil surface. This indicator received a 68.

Plant vigor received a high score at 78. Species such as Western wheatgrass, blue grama, and needleandthread were green and actively growing, although few of these plants had produced seed. Species such as Sandberg bluegrass, a grass that thrives in the early growing season, had achieved tall stature, produced seed, and gone dormant by sample day. Leader growth on big sagebrush plants was eight to 10 inches.

The Wyoming State Range Site Guides suggest potential **production** at this site should be 1200 pounds per acre in an average year. A single plot was clipped on sample day, whose dry weight was 850 pounds per acre, or significantly under the site's potential. As can be seen on the "Composition by Weight" table, much of this site's production was composed of big sagebrush and cheatgrass. No signs of utilization were recorded as of sample day.

Abundant **litter** was found on the soil surface. Litter amount received a perfect score.

Over most of the study plots, litter was **incorporating** well with soil. When digging a finger into the soil surface, it was often difficult to determine where litter ended and soil began, suggesting that litter was mixing rapidly, making the mineral cycle more rapid. This indicator received an 84.

Litter was well **distributed** over most of the study plots. In a few plots, it was slightly patchy. This indicator received an 88.

The **functional and structural groups** indicator examines the number of species found in a study plot and their growth form (grass, forb, shrub). Different growth forms have varied plant canopies that catch wind-driven snow and shade the soil surface. Underground, the different root structures elevate nutrients stored at different levels of the soil profile. At Tipperary, 4 to 9 plant species were present in most study plots. This indicator received a 54. Additional grass species and forbs are desired to elevate this indicator's score.

Most of the plant species found in the study plots were either undesired (cheatgrass or Japanese brome) or intermediates (blue grama, tansymustard). The **percent desired plants** indicator received a 52.

No signs of water erosion were found. **Rills and gullies** received a perfect score.

Some signs of sheet erosion were found on this minor slope. **Scouring and sheet erosion** received a 90 for its sdore. However, this sheet erosion was not so severe that it led to plant **pedestaling**, an indicator that received a perfect score.

The amount of **bare ground** varied in the plots. Some contained nearly no bare soil, while others contained some exposed areas. This indicator received a high score at 94.

Some of the study plots contained no **soil crust**, while others contained a crust that appeared to be older, well developed, and quite thick. This indicator received an 82.

Germination microsites are those areas on the soil surface where a new plant can find a start on life. At the Hall Pasture, new germination success would have been limited by the thick soil crust found at some sites, plus competition for resources from other species such as cheatgrass. This indicator received a 66.

Plant **age classes** are broken into seedlings, young, mature, and decadent plants. Most of the plots contained only mature plants, but a few contained both mature and decadent sagebrush plants. This indicator received a 62. When walking the area, the site did appear to contain an even-aged stand of sagebrush, with some decadent plants observed.

Additional comments:
Energy flow was at moderate levels on this site, with much sunlight energy striking the soil surface, but much also being intercepted by living plant leaves. The mineral cycle appeared to be rapid, with good litter amount and mixing of litter with the soil surface. The water cycle was mostly effective. No signs of water erosion were observed, but some signs of wind erosion were found. Within community dynamics, undesired species such as cheatgrass and Japanese brome were found in abundance. Desired grasses were found in the area, but not in the abundance desired. The community appeared to be in a stable state with minimal signs of change.

Hall Pasture **MRT07**

BIG SAGEBRUSH DATA

2005	2007	
		Line intercept:
56	43	*Number of big sage plants encountered*
		Line Intercept: Age Class Distribution
0%	0%	seedling
0%	0%	young
95%	93%	mature
5%	7%	decadent
26 inch	28 inch	*Average plant height*
48%	32%	*Percent canopy cover*
103	99	*Density per 1000 square feet*

PRODUCTION: Pounds per acre

2005	2007
670	850

ADDITIONAL INFORMATION

Site sampled September 4, 2005.
Site sampled August 17, 2007.

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

2005		2007	
Big sagebrush	32%	Big sagebrush	27%
Western wheatgrass	21%	Western wheatgrass	18%
Blue grama	11%	Cheatgrass	18%
Japanese brome	11%	Japanese brome	17%
Cheatgrass	9%	Sandberg bluegrass	12%

BASAL COVER

2005	2007	
19%	12%	Bare
79%	83%	Litter
2%	5%	Live

RELATIVE BASAL PLANT SPACING

2005	2007
1.6 inch	2.1 inch

RELATIVE BASAL PLANT SPACING BY SPECIES (Top 7 species for 2005, with total encountered for 2007)

2005		2007	
Western wheatgrass	60%	Western wheatgrass	59%
Sandberg bluegrass	14%	Big sagebrush	14%
Big sagebrush	13%	Blue grama	13%
Blue grama	9%	Sandberg bluegrass	9%
Western yarrow	2%	Dandelion	4%
Pricklypear cactus	1%	Needleandthread	1%
Cusick bluegrass	1%		

PLANT SPECIES FOUND IN TRANSECT AREA

2005	2007	
21	***24***	***Total count***
X	X	Japanese brome
X	X	Cusick bluegrass
X	X	Cheatgrass
X	X	Western wheatgrass
X	X	Blue grama
X	X	Needleandthread
X		Threadleaf sedge
X	X	Prairie junegrass
X	X	Sixweeksgrass
X	X	Sandberg bluegrass
X	X	Silver sagebrush
X	X	Big sagebrush
X	X	Winterfat
X	X	Lepidium
X	X	Pricklypear cactus
X	X	Western yarrow
X	X	Tansymustard
X	X	Vagrant lichen
X	X	Scarlet globemallow
X	X	Dandelion
1	1	Unknown perennial forbs
	X	Clover species
	X	Pennycress
	X	Woolly plantain
	X	Fringed sage

DISCUSSION OF HALL PASTURE DATA BETWEEN 2005 AND 2007.

Photos

See the site photo comparisons between the two years. A first glance shows the significant increase in plant canopy between the two years. Much of this canopy is increased presence of cheatgrass during the wet spring of 2007. The transect line photos also show much less sagebrush canopy in 2007 versus 2005. Look specifically toward the left side of the photo in the foreground. Sagebrush plants seen there in 2005 either appear to be missing, or decadent in 2007.

The same can be said for the sagebrush plant in the quadrat photos found at the bottom of the shot in 2005. That plant is still there in 2007, but is dying. This, accompanied by the data collected in the two years, signals a trend in the sagebrush community. The quadrat photo also shows the strong plant canopy found in 2007. Much of the growth seen in the 2007 photo is cheatgrass and Sandberg bluegrass.

Sagebrush data

The number of big sagebrush plants in this community was declining, as seen on both the line intercept and the belt transect. Further, the percent canopy declined by 16 percentage points, which is a significant drop over two years' time. Note, however, that the average plant height increased. This is likely due to the good moisture year of 2007. Had 2007 been dry, the reduction in canopy cover would likely have been greater.

Sagebrush in this area appears to be even aged and perhaps in decline. Through time, management should watch the change in vegetation in this area if big sage were to lose its grip on the community. If sagebrush begins dying back here, forbs and grasses may become much more prominent in the community.

Production

In both sample years, production was below the site's potential. This is likely due to two factors. First, the series of dry years combined to limit plant growth. Plants will take time to recover from reduced moisture. Second, the more mature and aging sagebrush stand did not appear to have the productive capacity it may have had in the past. In a plant community such as found at this site, sagebrush should be a large contributor to overall production. The older stand of sage may be inhibiting the growth of other grasses and forbs. Should the big sage community begin dying back, watch for increases in production of grasses, forbs, and new sagebrush plants.

Composition by weight

Big sagebrush and Western wheatgrass were the most productive plant species in both years. These species account for roughly half the site's production, when compared with other plant species. As stated earlier, cheatgrass and Sandberg bluegrass both had strong years, likely due to the wet spring.

Basal cover

The percent bare ground dropped by seven percentage points between the two sample years.. This is a positive sign. After the wet year of 2007, much plant growth was available to serve as a litter source and may fall to the ground to cover the remaining bare soil. The percent live cover increased by three percentage points. This is also a

positive sign. As stated above, should the big sage community falter in this area, new plants may find opportunities to grow where big sage had inhibited them previously. The percent live cover may jump significantly should a turnover in the big sage community occur.

Relative basal plant spacing
The distance to the nearest perennial plant increased by 0.5 inches between the two years. This number is significant and means that the density of plants had decreased (fewer perennial plants were found on the soil surface in 2007). This requires management attention (see management discussion below).

Relative basal spacing by species
Western wheatgrass was again the most abundant perennial plant found on the soil surface (by far, consisting of nearly 2/3 of the hits), as it was in 2005. The number of Sandberg bluegrass plants had increased during the two years. This is a species that will thrive with wet springs. The number of blue grama plants encountered increased slightly, while forbs changed places in the list of most abundant species found on the soil surface.

Plant species list
Four more plant species were found in 2007 than 2005. The species not encountered in 2007 was threadleaf sedge. We cannot explain why this species was not seen in 2007. Those species found in 2007, but not in 2005, were mostly forbs. This is a positive sign.

Range trend
Trend here was stable.

Management recommendations
Some aspects of this site changed slightly between the two sample years, but, for the most part, it changed little. This site appears to have achieved a stable state and may change little through time. Nature may change the site with such affects as fire or severe drought, but little else may change the character of this site. The driver of change here will be shifts in the big sagebrush community. That species, while desired at this site, is the dominant plant and controls much of the moisture available to plants.

Toward the goal of improving vegetative diversity, different age class distribution of sagebrush, improved grass production, and improved wildlife habitat, management should consider a vegetative sagebrush treatment. This may be herbicide or mechanical treatment, but this site, as well as the surrounding pasture, would benefit from disturbance of the sagebrush community.

In making this recommendation, we caution against using the Lawson Renovator here. That tool greatly disturbs the soil surface. Indicators sampled in both study years suggest that the soil was already pliable and able to receive moisture. Further, the soil did not appear to be sod bound. It may be that the Lawson machine would increase presence of cheatgrass in these pastures due to how it disturbs the surface.

Rather than such an intense disturbance of the surface, management should consider a more traditional brush beater, or even herbicide applications to manipulate

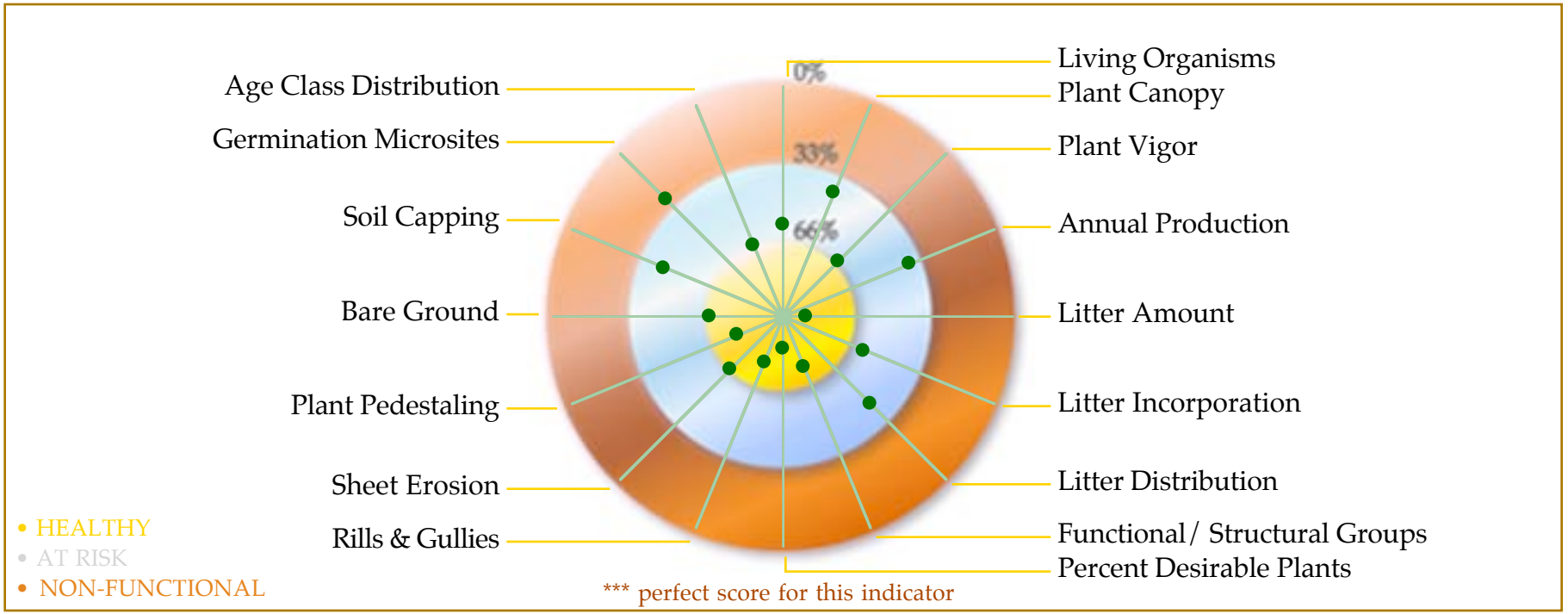
sagebrush in the area. Cost of application should be a major factor in making this determination.

If a vegetative treatment were to occur in this area, recovery time must be given to treated plants. It would not be necessary to rest this pasture or remove it from grazing. Rather, grazing durations should be kept short and plants utilized at moderate levels to further their propagation in the community.

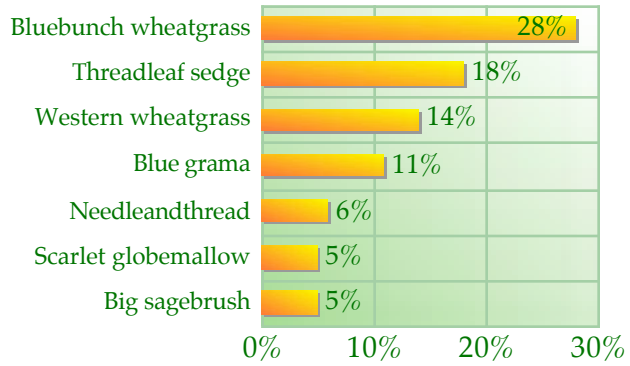
Early-warning indicators
Should management implement a vegetative treatment, and then graze the pasture, improper implementation of the tool would first be seen with these indicators. Reduced plant vigor of desired perennial bunchgrasses would result. This would suggest grazing durations that are too long and/or plant recovery periods that are too short. Increased bare ground would result after three to four years following the treatment. Increased erosion, likely from water movement, would then follow. Productivity would then drop.

If a vegetative treatment and subsequent grazing were properly implemented, plant vigor should increase. Both litter and live cover should climb. Plant productivity should increase and desired changes in species composition should result.

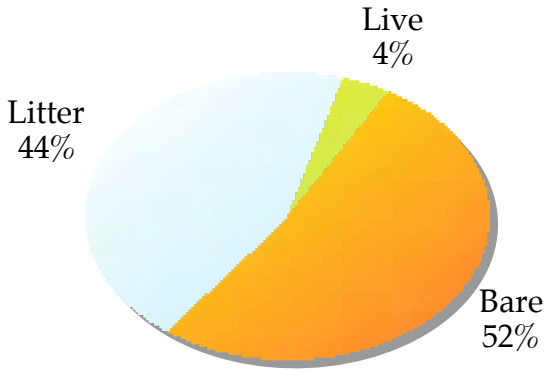
Tipperary **Transect MRT10** **Shallow loamy range site;**



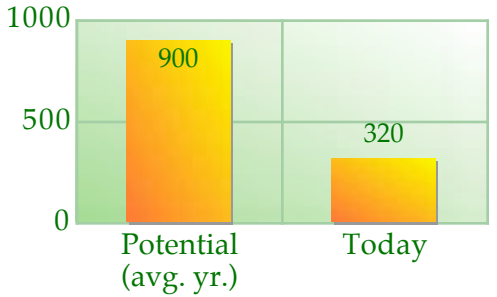
Basal Cover by Species - Top 7 Species



2007 Basal Cover



Forage Production



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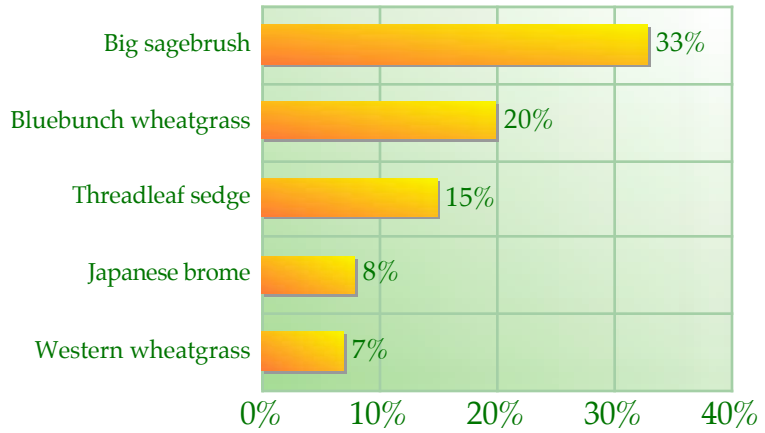
Tipperary **Transect MRT10** **Shallow loamy range site;**

Predominant Species: Composition by Weight



Additional Info: Overall Site Score: **62**

Apparent range trend:

Site sampled August 16, 2007.

UTM Coordinates: 13T 0379330 4917678

31 plant species found at site.

Big sagebrush data:
Line intercept: 35 plants encountered, 19% canopy cover.
Average plant height: 15.2 inches.
100% mature plants.
Belt transect: 127 plants growing in 1000 square feet.

Relative basal plant spacing: 1.8 inches.

Plant species encountered at site:

Cheatgrass
Japanese brome
Bluebunch wheatgrass
Threadleaf sedge
Western wheatgrass
Blue grama
Sandberg bluegrass
Kentucky bluegrass
Needleandthread
Prairie junegrass
Scarlet globemallow
Pricklypear cactus
Stickseed
Lepidium
Hood's phlox
Vetch species
Woolly plantain
Clover species
Senecio species
Aster species
Mustard species
Tansy mustard
Nailwort
Vagrant lichen
Salsify
2 unknown perennial forbs
Broom snakeweed
Big sagebrush
Fringed sage
Douglas rabbitbrush

Merlin Ranch

Tipperary (Transect MRT10)

This site was located in the Tipperary Pasture between water points. The site lies on a mild slope with more shallow soils. The site was chosen to be representative of the area.

The first plot studied at Tipperary.

The first indicator studied was **living organisms** where signs of the following species were recorded: pronghorn, rabbits, meadowlarks, golden eagle, flies, ants, and grasshoppers. This indicator received a 60 for its score.

The **plant canopy** was light at this site, allowing much sunlight energy to strike the soil surface, rather than being intercepted by desired plant leaves. This indicator received a 42.

Vigor of sagebrush was high, with leader growth of 6 to 8 inches. Desired perennial bunchgrasses appeared to be green and growing on sample day, but few had produced seed, nor were they of tall stature. This indicator received a 66.

The Wyoming State Range Site Guides suggest that **plant production** should be 900 pounds per acre on this shallow loamy site (USDA, 1990). A single plot was clipped at the Tipperary site that produced 320 pounds per acre, which is well below the desired level for this site. This indicator received a 40.

The **amount of litter** found in the plots varied greatly. Some plots contained much litter, while others contained very little. This indicator received a 90. The point intercept method revealed that 44% of the surface was covered by litter. This is an amount that can be increased.

Litter was touching the soil surface in most study plots, but was not mixing well with soil. **Litter incorporation** received a 62.

In those plots where litter was not abundant, litter was not well **distributed** across the soil surface. This indicator received a 46.

When examining **functional and structural groups**, investigators are asked to count the number of plant species found within a plot, as well as the growth form of that plant (grass, forb, shrub). At Tipperary, each plot usually had 10 plant species or more, many of different growth forms. This indicator received a 76.

The **desired plant species** were abundant in most of the plots. Japanese brome was the only undesired species encountered. Most of the plots also contained intermediate species (neither desired nor undesired), which knocked this indicator's score down. It received an 86.

Some signs of **rills and gullies** were evident on this site, meaning water was moving across the mild slope. This indicator received a 78.

Some signs of **scouring and sheet erosion** were also observed. This had resulted in formation of some desert pavement, where wind removes finer soil particles, leaving coarser materials behind. This indicator received a 68.

Some **plant pedestals** were also evident where wind and water had removed soil particles away from the base of plants. This indicator received a 78.

Too much **bare soil** was found in the study plots. This allowed the erosion described above. This indicator received a 70. Further, the point intercept method showed that 52% of the soil was bare. This amount is capable of being reduced.

An older and well formed **soil cap** had formed on this site. The crust was thick and would inhibit movement of water from rainfall into the soil surface. This indicator received a 44.

Germination microsites were limited by the soil crust. New plants would be deterred by the thick crust. This indicator received a 28.

The **age class** of plants found in the plots appeared to be uniform, with mostly the mature age class present. This indicator received a 66.

Additional comments:
The water and mineral cycles on this site were not effective. Excessive bare soil existed, erosion was occurring, and litter was not mixing well with soil. Within community dynamics, multiple plant species were found, and only Japanese brome was undesired. While the desired species were present, their abundance could be improved. Energy flow was light, where much sunlight energy struck the soil surface.

Range trend here was stable.

Management recommendations:
This site contained plants that were of lower vigor with much bare ground and some soil erosion. Two less than desired plant species (blue grama and threadleaf sedge) were also prominent on the soil surface. These indicators suggest that either grazing durations have been excessive on this site, or recovery periods between grazings have been too short. Plants have not had enough recovery between grazings to thrive and propogate. Low-growing, rhizomatous plants like blue grama and threadleaf sedge will thrive under these conditions. Management must favor the growth of

more desired perennial bunchgrasses, including bluebunch wheatgrass and needleandthread. While it is acceptable to graze these plants, management must ensure that they have enough recovery opportunity to recover from a prior bite. Thus, the best means of improving health of this site is to lengthen the recovery period between grazings. Given the state of health at this site, this may mean extending the recovery period to beyond one year.

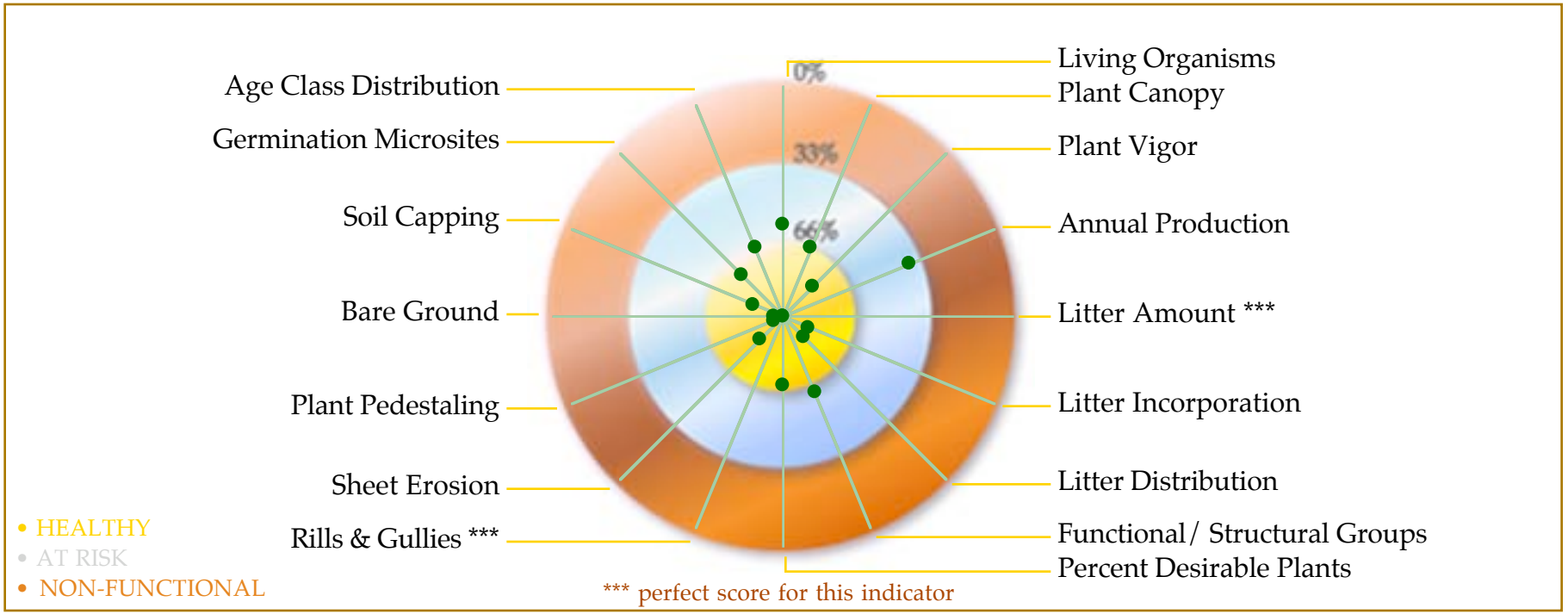
While extending this recovery period, management should enact a deferred rotation, which will help accomplish the same objective. Graze plants in this pasture in the early season one year, but not until later into fall the second year. This action may serve to allow plants two full spring growing opportunities between grazing events. The improvements in plant vigor should be quickly noticeable.

Further, ensure that utilization is more moderate. Prevent heavy harvest of plants. Ungrazed plant material may fall to the soil surface as litter and help cover the bare soil and prevent erosion. Managing for moderate utilization rates means ensuring that grazing durations are not excessive.

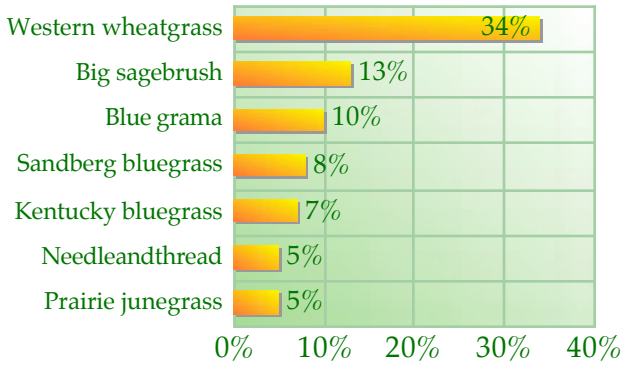
Early-warning indicators:
If management actions are improperly applied on this site, look first for plant vigor that declines further. Then look for increased signs of erosion, particularly water erosion. These would signal a grazing duration that is too lengthy, or harvest that is too high. Finally, watch for increased presence of cheatgrass, Japanese brome, and perhaps leafy spurge.

If management actions are properly applied, look first for improved plant vigor. Then watch litter amounts increase and bare ground decrease, with no more erosion. The improvement in the water cycle will lead to better productivity, better plant density, and increased presence of desired plants on the soil surface.

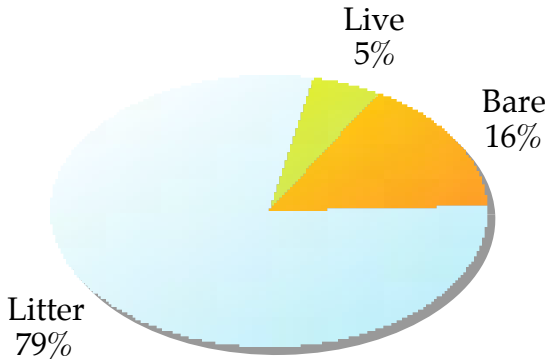
Three Section **Transect MRT11** **Shallow loamy range site;**



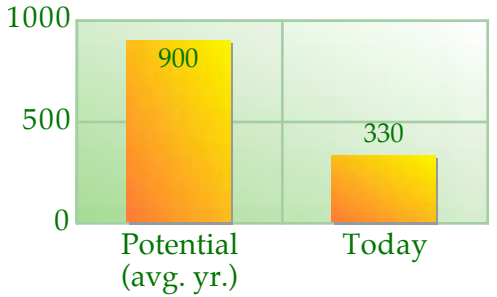
Basal Cover by Species - Top 7 Species



2007 Basal Cover



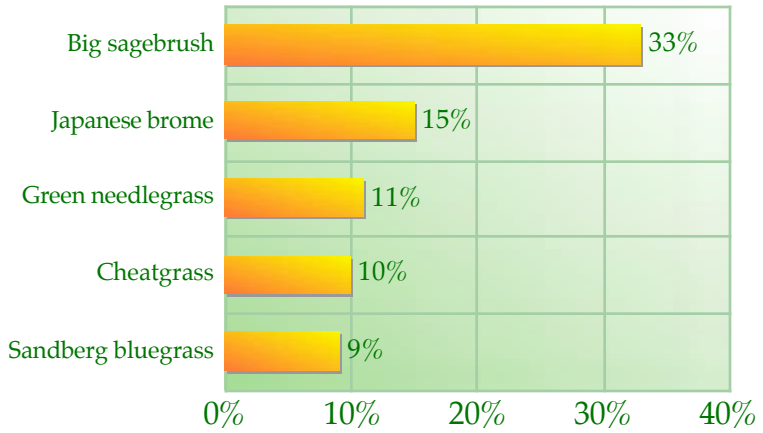
Forage Production



Merlin Ranch

Three Section **Transect MRT11** **Shallow loamy range site;**

Predominant Species: Composition by Weight



Additional Info: Overall Site Score: **79**

Apparent range trend:

Site sampled: August 17, 2007.

25 plant species encountered at site.

UTM Coordinates: 13T 0375889 4918590

Relative basal plant spacing: 2.3 inches.

Big sagebrush data:
Line intercept: 43 plants encountered, 16% canopy cover.
Average height: 27 inches.
Age class: 100% mature plants.
Belt transect: 152 plants growing in 1000 square feet.

Plant species encountered at site:

Cheatgrass
Japanese brome
Green needlegrass
Sandberg bluegrass
Western wheatgrass
Glue grama
Bluebunch wheatgrass
Prairie junegrass
Lepidium
Western yarrow
Pricklypear cactus
Hood's phlox
Stickseed
Scarlet globemallow
Tansymustard
Dandelion
Unknown mustard
Salsify
Big sagebrush
Fringed sage
Broom snakeweed
Rubber rabbitbrush
3 unknown perennial forbs

Merlin Ranch

Three Section (Transect MRT11)

This site lies nearly in the middle of the Three-Section Pasture. The pasture consists of large draws, rolling hills, and bottom land. Much of the pasture occurs in shallow loamy soils. This site was chosen due to its relative abundance of plant growth and species diversity to other reaches of the pasture.

The first plot studied at the Three-Section Pasture site.

The first indicator studied was **living organisms** where signs of the following species were recorded: mule deer, pronghorn, rabbits, sage grouse, red tailed hawk, meadow lark, various songbirds, beetles, ants, flies, butterflies, and grasshoppers. This indicator received a 60 for its score.

The **plant canopy** within the study plots was varied across the site. Those plots containing big sage plants had abundant plant growth within them. Those lacking the presence of a big sagebrush plant had fewer plants. The presence of big sage represented "islands of vegetation" in the area. Where big sage was present, the canopy was greater, but lacking big sage, sunlight struck the soil surface. This indicator received a 68.

Vigor of big sagebrush was strong, with leader growth approaching eight inches. Perennial bunchgrasses were green and growing, but many had not produced seed. Forbs such as salsify, Western yarrow, and dandelion were green and growing, even in mid August. This indicator received an 82.

The Wyoming State Range Site Guides suggest **annual production** at this site should be 900 pounds per acre in an average year (USDA, 1990). A single plot was clipped on sample day that produced 330 pounds per acre, or well below the site's potential. This indicator received a 40.

Litter amount found within the plots varied based on the presence of sagebrush as it did in the canopy discussion above. In most plots, litter was abundant. This indicator received a perfect score.

When digging a finger into the soil surface, in some plots, we found it difficult determining where litter ended and soil began. This suggests that litter was **incorporating** well with the soil. In other plots, litter was contacting the soil, but was not mixing well. This indicator received an 88.

Litter was well **distributed** across the soil in most plots. In two plots, however, litter was becoming light. This indicator received an 87.

When examining **functional and structural groups**, we look for both the number of plant species found in the plots as well as the growth form (grass, forb, shrub). These different growth forms have different plant canopies that trap wind-driven snow, and provide shade for the soil surface. Below ground, their varied root structures elevate nutrients from different parts of the soil profile. Thus, diversity is desired with this indicator. At Three-Section, the number of plants found within study plots was usually six to ten plant species. Often, the desired bunchgrasses were lacking. This indicator received a 64.

Plants such as cheatgrass and Japanese brome were dominant on this site. Further, desired bunchgrasses were lacking within many of the study plots. The **percent desired plants** indicator received a 70. Additional desired plant species are required for this score to improve.

No signs of water erosion were observed. **Rills and gullies** received a perfect score.

Some signs of wind erosion were observed, with mild scouring that resulted in desert pavement. **Scouring and sheet erosion** received a score of 86.

Some **plant pedestals** had also formed, although no roots were exposed. This indicator received a 96.

Most of the plots contained very little **bare soil**. Two of them, however, contained large patches of bare ground, resulting in a slightly reduced score at 96.

A recently formed **soil cap** was seen on the site, likely due to recent rains. The crust was no more than one centimeter thick. This indicator received an 86.

Germination microsites received a 74. The greatest limiting factor for germination success appeared to be competition with other plants (cheatgrass and Japanese brome) and exposure to the elements in some of the study plots.

Different **age classes** of sagebrush plants were observed in the study plots. These appeared to be younger big sage plants. The desired bunchgrasses appeared in the mature age class only. This indicator received a 68.

Additional comments:
The water cycle was effective, with little bare ground and no signs of water erosion. The mineral cycle was effective, but can improve through faster function. Within community dynamics, the desired plants were in the area, but not in the abundance desired. Further, Japanese brome and cheatgrass were found on the site in abundance. Energy flow was moderate. Islands of vegetation resulted in sunlight striking the soil surface in some plots, while being intercepted by living plant leaves in others.

Apparent range trend here was stable.

Management recommendations:
The greatest means of improving land health in this area lies in 1) a short spring grazing duration, 2) ample recovery periods between grazings, and 3) moderate utilization levels.

In this area, spring represents a critical growth window for perennial plants to produce leaf, replenish lost energy reserves from the winter, and produce seed. It is in this window of growth where management must prevent lengthy grazing durations. While grazing in this time frame is acceptable, management must prevent lengthy grazing durations where a plant that is regrowing from an earlier bite may be bitten again.

Management should allow for abundant opportunity for regrowth between grazing events, including recovery times longer than one year. Establish a deferred rotation approach, where different pastures are grazed at different times of the year. This will allow longer recovery perioods between grazings and will also allow plants to be grazed at different times each year.

Lastly, management must ensure that plants are grazed at moderate levels. Prevent heavy harvest of desired plants, since ungrazed plant material falls the surface as litter. Also, plants grazed more heavily require longer recovery periods to grow back. Thus, moderate harvest allows for more rapid plant recovery and also provides a litter supply.

Early-warning indicators:
If management actions are improperly applied, look first for decreased plant vigor and an increase in bare ground. These would signal that utilization rates have been too high, and/or recovery times between grazings insufficient. Erosion will then increase as will distance to nearest perennial plant.

Should management actions be applied properly, look for improved plant vigor, even in dry years. Ground cover should be maintained or improved. Distance to nearest perennial plant will decrease, and presence of desired plants will increase.

NUTRIENT ANALYSIS

At each study site, a single plot of plant growth was clipped and weighed to determine production. Next, species not likely to be selected by livestock, such as sagebrush, were discarded. The remaining plants were sent to Midwest Labs in Omaha, NE where a nutrient analysis is performed. The results from the three sites studied in 2007 are below:

	Hall Past	Tipperary	3-Section
Crude Protein (%)	6.42	6.99	6.9
Acid Detergent Fiber (%)	45.2	43.4	41.8
Total Digestible Nutrients (%)	51	53.1	54.9
Net energy-lactation (Mcal/lb)	0.51	0.54	0.56
Net energy-maintenance (Mcal/lb)	0.48	0.51	0.53
Net energy-gain (Mcal/lb)	0.27	0.29	0.3
Sulfur (%)	0.07	0.13	0.1
Phosphorus (%)	0.1	0.07	0.14
Potassium (%)	0.65	0.72	0.82
Magnesium (%)	0.1	0.14	0.1
Calcium (%)	0.29	0.55	0.36
Sodium (%)	0.01	0.01	0.01
Iron (ppm)	46	483	91
Manganese (ppm)	42	60	68
Copper (ppm)	4	7	4
Zinc (ppm)	20	77	28

The three samples were reasonably similar in their nutrient content with none overly superior to the others. This would suggest management should expect similar livestock performance across the pastures should the herd be placed there during the mid August grazing window. All samples were short in trace minerals such as copper and zinc. Phosphorus levels were low. Crude protein and energy (total digestible nutrient or TDN) levels were low across the three samples. None of the trace mineral amounts was toxic.

As has been done in previous years, each of these samples will be assessed in relation to the needs of an 1100-pound lactating cow of average milking ability. Using the Nutrient Requirements of Beef Cattle tables (NRC, 1984), the requirements of this cow are stated as follows:

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

If this animal meets her dry matter requirements, the sample obtained at **Hall Pasture** will provide the following:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.4#	11#	28g	10g

Neither the crude protein or energy requirements of the cow will be met from this sample while she's lactating. Calcium requirements would be easily met, while phosphorus was quite low in the sample. The calcium to phosphorus ratio was roughly 3:1, which was below the recommended maximum of 7:1.

The **Tipperary** sample will provide the following to the same 1100-pound cow, assuming she meets her dry matter requirements:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.5#	11.5#	54g	7g

With this sample, only the calcium requirement would be met. Notably, the phosphorus contribution was quite low. Further, the calcium to phosphorus ratio was 8:1, slightly above the 7:1 recommended limit.

Finally, the **Three-Section** sample will provide the following to the same cow:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.5#	11.9#	35g	14g

The Three Section sample contained enough energy to nearly meet the cow's requirements. The phosphorus contribution was also higher here. The calcium to phosphorus ratio was roughly 3:1 and well within accepted limits.

Management recommendations gained from nutrient analysis

Compiling data on a nutrient analysis serves as a guide for management in considering nutritional factors as they relate to livestock performance. It is intended to be a "shotgun" approach to examining livestock performance, rather than serving as a precise science. Note that in any given pasture, forage sampled is not the only forage available to a grazing animal. The 1100-pound lactating cow may find different plant species within the same pasture that may improve her performance. The following recommendations are intended to help management prevent problems with the analyses presented here.

Samples collected here were taken in the hot part of summer in mid August. Although some of the perennial bunchgrasses were green and still had growth potential, many of the sampled plants had produced seed and were preparing for dormancy. Further, the samples sent to the lab contained some cheatgrass and Japanese brome, both of which had gone dormant much earlier in the summer. Thus, management should expect that these samples not meet the needs of the sample cow this late in the growing season.

As is often the case in northeast Wyoming, cooler fall temperatures and fall rains may lead to greenup of these rangeland pastures. This would bring back the nutrient content of these plants and likely meet some of the major requirements of the cow and calf. Management should thus consider these samples as the potential low nutrient point during the time in which the cow is on the calf during the summer grazing season. Body condition of the cow may be drawn down during this window. Two options are revealed as possibilities for management consideration. The first is moving the herd to better pastures, such as the hay grounds after frost has taken the bloat potential out of the alfalfa. Irrigating water applied to these fields should have produced some green forage that may help the cow replenish lost reserves. The second option would be to wean the calves early. Pulling the calf off the cow would allow the newly dry cow to restore body condition even on these dry rangeland plants. Due to cost considerations, supplemental feeding of trace minerals is also an option, but perhaps more

costly than managing to fit the cow with her forage base. Should trace mineral supplementation be considered as a possibility, best utilize this effort by feeding he mineral in the last trimester of pregnancy.

MONITORING METHODS

On August 15, 2006, Mark Gordon of Merlin Ranch, Nathan Lindsey of Ucross Ranch and Todd Graham of Aeroscene toured Ucross and Merlin Ranches, examining potential study sites. They selected three study sites on each ranch to be sampled in 2007.

Todd 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.

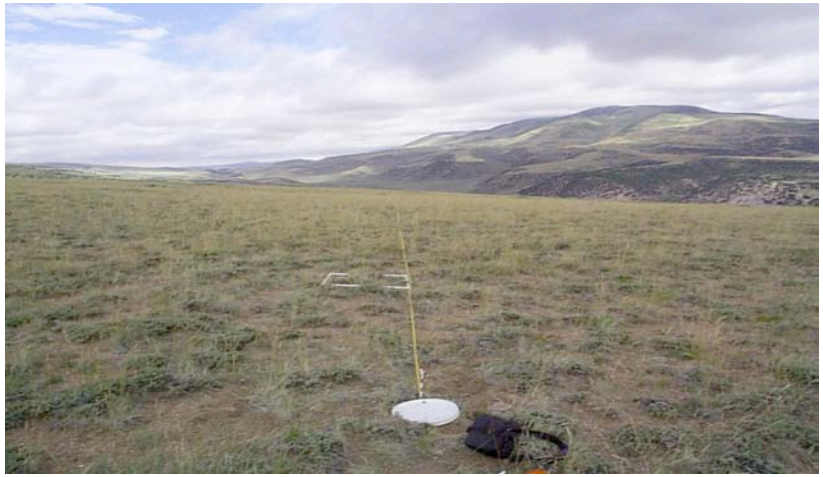


***Figure 2: Permanent transects were 200 feet long and were permanently marked* on each end.**

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.

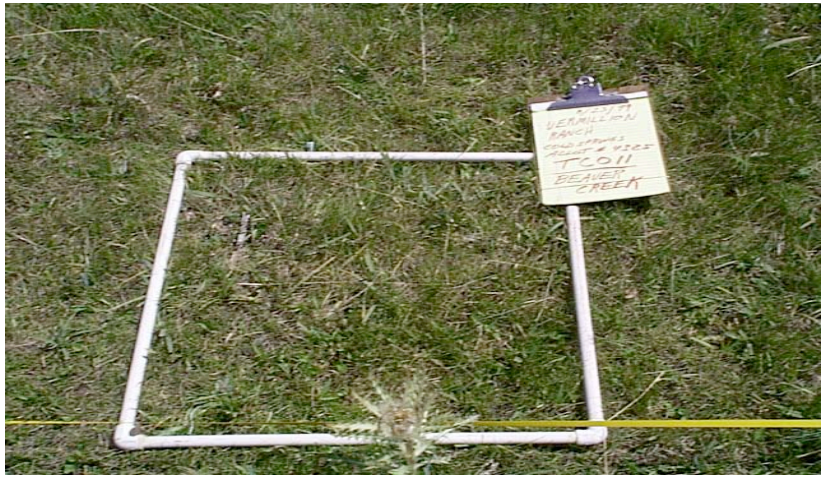


Figure 3: The first plot on a transect. [This plot lies in Colorado.]

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.

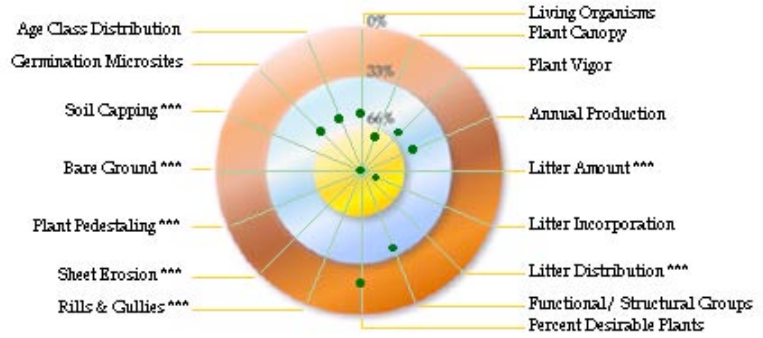


Figure 4: The target portrays results of each of the 16 indicators studied based on field scores.

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 16 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 below. 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.

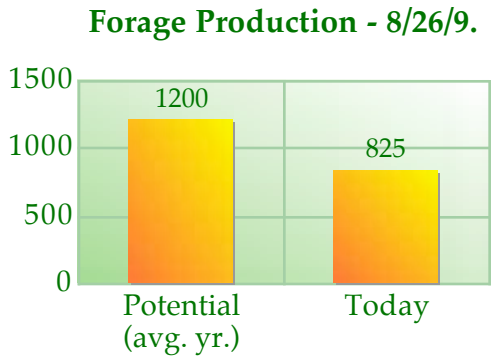


Figure 5: Plant production on sample day as compared with the site's potential from the soil survey.

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.

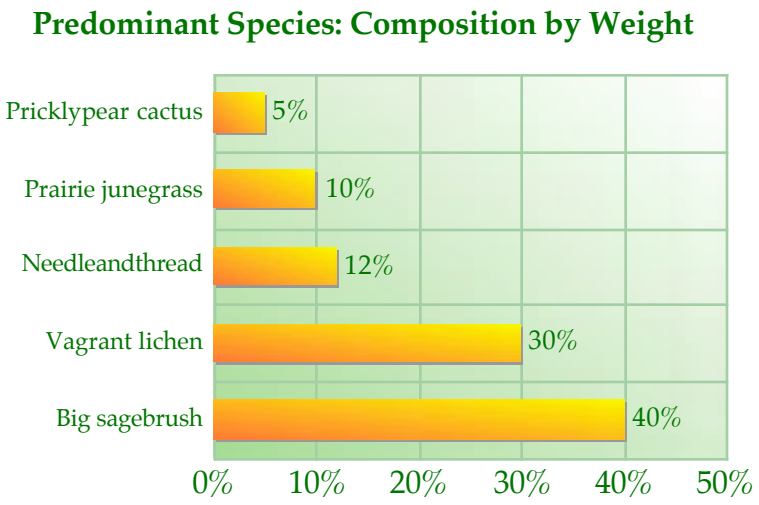


Figure 6: The most abundant species as composition by weight.

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 plant density. Using the point intercept method, a steel rod is lowered to the soil surface using a point frame (Figure 7).

Figure 7: The point frame used in point intercept sampling for gathering ground cover and plant density data.

The 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 8).

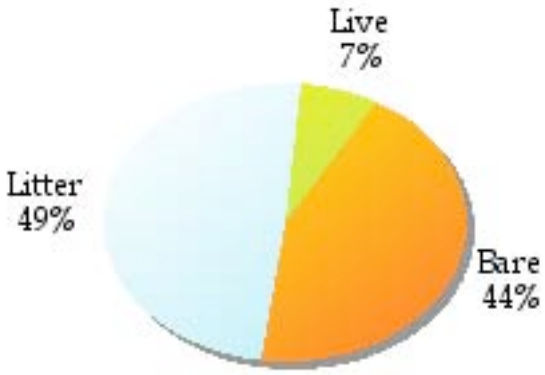


Figure 8: The ground cover chart generated by using the point intercept method.

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. 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 (the most dense) are portrayed in the "Basal Cover by Species" bar graph (Figure 9).

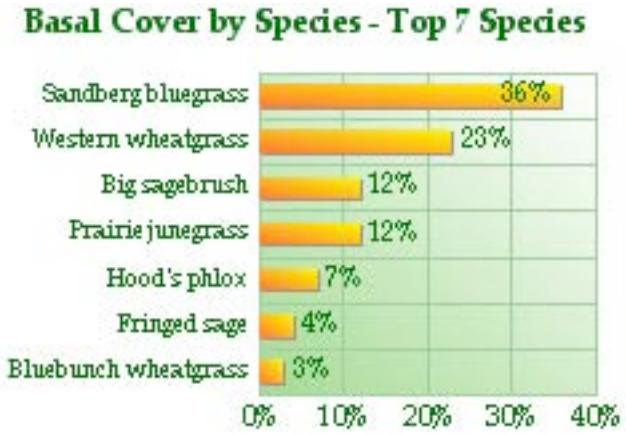


Figure 9: Basal cover by species bar graph created by measuring the distance to the nearest perennial plant using the point intercept method. The seven most numerous species are displayed here.

This means of collecting plant density data was developed by the Holistic Management International in Albuquerque, NM.

Rangeland Health Indicators Scoring Guide

Side One

Indicator	5	4	3	2	1
Living Organisms	Abundant signs of non-plant life. Many different life forms.	Several signs of non-plant life; different life forms.	Moderate signs of non-plant life. Some different life forms.	Few signs of non-plant life and different life forms.	Little, if any, sign of non-plant species.
Plant Canopy	Canopy: 81 -100% of plot. Best photosynthetic activity.	Canopy: 61-80% of plot. Good photosynthetic activity.	Canopy: 41-60% of plot. Moderate photosynthetic activity.	Canopy: 21-40% of plot. Photosynthetic area low.	Canopy 0-20% of plot. Photosynthetic area very low.
Plant vigor	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.	Capability to produce seed or veg. tillers is only slightly limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.	Capability to produce seed or vegetative tiller is greatly reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.
Annual Production	Exceeds 80% of potential production.	60-80% of potential production.	40-60% of potential production.	20-40% of potential production.	Less than 20% of potential production.

Indicator	5	4	3	2	1
Litter Cover	30-70% of soil surface in plot covered with litter.	20-30% of soil surface in plot covered with litter.	10-20% of soil surface in plot covered with litter.	1-10% of soil surface in plot covered with litter.	No litter present on soil surface in plot.
Litter Incorporation	Litter mixing well with soil, resulting in more rapid mineral cycle.	Litter partially mixing with soil. Litter contacting soil.	Some mixing of litter with soil. Some elevated litter.	Reduced mixing of litter with soil; elevated litter; lesser litter amount.	Litter amount is light, resulting in slow cycling.
Litter distribution	Uniform across plot.	Less uniformity of litter cover in plots.	Litter becoming associated with prominent plants or other obstructions.	Plot showing general lack of litter, with patches around prominent plants.	Litter largely absent.
Functional/ Structural Groups	F/S groups and number of species in each group closely match that expected for site.	Number of F/S groups slightly reduced and/or number of species slightly reduced.	Number of F/S groups moderately reduced and/or number of species moderately reduced.	Number of F/S groups reduced and/or number of species significantly reduced.	Number of F/S groups greatly reduced and/or number of species dramatically reduced.
Percent Desirable Plants	Desirable species exceed 80% of plant community. Scattered intermediates.	community are desirable species. Remainder mostly intermediates and/or a few undesirables present.	40-60% desirable plant species. And/or some presence of undesirable species.	20-40% of desirable plant species in plot. And/or strong presence of undesirable species.	Less than 20% of plants are desirable species. And/or undesirable species dominate plot.

Rangeland Health Indicators Scoring Guide

Side Two

Indicator	5	4	3	2	1
Rills and Gullies	Rills or gullies absent.	Rills or gullies with blunted and muted features.	Rills or gullies small and embryonic, and not connected into a dendritic pattern.	Rills and gullies connected with dendritic pattern.	Well defined and actively expanding dendritic pattern.
Scouring or sheet erosion	No visible scouring or sheet erosion	Small patches of bare soil or scours. No desert pavement.	Patches of bare soil or scours developing. Formation of desert pavement.	Patches of bare areas or scours are larger. Desert pavement more widespread.	Bare areas and scours well developed and contiguous. Abundant desert pavement.
Plant pedestaling	No pedestals present.	Active pedestaling or terecette formation is rare.	Slight active pedestaling.	Moderate active pedestaling. Occasional exposed roots.	Abundant active pedestaling. Exposed plant roots are common.
Bare ground	Amount and size of bare areas nearly to totally match that expected for the site.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.	Much higher than expected for the stie. Bare areas are large and generally connected.

Indicator	5	4	3	2	1
Soil Crusting	No physical crusting present.	Recently formed physical crust seen over some of plot.	Recently formed physical crust seen over much of plot.	Older physical crust formed over much of plot.	Plot dominated by older physical crust.
Germination Microsites	Microsites present and distributed across the site.	Some formation of crust, soil movement, litter that would degrade microsites.	Developing crusts, soil movement, and/or litter degrading microsites; developing crusts are fragile.	Soil movement, crusting, litter, lack of protection sufficient to inhibit some germination and seedling establishment.	Soil movement, crusting, litter, lack of protection sufficient to inhibit most germination and seedling establishment.
Age class distribution	Variety of age classes seen in plot.	Some sign of seedlings and young plants.	Seedlings and young plants missing.	Some deteriorating plants present.	Primarily old or deteriorating plants present.

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.

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