MERLIN RANCH:

2014 Rangeland Health Monitoring: Hall, Lower, and Lawrence Pastures

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INTRODUCTION

This document presents the findings of three rangeland health monitoring transects examined on Merlin Ranch in August 2014. These sites were located in the Hall, Lawrence, and Lower Pastures. Each site had been previously established, and data from those prior readings will be displayed side-by-side with data from 2014.

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 shown 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
2014	Hall Pasture
	Lawrence
	Lower

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 2014 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 Pasture – MRLNT07

This site was originally established in 2005 as an area that would be treated with the Lawson Renovator. In an effort to improve rangeland health and wildlife habitat, Merlin Ranch intended to participate in a trial whereby mechanical treatment would be used to decrease sagebrush predominance and promote the growth of forbs and perennial grasses. However, this site was not treated as part of the effort. Highlights of changes at the site since 2005 include the following:

- The amount of bare ground fell by 16 percentage points.
- Live plant cover more than tripled.
- The spacing between perennial plants on the soil surface has varied widely each year.
- Low and mid-seral plant species were predominant at the site each year, including western wheatgrass, Sandberg bluegrass, blue grama, cheatgrass, and Japanese brome. Highly desired grasses like needleandthread were present, but not in abundance. This has resulted in lower than expected production.
- The big sagebrush community continued its decline, with several fewer big sage plants since 2005.

The site displayed strong improvements in ground cover since 2005, and a continued reduction in big sagebrush. Unfortunately, desired shifts in species composition had not occurred, and the successional process was lagging behind the other ecosystem processes. Given current management practices, the successional process should catch up, and the desired species are expected to move into this community. Ensure that grazing durations remain short, and alter timing of grazings seasonally.

Lower Pasture – MRT13

This site was established in 2008 to represent the Lower Pasture. The transect lies in a flat portion of the pasture containing multiple plant species. A stock water tank was not far away, and a nearby draw contained smooth brome that appeared to be moving upward into the rangelands. The area was used in recent years for late-winter calving. Highlights of changes since 2008 include the following:

- The amount of bare ground fell from 23% to zero.
- Live plant cover declined, which was undesired.
- The spacing between perennial plants increased, which was undesired.
- Mid-seral plant species, such as Sandberg bluegrass, have continued to dominate the site. Desired species were present, but not in the abundance desired.

This site has been used as a calving pasture in the late part of the dormant season and early part of the growing season. As such, the chance to excessively graze the highly desired perennial bunchgrasses is reduced. If grazing utilization rates can be kept at moderate levels (30 – 40% of standing crop), then the desired perennial grasses should be able to increase their presence. However, this has not happened in this pasture. The desired perennial grasses were present, but did not appear to be propagating. Spring grazing durations should thus be shortened to favor their growth. If this pasture could be subdivided with a temporary electric fence to ensure grazing durations are kept short, then it may be used in spring for calving while favoring the growth of desired species.

Lawrence – MRT23

This transect was established in 2011 in an open bowl of the Lawrence Pasture not far from the pasture boundary fence and also from stockwater. This portion of the pasture contained mixed plant cover, steeper slopes, small flats, areas with minimal big sagebrush cover, and areas with much big sage. This transect was specifically chosen to lie in an area that contained a mix of grasses, forbs, and shrubs. It should provide a good representation of changes occurring in the pasture. Highlights of changes since 2011 include the following:

- The amount of bare ground increased, which was undesired change.
- Live plant cover declined from 10% to 4%, which represents a strong loss in plant cover.
- Plant productivity declined.
- The spacing between perennial plants increased by 0.9 inches, which represented a strong loss in live plant cover of perennial plants.
- Early and mid-seral plant species like Sandberg bluegrass increased strongly, while highly desired perennial bunchgrasses like green needlegrass declined sharply.
- The number of plant species found at the site fell by 7.

Overall, this pasture's rangeland health declined, and the trend was downward. The pasture was grazed for roughly 7 days in August of 2013 and 2014, which should produce desired results on these rangelands. However, the trend turned downward, which was unexpected. No ready explanation exists for this change. Mid-seral species tend to propagate in years of strong spring and/or fall rains, which occurred between the two transect reading years. Those species may have "flushed," and species like Sandberg bluegrass and prairie junegrass may have greatly increased their presence in the community. This, however, does not explain the strong decline in live plant cover and increase in bare ground. For now, the growth of those desired grasses must be favored, which means continuing to graze this pasture late in the growing season, such as August. The 2014 duration was around 8 days, and utilization rates were light. This should be continued until the desired grasses respond to this management practice.

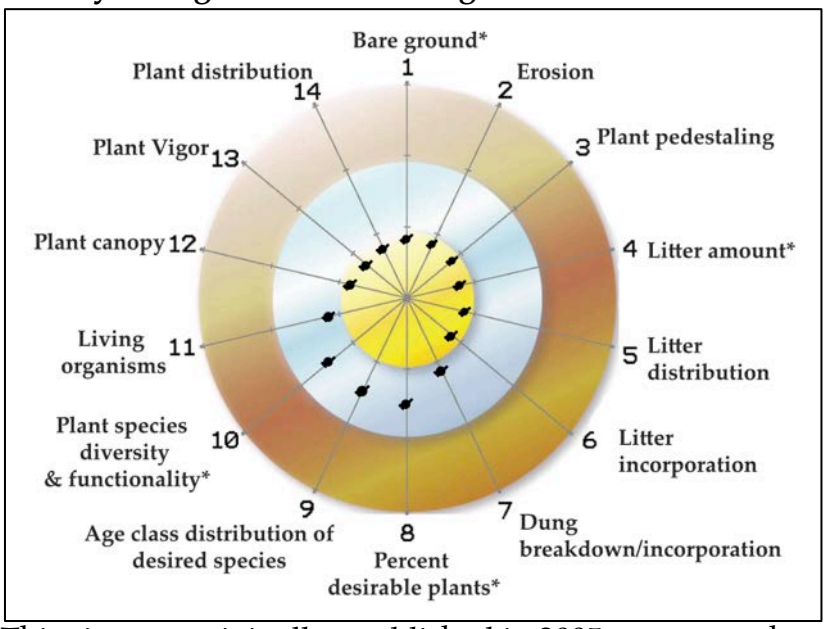
Findings from the three Merlin Ranch transects are displayed below.

Hall Pasture

MRT07

Data Comparisons

Bullseye Rangeland Health Target



This site was originally established in 2005 as an area that would be treated with the Lawson Renovator. In an effort to improve rangeland health and wildlife habitat, Merlin Ranch intended to participate in a trial whereby mechanical treatment would be used to decrease sagebrush predominance and promote the growth of forbs and perennial grasses. However, this site was not treated as part of the effort.

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 effective here, with almost no bare ground, no signs of erosion, and very few plant pedestals.

The **mineral cycle** was mostly rapid. The amount of litter here was optimal, litter was well distributed across the soil surface, and litter was also mixing well with soil. However, cow pies tended to be a little older, reaching ages of two years. These droppings appeared to be slow in breaking down, which results in a slower mineral cycle.

Within the **successional process**, the percent desired plants was moderate. Many cheatgrass and Japanese brome plants were present here. The age class distribution was also moderate, and the site tended to lack young needleandthread grasses that were highly desired here. Further, many aging big sagebrush plants were present, while younger members were lacking. This suggests that big sagebrush community was not replacing itself at the site. Plant species diversity was also moderate. The site was dominated by low-seral grass species, including prairie junegrass and Sandberg bluegrass. Overall, the site was lacking plant species diversity, and the successional process was lagging behind the other ecological processes.

Energy flow was elevated at the site. The site displayed a strong plant canopy, plant vigor was high, with leader growth on sagebrush of 6 inches, and plants were well distributed across the soil surface.

Transect view. Photo taken August 17, 2007.

Transect view. Photo taken August 12, 2014.


Transect view. Photo taken August 11, 2010.

Quadrat photo. Photo taken August 17, 2007.

Quadrat photo. Photo taken August 12, 2014.


Quadrat photo. Photo taken August 11, 2010.

BASAL COVER

2005	2007	2010	2014	
19%	12%	5%	3%	Bare
79%	83%	90%	90%	Litter
2%	5%	5%	7%	Live

ADDITIONAL INFORMATION

Site sampled September 4, 2005.
Site sampled August 17, 2007.
Site sampled August 11, 2010.
Site sampled August 12, 2014

RELATIVE BASAL PLANT SPACING - inches

2005	2007	2010	2014
1.6	2.1	1.4	1.9

RELATIVE BASAL PLANT SPACING BY SPECIES (TOP 7 SPECIES)

2005		2007		2010		2014	
Western wheatgrass	60%	Western wheatgrass	59%	Western wheatgrass	74%	Western wheatgrass	66%
Sandberg bluegrass	14%	Big sagebrush	14%	Big sagebrush	9%	Sandberg bluegrass	19%
Big sagebrush	13%	Blue grama	13%	Sandberg bluegrass	7%	Big sagebrush	7%
Blue grama	9%	Sandberg bluegrass	9%	Scarlet globemallow	3%	Blue grama	3%
Western yarrow	2%	Dandelion	4%	Western yarrow	2%	Scarlet globemallow	3%
Pricklypear cactus	1%	Needleandthread	1%	Prairie junegrass	2%	Hood's phlox	1%
Cusick bluegrass	1%	No seventh species		Needleandthread	1%	Western yarrow	1%

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

2005		2007		2010		2014	
Big sagebrush	32%	Big sagebrush	27%	Western wheatgrass	31%	Sandberg bluegrass	26%
Western wheatgrass	21%	Western wheatgrass	18%	Big sagebrush	26%	Western wheatgrass	26%
Blue grama	11%	Cheatgrass	18%	Japanese brome	14%	Big sagebrush	23%
Japanese brome	11%	Japanese brome	17%	Cheatgrass	10%	Cheatgrass	7%
Cheatgrass	9%	Sandberg bluegrass	12%	Sandberg bluegrass	6%	Japanese brome	5%

PRODUCTION: Lbs per acre

2005	2007	2010	2014
670	850	1280	860

PLANT SPECIES FOUND IN TRANSECT AREA

2005	2007	2010	2014	
21	*24*	21	18	*Total count*
X	X	X	X	Japanese brome
X	X			Cusick bluegrass
X	X	X	X	Cheatgrass
X	X	X	X	Western wheatgrass
X	X	X	X	Blue grama
X	X	X	X	Needleandthread
X		X		Threadleaf sedge
X	X	X		Prairie junegrass
X	X			Sixweeksgrass
X	X	X	X	Sandberg bluegrass
X	X		X	Silver sagebrush
X	X	X	X	Big sagebrush
X	X	X	X	Winterfat
X	X	X		Lepidium
X	X	X	X	Pricklypear cactus
X	X	X	X	Western yarrow
X	X	X		Tansymustard
X	X			Vagrant lichen
X	X	X	X	Scarlet globemallow
X	X	X		Dandelion
	X			Clover species
	X			Pennycress
	X			Woolly plantain
	X	X	X	Fringed sage
		X		Kentucky bluegrass
		X	X	Salsify
		X		Vetch species
		X		Mustard species
1	1			Unknown perennial forbs

PLANT SPECIES CONTINUED

2005	2007	2010	2014	
			X	Crested wheatgrass
			X	Flax
			X	Peppergrass
			X	Hood's phlox

SAGEBRUSH DATA

2005	2007	2010	2014	
				Line intercept:
56	43	39	37	*Number of big sage plants encountered*
				Line Intercept: Age Class Distribution
0%	0%	0%	0%	seedling
0%	0%	0%	0%	young
95%	93%	97%	89%	mature
5%	7%	3%	11%	decadent
26	28	29	22.8	*Average plant height - inches*
48%	32%	36%	29%	*Percent canopy intercept*
103	99	75	70	*Density per 1000 square feet*

HALL PASTURE DISCUSSION

Photos

The transect view photo shows three major changes. First, there is a strong reduction in the amount of big sagebrush visible in the photos. Quite a bit of sagebrush is visible in the 2007 photo, but then begins to decline in 2010. By 2014 many of the big sagebrush plants visible in 2007 are no longer there and have fallen to the ground. Second, the vigor of big sagebrush plants in the transect view photos was lower in 2014 then either of the two other sample years. These plants appeared to be in worse shape as time has progressed, suggesting they were declining in the community. Third, the vigor of perennial grasses appears as strong in 2014 as it did in 2010, although 2010 was a wetter year. This suggests the water cycle was improving at this site.

Basal Cover

The basal cover chart depicts the relationship among bare ground, litter cover, and live plant cover. A strong reduction in bare ground of 16 percentage points occurred since 2005, denoting positive change. Further, the amount of live cover more than tripled since 2005, which was also highly positive.

Relative Basal Plant Spacing

This is a measure of the distance between perennial plants. A lower number denotes tighter plant spacing, which is desirable. The lower the number, the tighter the plant spacing. Conversely, the reverse is also true: the higher the number, the looser the plant spacing between perennial plants. A desirable drop in spacing occurred between 2007 and 2010. This would suggest new plants had been recruited to the soil surface in that time period. By 2014, however, the distance between perennial plants had increased by nearly half an inch. No ready explanation exists for this increase, but it may be possible that shifts in plant species composition have contributed to this. For example, the decline in the amount of western wheatgrass would suggest less of this species was growing on the soil surface. By contrast, the amount of Sandberg bluegrass appears to have increased substantially. This species, which grows as a bunchgrass, may have pushed out much of the western wheatgrass, thereby dropping the spacing between plants and showing a much larger gap between species.

Relative Basal Plant Spacing by Species

When relative basal plant spacing data are collected, the species of those plants may also be determined. This data set portrays the most basally abundant plant species on the soil surface. The relative basal plant spacing by species data set shows the wide fluctuation in the mid-seral grass Sandberg bluegrass through the years. This species declined initially, but then rebounded strongly in 2014 to become one of the most prominent plants on the soil surface. At the same time, the amount of big sagebrush changed minimally. Further, the less desired species blue grama was initially somewhat high in the community, increased more by 2007, then largely dropped out by 2010. By 2014, the species had increased its presence and was prominent again in the community. These data suggest at the successional process was active, but the site had not yet produced the desired plant species composition as measured by basal cover.

Relative Composition by Weight
The next chart portrays the five most abundant plant species as measured by weight. Unlike the basal spacing data set above, this measure includes annual plants. The composition by weight data set shows the steady decline in big sagebrush through time. This was observable in the site photos, and these data again show the reduction in big sagebrush. Simultaneously, the mid-seral species Sandberg bluegrass also showed fluctuations in its contribution to the community each sample year. By 2014, it was the most productive plant species in the community, which does not denote positive change. The undesired species cheatgrass and Japanese brome have both been prominent in the community each sample year. By 2014, however, both species' contribution to the community had begun to decline even further than they had in prior sample years. This was a positive sign. This data set shows that the successional process was active at the site, but that the site was producing many mid-seral grasses with fewer late-seral and highly desired grasses in abundance.

Production
The production data show widespread variation in pounds per acre recorded at the study site. The site initially began increasing production rapidly in the first few sample years, culminating with over 1000 pounds per acre in 2010, which was a very wet year. In 2014, which was more of a normal precipitation year, production had slipped to 860 pounds per acre. This puts it in line with the site's potential, which is about 900 pounds per acre.

Plant Species
The number of plant species recorded at the site fell to the lowest number ever found. Some losses from the list of species were desirable, including sixweeks grass and threadleaf sedge. By contrast, other species grew there for the first time, including crested wheatgrass and phlax. While the overall decline in species count was undesired, this data set again shows that the successional process was active and that shifts in plant species composition should be expected at this site.

Big Sagebrush Data
The big sagebrush data show a steady decline in the number of big sagebrush plants encountered on the transect line. Further, age class data show continued presence of decadent, or dying big sagebrush plants. Percent canopy intercept has slipped each year, and the density of shrubs has continued to decline. This was evident in the site photos, and shows the continued decline of the species in this community. It does not appear to be replacing itself within this community, and ideally new grasses and forbs will be recruited.

Range Trend
Range trend here was slowly upward. The site displayed reduced bare ground, increased live plant cover, and a reduction in big sagebrush. That being said, the desired plant species were not being rapidly recruited to the site, so progress in this area has been slow.

Management recommendations
This site was originally established in 2005 to be in a harsher portion of this past year. It was intended to be part of the Lawson Renovator mechanical vegetative treatment that never actually occurred, so does not reflect

the surrounding vegetation in this pasture. That vegetation appears as much higher in stature, higher in productivity, and contains much higher needle and thread grass than does the actual transect site. The photo below shows an area to the north of the transect site with its much higher production of needleandthread and much higher plant vigor.

Photo shows an area of the Hall Pasture lying to the north of the transect site. This area displays much higher plant vigor, production, better species composition, and overall better rangeland health than does the transect site.

The transect site itself displayed a successional process that lagged behind the other three major ecological processes. The water cycle, mineral cycle, and energy flow all displayed elevated performance, but the shift in plant species composition had not yet occurred at this site to truly achieve the desired level of rangeland health. In time, the expected desired plants should propagate in this area and help improve rangeland health, wildlife habitat, and greatly increased plant productivity. However, this had not yet occurred.

As has been done in recent years, grazing durations should remain short, ideally lower than 20 days. Further, seasonal timing of grazings should be altered to allow various plant species uninterrupted growth opportunities at different times of the year. As sagebrush slowly dies back at this site, voids will form on the soil surface that can be filled by undesired species, or more highly desired plants. It is the job of management to ensure that desired species like needleandthread fill those voids. This is best done by preventing lengthy grazing durations and heavy utilization rates.

Early-warning indicators

Early-warning indicators provide managers rapid feedback regarding how their management actions are affecting a particular site. Should implemented plans be taking a site away from a desired state, managers must make changes quickly before costly and time-consuming corrections are needed. Early-warning indicators provide those first glimpses at a site that something is awry and course corrections are needed.

If management actions are improperly applied here, look first for reduced plant vigor and a more open plant canopy, along with increased bare soil. These suggest utilization rates have been too high and/or grazing durations too long. Next, look for shifts in species composition away from the desired perennial bunchgrasses toward less desired plants.

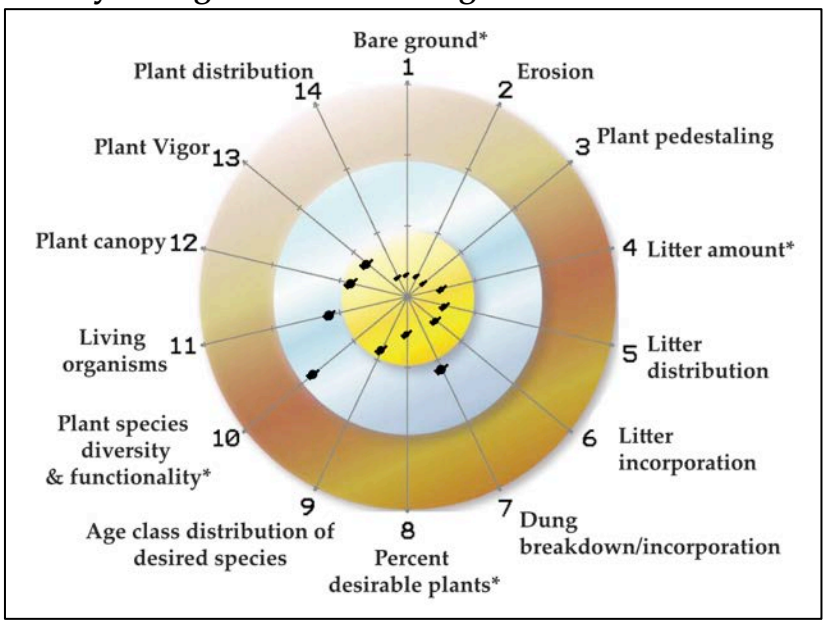
If management actions are properly applied, look for maintained plant vigor, even in years not as wet as 2011. Next, look for increased live plant cover and shifts in plant species composition toward the more desired plants.

Lower Pasture

MRT13

Data Comparisons

Bullseye Rangeland Health Target



This site was established in 2008 to represent the Lower Pasture. The transect lies in a flat portion of the pasture containing multiple plant species. A stock water tank was not far away, and a nearby draw contained smooth brome that appeared to be moving upward into the rangelands. The area was used in recent years for late-winter calving.

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** here was effective. Almost no bare soil was observed, no signs of erosion were found, and no plant pedestals were evident. Any precipitation should infiltrate the soil here, rather than running off.

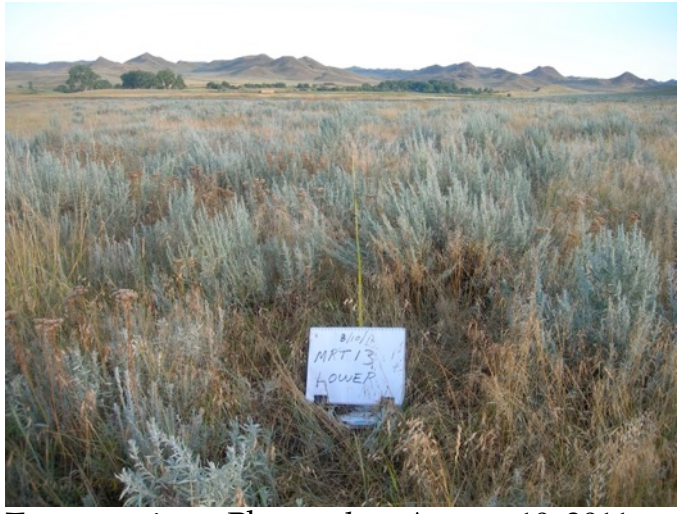
The **mineral cycle** was rapid. The litter amount was optimal for this site, litter was well distributed across the soil surface, and litter was also incorporating well with soil. Some aging cow pies were present on the soil surface, which likely formed when cattle consumed heavily lignified forage in the dormant season. This will slow the mineral cycle, but did not present reason for concern.

Within the **successional process**, the percent desired plants was high, with cheatgrass and Japanese brome being the only undesired species. The age class distribution of desired species was also high, with obvious signs of younger/older silver sagebrush and many younger winterfat plants. Several younger green needlegrass and needleandthread plants were also found, suggesting they were being recruited to the site. Overall, species diversity and functionality was low. The site tended to lack forbs, and early-seral and invasive grasses were predominant. The successional process appeared to be lagging other ecological processes at this site.

Energy flow was elevated. As the site photos below will show, the plant canopy was robust. Plant vigor was also high, with plants having achieved tall stature, produced seed, and they were green and growing in mid August. Plants were also well distributed across the soil surface.

Transect view. Photo taken August 27, 2008.

Transect view. Photo taken August 12, 2014.



Transect view. Photo taken August 10, 2011.

Quadrat view. Photo taken August 27, 2008.

Quadrat view. Photo taken August 12, 2014.

Quadrat view. Photo taken August 10, 2011.

BASAL COVER

2008	2011	2014	
23%	0%	0%	Bare
72%	96%	97%	Litter
5%	4%	3%	Live

ADDITIONAL INFORMATION

Site sampled August 27, 2008.
Site sampled August 10, 2011.
Site sampled August 12, 2014.

RELATIVE BASAL PLANT SPACING - inches

2008	2011	2014
1.8	1.5	2.2

RELATIVE BASAL PLANT SPACING BY SPECIES (TOP 7 SPECIES)

2008		2011		2014	
Western wheatgrass	58%	Western wheatgrass	50%	Western wheatgrass	33%
Silver sagebrush	20%	Needleandthread	16%	Sandberg bluegrass	19%
Scarlet globemallow	12%	Silver sagebrush	15%	Silver sagebrush	17%
Smooth brome	3%	Western yarrow	7%	Scarlet globemallow	12%
Western yarrow	2%	Green needlegrass	5%	Smooth brome	6%
Green needlegrass	2%	Smooth brome	3%	Western yarrow	5%
Needleandthread	1%	Sandberg bluegrass	3%	Green needlegrass	3%

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

2008		2011		2014	
Cheatgrass	28%	Silver sagebrush	28%	Silver sagebrush	29%
Silver sagebrush	25%	Western wheatgrass	25%	Cheatgrass	19%
Western wheatgrass	23%	Cheatgrass	11%	Western wheatgrass	19%
Japanese brome	14%	Needleandthread	9%	Sandberg bluegrass	9%
Scarlet globemallow	2%	Japanese brome	7%	Japanese brome	7%

PRODUCTION: Lbs per acre

2008	2011	2014
1740	1740	1920

PLANT SPECIES FOUND IN TRANSECT AREA

2008	2011	2014	
20	*18*	*14*	*Total count*
X	X	X	Cheatgrass
X	X	X	Western wheatgrass
X	X	X	Green needlegrass
X	X	X	Smooth brome
X	X	X	Japanese brome
X	X	X	Sandberg bluegrass
X	X	X	Silver sagebrush
X	X		Fringed sage
X	X	X	Scarlet globemallow
X	X	X	Salsify
X			White alyssum
X		X	Pricklypear cactus
X	X		Tansymustard
X	X	X	Western yarrow
X	X		Kochia
X			Musk thistle
X			Curlycup gumweed
X			Mustard species
X			Woolly plantain
X	X		Pennycress
	X		Alfalfa
	X		Curlydock
	X		Purple fleabane
	X	X	Winterfat
		X	Needleandthread
		X	Cudweed sagewort

SILVER SAGEBRUSH DATA

2008	2011	2014	*Line intercept:*
55	63	61	*Number of plants encountered*
			Line Intercept: Age Class Distribution
0%	3%	0%	seedling
7%	11%	11%	young
88%	86%	89%	mature
5%	0%	0%	decadent
19	17	16.9	*Average plant height - inches*
23%	32%	30%	*Percent canopy intercept*
156	220	223	*Density per 600 square feet*

LOWER PASTURE DISCUSSION

Photos

The major change evident in the site photos was the increase in vigor of both grasses and silver sagebrush plants. While all three years received above-average precipitation levels, the 2014 transect view photo displayed the strongest vigor, due to the stature of grasses and leader growth on silver sagebrush. All plants appeared of high vigor in this area. The quadrat photos also portray the high level of vigor of this plot, and the 2014 photo shows some recruitment of silver sagebrush.

Basal Cover

The basal cover chart depicts the relationship among bare ground, litter cover, and live plant cover. Note the tremendous reduction in bare soil here (23% in 2008 to 0% in 2011). This was terrific improvement, which was maintained into 2014. Unfortunately, percent live cover dropped each sample year. The site should contain roughly 10% live cover with a mix of desired perennial bunchgrasses and forbs. The data provide no ready explanation for the reduction in live plant cover, but it may be linked to the shift in plant species composition, which will be described below.

Relative Basal Plant Spacing

This is a measure of the distance between perennial plants. A lower number denotes tighter plant spacing, which is desirable. At the Lower Pasture, the distance between perennial plants favorably dropped by 0.3 inches since 2008, but then rebounded to over 2 inches by 2014. This usually suggests that the site either lost plant cover (as evidenced by the live cover data above), or that plant crowns had shrunk and were now smaller. Of these, the loss of plants on the soil surface would be the most undesirable. But a glance at the basal plant species data below may provide a clue for this change.

Relative Basal Plant Spacing by Species

When relative basal plant spacing data are collected, the species of those plants may also be determined. This data set portrays the most basally abundant plant species on the soil surface. The amount of western wheatgrass dropped sharply since 2008. This rhizomatous species remained the most basally abundant species in 2014, but its contribution to the community had declined. Early-seral species like Sandberg bluegrass propagated greatly between 2011 and 2014. The strong increase in this bunchgrass may have resulted in looser plant spacing, simply by the way it grows, meaning more space existing between bunches, whereas the rhizomatous western wheatgrass resulted in tighter plant spacing. That being said, the increased cover by a bunchgrass should suggest that the amount of live plant cover increased, but this was not the case. Again, no ready explanation exists for these changes, but the data show that the successional process was active in the community.

Relative Composition by Weight

The next chart portrays the five most abundant plant species as measured by weight. Unlike the basal spacing data set above, this measure includes annual plants. The 2008 data contained 42% production from the undesired species cheatgrass and Japanese brome, which was too high for this site. By 2011, these invasives contributed 18%, which was a substantial drop. By 2014, however, the cheatgrass had increased in the community. This change in data through the years shows that the

successional process was active in the community, but the site was predominantly undesired and low-seral grasses. Ideally, more desired grasses and forbs like needleandthread, green needlegrass, scarlet globemallow, winterfat, and even alfalfa would compose more of this list of the top five most productive species.

Production
This loamy ecological site in a 10 – 14 inch precipitation zone should produce 1,200 pounds per acre in an average year, and up to 1,500 pounds per acre in above-average precipitation years. Each year the pasture was visited, the site produced beyond the site's expected level, which was a positive finding.

Plant Species
The number of plant species counted at the site fell by six since 2008, which was undesired. Ideally, a site like this should add species through time. However, some species will not be missed, such as fringed sage, alyssum (also called peppergrass), kochia, musk thistle, and curlydock. Losing these species was good. But the site did not gain any new desired species, which is a further indicator that the successional process was lagging the other ecosystem processes at this site.

Silver Sagebrush Data
By most measures, the silver sagebrush community increased its presence at the site. The canopy intercept and density both increased substantially since 2008. This shrub likely responded favorably to the recent series of average or above average precipitation years. No corrective management actions were warranted on this shrub growth.

Range Trend
At the Lower Pasture, the water cycle was effective, the mineral cycle was rapid, and energy flow was elevated. The successional process was lagging behind the other ecosystem process, but was gaining ground between the two sample years. Range trend here was static. The desired gains in plant species composition had not yet been realized, and undesired species like cheatgrass, as well as early-seral species like Sandberg bluegrass were still predominant here.

Management recommendations
This pasture has been used over the past four years or so as a calving pasture. Cattle enter the pasture in the mid-March window (depending on the year's planned herd movements) and spend roughly 14 days here. At this time of year, most grazing will occur on prior year's growth, so less damage to plants should be expected. Afterward, the pasture is rested (with the exception of grazing for some horses in summer and a few bulls in fall) for the bulk of the growing season. This management program has produced a stable range trend, so no major course corrections were warranted at this time. That being said, management must take care to keep grazing durations short in the early growing season (again, depending on the year's planned herd movements) so that no rapidly growing plants are bitten twice while the herd is in the pasture. Next, ensure that the utilization rate is not excessive here (take 30 – 50% of the spring growth) in an effort to avoid slowing regrowth. The less taken of a perennial bunchgrass, the quicker it will regrow.

Managers should continue watching movements of silver sagebrush. At 30% canopy, the species gains a

prominent position in the plant community that may negatively reduce the performance of other desired plants. Should recruitment of silver sagebrush appear evident at this site, consider feeding hay atop the site in that late winter grazing window to apply a dose of animal impact to the silver sage plants. Let the hooves of cows in late winter open this plant canopy in an effort to favor the growth of more desired grasses and forbs. Note that the effort here would not be to rid the site of silver sagebrush (the canopy may trap wind-driven snow from which all plants would benefit), but to simply open the canopy and prevent silver sage from becoming too prominent.

Early-warning indicators

Early-warning indicators provide managers rapid feedback regarding how their management actions are affecting a particular site. Should implemented plans be taking a site away from a desired state, managers must make changes quickly before costly and time-consuming corrections are needed. Early-warning indicators provide those first glimpses at a site that something is awry and course corrections are needed.

If management actions are improperly applied here, look first for reduced plant vigor and a more open plant canopy, along with increased bare soil. These suggest utilization rates have been too high and/or grazing durations too long. Next, look for shifts in species composition away from the desired perennial bunchgrasses toward less desired plants.

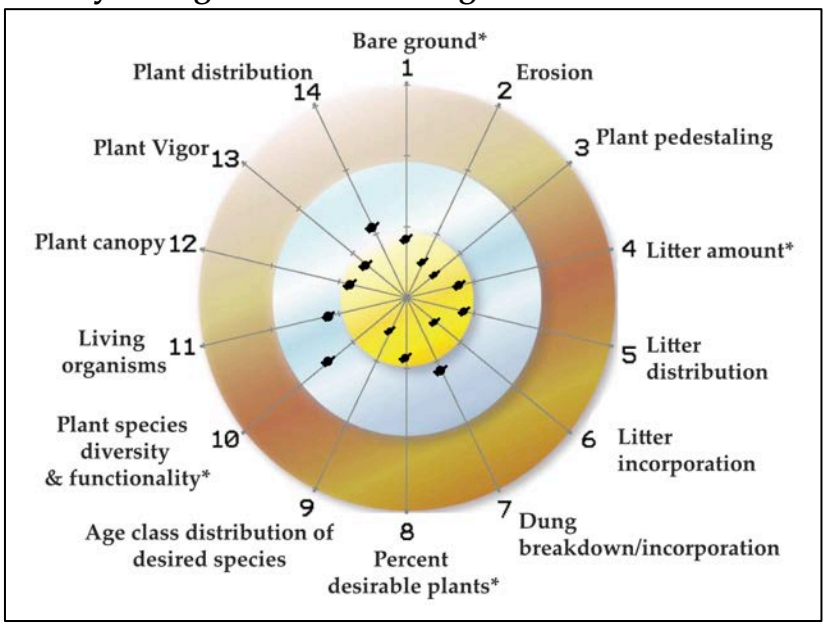
If management actions are properly applied, look for maintained plant vigor, even in years not as wet as 2011. Next, look for increased live plant cover and shifts in plant species composition toward the more desired plants.

Lawrence Pasture

MRT23

Data Comparisons

Bullseye Rangeland Health Target



This transect was established in 2011 in an open bowl of the Lawrence Pasture not far from the pasture boundary fence and also from stock water. This portion of the pasture contained mixed plant cover, steeper slopes, small flats, areas with minimal big sagebrush cover, and areas with much big sage. This transect was specifically chosen to lie in an area that contained a mix of grasses, forbs, and shrubs. It should provide a good representation of changes occurring in the pasture.

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** here was effective. Little bare soil was evident, no signs of erosion were observed, and no plant pedestals were observed on this mild slope.

The **mineral cycle** appeared to be functioning rapidly. The litter amount was almost optimal for this site, but could have increased slightly to cover some of the site's bare patches. Litter was well distributed across the soil surface. Litter was contacting and mixing well with soil, suggesting the incorporation process was rapid and showing proper use of animal impact as a tool. Dung breakdown was mixed, with some wildlife pellet groups being younger, while some of the cow pies were roughly two years old. This pasture had been grazed later in the growing season, so cattle had been consuming forage with more lignin, suggesting the pies should take longer to break down.

Within the **successional process**, undesired species like Japanese brome were abundant. This was likely the result of dying big sagebrush plants in the area. Obvious young age classes of the desired green needlegrass and bluebunch wheatgrass were abundant, suggesting these species were moving into the community. Plant species diversity and functionality was low, with undesired and low-seral species being predominant at the site, and highly desired species were lacking.

Energy flow was high, with a robust canopy, high plant vigor, and moderate plant distribution.

Transect view. Photo taken August 10, 2011.

Transect view. Photo taken August 13, 2014.

Quadrat view. Photo taken August 10, 2011.

Quadrat view. Photo taken August 13, 2014.

BASAL COVER

2011	2014	
8%	9%	Bare
82%	87%	Litter
10%	4%	Live

ADDITIONAL INFORMATION

Site sampled August 10, 2011.
Site sampled August 13, 2014.

RELATIVE BASAL PLANT SPACING - inches

2011	2014
1.2	2.1

RELATIVE BASAL PLANT SPACING BY SPECIES (TOP 7 SPECIES)

2011		2014	
Western wheatgrass	33%	Western wheatgrass	52%
Green needlegrass	17%	Sandberg bluegrass	19%
Needleleaf phlox	12%	Big sagebrush	9%
Sandberg bluegrass	11%	Hood's phlox	7%
Big sagebrush	7%	Scarlet globemallow	4%
Bluebunch wheatgra	5%	Green needlegrass	2%
Needleandthread	4%	Prairie junegrass	2%

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

2011		2014	
Big sagebrush	24%	Big sagebrush	23%
Green needlegrass	23%	Western wheatgrass	22%
Western wheatgrass	13%	Green needlegrass	9%
Japanese brome	7%	Bluebunch wheatgrass	9%
Vetch species	6%	Japanese brome	9%

PRODUCTION: Lbs per acre

2011	2014
860	700

PLANT SPECIES FOUND IN TRANSECT AREA

2011	2014	
27	20	*Total count*
X		Allium species
X	X	Big sagebrush
X	X	Blue grama
X	X	Bluebunch wheatgrass
X	X	Broom snakeweed
X	X	Cheatgrass
X		Dandelion
	X	Flax
X	X	Fringed sage
X	X	Green needlegrass
	X	Hood's phlox
X	X	Japanese brome
X		Mushroom
X		Needleleaf phlox
X	X	Peppergrass
X	X	Prairie junegrass
X	X	Pricklypear cactus
X	X	Salsify
X	X	Sandberg bluegrass
X	X	Scarlet globemallow
X		Sego lily
X		Showy fleabane
X		Second fleabane species
X	X	Threadleaf sedge
1	1	Unknown perennial forb
X		Vetch Species
X	X	Western wheatgrass
X	X	Western yarrow
X		Winterfat

BIG SAGEBRUSH DATA

2008	2014	*Line intercept:*
45	39	*Number of big sage plants encountered*
		Line Intercept: Age Class Distribution
0%	0%	seedling
0%	0%	young
82%	87%	mature
18%	13%	decadent
17	16.7	*Average plant height - inches*
25%	24%	*Percent canopy intercept*
99	87	*Density per 600 square feet*

LAWRENCE PASTURE DISCUSSION

Photos
The transect view photos show a strong reduction in the vigor of big sagebrush plants between 2011 and 2014. Further, fewer plants appear in the 2014 photos, suggesting big sagebrush was in decline in this community. Data below will show how the sagebrush committee has declined, for several big sagebrush plants died and were not being actively replaced. Further, the 2014 photos shows disturbance of the grasses, for they were being grazed when the site was photographed. The quadrat view photo also shows loss of sagebrush, for fewer big sagebrush plants are visible in the 2014 photo. The 2014 photos also showed the trampling affects of livestock, since cattle were in the pasture when this photo was taken.

Basal Cover
The basal cover data table shows an increase in the amount of bare ground since 2011. This was undesirable change. Further, the amount of live plant cover dropped by six percentage points since 2011, which was also highly undesired. No ready explanation exists for the reduction in life plant cover at this site, but this is a trend worth noting, for it was highly undesired.

Relative Basal Plant Spacing
The basal cover data set displays the relative distance between perennial plants on the soil surface. The lower the number, the tighter the spacing. The reverse is also true: the larger the number, the looser the spacing between perennial plants. These data show in increase in the distance of nearly one inch, which was undesired. Ideally, this figure should drop below one inch, so the increase to 2.1 inches was highly undesired. This data set portrays undesired change on the land.

Relative Basal Plant Spacing by Species
When determining the distance between perennial plants in the prior measurement, the predominant species found on the soil surface may also be determined. This data set shows a strong increase in the basal composition of early-seral grasses, such as western wheatgrass, Sandberg bluegrass, and prairie junegrass. Simultaneously, the late-seral and highly desired grasses of green needlegrass, bluebunch wheatgrass, and needleandthread all decreased in basal composition. These were unfavorable trends and suggest that unfavorable shifts in species composition were occurring at this site.

Relative Composition by Weight Ranking
This data set displays the five most productive plants as composition by weight. This data set also shows the reduction of desired species (green needlegrass), coupled with an increase in early-seral species like Western wheatgrass, as well as undesired species like Japanese brome. These were all undesired findings. By contrast, the productive composition of the desired bluebunch wheatgrass climbed. Overall, the 2014 vegetative community was not desired, but the successional process was active in the area as these data show.

Production
The site produced below its potential of 1100-pounds per acre in a Loamy ecological site both years. Plant productivity here was in flux, with losses of big sagebrush and much Japanese brome and cheatgrass growing under the skeletons. As this community

changes, look for corresponding changes in plant productivity.

Plant Species
Seven plant species were lost in this community between the two years, which was an undesired change. Most of those that were lost consisted of desired forbs that likely thrived at the site in the wet growing season of 2011. However, since 2014 was also a wet growing year, may of those same forbs were expected at this site. Their loss suggests undesirable changes in the land were occurring.

Big Sagebrush Data
By every measure, the big sagebrush community declined. From the number of plants intercepted on the transect line to height, to canopy intercept, to density, this sagebrush community was declining. Further, no recruitment of young big sagebrush plants was observed, so other plant species will fill voids on the soil surface where big sagebrush plants dies.

Range Trend
Range trend here was downward. The increase in bare ground, loss of live plant cover, increased basal plant spacing, and undesired shifts in plant species composition all point toward a dropping range trend.

Management Recommendations
The data presented above show a site in decline. The water cycle became less effective, the mineral cycle got slower, energy flow was reduced, and the successional process moved in an undesired direction. All since 2011.

To summarize these findings, these data display a pasture that had been grazed with a long duration and a high utilization rate during the active part of the spring growing season. But this was not the case. In 2014, the pasture was grazed for 8 days in the middle of August, and a utilization rate of 20 – 30% was produced. The pasture was not grazed at any other time of the year. Further, the same practice occurred in 2013. Such a two-year grazing strategy should have resulted in greatly improved rangeland health data over 2011, but this did not occur. Such findings are difficult to explain, for the opposite trend on the land was expected to occur.

In the past, this pasture was grazed in May and June when rapid plant growth rates may exacerbate improper grazing management, such as lengthy durations and high utilization rates. But such spring grazing had not occurred here for several years, and no conclusions can be drawn regarding this sudden reduction in rangeland health.

Much of the concern with shifts in species composition surrounds the strong increase in species like Sandberg bluegrass, western wheatgrass, and prairie junegrass. Each of these species is known to thrive during years with wet springs and falls. This occurred in spring of 2011 and fall of 2013 (see Buffalo precipitation data here: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy1165). Thus, these species may have "flushed," meaning they germinated and propagated rapidly. With the loss of big sagebrush plants, these species likely moved to fill some of the voids.

Fortunately for this pasture, the area displayed multiple young green needlegrass and bluebunch wheatgrass plants, as if they were being rapidly recruited to the site. Perhaps the good growing conditions may allow

propagation of these higher producing and more favored grass species, which would greatly elevate rangeland health in this area.

For now, grazing managers should avoid using this pasture in the spring months. Try to favor the growth of the desired perennial bunchgrasses by using the pasture later in the growing season (August and September) as was done in 2013 and 2014. Also avoid late September and October when these plants are forming their growth points for the following year.

Continue grazing at light to moderate utilization levels (20 – 30% harvest of standing crop) as was done in 2014. In time, this practice should help the desired plant species move into the voids created by sagebrush death. This pasture will need to be checked again to ensure that its rangeland resources are moving in the correct direction.

Early-warning indicators
If management actions are improperly applied, look first for reduced vigor of desired grasses and more bare soil. These indicators suggest utilization rates are too high, grazing durations are too long and/or recovery periods between grazings are too short. Next, look for shifts in species composition away from the desired perennial bunchgrasses toward mid-seral grasses and/or undesired plants.

If management actions are properly applied, look first for maintained plant vigor, even in years not as wet as 2011. Next, look for reduced bare soil (that small percent could still be reduced). Lastly, look for increased presence of green needlegrass, bluebunch wheatgrass, and winterfat.

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 2014.

	Hall Past	Lawrence	Lower
Crude Protein (%)	7.8	8.1	8.2
Acid Detergent Fiber (%)	44.9	43.2	45.5
Total Digestible Nutrients (%)	51.4	53.3	50.7
Net energy-lactation (Mcal/lb)	0.52	0.54	0.51
Net energy-maintenance (Mcal/lb)	0.49	0.51	0.48
Net energy-gain (Mcal/lb)	0.27	0.29	0.26
Sulfur (%)	0.1	0.11	0.14
Phosphorus (%)	0.09	0.11	0.14
Potassium (%)	1.13	1.44	1.19
Magnesium (%)	0.14	0.13	0.15
Calcium (%)	0.44	0.58	0.49
Sodium (%)	no test	no test	no test
Iron (ppm)	81.1	109	63.1
Manganese (ppm)	37.3	57.6	37.6
Copper (ppm)	3	3	6
Zinc (ppm)	12	12	16

No nutrients were contained at toxic levels in these samples, but some (copper, zinc, phosphorus) were low, which has been the case during the history of taking these samples at the ranch.

As was done in previous years, the nutrients provided by the samples will be compared against the needs of an 1100-pound lactating cow. The plants were collected in mid August of a wet year. 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 **Lower** sample will return the following to her:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.7#	11.1#	43g	9g

As may be seen, our sample cow is short on all nutrients but calcium, with the most notable being phosphorus. See the implications for management section below for means of addressing this shortfall.

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

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.8#	11.5#	57g	11g

This forage was short in both crude protein, energy (TDN), and phosphorus.

Lastly, the **Lower** sample will return the following to our sample cow:

Dry Matter	Crude Protein	TDN	Ca	P
21.6#	1.8#	11#	48g	14g

Again, this sample was short on crude protein, TDN, and phosphorus.

Each of the TDN results was low in 2014, which has not typically been the case for Merlin Ranch. In most years, the TDN amount has been above the recommended minimum. No ready explanation exists for why TDN levels were low in 2014.

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 course of 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, once calves are weaned in the dormant season, management may place dry cows on the hay meadows that were irrigated all season. Nutrient content of these plants should be higher than the rangeland plants. 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 so the body

condition of the cow may be replenished more readily.
Only pursue this option if cow performance is an issue.

MONITORING METHODS

On August 12 and 13, 20114, Todd Graham of Ranch Advisory Partners toured the ranch, examining potential study sites. Three study sites were selected to be read in 2014, based upon length of time since the last reading.

Graham read those transects over the next few days. They 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.

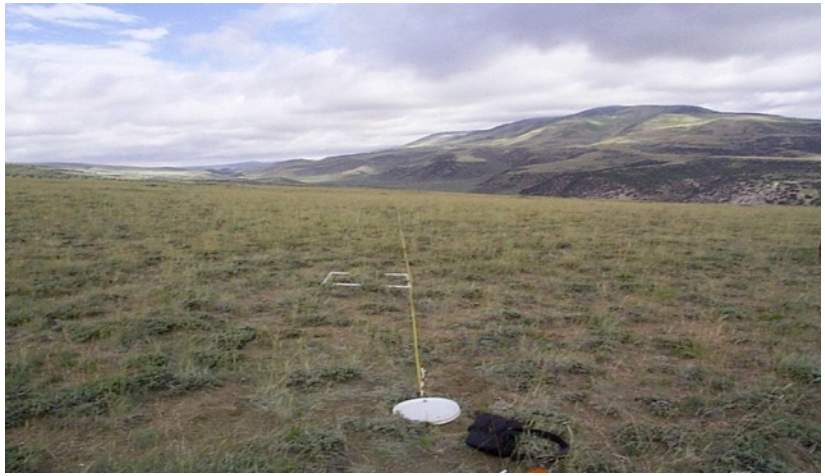


***Figure 2: Permanent transects were 200 feet long and were permanently marked* on each end.**

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.

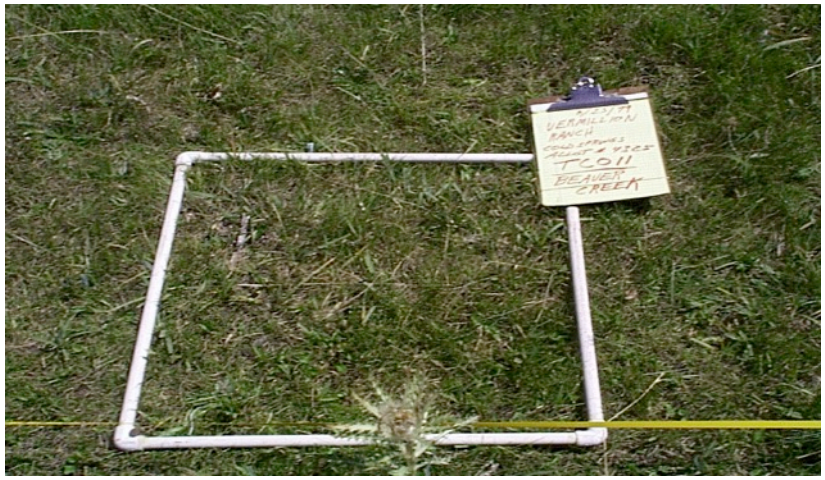


Figure 3: The first plot on a transect. [This sample plot lies in Colorado.]

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.

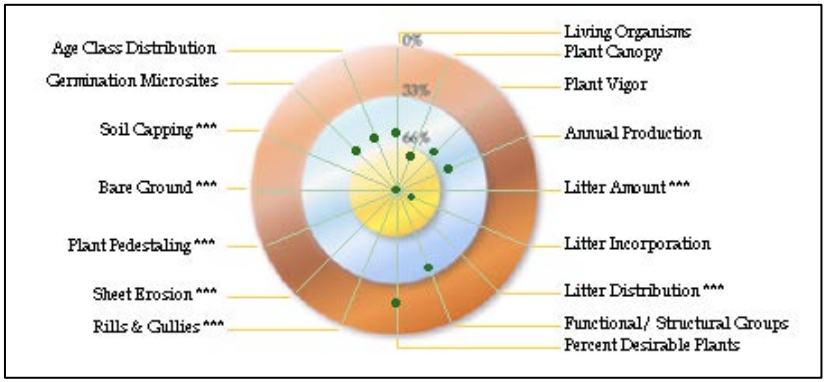


Figure 4: The target portrays results of each of the 16 indicators studied based on field scores.

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.

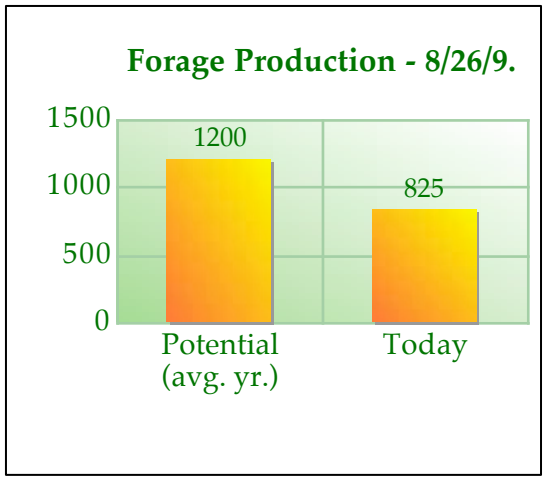


Figure 5: Plant production on sample day as compared with the site's potential from the soil survey.

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.

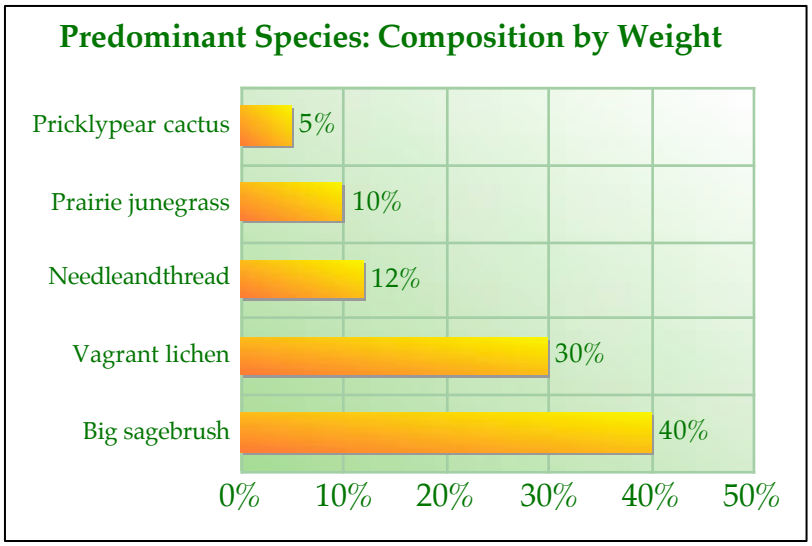


Figure 6: The most abundant species as composition by weight.

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).

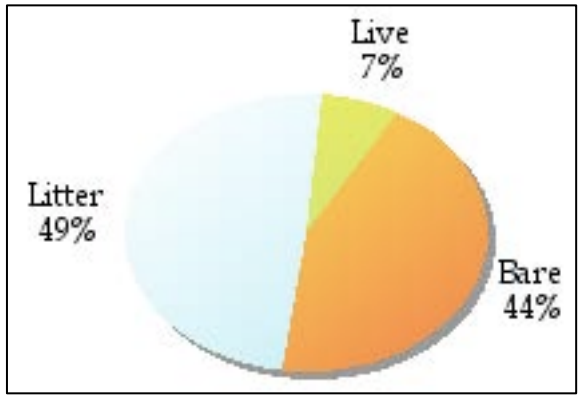


Figure 7: The ground cover chart generated by using the point intercept method.

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.

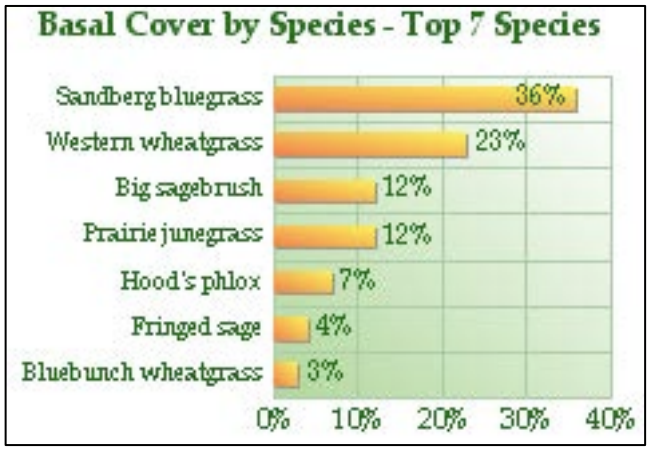


Figure 9: Basal cover by species bar graph created by measuring the distance to the nearest perennial plant using the point intercept method. The seven most numerous species are displayed here.

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.

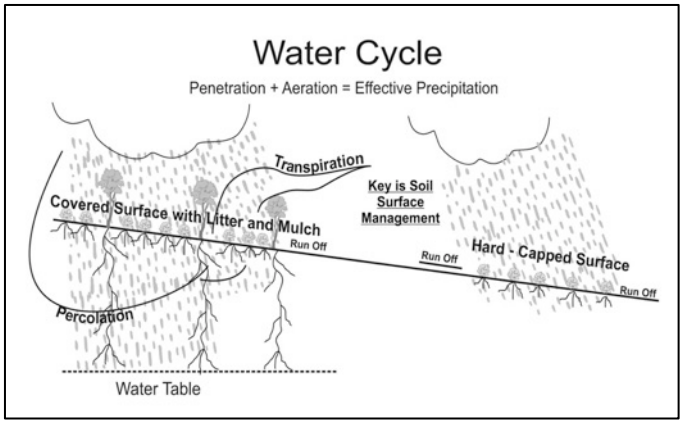
*Refer to ecological site descriptions available from NRCS

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.

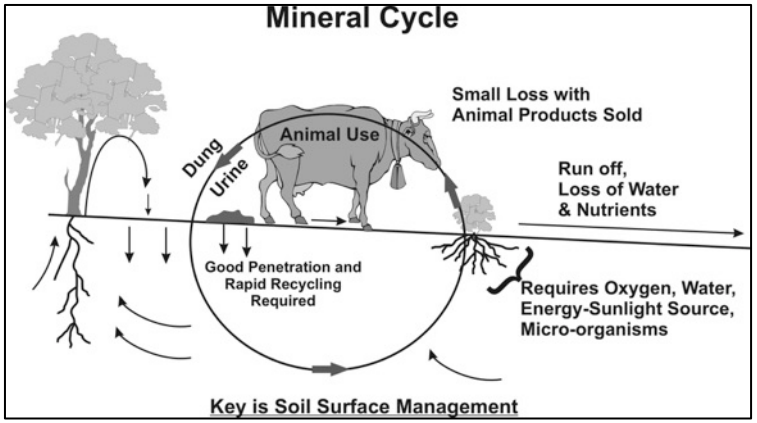
The monitoring methods used here were intended to observe changes in rangeland health through time. Both qualitative observations and quantitative methods were employed. Both are intended to provide decision-making information to land managers. Methods used in generation of this report are aligned with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



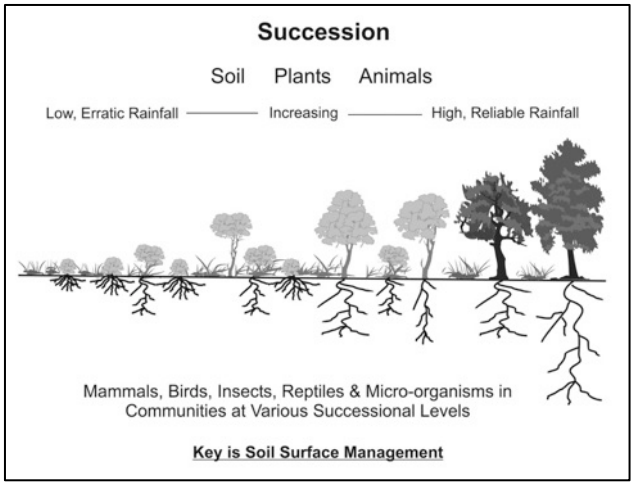
An effective water cycle requires covered soil and high biodiversity. When effective, most water soaks in quickly where it falls. Later, it's released slowly through plants that transpire it, or through rivers, springs, and aquifers that collect through seepage what the plants don't take. When biodiversity 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.



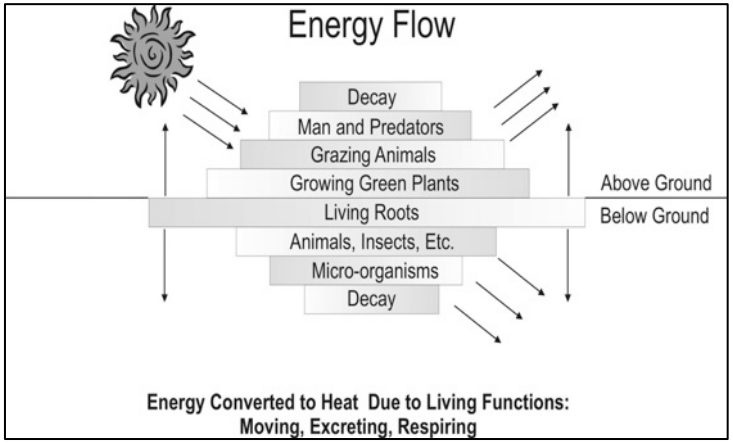
Like the water cycle, an effective and rapid mineral cycle requires covered soil and high biodiversity. When effective, many nutrients cycle between living plants and living soil continually. When soil is exposed and biodiversity low, nutrients become trapped at various points in the cycle, or are lost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

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