Merlin Ranch

2020 Rangeland Health Monitoring

By

RANCH ADVISORY PARTNERS

EXECUTIVE SUMMARY

The Merlin Ranch monitoring program was initiated in 2006 to track changes in rangeland health and provide information for improving grazing management decision-making. A total of 17 permanent rangeland health transects have since been established, including one new site in the Reservoir Pasture, which was added in 2020.

Monitoring data was collected at a total of three sites in 2020. Rangeland health across these three sites was generally high despite the dry spring and summer. Bare ground was low, litter was high, and species richness was high, all of which were good signs that the water cycle was effective. In addition, all sites displayed active recruitment of needleandthread and the successional process appeared to be moving plant communities in a good direction. Vigor was slightly reduced in the Lawrence and Reservoir pastures due to recent grazing events and the lack of moisture, which limited recovery, but it was high in the Three Section pasture.

Pastures on the Merlin Ranch appear particularly sensitive to early season grazing. Thus, strategies that defer spring grazing for one to two years have benefited the ranch as a whole. Further, pasture subdivisions have facilitated implementation of shorter grazing durations, longer recovery periods, and altered season of use. These strategies have been integral to the successful improvement of rangeland health across the ranch over the past decade and these improvements were evident in 2020. No course corrections in management were recommended and the ranch should continue with its current grazing program.

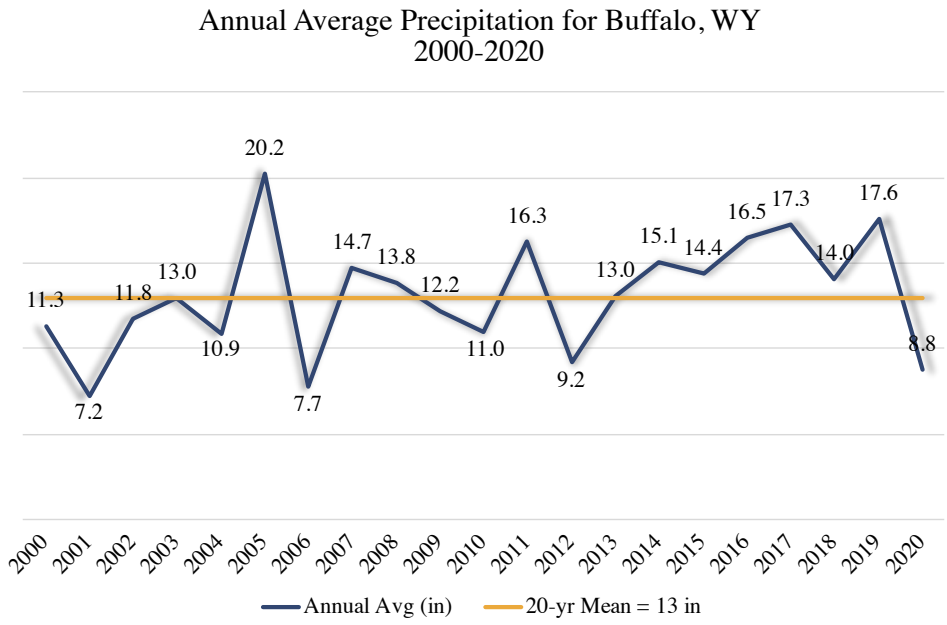
INTRODUCTION & PURPOSE

This document presents the findings from three rangeland health transects assessed on the Merlin Ranch in August 2020. Two of the three sites had been previously established in 2007 and 2011, and one (MRT31) was added in 2020. These sites were chosen to track changes in rangeland health through time, determine trend, and provide recommendations for adjusting grazing management to improve pasture performance. The map above displays the general location of each monitoring, which were:

- Three Section (MRT11)
- Lawrence Pasture (MRT23)
- Reservoir Pasture (MRT31)

SUMMARY OF FINDINGS & MANAGEMENT RECOMMENDATIONS

Bare ground, plant vigor, plant production and species composition are all influenced over time by a combination of management practices and precipitation. For the purposes of this report, and to provide some context for its findings, the most recent 20 years of precipitation data was pulled from the Buffalo Weather Station via the Western Regional Climate Center's website. The chart below summarizes the trend in precipitation for this time period and provides actual figures for each individual year. The mean precipitation for the past twenty years has been 13 inches. In 2020, total annual precipitation was low at 8.8 inches.



Data sourced from the Western Regional Climate Center database: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy1165

A summary of the findings from each of the three transects monitored in 2019 is provided below, along with management recommendations for continued improvement of the resource base. See the data and discussion from each site provided later in this document for added detail.

Three Section (MRT11)

This monitoring site was originally established in 2007 to track changes in range condition in the Three Section in response to management actions. In 2009, the site was treated with a Lawson

Renovator to remove sagebrush, but the treatment mostly missed the area where the transect was located, yielding little in the way of informative data on the the effect of shrub removal. The ranch has been focusing on grazing management practices such as altering seasons of use, shortening grazing durations, lengthening recovery periods and increasing stock density since the early 2000's and the effects of steady improvements in grazing management were obvious in 2020. Bare ground has remained low and litter cover high after showing initial improvement between 2007 and 2010. In addition, species composition has shown steady improvement through time that reflect more effective water cycling as well as better grazing management, which have enabled the establishment and expansion of perennial bunchgrasses. The trend in this pasture was clearly upward and no course corrections in management were warranted.

Lawrence Pasture (MRT23)

This transect was initially established in 2011 to track changes in rangeland health and inform grazing management in one of the ranches smaller pastures. The site is located fairly close to water and therefore receives more abundant hoof action and higher utilization when cattle are present. Rangeland health in 2020 was fairly high and the trend through time was mostly upward. Bare ground remained low through time while litter remained high. Species richness was also consistently high and recruitment of desired species like needleandthread and bluebunch wheatgrass was evident in 2020. The dry year resulted in slightly reduced plant vigor. No major adjustments in management were recommended for this area. Continuing to alter the season of use to provide regular growing season rest, and maintaining short grazing durations with moderate utilization rates are the key strategies to achieve ongoing improvement in species composition and forage production over time.

Reservoir Pasture (MRT31)

This monitoring site was newly established in 2020. It was chosen to be representative of the Reservoir Pasture, which is a relatively new acquisition to the Merlin Ranch. Rangeland health was fairly high for a dry year. The greatest opportunity for improvement existed with the composition of the plant community, which was characterized by a higher than desired abundance of annual grasses. However, active recruitment of needleandthread was a strong indication that the successional process was active and likely moving the plant community in a desired direction. Further, the water cycle appeared effective. Grazing management in this area should focus on altering the season of use, keeping durations short (particularly during the growing season), and maintaining moderate utilization rates. If the ranch plans to continue running smaller herds of cattle in this area, splitting this pasture into two units might be a worthwhile endeavor to add flexibility to the grazing management program.

Three Section (MRT11) Site Summary

This site was established in 2007 near the center of the Three Section Pasture. This pasture is characterized by large draws and rolling hills with shallow loamy soils. This site was chosen due to the abundance of plant growth and species diversity relative to other portions of the pasture. In 2009, a Lawson Renovator was brought through to reduce the abundance of sagebrush in the area, but missed the monitoring site.

Transect View

Photo taken August 17, 2007

Quadrat View

Photo taken August 17, 2007

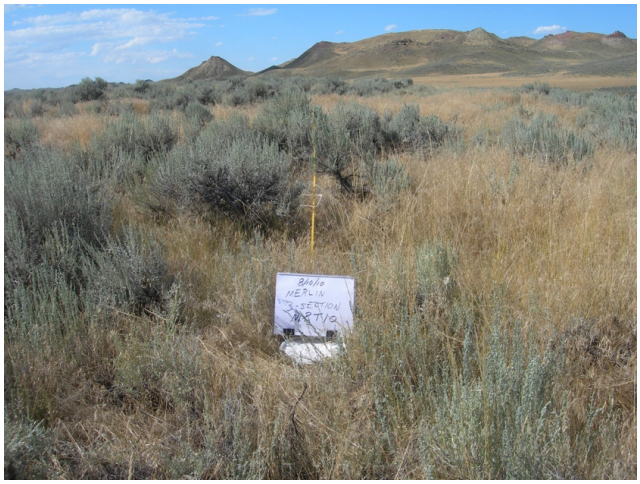


Photo taken August 10, 2010

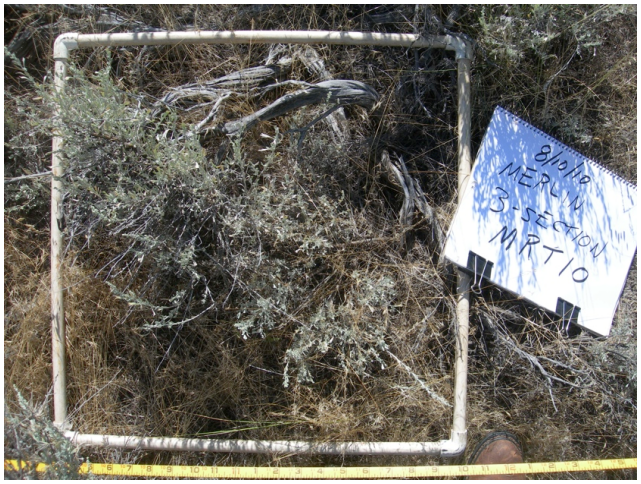


Photo taken August 10, 2010

Transect View

Photo taken August 2, 2016

Quadrat View

Photo taken August 2, 2016

Photo taken August 13, 2020

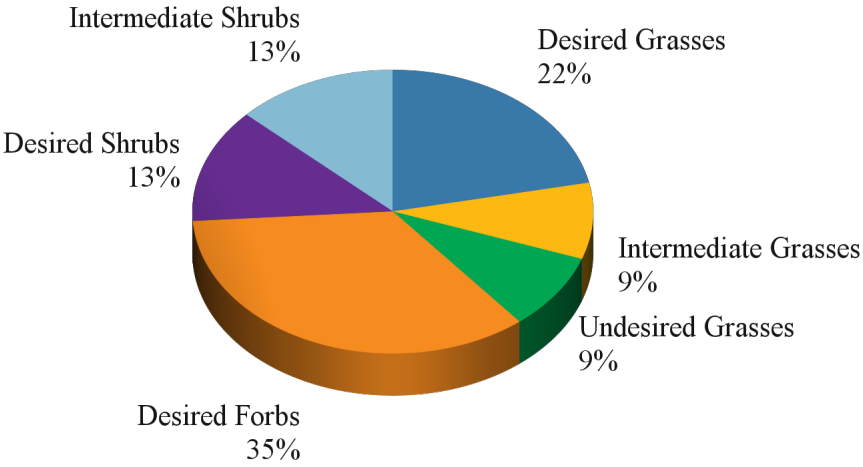
Photo taken August 13, 2020

A comparison of the 2007 and 2010 **Site Photos** shows the effects of the Lawson Renovator to the right of the transect line, where the machine made a swath through the site removing much of the big sagebrush and opening this area for increases in herbaceous production. Herbaceous production appears highest in 2010, which was a slightly below average moisture year. The Quadrat photos reveal an increase in western yarrow as of 2020, which was notable in a dry year and indicative of improved water cycling.

Plant Community Composition

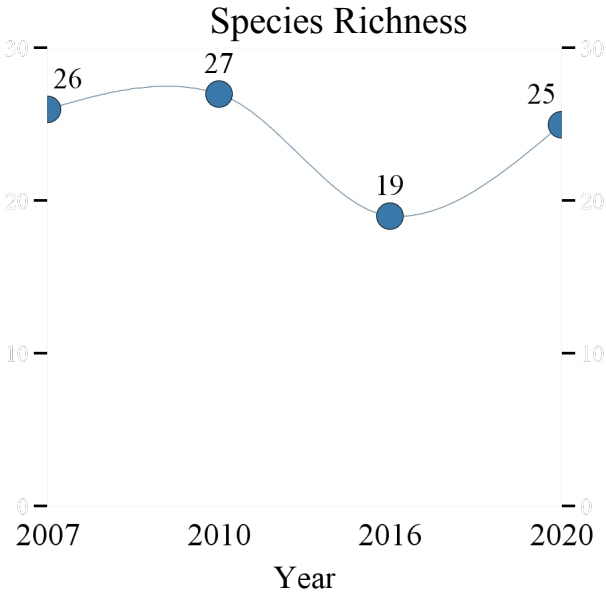
Three Section (MRT11)

Composition by Functional Group



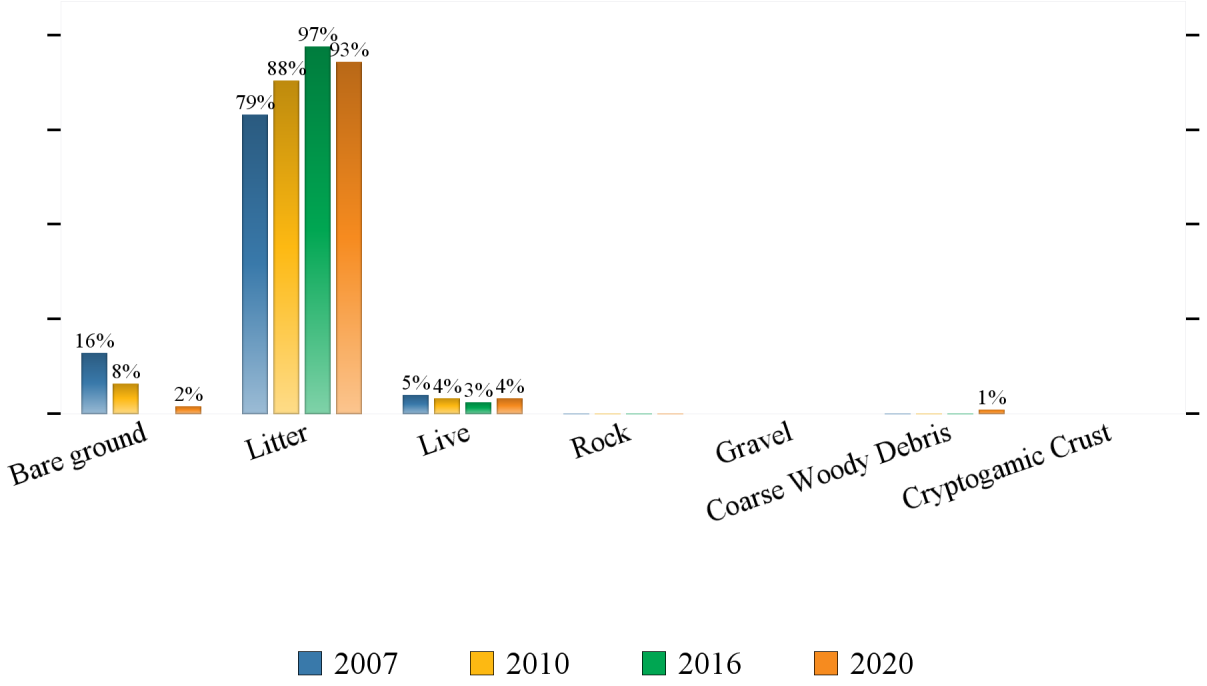
Key Interpretations:

Species Richness has varied slightly through time, ranging between 19 and 27 recorded plants. The pie chart shows the distribution of species across functional groups in 2020. Desired Grasses, Forbs and Shrubs accounted for 70% of the total richness, which was a positive finding. These groups included species such as bluebunch wheatgrass, green needlegrass, needleandthread, western wheatgrass, scarlet globemallow, salsify, prairie coneflower, lupine, vetch, western yarrow, daisy, fourwing saltbush, Wyoming big sagebrush, and rubber rabbitbrush. Intermediate species accounted for 22% of the richness and included broom snakeweed, fringed sagewort, pricklypear, Sandberg bluegrass, prairie junegrass, and peppergrass. Undesired species made up just 9% of the richness and included cheatgrass, Japanese brome and musk thistle.



Ground Cover

Three Section (MRT11)

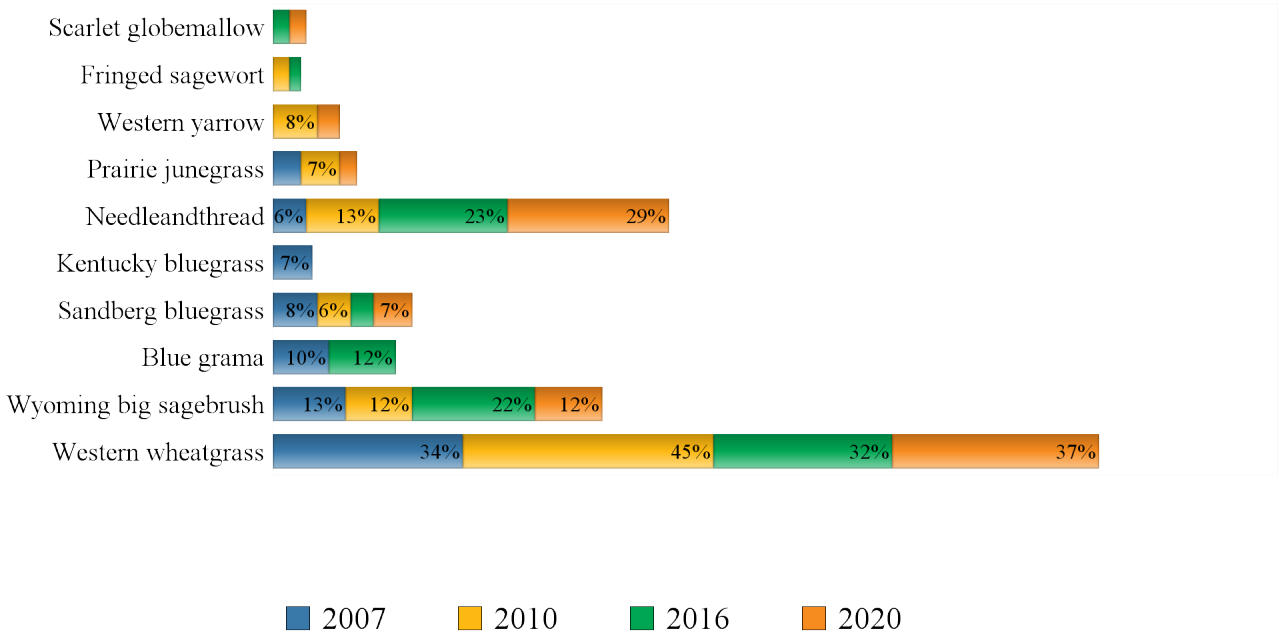


Key Interpretations:

Ground Cover data provide important information on hydrologic function and site stability. Low bare ground, high litter, and high live cover are generally associated with better water cycling and a lower risk of erosion. Here, the data show a steady decline in bare ground and increase in litter between 2007 and 2016, after which bare ground has remained low and litter high. Live cover has generally hovered between 3-5% over time, which is a decent result, but a finding that would likely increase with an increase in basal cover by mature perennial grasses. Overall, however, these data reveal an effective water cycle and high site stability.

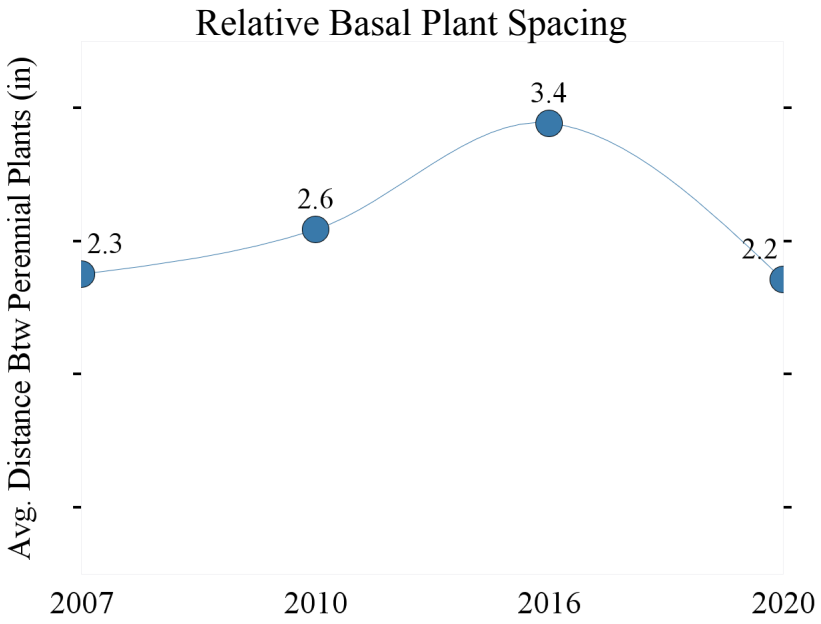
Relative Basal Cover (Top 7 Species)

Three Section (MRT11)



Key Interpretations:

The **Relative Basal Cover** chart offers a look at the suite of *perennial* plant species dominating the soil surface, thus providing information on perennial plant community composition. These data highlight consistent basal dominance by western wheatgrass over time, an increasing abundance of needleandthread through time, and a moderate abundance of big sagebrush through time. In 2020, western wheatgrass, needleandthread, and big sagebrush were the top three most abundant perennial plants on the soil surface with lesser contributions from Sandberg bluegrass, prairie junegrass, western yarrow, and scarlet globemallow. This represented a highly desired species composition for this site, which should support an abundance of perennial grasses and forbs, as well as a conspicuous sagebrush community.

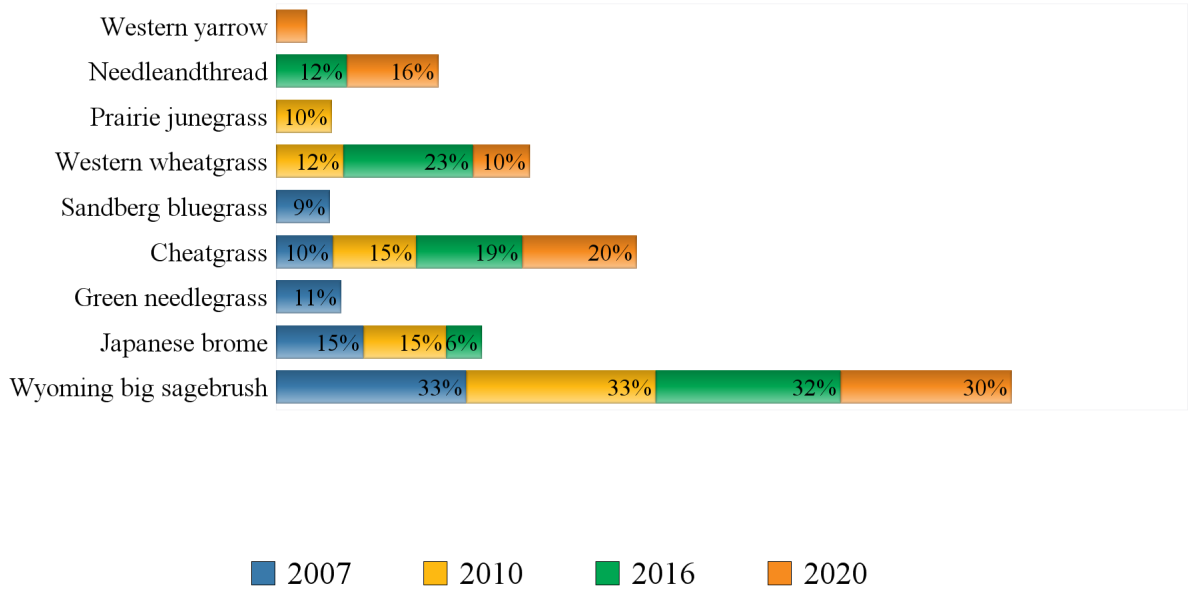


Key Interpretations:

The **Relative Basal Plant Spacing** metric assesses the abundance of perennial species on the soil surface and insight into the stability of the site. Perennial plants should be tightly spaced, providing good soil coverage to limit erosion and prevent undesired species from gaining a foothold in the community. Results of less than 1 inch are ideal for this metric. Here, the average distance to the nearest perennial plant has ranged from just above 2 inches to nearly 3.5 inches, and was 2.2 inches in 2020. These data reflect room for improvement in the distribution and abundance of perennial plants at the level of the soil surface.

Community Composition by Weight

Three Section (MRT11)

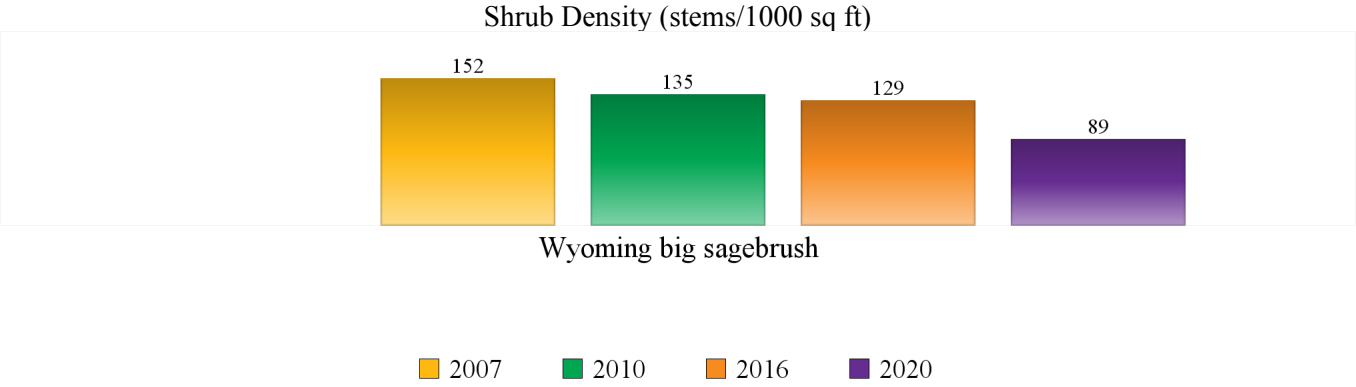


Key Interpretations:

The **Community Composition by Weight** chart shows the top five most productive species by weight, offering a look at species composition from the perspective of plant production and biomass. Where the basal cover data focuses only on perennial plants, this data set encompasses both annuals and perennials. A look at this chart tells a story of succession and reveals an upward trend in species composition. In 2007, Wyoming big sagebrush, Japanese brome, green needlegrass, cheatgrass, and Sandberg bluegrass dominated production in this area. In 2010, cheatgrass had increased (possibly reflecting initial improvements in the water cycle) and production by western wheatgrass and prairie junegrass had displaced that of green needlegrass and Sandberg bluegrass. By 2016, the abundance of Japanese brome had begun to decline, cheatgrass continued to increase, western wheatgrass production increased substantially, and needleandthread made its first appearance. As of 2020, Japanese brome had declined sufficiently not to register in this chart, the increase in cheatgrass had leveled off, western wheatgrass remained prominent, but had declined a bit in favor of increases in needleandthread and western yarrow. These trends in species composition reflect good grazing management over time, which has focused on increasing springtime rest to facilitate germination and expansion by desired grasses.

Shrub Data

Three Section (MRT11)



Line Intercept Data

2007	**Wyoming big sagebrush**
Percent Canopy Intercept	29%
Average Height - inches	27
Age Class: Seedling	*0%*
Age Class: Young	*0%*
Age Class: Mature	*100%*
Age Class: Decadent	*0%*
Age Class: Dead	*0%*

2010	**Wyoming big sagebrush**
Percent Canopy Intercept	24%
Average Height - inches	20
Age Class: Seedling	*0%*
Age Class: Young	*8%*
Age Class: Mature	*78%*
Age Class: Decadent	*15%*
Age Class: Dead	*0%*

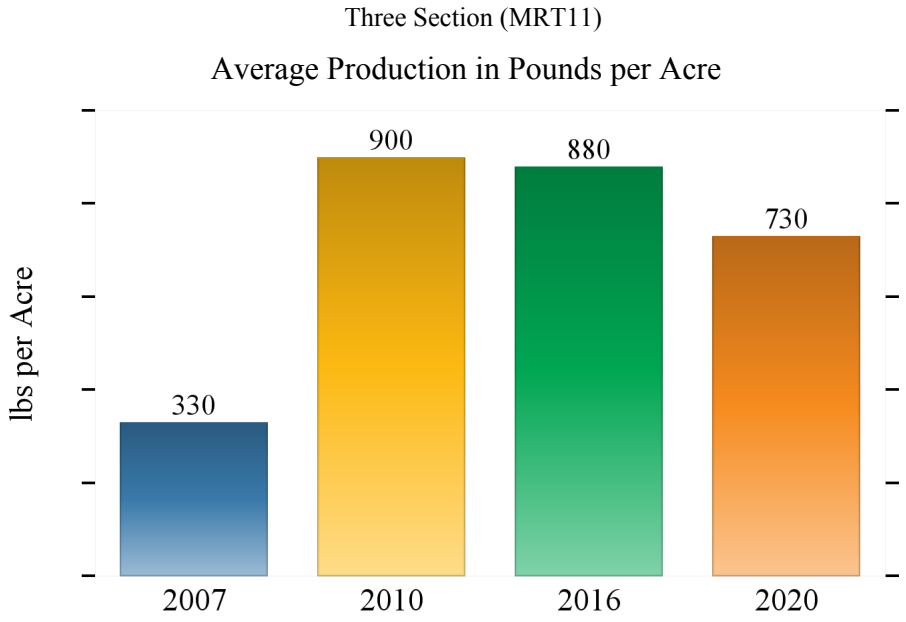
2016	**Wyoming big sagebrush**
Percent Canopy Intercept	27%
Average Height - inches	15
Age Class: Seedling	*0%*
Age Class: Young	*0%*
Age Class: Mature	*96%*
Age Class: Decadent	*4%*
Age Class: Dead	*0%*

2020	**Wyoming big sagebrush**
Percent Canopy Intercept	29%
Average Height - inches	17
Age Class: Seedling	*0%*
Age Class: Young	*5%*
Age Class: Mature	*79%*
Age Class: Decadent	*7%*
Age Class: Dead	*9%*

Key Interpretations:

Shrub Data provide information on the abundance and successional status of select shrub species at a particular site. The Shrub Density data reveal a long-term decline in the density of Wyoming big sagebrush. This data likely reflects patterns in succession whereby maturation of the sagebrush community has led to an overall decline in density but not a decline in canopy cover, as seen in the Line Intercept data. The percent canopy intercept of sagebrush has slowly increased over time as this community has matured. Interestingly, recruitment of younger plants has varied through time an appears more active in 2010 (shortly after the Lawson Renovator treatment) and in 2020. The Renovator treatment was expected to stimulate recruitment, but given that only a portion of the area surrounding the transect was treated, its actual effects are hard to discern in the data. Overall, the shrub data reveal a moderately high abundance of sagebrush, most of which was mature in 2020, with some slow turnover evident in the distribution of age classes.

Forage Production

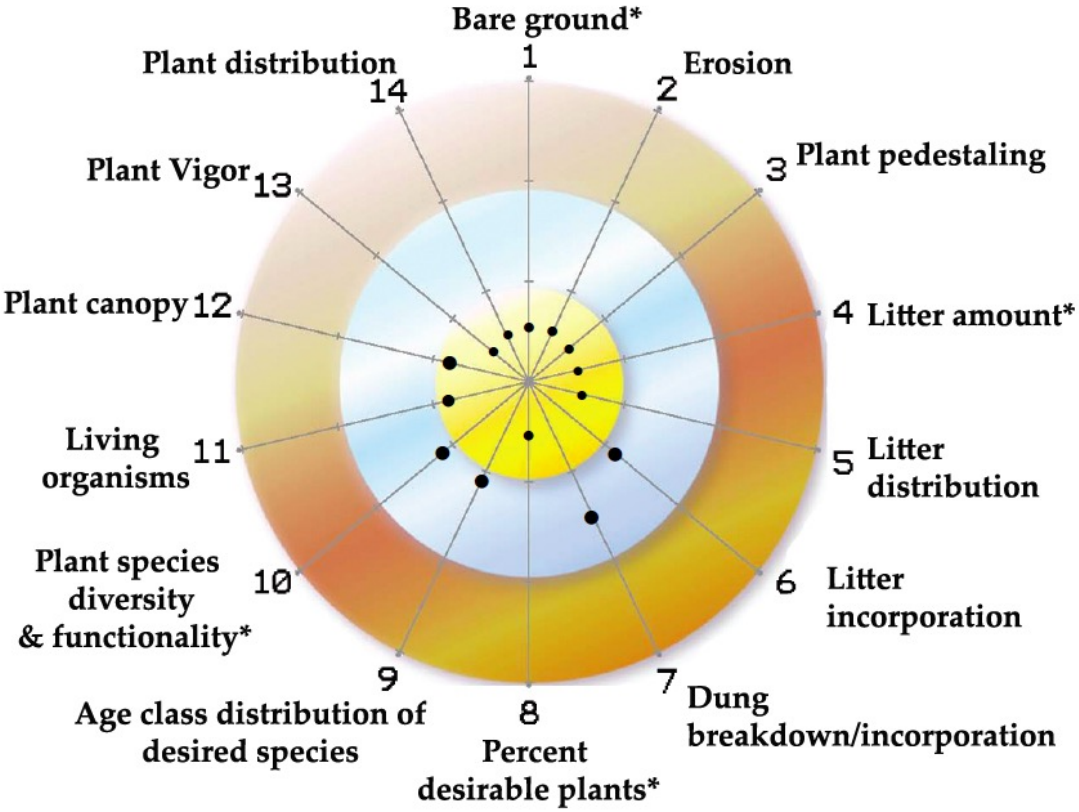


Key Interpretations:

Forage Production has varied through time as would be expected in response to precipitation and the timing of grazing events. Production was at its lowest in 2007, which was an above average moisture year, but followed a deep drought in 2006. Production came up in 2010 despite dry conditions, reflecting the release of some of the herbaceous understory after the Lawson Renovator treatment, and remained high in 2016, which was an above average moisture year. Finally, production in 2020 fell slightly compared to the two previous years, but a light graze had occurred earlier in the season followed by very little moisture to aid recovery. For reference, the NRCS's Web Soil Survey identifies potential production in this are in a poor precipitation year (such as 2020) as ranging from 525 to 625 pounds per acre.

Bullseye

Three Section (MRT11)



The **Bullseye** provides an overview of range condition at a specific point in time based on a visual assessment of 14 indicators of rangeland health. The Bullseye scored from 2020 were similar to those in 2016 with the exception that the mineral cycle was slightly more rapid in the wetter year of 2016 (as would be expected) and successio appeared more active in 2020.

Bare ground in 2020 was low with no signs of erosion or plant pedestaling in the area. Litter was high, in part due to the abundance of cheatgrass, but it was evenly distributed, helping to cover the soil surface and prevent moisture loss to evaporation or soil loss to erosion. In addition, litter was in contact with the soil surface and some slow mixing appeared to be happening. Cowpies in the area showed signs of oxidation rather than decomposition, with little bug activity. Overall, the water cycle appeared effective and the speed of the mineral cycle was moderate.

Species richness was high with 27 plants recorded in the area. Cheatgrass, Japanese brome and musk

thistle represented the only undesired plants encountered, resulting in a high score for the percent desired species indicator. A handful of younger needleandthread plants were observed as well as a few younger sagebrush, indicating the successional process was active. Ideally, recruitment would be more rapid, but in a dry year, any recruitment was also a good sign. The diversity and functionality of the plant community was decent with good presence by desired grasses, forbs and shrubs, but an overabundance of cheatgrass.

The plant canopy was high, in part due to the abundance of cheatgrass, but allowing almost no sunlight to strike the ground. Plant vigor was also high despite the lack of moisture received that spring and summer. Cows had grazed this site earlier in the year, but utilization appeared light and the grasses showed good stature and seed production. In addition, plants were evenly distributed throughout the site. These findings suggest that energy flow through the system was effective.

Management Recommendations & Early Warning Indicators

Three Section (MRT11)

Management Recommendations

Rangeland health in the Three Section was high in 2020 despite a dry spring and summer, and the trend through time was upward. The water cycle and energy flow were clearly effective given low levels of bare ground, high plant vigor, high species richness, and active succession with shifts in species composition telling a story of steady improvement over time.

The Three Section Pasture has historically been grazed for 2-3 weeks in the spring followed occasionally by a short graze in the fall. In 2016, the ranch split this pasture into two units for the first time, which brought the grazing duration down to one week in each unit. This helped lengthen recovery periods and minimize grazing durations during, particularly in that sensitive spring growth window. Management has considered splitting this pasture one more time if possible. This would be recommended to further increase stock density, shorten grazing durations, and add more flexibility to the season of use. Any opportunity to provide springtime rest and increase hoof action in this pasture will enable ongoing establishment and expansion of desired perennial bunchgrasses. When using this pasture in the spring, keep grazing durations to no more than 10 days and preferably to 7 or fewer. If grazing in the fall, then durations may be extended to 20 days but utilization rates should remain light to moderate (30-40%) regardless of the season. Periodic growing season rest in this area will further facilitate desired shifts in species composition and improvements in forage production.

Finally, the site appeared to have fully recovered from the Lawson Renovator partial treatment in 2009. Overall, this treatment appeared to have added little value to the site and the gains in range condition were largely due to good grazing management.

Early Warning Indicators

Early−warning indicators provide managers with rapid feedback regarding how management actions are affecting a particular site. If management can quickly assess whether implemented plans are taking a site away from a desired state, then it is possible to respond promptly and avoid costly and time-consuming corrections down the road. Early−warning indicators provide those first glimpses that help one identify when course corrections are needed.

If management practices move rangeland health in a positive direction, look first for maintained high plant vigor even in dry years. Next, look for more rapid incorporation of litter into the soils accompanied by ongoing shifts in species composition that favor greater perennial bunchgrasses and forbs over cheatgrass and Japanese brome.

If management practices move rangeland health in a negative direction, look first for reductions in plant vigor, suggesting that grazing durations may be too long and recovery periods may be too short. Next, look for increases in bare ground and reductions in litter, both of which would indicate that

utilization rates may be too high. Finally, look for shifts in species composition that favor undesired and mid-seral species like cheatgrass, Japanese brome, Kentucky bluegrass, Sandberg bluegrass, and prairie junegrass..

Lawrence Pasture (MRT23) Site Summary

This transect was established in 2011 in an open bowl of the Lawrence Pasture not far from the pasture boundary fence and close to stockwater. This transect was specifically chosen to lie in an area that contained a mix of grasses, forbs, and shrubs. Sometime after the transect was established a lightly used two track road was added to the area, which overlapped with the first 10 feet of the transect in 2016 and 2020.

Transect View

Photo taken August 10, 2011

Quadrat View

Photo taken August 10, 2011

Photo taken August, 13, 2014

Photo taken August, 13, 2014

Transect View

Photo taken August 2, 2016

Quadrat View

Photo taken August 2, 2016

Photo taken August 13, 2020

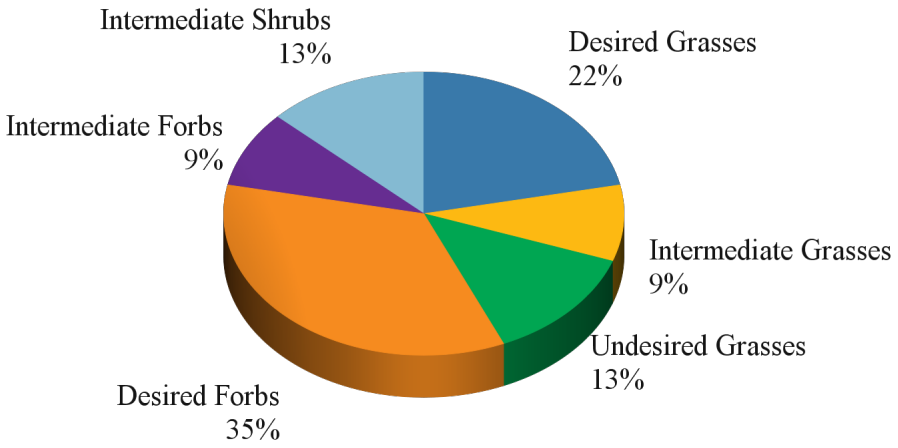
Photo taken August 13, 2020

The **Site Photos** show high ground cover by litter in all four sampling years. The plant canopy was highest in 2011 and 2014, both of which were above average precipitation years. The pasture was grazed shortly prior to monitoring in both 2016 and 2020, thus the canopy appears reduced in both of theses latter years. The Quadrat photos portray good ground cover in all years, though utilization and hoof action reduced litter cover in 2016.

Plant Community Composition

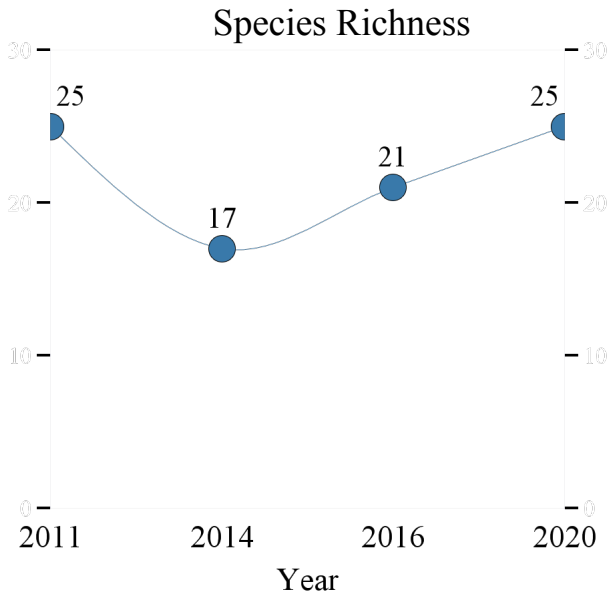
Lawrence Pasture (MRT23)

Composition by Functional Group



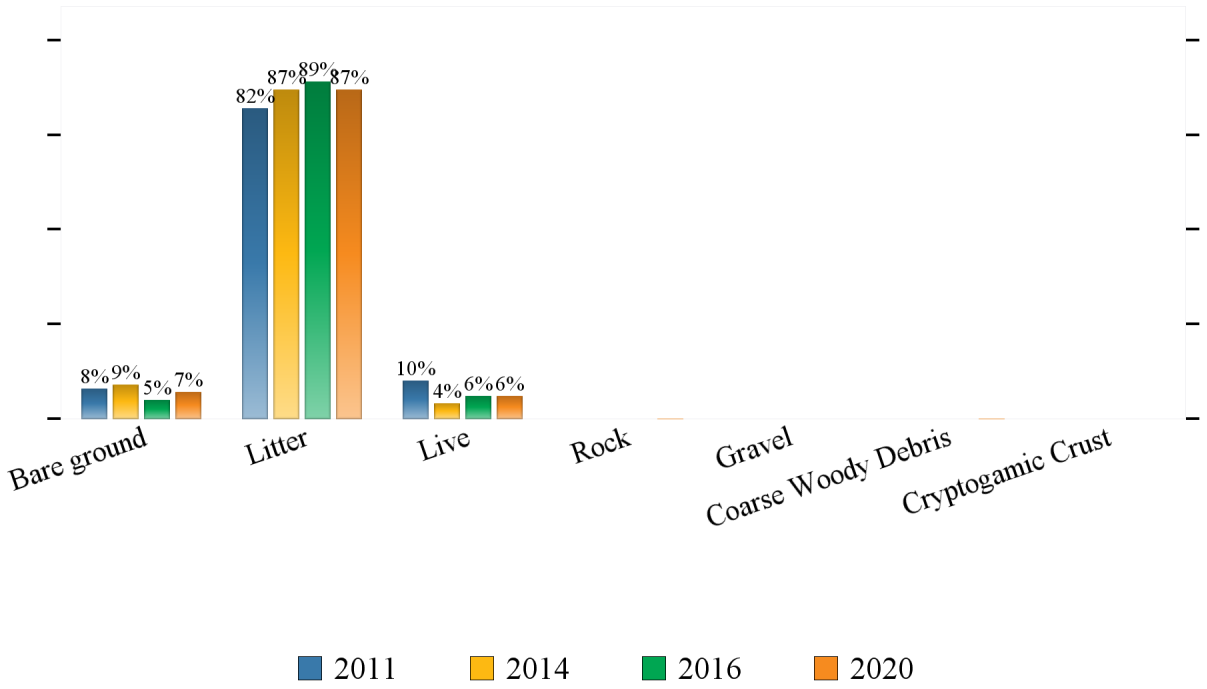
Key Interpretations:

Species Richness has varied from 17 to 25 recorded plants over time, with high richness present in all years. In 2020, a total of 25 plants were found in the vicinity of the transect. The pie chart shows the distribution of species across functional groups in 2020. Desired Grasses, Forbs and Shrubs accounted for a majority (58%) of the total richness (shrubs are not shown in the pie chart, but accounted for 4% of the richness). These groups included species like blue grama, bluebunch wheatgrass, green needlegrass, needleandthread, western wheatgrass, lupine, salsify, scarlet globemallow, vetch, western yarrow, daisy, and Wyoming big sagebrush. Intermediate species accounted for 32% of the richness and included Sandberg bluegrass, prairie junegrass, peppergrass, tansymustard, broom snakeweed and fringed sagewort. Finally, Undesired species included cheatgrass and Japanese brome.



Ground Cover

Lawrence Pasture (MRT23)

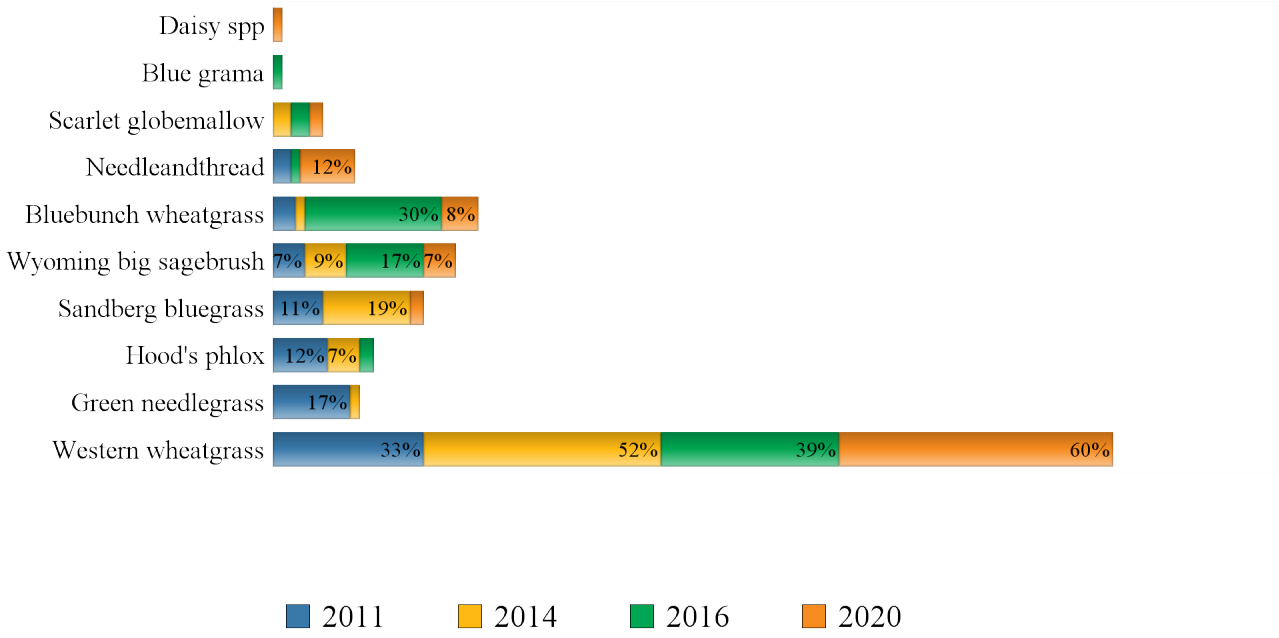


Key Interpretations:

The **Ground Cover** chart reveals fairly consistent results over time with low bare ground, high litter and moderate live cover. Bare ground was highest in 2011 and lowest in 2016, but the change over time was a matter of three percentage points. Overall, the ground cover data were favorable and indicated the water cycle was effective and site stability high.

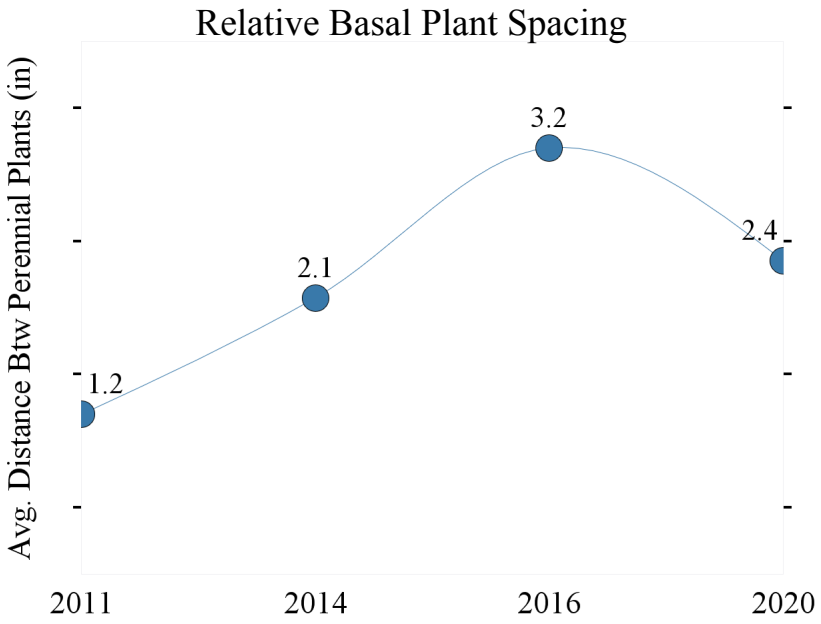
Relative Basal Cover (Top 7 Species)

Lawrence Pasture (MRT23)



Key Interpretations:

The **Relative Basal Cover** chart offers a look at the suite of *perennial* plant species dominating the soil surface, thus providing information on perennial plant community composition. This chart highlights consistent dominance by western wheatgrass over time, which was expected for this area. Shifts in the relative abundance of other species through the years have been indicative of active succession. Most importantly, high value perennial bunchgrasses have composed much of the perennial basal cover in all years, though the relative abundance of various species has shifted over time. Green needlegrass was moderately abundant in 2011, whereas bluebunch wheatgrass was abundant in 2016 and needleandthread was abundant in 2020. Intermediate species like Sandberg bluegrass and Hood's phlox have remained fairly low in abundance. Overall, these data reveal good presence by a variety of desired species with ongoing room for improvement in the abundance of perennial bunchgrasses.

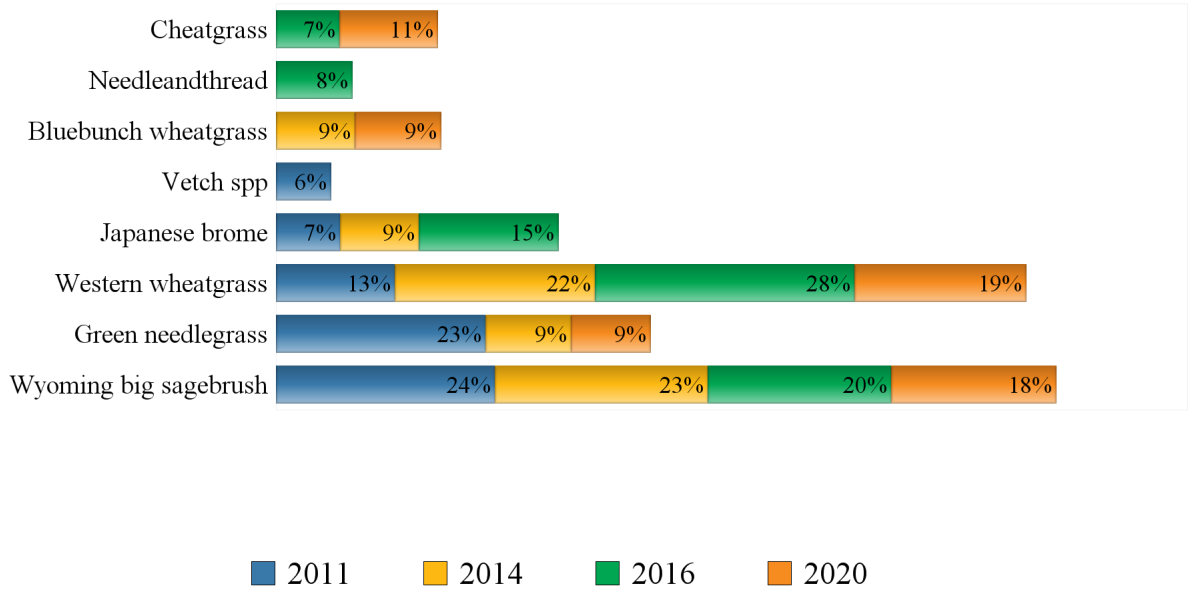


Key Interpretations:

The **Relative Basal Plant Spacing** metric assesses the abundance of perennial species on the soil surface. Perennial plants should be tightly spaced, providing good soil coverage to limit erosion and prevent undesired species from gaining a foothold in the community. However, this metric has shown an undesired trend over time, increasing from a low of 1.7 inches in 2011 to a high of 3.2 inches in 2016 and dropping slightly to 2.4 inches in 2020. The 2016 figure is likely explained by the high utilization and abundant hoof action that characterized the site at the time of monitoring that year. In addition, the abundance of Hood's phlox has declined over time, which tends to take up a large basal area. Ideally, the average distance to the nearest perennial plant would be 1 inch or less in this area.

Community Composition by Weight

Lawrence Pasture (MRT23)



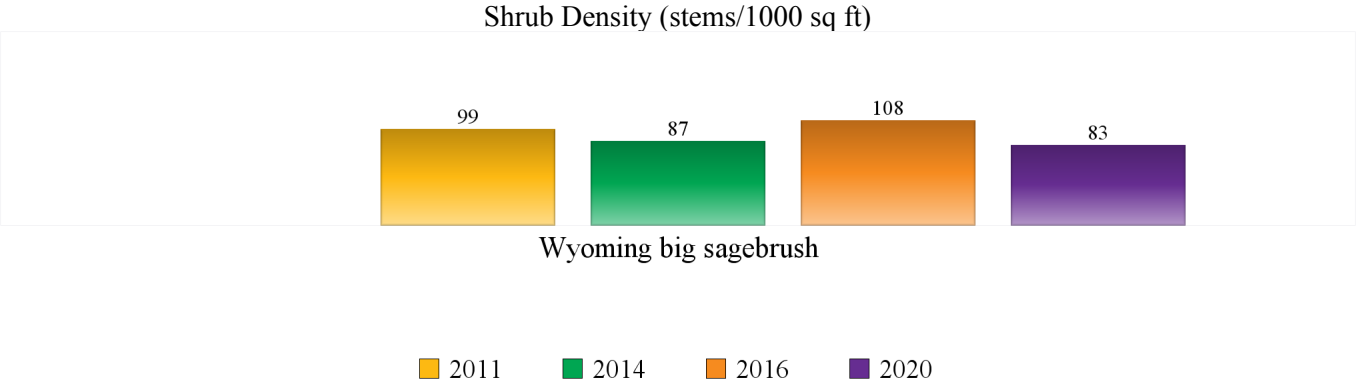
Key Interpretations:

The **Community Composition by Weight** chart shows the top five most productive species by weight, offering a look at species composition from the perspective of plant production and biomass. These data reveal active succession through time and potentially the effects of the grazing events that occurred in both 2016 and 2020 shortly prior to monitoring. A look at the chart reveals consistently high productive contributions from Wyoming big sagebrush and western wheatgrass over time, which was expected for the site. Japanese brome increased steadily between 2011 and 2016 but was not highly productive in 2020. In contrast, cheatgrass was less abundant in 2011 and 2014, but increased sufficiently to rank in this chart in 2016 and 2020. Perhaps most interesting is the fact that needleandthread was prominent in the 2020 basal cover results but did not rank among the top five most productive species by weight, suggesting a reduction due to utilization in 2020 rather than low abundance. Conversely, green needlegrass was not basally abundant, but did account for 9% of the production by weight in 2020, indicating a moderate presence and less utilization on this species.

Overall, these data highlight good presence by several desired species through time (Wyoming big sagebrush, western wheatgrass, green needlegrass, and bluebunch wheatgrass) as well as an ongoing overabundance of cheatgrass. Further shifts in species composition should be expected as the successional process continues to drive community dynamics in this area.

Shrub Data

Lawrence Pasture (MRT23)



Line Intercept Data

2011	**Wyoming big sagebrush**
Percent Canopy Intercept	25%
Average Height - inches	17
Age Class: Seedling	*0%*
Age Class: Young	*0%*
Age Class: Mature	*82%*
Age Class: Decadent	*18%*
Age Class: Dead	*0%*

2014	**Wyoming big sagebrush**
Percent Canopy Intercept	24%
Average Height - inches	17
Age Class: Seedling	*0%*
Age Class: Young	*0%*
Age Class: Mature	*87%*
Age Class: Decadent	*13%*
Age Class: Dead	*0%*

2016	**Wyoming big sagebrush**
Percent Canopy Intercept	18%
Average Height - inches	14
Age Class: Seedling	*0%*
Age Class: Young	*3%*
Age Class: Mature	*88%*
Age Class: Decadent	*9%*
Age Class: Dead	*0%*

2020	**Wyoming big sagebrush**
Percent Canopy Intercept	18%
Average Height - inches	19
Age Class: Seedling	*0%*
Age Class: Young	*0%*
Age Class: Mature	*70%*
Age Class: Decadent	*17%*
Age Class: Dead	*13%*

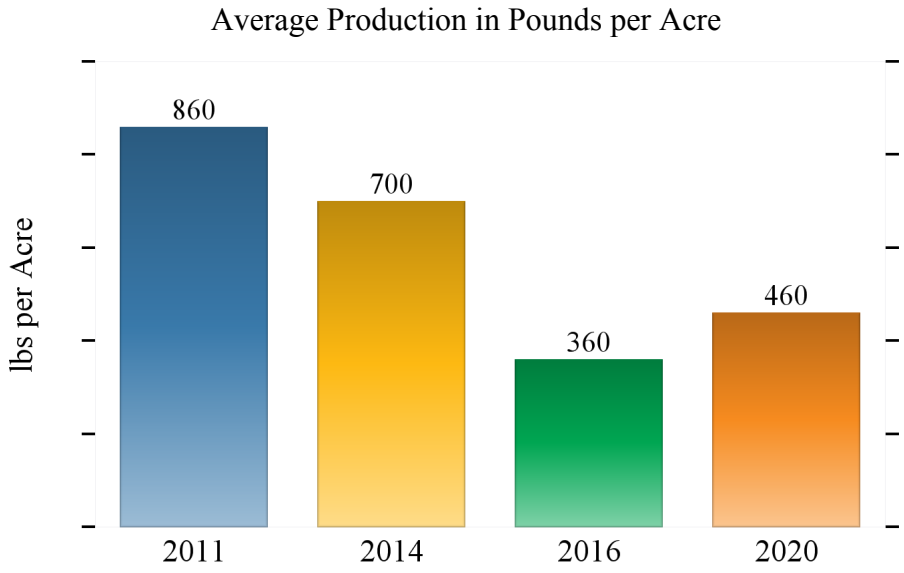
Key Interpretations:

Shrub Data provide information on the abundance and successional status of select shrub species at a particular site. Over time, both Line Intercept and Shrub Density data have been collected for this site. Wyoming big sagebrush density has been high in all sampling years ranging from 83 to 108 plants per 100 square feet. The variation over time may reflect variation in recruitment activity or slight variations in the position of the transect tape. The important takeaway from this is that sagebrush density has been consistently high through time.

The Line Intercept data highlight a stronger declining trend in this community through the years than one of recruitment and replacement. In 2016, 3% of plants encountered were young, but none of the other years captured active recruitment. Rather, the sagebrush community has tended to show varying levels of decadence, much of which may be explained by variations in moisture. Wyoming big sagebrush will often drop its leaves in times of drought, making a higher proportion of the community appear decadent, such as occurred in 2020 when 17% of the community was decadent. In contrast, in 2016, which was a wetter year, only 9% of the community was decadent. The percent canopy intercept data, however, tell a story of slow decline. In 2011, sagebrush accounted for 25% canopy cover, declining to 24% in 2014 and 18% in both 2016 and 2020.

Forage Production

Lawrence Pasture (MRT23)

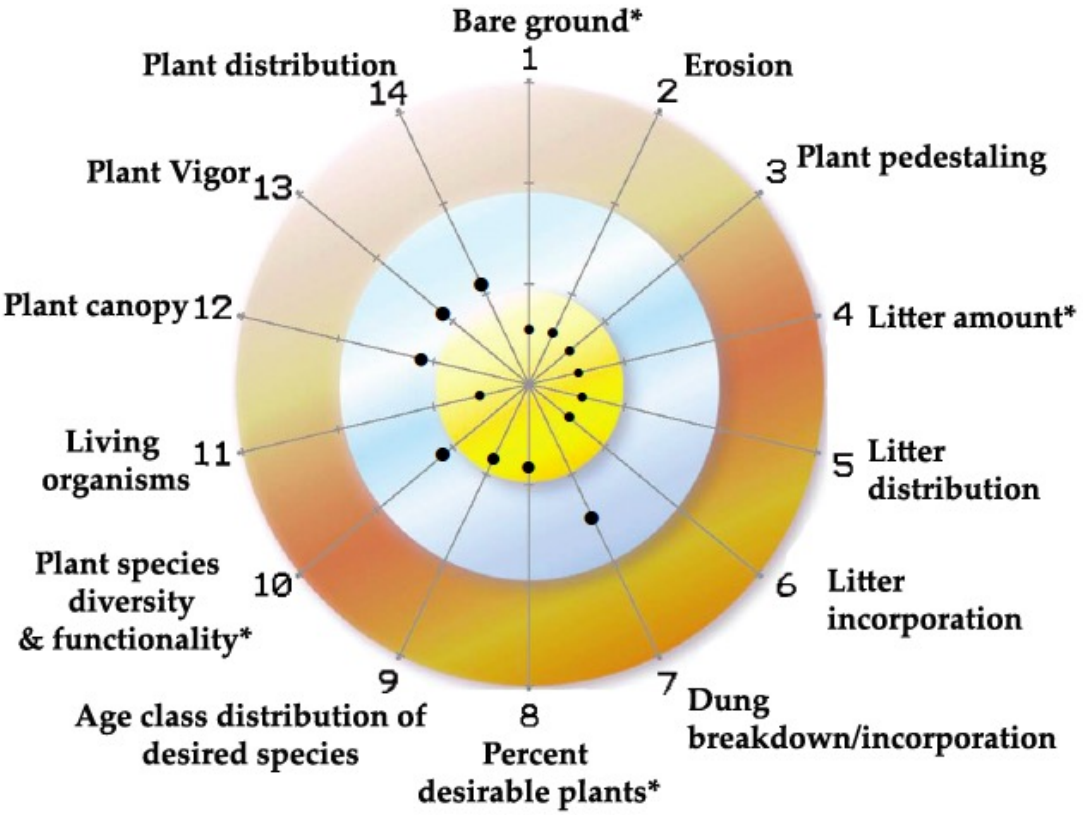


Key Interpretations:

Forage Production was on the low side in 2020 compared to previous years. This was due both to the recent grazing event and the dry year. Production in wetter years when the site had not yet been grazed was much higher and more representative of the potential for this area, which, according to NRCS is 485 pounds per acre in a poor precipitation year and 1,110 in an average precipitation year.

Bullseye

Lawrence Pasture (MRT23)



The **Bullseye** provides an overview of range condition at a specific point in time based on a visual assessment of 14 indicators of rangeland health. Compared to 2016, the Bullseye indicators reflect improvement in water and mineral cycling. Bare ground in 2020 was low with no signs of erosion or plant pedestaling. Litter was abundant, well distributed and actively incorporating into the soil surface. The hoof action from cattle grazing in this area shortly prior to when monitoring occurred had encouraged this mixing of litter and soil. Cowpies were abundant in the area and both new and old ones were present. Dung breakdown appeared slower. Altogether, the water cycle was effective and mineral cycling was moderately rapid.

Species richness was high in this area with 25 different plants recorded. The percent desired species was high with cheatgrass and Japanese brome the only undesired plants encountered. The sagebrush community was predominantly mature with a low to moderate level of decadence and few younger plants evident. Active recruitment of needleandthread and bluebunch wheatgrass was, however, an

obvious indication that the successional process was active. In general, the area displayed a decent abundance of desired grasses, forbs and shrubs, but an overabundance of cheatgrass indicated room for improvement in the diversity and functionality of the plant community. Ideally, perennial bunchgrasses would be more dominant as well.

The plant canopy had been reduced by grazing and had not yet had time to recover. Plant vigor also appeared slightly reduced with minimal recovery evident on grazed plants and lower than expected seed production within the perennial bunchgrass community. This was not surprising, however, given the low moisture received that spring and summer. Finally, the distribution of plants across the soil surface showed room for improvement with a lower than desired presence by native, perennial grasses. Ideally, these species will continue to recruit younger individuals and eventually crowd out the cheatgrass on the soil surface. Overall, these observations suggest that energy flow through the system was moderately effective.

Management Recommendations & Early Warning Indicators

Lawrence Pasture (MRT23)

Management Recommendations

The Lawrence Pasture is a small pasture in which Merlin Ranch has been implementing short grazing durations and altered seasons of use for many years. These are good strategies that are designed to maximize recovery after grazing events and provide perennial grasses with periodic, uninterrupted growth during the spring and summer. Growing season grazing durations in this area should not exceed 14 days and utilization rates should be kept light to moderate (20-40%).

Early Warning Indicators

Early−warning indicators provide managers with rapid feedback regarding how management actions are affecting a particular site. If management can quickly assess whether implemented plans are taking a site away from a desired state, then it is possible to respond promptly and avoid costly and time-consuming corrections down the road. Early−warning indicators provide those first glimpses that help one identify when course corrections are needed.

In the Lawrence Pasture, the first indication that management actions are moving the site in a desired direction will be maintained plant vigor even in dry years. Next, look for more rapid dung breakdown and continued incorporation of litter into the soil. If a positive trend continues, look for improved forage production and shifts in species composition that favor perennial bunchgrasses like bluebunch wheatgrass, needleandthread, and green needlegrass, as well as a diversity of perennial forbs.

By contrast, the first indications that the site is moving away from the desired condition will be reductions in plant vigor. Next, look next for increased levels of bare ground, reductions in litter, and more active erosion. These trends would indicate that grazing durations are too long and/or utilization rates too high. If a negative trend continues, look for shifts in species composition toward a greater abundance of intermediate and annual grasses (e.g., Sandberg bluegrass, prairie junegrass, Kentucky bluegrass and/or cheatgrass), as well as intermediate shrubs and forbs (e.g., fringed sagewort, broom snakeweed, dandelion, peppergrass, woolly plaintain).

Reservoir Pasture (MRT31) Site Summary

This transect was established in 2020 to track rangeland health in a recently acquired parcel near the Healy Reservoir. The site was located away from water and above a nearby draw where cattle may tend to linger and was selected to be representative of the uplands in this pasture.

Transect View

Photo taken August 13, 2020

Quadrat View

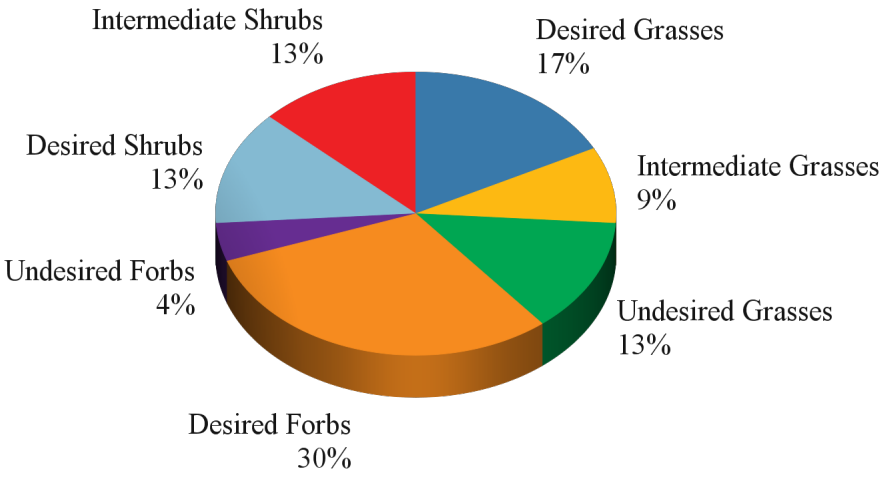
Photo taken August 13, 2020

The **Site Photos** illustrate the dormant nature of the plant canopy as a result of the drought in 2020. The Transect view photo highlights the mix of grasses and shrubs that characterized this site with several older cowpies visible in the foreground. The Quadrat photo shows low bare ground and decent cover by litter, but also a fairly low plant canopy.

Plant Community Composition

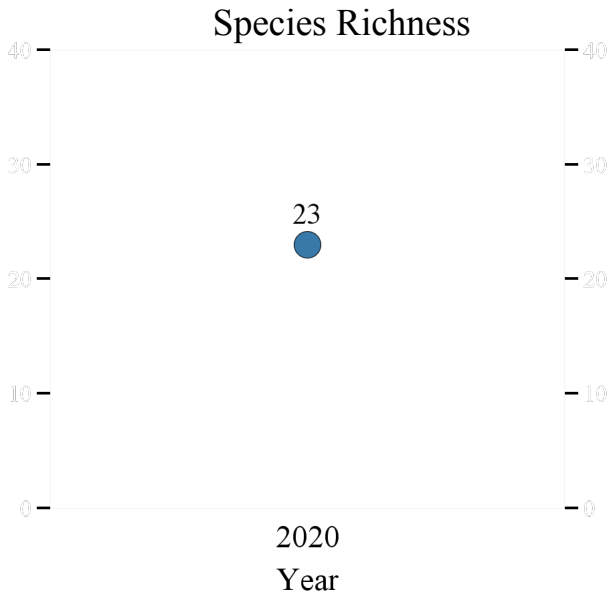
Reservoir Pasture (MRT31)

Composition by Functional Group



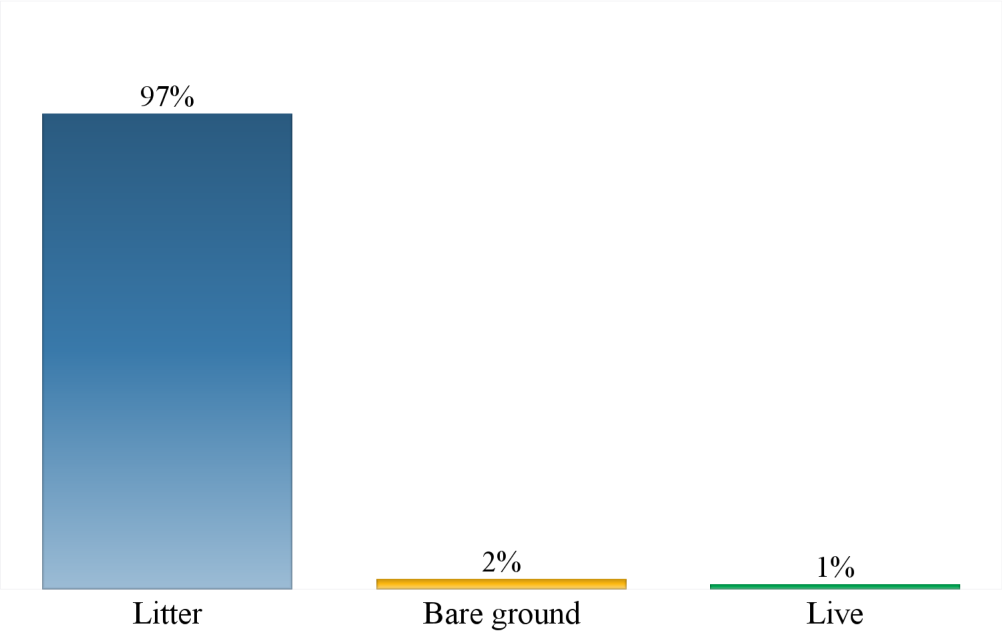
Key Interpretations:

Species Richness was fairly high in 2020 with 23 plants recorded in the area. The pie chart shows the distribution of species across functional groups. Desired Grasses, Forbs and Shrubs accounted for 60% of the species richness and included plants such as blue grama, needleandthread, western wheatgrass, daisy, curlycup gumweed, salsify, scarlet globemallow, western yarrow, Wyoming big sagebrush and silver sagebrush. Intermediate species accounted for 22% of the richness and included Sandberg bluegrass, prairie junegrass, fringed sagewort, broom snakeweed and pricklypear. Undesired species were responsible for 17% of the richness and included cheatgrass, Japanese brome, and musk thistle.



Ground Cover

Reservoir Pasture (MRT31)

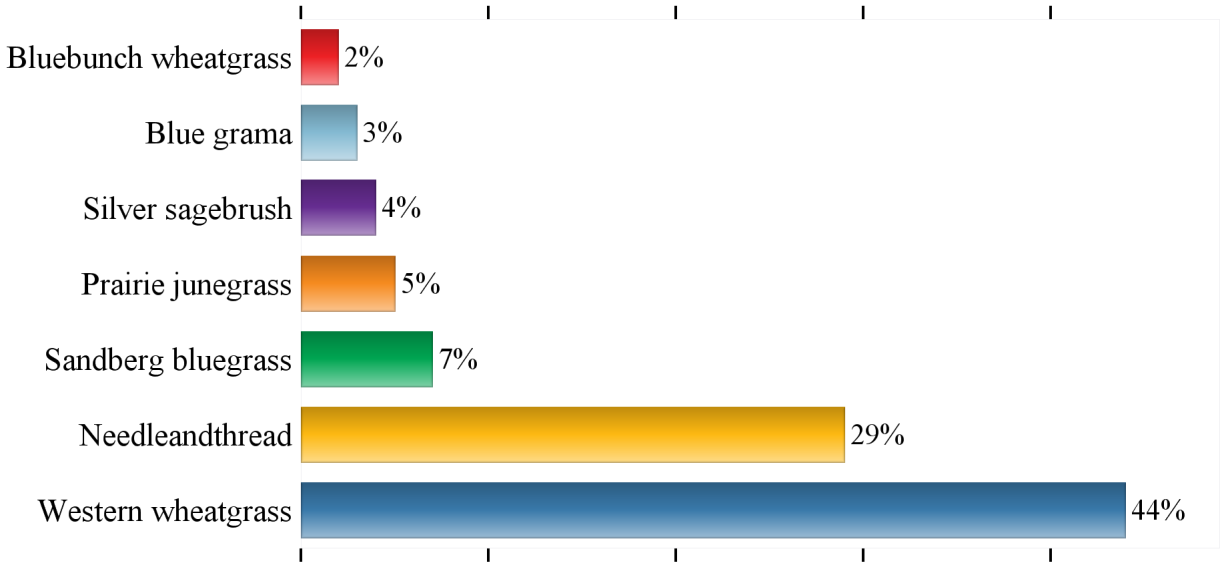


Key Interpretations:

Ground Cover data provide an important indicator of hydrologic function and site stability. Low bare ground, high litter and higher live cover generally equate to more effective water cycling and lower risk of erosion. Here, bare ground was low at 2% and litter was high at 97%. This was partially due to an abundance of cheatgrass in the area, which was helping generate litter to cover the soil surface. Live cover was low at 1% reflecting room for improvement in the abundance of mature bunchgrasses at the level of the soil surface.

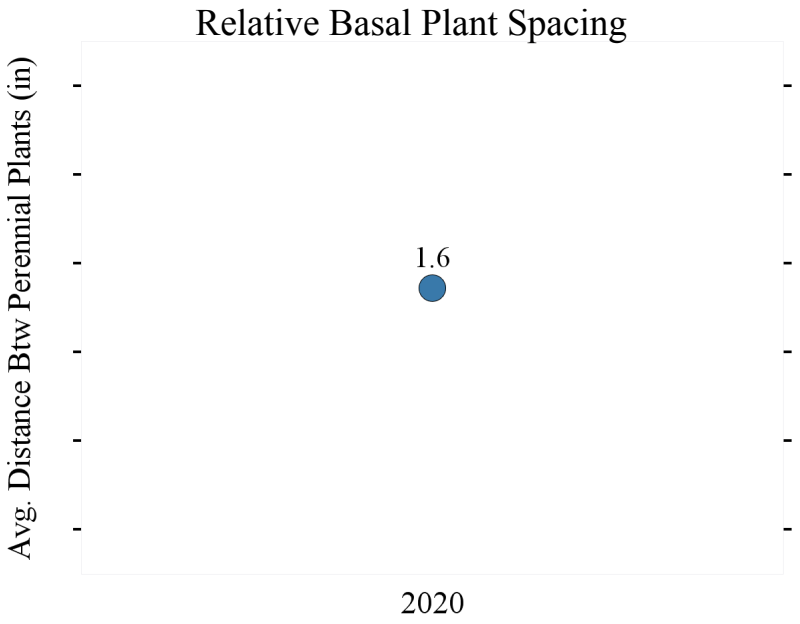
Relative Basal Cover (Top 7 Species)

Reservoir Pasture (MRT31)



Key Interpretations:

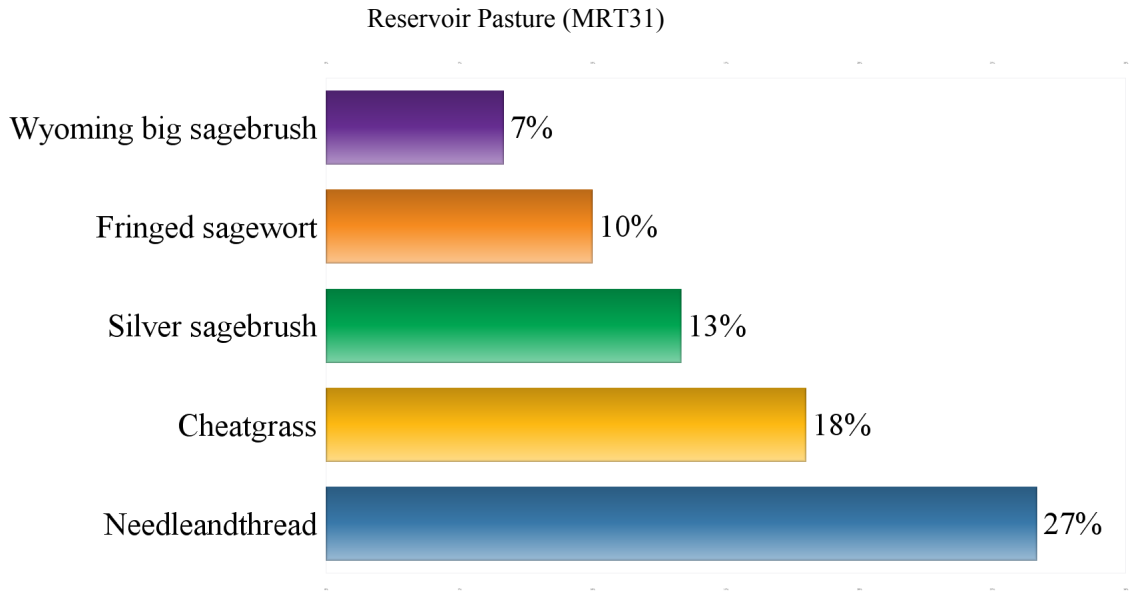
The **Relative Basal Cover** chart offers a look at the suite of *perennial* plant species dominating the soil surface, thus providing information on perennial plant community composition. A look at this chart highlights the abundance of both western wheatgrass and needleandthread, two highly desired grasses for this area. Overall, the suite of species dominating the basal cover was favorable, but with some room for improvement in the relative abundance of various plants. Bluebunch wheatgrass, for instance, accounted for just 2% of the basal cover in 2020, but would ideally be a more prominent component of the plant community.



Key Interpretations:

The **Relative Basal Plant Spacing** metric assesses the abundance of perennial species on the soil surface. Perennial plants should be tightly spaced, providing good soil coverage to limit erosion and prevent undesired species from gaining a foothold in the community. In 2020, the average distance to the nearest perennial plant was 1.6 inches, which was higher than desired and revealed room for improvement in the abundance of perennial species at the level of the soil surface. Results of 1 inch or less are ideal for this metric.

Community Composition by Weight



Key Interpretations:

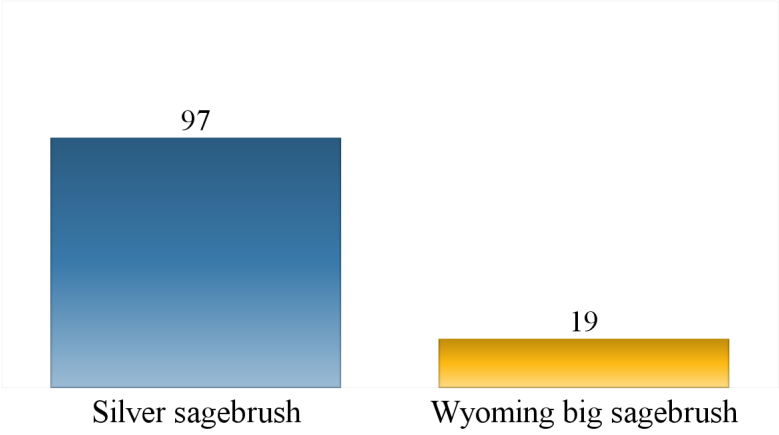
The **Community Composition by Weight** chart shows the top five most productive species by weight, offering a look at species composition from the perspective of plant production and biomass. These data highlight several important takeaways: First, needleandthread was highly productive in 2020, despite the dry year. This was a positive finding. Second, cheatgrass was overly abundant. Given cheatgrass's low biomass relative to most perennial grasses, it tends only to show up in this metric when it is high in abundance. Third, shrubs accounted for nearly a third of the site's production by weight which was a bit higher than desired. However, these data may also have been a bit skewed towards shrub production because this pasture was grazed shortly prior to monitoring.

Overall, this chart reveals room for improvement in the composition of the plant community. Ideally, perennial grasses would compose a majority of the production by weight, with lesser contributions from desired shrubs and perennial forbs.

Shrub Data

Reservoir Pasture (MRT31)

Shrub Density (stems/1000 sq ft)



Line Intercept Data

	Silver sagebrush	**Wyoming big sagebrush**
Percent Canopy Intercept	5%	2%
Average Height - inches	7	24
Age Class: Seedling	*0%*	*0%*
Age Class: Young	*27%*	*0%*
Age Class: Mature	*73%*	*100%*
Age Class: Decadent	*0%*	*0%*
Age Class: Dead	*0%*	*0%*

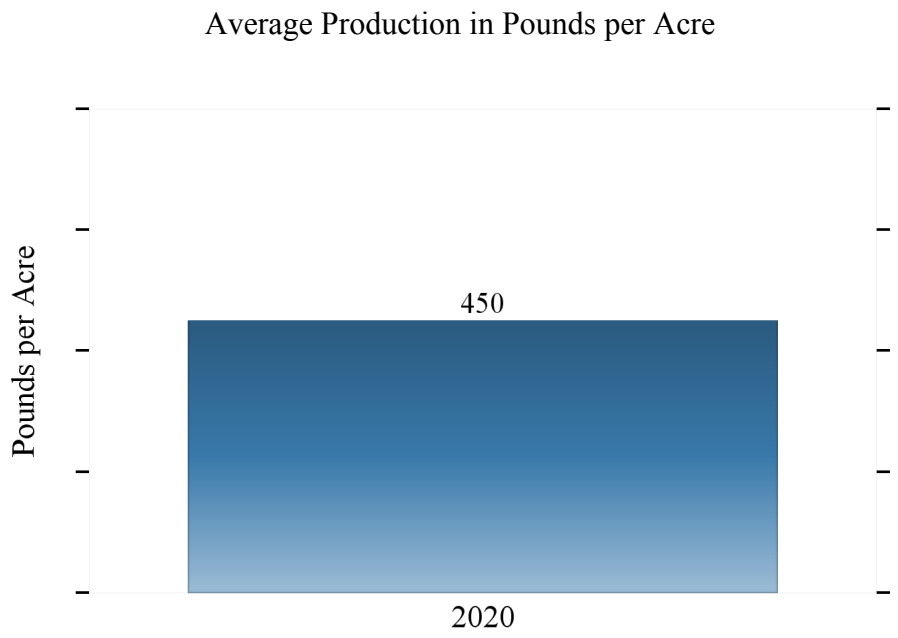
Key Interpretations:

Shrub Data provide information on the abundance and successional status of select shrub species at a particular site. In 2015, density data was collected on silver and Wyoming big sagebrush. These data reveal a much higher density of silver sagebrush (97 plants/1000 sq ft) compared to big sagebrush (19 plants/1000 sq ft).

The Line Intercept data highlight shrub contributions to the plant canopy and their successional status. Despite its density, many of the silver sagebrush plants were small in size and this species only accounted for 5% canopy cover. Twenty-seven percent of the community was young and 73% was mature. By contrast, 100% of the Wyoming big sagebrush community was mature and this species accounted for just 2% canopy cover.

Forage Production

Reservoir Pasture (MRT31)

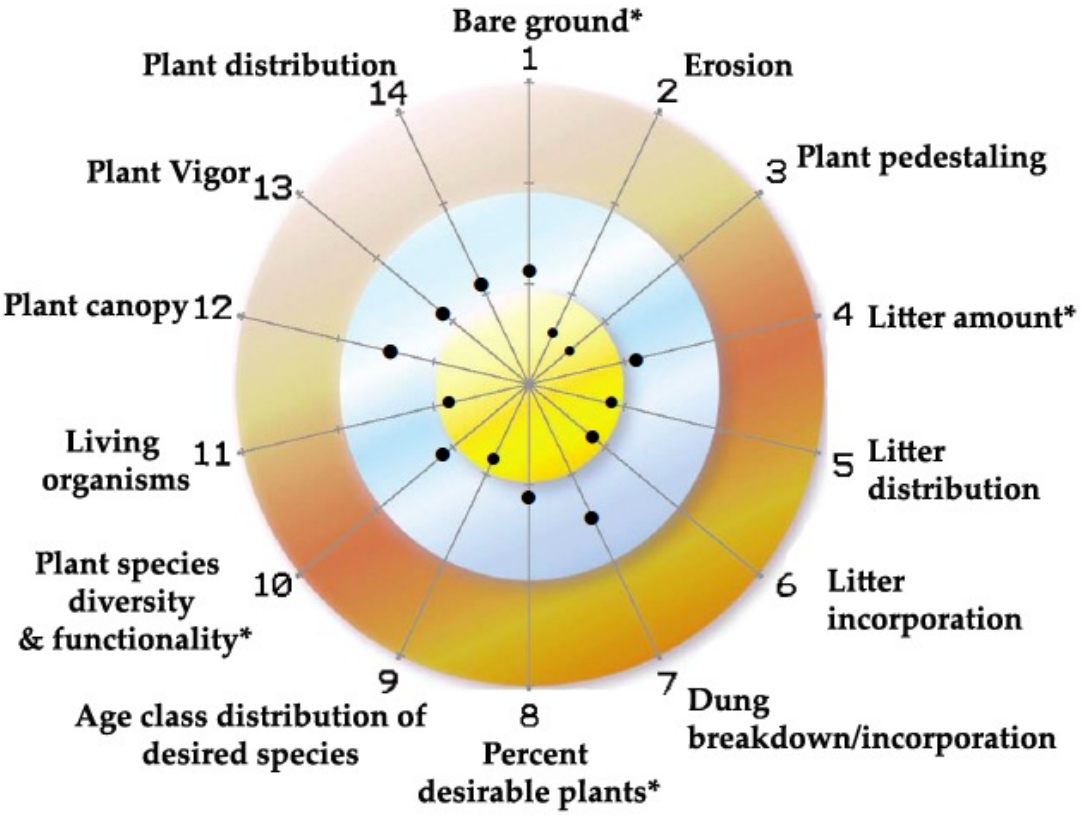


Key Interpretations:

Forage Production in 2020 was somewhat low at 450 pounds per acre. However, production was reduced both by the a lack of moisture and by the recent grazing event. Monitoring occurred shortly after cattle left this pasture so plants had not had much time to recover. For reference, the NRCS's Web Soil Survey indicates potential production for this area in a poor precipitation year to be 368 pounds per acre, suggesting that production was, in face, within an expected range in 2020. In more normal precipitation years, production may climb to 695 pounds per acre.

Bullseye

Reservoir Pasture (MRT31)



The **Bullseye** provides an overview of range condition at a specific point in time based on a visual assessment of 14 indicators of rangeland health. Bare ground in this area was low but showed room for improvement. No sign of active wind or water erosion was observed and plant pedestaling was absent. Litter cover was decent and fairly well distributed, and incorporation into the soil was active. Cowpies in the area were older, however, and tended to be oxidizing rather than breaking down biologically. These observations indicate the water cycle was mostly effective and mineral cycling was moderately rapid.

Species richness was fairly high with 23 plants recorded in the area. Cheatgrass and Japanese brome were the only undesired species encountered so the percent desired plants was high. Both the silver and Wyoming big sagebrush communities displayed multiple age classes. An abundance of younger silver sage and a handful of younger Wyoming big sagebrush plants were evident. The big sagebrush community displayed a higher level of decadence and more active decline, though this

may also have simply been the effect of annual drought. Species diversity and functionality showed room for improvement in the overabundance of cheatgrass. The abundance of needleandthread was favorable, but a greater diversity of perennial grasses and forbs would have been ideal to see in this area.

The plant canopy was reduced due to a recent grazing event and minimal time or moisture to aid recovery since. As a result, sunlight energy was striking the ground throughout much of the area. Vigor was slightly reduced due to the dry growing season. The big sagebrush community looked tougher with heavier browse pressure and minimal new leader growth. Ungrazed perennial bunchgrasses had produced seed earlier in the summer but were largely dormant at the time of monitoring. In addition, there was room for more perennial plants on the soil surface. Overall, these findings indicate that energy flow through the system was moderate.

Management Recommendations & Early Warning Indicators

Reservoir Pasture (MRT31)

Management Recommendations

Rangeland health in the Reservoir Pasture was fairly high for a dry year. The greatest opportunity for improvement existed with the composition of the plant community, which was characterized by a higher than desired abundance of annual grasses. However, active recruitment of needleandthread was an strong indication that the successional process was actively and likely moving the plant community in a desired direction.

This pasture was grazed for approximately 10 days by 63 head in late July 2020 and utilization appeared light at the time of monitoring, which was shortly after cattle had been removed. This was an appropriate grazing duration for the time of year and given the lack of moisture. As with other pastures on the Merlin Ranch, the key tools to drive improvements in range condition in this area will be maintaining short grazing durations, altering the season of use over time, and keeping utilization rates light to moderate. If planning two grazes in a season, make sure grasses have recovered sufficiently after the first event to withstand a second event and consider providing extra rest the following year. In addition, if the ranch plans to continue running smaller herds in this pasture, then splitting it into two units could add greater flexibility to seasons of use, help increase stock density for greater hoof action, improve grazing distribution, and facilitate short durations over time.

Early Warning Indicators

Early−warning indicators provide managers with rapid feedback regarding how management actions are affecting a particular site. If management can quickly assess whether implemented plans are taking a site away from a desired state, then it is possible to respond promptly and avoid costly and time-consuming corrections down the road. Early−warning indicators provide those first glimpses that help one identify when course corrections are needed.

In the Reservoir Pasture, the first indication that management actions are moving the site in a desired direction will be maintained plant vigor even in dry years. Next, look for continued litter accumulation and low bare ground accompanied by more rapid litter incorporation and dung breakdown. If a favorable trend continues, look for ongoing recruitment of needleandthread and other desired grasses such as bluebunch wheatgrass and green needlegrass. Over time, forb diversity should also increase and cheatgrass abundance should decline.

By contrast, the first indications that the site is moving away from the desired condition will be reductions in plant vigor. Next, look next for increased levels of bare ground, reductions in litter, and more active erosion. These trends would be indications that grazing durations are too long and/or utilization rates too high. If a negative trend continues, look for reductions in the abundance of needleandthread, reductions in species diversity, and increases in cheatgrass and Japanese brome.

NUTRIENT ANALYSIS REPORT

At each of the three monitoring sites, a single plot of forage was clipped, dried, sorted to remove unpalatable species (such as sagebrush), and sent to Midwest Labs in Omaha, NE for nutrient analysis. Unfortunately, two of the samples were misplaced prior to being shipped to the lab this year. The following table displays the dry matter nutrient content for the one available sample in the Reservoir Pasture.

Nutrient	Reservoir
Crude Protein (%)	7
Acid Detergent Fiber (%)	38.7
Total Digestible Nutrients (%)	58.4
Net energy-lactation (Mcal/lb)	0.6
Net energy-maintenance (Mcal/lb)	0.57
Net energy-gain (Mcal/lb)	0.34
Sulfur (%)	0.15
Phosphorus (%)	0.13
Potassium (%)	1.18
Magnesium (%)	0.2
Calcium (%)	0.45
Sodium (%)	not detected
Iron (ppm)	120
Manganese (ppm)	68.1
Copper (ppm)	3.6
Zinc (ppm)	63.1

This table reveals that none of the trace minerals occurred at toxic levels. As is typical in the Rocky Mountain West, a few of the minerals (particularly phosphorous, zinc and copper) were low.

A comparison of the nutrients provided by pasture against the needs of a 1100-pound lactating cow is provided in the table below. Forage samples were collected in mid-August in a dry year. The nutrient requirements for an 1100-pound lactating cow of average milking ability were drawn from Nutrient Requirements of Beef Cattle tables (NRCS, 1984).

Nutrient Requirements vs. Nutrient Actuals

	Dry Matter	*Crude Protein*	*TDN*	*Ca*	*P*	*Ca:P Ratio*
1100-lb Lactating Cow	21.6#	2#	12.1#	27g	22g	1:1
Reservoir	21.6#	1.5#	12.6#	44.1g	12.7g	4:1

Assuming our example cow meets her dry matter requirements, the Reservoir Pasture was slightly short on crude protein. In addition, this pasture exceeded the total daily nutrients and calcium requirements but fell short on phosphorous, which is a common occurrence on the Merlin Ranch.

Phosphorous is a critical micronutrient in reproduction and when levels are too low it can affect breeding success. The calcium to phosphorous ratio is important because calcium can tie up phosphorous in the cow's system leading to a variety of health problems if the ratio exceeds 7:1, which was not the case in 2020.

Nutrient Management Recommendations

Analysis of the sample nutrients 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. Further, seasonal variations in nutrient content of forage are normal. This provides variety in the diet and likely meets the cow's needs, including those critical crude protein levels.

The Merlin 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 lactating cows. However, 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 requirements 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

Six different monitoring methods were used to gather data and information at this monitoring site:

- Photographs
- Line-point intercept
- Most abundant plant by weight
- Line-intercept
- Belt Transect
- Qualitative indicators of rangeland health (Bullseye)

The same suite of monitoring methods was repeated at each monitoring site visited during the summer 2016 monitoring effort. A 200-foot tape measure, laid along the soil surface, served as the basis of the monitoring protocol, and represented the transect line. A five-gallon bucket lid was nailed to the soil surface to permanently mark the beginning point of each transect (Figures 1).

Photographs of each transect (Figure 2), as well as of a 4.8 square foot quadrat placed at the 10-foot mark along the transect (Figure 3) were taken at each site.

Each assessment began with a qualitative examination of rangeland health using the Bullseye method developed by Gadzia & Graham (2009). This approach was based on several valuable sources, but one worthy of mention here is the 1994 report *Rangeland Health* by the National Research Council. This report 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.

FIGURE 1: *An example of the type of five-gallon bucket lid used to mark the beginning of each transect line.*

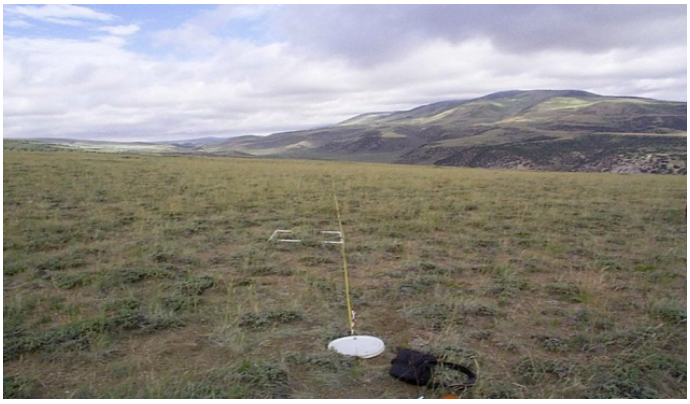


FIGURE 2: *An example of a permanent, 200-ft transect. Note the bucket lid marking the beginning point.*

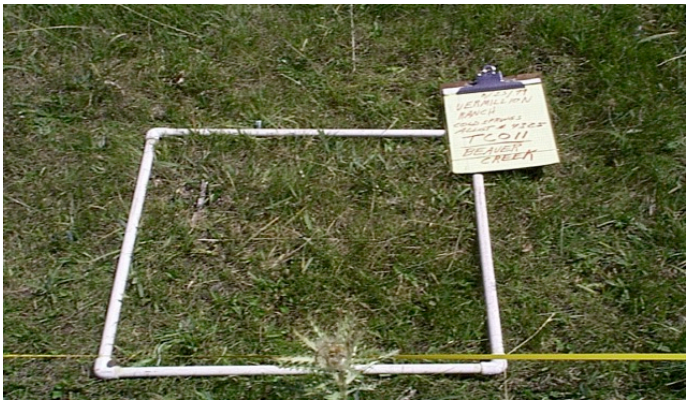


FIGURE 3: *An example of a quadrat plot with the left-hand, lower corner aligned with the 10-meter mark on the tape.*

The qualitative rangeland health indicators used in this initial assessment describe functionality in four fundamental ecosystem processes: the water cycle, mineral cycle, successional process, and energy flow.

An effective water cycle requires covered soil and high biodiversity. When effective, most water soaks into soils quickly where it falls, without running off. Later, this moisture is released slowly through plants that transpire it, or through rivers, springs, and aquifers that collect through seepage what the plants don't use. When biodiversity is reduced and soils exposed, much water runs off the soil surface. What little soaks in is released rapidly from evaporation which draws moisture back up through the soil surface (Figure 4; Savory, 1993).

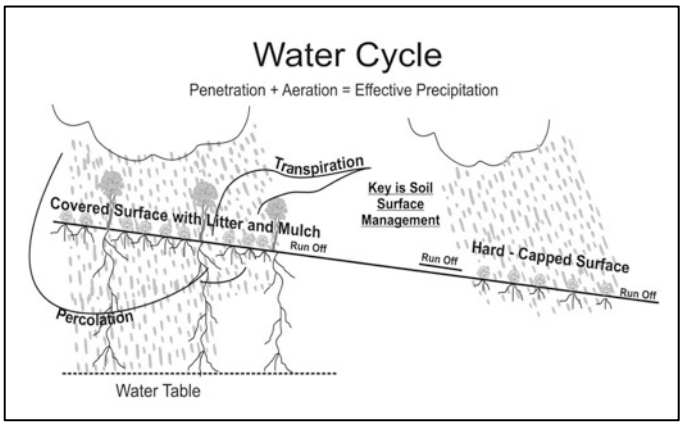


FIGURE 4: *A visual of the water cycle.*

The water cycle was described as either "effective," or "ineffective." If the water cycle was described as effective, then precipitation appeared to be moving into the soil and evaporation from the soil surface was minimal. Conversely, sites with an ineffective water cycle displayed signs of water leaving the site, such as 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 continuously between living plants and living soil. When soil is exposed and biodiversity low, nutrients become trapped at various points in the cycle, or are lost to wind and water erosion (Figure 5; Savory, 1993).

In the monitoring report, the *speed* of the mineral cycle was described. If the cycle was moving slowly, then nutrients were not moving back into the system. An indicator of this would be past years' plant growth (known as litter) either elevated above the soil surface or lying idly on the soil surface and showing signs of oxidation rather than decomposition. Ideally, litter should contact the soil surface where soil-borne organisms of decay may begin to break it down and speed the re-utilization of nutrients in the system.

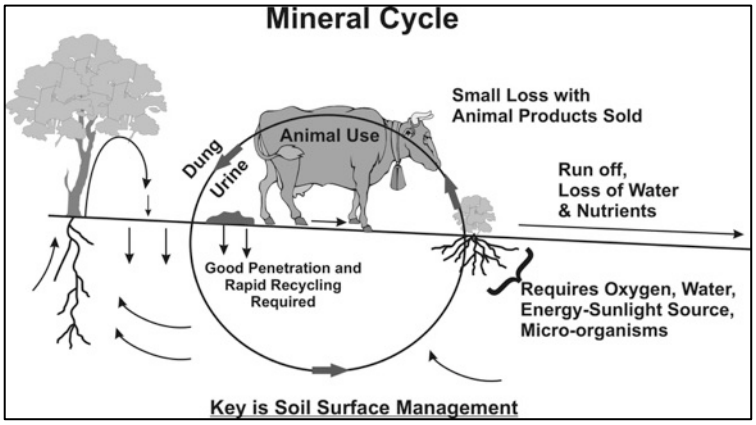


FIGURE 5: *A visual of the mineral cycle.*

With few exceptions, ecological communities tend to cycle through processes of building complexity in response to disturbances, which tend to reduce complexity. From unstable bare ground, where biodiversity is low, stable complex range or forest communities, high in biodiversity tend to develop over time (Figure 6; Savory, 1993). This is succession.

The plant communities composing a site help characterize past management actions as well as shape current expectations for land and livestock performance. Thus, in this monitoring report, plant community composition was described and classified as high seral (meaning desirable), mid seral (neither desired nor undesired), and low seral (weedy or less desired). Importantly, indicators like the presence of seedlings and young plants of different species represent early changes in plant communities likely to become evident in coming years. Such observations further inform management expectations.

Almost all life requires energy that flows 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 whatever eats the consumers of plants. Energy doesn't cycle, but flows through the ecosystem until it is consumed (Figure 7; Savory, 1993).

In this report, energy flow was described as "elevated," "moderate," or "reduced." Sites with elevated levels of energy flow showed signs that much solar energy was being captured by living plants and that much photosynthesis was occurring. The indicators of elevated energy flow include robust canopy cover, high plant vigor, and high plant stature. Conversely, sites with reduced energy flow showed signs that much sunlight energy was striking the soil surface and not being captured. These sites displayed higher levels of bare ground (relative to expectations for the ecological site and to current climatic conditions), lower plant canopies, vigor and stature.

A rangeland health qualitative scoring guide describing the parameters for each of 14 indicators of rangeland health was used to evaluate each site (more information on the Bullseye Target method and scoring can be found here:

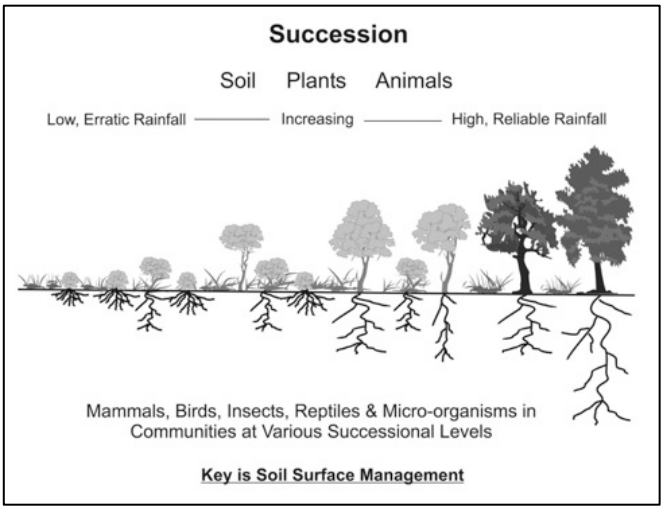


FIGURE 6: *A visual of the successional process.*

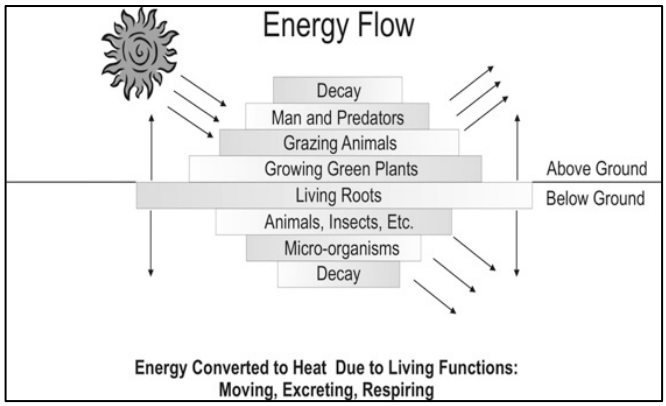


FIGURE 7: *A visual of the flow of energy through ecological systems.*

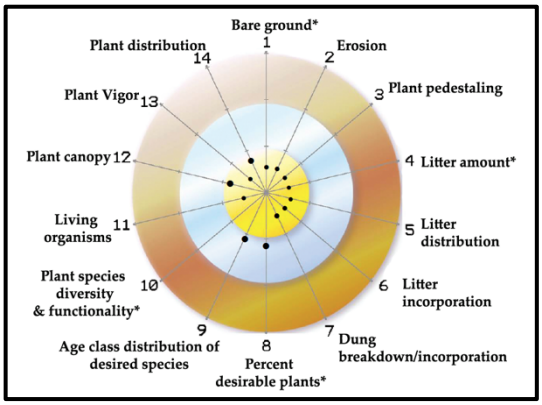


FIGURE 8: *The Bullseye Target provides a representation of 14 indicators of rangeland health assessed during the qualitative component of the monitoring effort.*

http://ranchadvisory.com/rangelands-monitoring). Each indicator was assigned a "score" relative to its degree of functionality. Each score has an associated color and position on the "Bullseye Target," providing an efficient, but effective means of characterizing the condition of a site (Figure 8). If, for example, the indicator "litter distribution" displayed uniform cover across the soil surface, this indicator was considered functional, and a mark was placed in the gold area on the Bullseye Target. The final product provides management with a visual portrayal of ecosystem function at a given point in time.

In addition to the qualitative methods described above, several quantitative methods were part of the monitoring process. First, a custom soil survey was generated for the sample area using NRCS's Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). The custom report generated provides information on desired plant species, expected shifts in species composition under differing management regimes, and expected productivity of a site. Using this information, indicators for desired plant community composition, functional and structural groups, and expected levels of erosion, bare ground, and litter cover can be reviewed and compared to current conditions.

Second, various data were collected at each site along a permanent, 200-foot transect using a variety of monitoring methods:

1. Line-point Intercept Method

With this method, a steel rod or sturdy metal wire is lowered to the soil surface at every other foot along the tape measure (Figure 9) for a total of 100 points. At each point where the wire touches the ground, data on ground cover (bare soil, litter, living plants or rock/gravel) are collected. The data from all 100 points are then compiled and the percentage of each ground cover type calculated.

FIGURE 9: *A visual of the line-point intercept method. The metal rod is lowered to the soil surface. Whatever it touches is recorded as "ground cover". The ruler is used to measure the distance to the nearest perennial plant.*

In addition to ground cover data, the line-point intercept method is used to collect information on the most abundant perennial plant species covering the soil surface and the average distance to perennial plants. At each point where the wire is lowered to the ground, the distance to the nearest perennial plant is measured and the species recorded. This data gets compiled for all 100 points and the distance to each species averaged. These data provide a look at perennial plant species composition at the level of the soil surface and how common they are.

2. Most Abundant Plant by Weight

This method measures plant species composition by productivity. Quadrats get evaluated every 20 feet starting at the 10-foot mark to determine which species produce the most biomass by weight. The top five most abundant species by weight are estimated within each quadrat with the most abundant species receiving a score of 5 and the least abundant receiving a score of 1. The combined scores yield a percent composition by species for each monitoring site, and the top five most abundant plant species by weight are presented in a chart like the one portrayed in Figure 12.

3. Line Intercept Method

This method is used to measure the canopy cover of shrubs. Data is collected by looking straight down on the transect tape measure and recording the number of centimeters of canopy intercepted by shrub species (Figure 10). The age class (seedling, young, mature, decadent, dead) and plant height are also recorded. These data are then tallied by species and displayed as an average or percentage. Tracking this data through time provides information on habitat values and succession within the shrub communities.

4. Belt Transect Method

Complementing the line-intercept data, shrub density is measured using the belt transect method. In this method, a five-foot long rod was held perpendicular to the transect tape and the number of shrubs intercepted by the rod recorded by species (Figure 11). Following this protocol along the entire 200 feet of the tape provided a shrub density estimate for the site (i.e., number of shrubs per 1000 square feet).

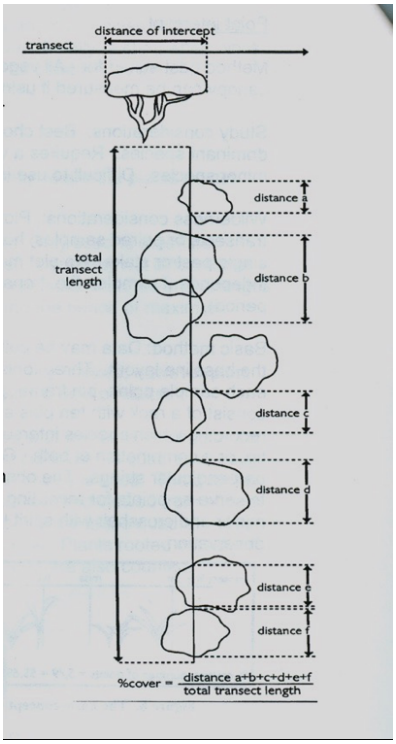


FIGURE 10: *An illustration of the line intercept method. The straight line (no arrows) represents the outstretched tape measure of the transect. Each polygon represents the canopy cover of a shrub. The canopy intercept for each shrub is represented by the dotted lines.*

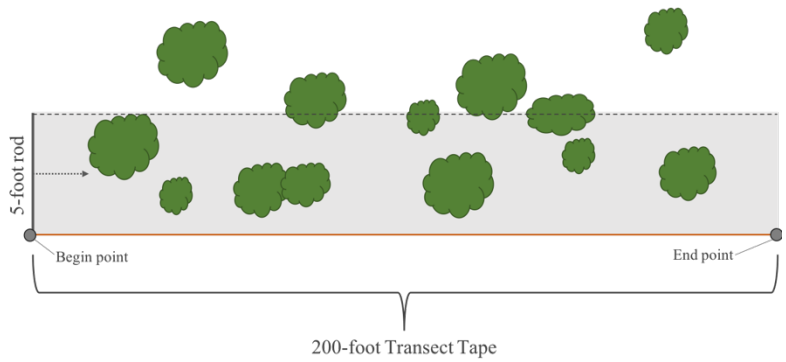


FIGURE 11: *An illustration of the belt transect method.*

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About the Authors

Ranch Advisory Partners, Inc. provides agricultural advisory services in the ecological and financial aspects of ranching and agricultural properties. Services include total ranch management; structured finance strategies; operations financial optimization; agricultural operations design, implementation, and oversight; grazing planning; rangeland health evaluations and monitoring; wildlife habitat vegetative manipulation and monitoring; and hydrology.

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