USDA Natural Resources Conservation Service

# Ecological site DX032X02A122
# Loamy (Ly) Wind River Basin Core

Last updated: 3/04/2025
Accessed: 05/11/2025

## General information

**Approved**. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

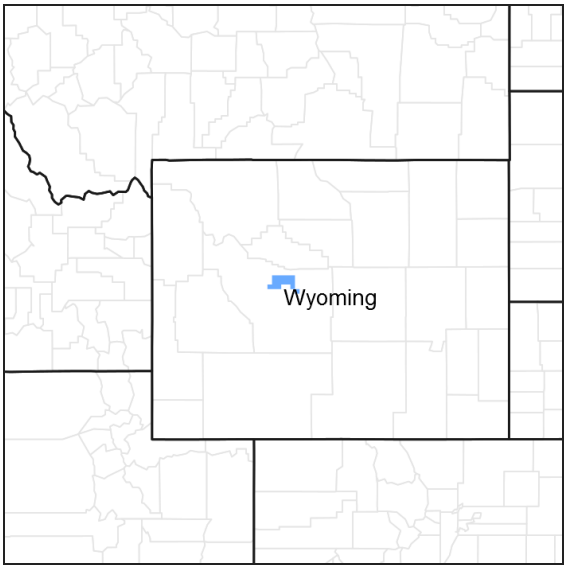



**Figure 1. Mapped extent**

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

## MLRA notes

Major Land Resource Area (MLRA): 032X–Northern Intermountain Desertic Basins

032X – Northern Intermountain Desertic Basins – This MLRA is comprised of two major Basins, the Big Horn and Wind River. These two basins are distinctly different and are split by LRU's to allow individual ESD descriptions. These warm basins are surrounded by uplifts and rimmed by mountains, creating a unique set of plant responses and communities. Unique characteristics of the geology and geomorphology single these two basins out.

Further information regarding MLRAs, refer to: United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. Available electronically at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053624#handbook.

## LRU notes

Land Resource Unit (LRU):

32X02A (WY): This LRU is the Wind River Basin within MLRA 32X. This LRU is tends to be just a fraction higher in elevation, slightly cooler (by 1-degree Celsius), and spring snowpack tends to persist longer into the spring than the

Big Horn Basin (LRU 01). This LRU was originally divided into two LRU's - LRU C which was the core and LRU D which was the rim. With the most current standards, this LRU is divided into two Subsets. This subset is Subset A, referred to as the Core, which is warm, dry eroded basin floor. As the subset shifts towards the outer edges, aspect and relation to the mountains create minor shifts in soil chemistry influencing the variety of ecological sites and plant interactions. The extent of soils currently correlated to this ecological site does not fit within the subset boundaries. While some of the map units are approved (not correlated), all other map units are correlated. Some as small inclusions within other MLRA's/LRU's based on location and surveys. Questionable correlations will be reviewed and corrected as update projects.

Moisture Regime: Typic Aridic
Temperature Regime: Mesic
Dominant Cover: Rangeland, Saltbush flats.
Representative Value (RV) Effective Precipitation: 5-9 inches (127 – 229 mm)
RV Frost-Free Days: 105-130 days

## Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):
3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
3.B Cool Semi-Desert Scrub & Grassland Subclass
3.B.1 Cool Semi-Desert Scrub & Grassland formation
3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division
M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup
G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group
CEGL001009 - Artemisia tridentata ssp. wyomingensis/Pseudoroegneria spicata Shrubland

Ecoregions (EPA):
Level I: 10 North American Deserts Level II: 10.1 Cold Deserts
Level III: 10.1.18 Wyoming Basin
Level IV: 10.1.18.a Semi-arid Rolling Sagebrush Steppe (and)
10.1.18.g Big Horn Salt Desert Shrub Basin

## Ecological site concept

• Site receives no additional water.
• Slope is <30%
• Soils are:
o Textures range from very fine sandy loam to clay loam in top 4" (10 cm) of mineral soil surface
o Clay content is = 32% in top 4" (10 cm) of mineral soil surface
o All subsurface horizons in the particle size control section have a weighted average of =18% but <35% clay.
o Moderately deep to very deep (20-80+ in. (50-200+ cm)
o <3% stone and boulder cover and <20% cobble and gravel cover
o Not skeletal (<35% rock fragments) within 20" (50 cm) of mineral soil surface
o None to Slightly effervescent throughout top 20" (50 cm) of mineral soil surface
o Non-saline, sodic, or saline-sodic

The Loamy ecological site concept is based on minimal (none to slight) influence from salts, carbonates, gypsum or other chemistry within the top 20 inches (50 cm) of the mineral soil surface. The main soil characteristic is a moderately deep to very deep soil profile with 18-35% clays, having a sandy loam to clay loam textural class. The soil surface 4 inches may be lighter(coarser) in texture, typically falling in the loamy fine sand to very fine sandy loam textural class. Once the lower threshold for this site (< 18% clay) is reached, the plant community will transition to a higher Indian ricegrass and needleandthread composition, with little to no bluebunch wheatgrass or rhizomatous wheatgrasses (Sandy ecological site). As the upper threshold is crossed (>35% clay), increased rhizomatous wheatgrasses and bare ground occur, with a corresponding shift in forbs and loss of Needleandthread (Clayey ecological site).

The Loamy ecological site occurs in several different catenas throughout the basin. On an escarpment catena, loamy occurs with shallow and very shallow soils. Hillslope catenas have Sandy and Loamy occurring in a complex mosaic pattern where the geology is controlled by interbedded sandstone and shale, this catena will also have loamy calcareous, and saline upland ecological sites. A catena derived from alluvial parent material will also support the complex mosaic pattern of Sandy and Loamy ecological sites.

A significant change from historic range sites for Loamy, is the removal of the salt altered state (soils profile supporting a Gardner's saltbush community). Wicking of salts or carbonates to the soil surface in response to management concerns or climatic patters, may shift the plant community to a salt dominated composition. With misuse or prolonged drought, soils will become salt laden or will develop a calcic layer that will further hinder the soil hydrologic cycle until it crosses a threshold for plant tolerance. The arid (dry, warm) environment lacks the precipitation, under natural measures, to flush the chemistry lower or out of the plant root zone; rendering the reversal unfeasible. The change in chemistry, and resulting shift in plant dynamics, altered hydrologic function and soils creates a change beyond a state, to a site correlation threshold.

## Associated sites

| | |
|---|---|
| DX032X02A144 | **Saline Upland (SU) Wind River Basin Core**<br>Saline upland sites commonly occur intermixed with Loamy sites, especially along marine shale deposits or escarpments with inter-bedded shale and sandstone. Saline uplands are dominated by short saltbush species and limited productivity from saline soils. |
| R032XD130WY | **Overflow 10-14" Mesic Wind River Basin**<br>Overflow site are found in concave areas that have concentrated flows within a loamy or other similar sites. This site is characterized by Basin big sagebrush and Basin wildrye. In areas that have burned, the community is a dense mat of cheatgrass or in other areas it transitions to rhizomatous wheatgrasses. The concave nature with increased capture of overland flows increases productivity above a Loamy site and the transition to Basin big Sagebrush is an easy key on the landscape. |
| R032XY204WY | **Clayey (Cy) 5-9" Wind River Basin Precipitation Zone**<br>The Clayey ecological site has similar production potential; however, responses to disturbance, management and climatic changes will be different. Location on the landscapes are similar, but Clayey tend to fall along alluvial drainages or below shale outcrops/outwashes. |
| R032XY228WY | **Lowland (LL) 5-9" Wind River Basin Precipitation Zone**<br>The Lowland site will have similar soils, outside of the presence of a water-table during parts of the year at a depth. This water-table influences the vegetation so have Basin big sagebrush, and other water demanding plants. |
| R032XY250WY | **Sandy (Sy) 5-9" Wind River Basin Precipitation Zone**<br>Sandy sites will also be similar in production, but again response to management, disturbance and climatic shifts will vary. Sandy sites are generally at the base of sandstone outcrops or outwashes, and will be on terrecettes within the landscape (wind deposited). |
| R032XY262WY | **Shallow Loamy (SwLy) 5-9" Wind River Basin Precipitation Zone**<br>Shallow Loamy sites are generally located on the break of slopes, on or surrounding rock outcrops before it transitions into more gently rolling landforms with deeper soils. Similar plant communities with more pincushion forbs and a higher percentage of Bluebunch wheatgrass, but a marked reduction in production and increased bare ground. |

## Similar sites

| | |
|---|---|
| DX032X01A122 | **Loamy (Ly) Big Horn Basin Core**<br>This site is a division of the original 32XY322 site. The separation was based on frigid foothill (MLRA 46) compared to mesic basin (MLRA 32) landforms. Basin soils will be lower in production and less responsive to management (climate driven). |
| R032XY322WY | **Loamy (Ly) 10-14" East Precipitation Zone**<br>This site was all-encompassing for the 10-14" precipitation zone in Wyoming following the removal of MLRA 46. Re-instatement or compensation for MLRA 46 will create new sites to separate the Mesic (Basin landscape) from the Frigid (foothills landscape) soils. Slight shifts in production and plant species occurs from the original concept. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | (1) *Artemisia tridentata subsp. wyomingensis* |
| Herbaceous | (1) *Pascopyrum smithii*<br>(2) *Hesperostipa comata* |

## Legacy ID

R032XC122WY

## Physiographic features

The Loamy ecological site generally occurs on slopes ranging from near level to moderately steep lands to 30%. Alluvial fans, stream terraces, and hillsides/ridges are identified as the major landforms where this site exists. The site also occurs on relict stream terraces or fan remnants, with minimal or no active soil deposition occurring. Dissected large landforms within this landscape create extents that cross climatic gradients, observed through the variability of plant species from upper to lower extents along a landform.

The complexes of soil components mapped on these landforms are typically separated by chemistry, amount and depth of rock fragments or depth to bedrock (lithic or paralithic). Many of these landforms are erosional remnants and have soils ranging from moderately deep to very deep; and are formed from interbedded sandstone and shales. The variability of soils across the landform is influenced by the geology and its inherent chemistry. This will create pockets of calcareous or saline/sodic soils as well as areas that are not influenced by chemistry. The change in plant communities can be abrupt, but often it is difficult to identify clearly the transition between sites and to distinguish which site is dominant across the landform.

Drainage ways and fan aprons are landforms that occur together and generally contain the loamy ecological site. Fan aprons receive run off moisture from the surrounding uplifts or uplands and that moisture is funneled into channels or drainage ways that dissect the fan apron. Shallow drains or concave areas may express a more robust plant community and could be correlated as an overflow; however, within steeper drainages, the bottoms have drier steps or risers that are presumed to be overflow, but due to down-cutting, lack of water table, flooding, and/or concentrated flows, have no expression of an overflow site (receives extra moisture from overland movement of surface water that encourages basin wildrye, basin big sagebrush and in some areas greasewood).

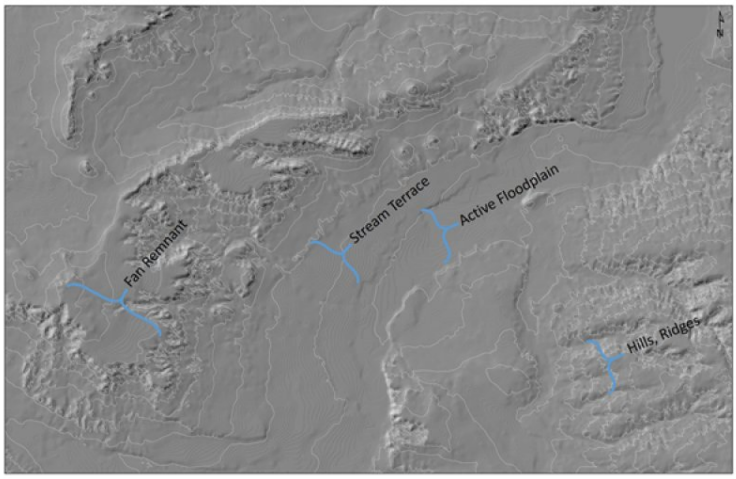



**Figure 2. Physiographic Image.—Aerial View of landforms**

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Hill<br>(2) Alluvial fan<br>(3) Stream terrace |
| Flooding frequency | None |
| Ponding frequency | None |

| | |
|---|---|
| Elevation | 4,500–6,600 ft |
| Slope | 0–30% |
| Ponding depth | 0 in |
| Water table depth | 60 in |
| Aspect | Aspect is not a significant factor |

## Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 5 to 9 inches (127 – 229 mm). The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50% of the mean annual precipitation. Much of the moisture that falls in the latter part of the summer is lost by evaporation and much of the moisture that falls during the winter is lost by sublimation. Average snowfall is about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. High winds are generally blocked from the basin by high mountains, but can occur in conjunction with an occasional thunderstorm. Growth of native cool-season plants begins about April 1st and continues until about July 1st. Cool weather and moisture in September may produce some green up of cool season plants that will continue through late October.

Review of a 30 year trend of data for Average Temperature as well as Average Precipitation, shows there has been a warming trend, but as the last 12 years graphed, the temperatures have swayed high and low, but overall it has maintained a steady trajectory, neither increasing nor decreasing. Where on the moisture side, the trajectory in trend has been a slow decline. The swings of when spring warm up and first frost hit with the decline in average precipitation have produced a drought effect where the moisture is not being received when the plants and ground is able to utilize the moisture. And in some cases, the late precipitation has encouraged the warm season or mat forming species over the cool season bunchgrasses that are the drivers of the natural system. Early frosts, with dry open winters has created a more arid or desert effect on plants resulting in high rates of winter kill, loss of vigor or overall damage to the plant.

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/. “Riverton” and "Pavillion" are the representative weather stations within LRU C. The following graphs and charts are a collective sample representing the averaged normals and 30 year annual rainfall data for the selected weather stations from 1981 to 2010.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 107 days |
| Freeze-free period (average) | 128 days |
| Precipitation total (average) | 8 in |

## Climate stations used

- (1) RIVERTON [USC00487760], Riverton, WY
- (2) PAVILLION [USC00487115], Pavillion, WY

## Influencing water features

The characteristics of these upland soils have no influence from ground water (water table below 60 inches (150 cm)) and have minimal influence from surface water/overland flow. There may be isolated features that are affected by snow pack that persists longer than surrounding areas due to position on the landform (shaded/protected

pockets), but is not significant enough to provide the hydrology needed for an overflow site. No streams are classified within this ecological site.

Depth to water table was originally stated to occur below 48 inches (120 cm) of the soil surface, meaning there is no indication of a water table within this depth at any point throughout the calendar year. In the majority of instances of this site, the water table is below 60 inches (150 cm) for the calendar year. This site is also characterized by no additional moisture capture; it occurs with isolated pockets where surface moisture collects briefly creating an overflow site.

## Soil features

The soils of this site are moderately deep to very deep (greater than 20 inches (51 cm) to bedrock), moderately well to well drained, and have moderately slow to moderate permeability. The main soil characteristic that influences the plant community is the permeability of the soil, which allows water to infiltrate into the soil profile and become available for plant use. The permeability also influences the soil chemistry by the rate/depth of leaching of salts, calcium carbonate, and other influencing chemistry out of the zone of plant influence. The rate is slower in loamy soils, reducing the movement of chemistry lower in the profile, in comparison to the Sandy ecological site.

The general soil profile has a sandy loam or loam surface over a subsurface with sandy clay loams and clay loams. These soils may have an alluvial layer (gravel or coarse sands) or interbedded sandstone and shales, lower in the profile (below 20 inches (51 cm)). In areas with alluvial parent material, alluvial gravels may be present on the surface and throughout the soil profile up to 15% by volume.

Concentrations of salts and carbonates occur below the depth of plant influence (20 inches (51 cm)). If they are present in the upper 20 inches, they can be finely disseminated or as small masses or soft nodules in low concentrations throughout. The range of values characterizing this site are listed below. As the amount of calcium carbonates or other soluble salts increases beyond the stated ranges (recognized as a diagnostic characteristic in the soil) then they have crossed a threshold beyond a loamy ecological site and will need to be re-correlated to the proper ecological site (Loamy Calcareous or Saline Upland Loamy).

The soils develop a cap or platy surface that resembles a thin vesicular crust that can hinder germination and seedling establishment. Hoof action or other sources of light disturbance can easily break up this crust, allowing seedling establishment and helps incorporate litter matter. The nature of these soils are not susceptible to wind or water erosion, but when disturbed or loosened during high wind or other extenuating circumstance, the soils are more prone to further erosion once the cap has been loosened or with the loss of vegetative cover. The arid climate is noted for high intensity storms, which are part of these extenuating circumstances. The lighter textured surface profile over a noticeably heavier textured subsurface profile has a tendency to alter infiltration and permeability through the profile, encouraging a diverse plant community that makes the site hard to distinguish from its Sandy and Clayey counterparts. The heavier textured soils lower in the profile increases holding capacity reducing the drought stress, while the lighter cap prevents sealing and allows for a higher rate of germination of a variety of species.

Many of the landforms where these soils occur have an alluvial influence leaving a surface layer of gravels and cobbles. Much of this layer is within 10% cover, however some areas do breach into a surface texture modifier of gravelly (having greater than 15% of gravels and a few cobbles). This layer will vary in depth of thickness in the profile, but has minimal influence on the plants.

Major soil series correlated to this site include: Avalon, Emblem, Frisite, Griffy, Lostwells, Rairdent, Teapo, and Youngston. This list of soil series is subject to change upon completion and correlation of the initial soil surveys: WY647 and WY617; as well as revisions to completed soil surveys: WY613, WY713, WY625, and WY677.
Typical Pedon - FRISITE SERIES

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Typic Haplargids. The Frisite fine sandy loam series consists of deep, well drained soils on terraces, fan aprons, valley fill and hill backslope positions in the Cool mountain basins and plains in western and central Wyoming. The soils formed in alluvium from mixed sources that are well drained, have a medium runoff potential, and have moderate permeability. The climate is semiarid with cold dry winters and cool moist springs and warm dry summers. The mean annual precipitation is about 7 inches of which about half falls as snow and rain in April, May, and early June. The mean annual is about 46 degrees F, and

ranges from 43 to 50 degrees F. The frost-free season is estimated to range from 110 to 130 days depending upon elevation, aspect, and air drainage.

GEOGRAPHIC SETTING: Frisite soils are on relic terraces, fan aprons, valley fill and hill backslope positions. These soils formed in alluvium weathered from preliminary shale and interbedded sandstone but modified by slope alluvium from mixed sources. Slopes are simple and range from 0 to 10 percent. Elevation ranges from 4,800 to 6,300 feet.

A--0 to 3 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and few medium roots; many very fine and fine vesicular pores; moderately alkaline (pH 8.2); abrupt smooth boundary. (2 to 6 inches thick)
Range of Characteristics: The A horizon has hue of 2.5Y through 7.5YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. Reaction is mildly or moderately alkaline. The BA or AB horizon has the same morphological properties as defined for color and reaction.

BA--3 to 6 inches; yellowish brown (10YR 5/4) loam, yellowish brown (10YR 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, nonsticky and slightly plastic; few very fine, fine, and medium roots; moderately alkaline (pH 8.2); clear smooth boundary. (2 to 5 inches thick)

Bt--6 to 13 inches; pale brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) moist; strong medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine, fine, and medium roots; continuous thin and few thick clay films on faces of peds; moderately alkaline (pH 8.2); clear smooth boundary. (7 to 16 inches thick)
Range of Characteristics: The Bt horizon has a hue of 2.5Y through 7.5YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. Texture is loam, clay loam, or sandy clay loam with 18 to 35 percent clay, 20 to 55 percent silt, and 20 to 55 percent sand with more than 15 but less than 35 percent fine sand or coarser. Reaction is moderately or strongly alkaline.

Btk--13 to 16 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine, fine, and medium roots; continuous thin clay films on faces of peds; strongly effervescent, carbonates disseminated and as common fine soft masses and seams; moderately alkaline (pH 8.4); gradual wavy boundary. (3 to 6 inches thick)
Range of Characteristics: The Btk horizon has a hue of 2.5Y through 7.5YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. Texture is loam, clay loam, or sandy clay loam with 18 to 35 percent clay, 20 to 55 percent silt, and 20 to 55 percent sand with more than 15 but less than 35 percent fine sand or coarser. Reaction is moderately or strongly alkaline.

Bk--16 to 41 inches; light gray (10YR 7/2) loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky and slightly plastic; strongly effervescent, carbonates disseminated and as common fine soft masses and seams; strongly alkaline (pH 8.6); gradual wavy boundary. (14 to 30 inches thick)
Range of Characteristics: The Bk horizon has hue of 2.5Y through 7.5YR, value of 5 through 7 dry, 5 or 6 moist, and chroma of 2 through 4. Texture averages loam but clay loams are common when clay size carbonates are present. Noncarbonate clay ranges from 18 to 30 percent. Calcium carbonate equivalent ranges from 4 to 14 percent. This horizon is not a diagnostic calcic horizon. Reaction is moderately or strongly alkaline.

C-- 41 to 60 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; slightly effervescent, carbonates disseminated; moderately alkaline (pH 8.2).
Range of Characteristics: The C horizon has hue of 2.5Y through 7.5YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 through 4. Texture is loam, sandy loam, or clay loam. Reaction is moderately or strongly alkaline.

RANGE IN CHARACTERISTICS:
Depth to bedrock is greater than 60 inches.
Depth to the base of the argillic horizon ranges from 15 to 27 inches.
Free carbonates at the surface are common where soils have been influenced by recharge, but these soils may be leached free of carbonates through the argillic horizon.
The mean annual soil temperature ranges from 47 to 51 degrees F.
Rock fragments of the entire soil to 60 inches ranges from 0 to 15 percent rounded pebbles.

EC to a depth of 60 inches ranges from 0 to 2 mmhos.

TYPE LOCATION: Fremont County, Wyoming; about 300 feet west and 500 feet north of the SE corner of sec. 5, T. 34 N., R. 92 W. Series was established in Fremont County, Wyoming, East Part; 1985.

**Figure 7. Soils Profile Image.—**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Alluvium–shale<br>(2) Residuum–sandstone |
| Surface texture | (1) Gravelly sandy loam<br>(2) Loam<br>(3) Sandy clay loam |
| Family particle size | (1) Loamy |
| Drainage class | Moderately well drained to well drained |
| Permeability class | Moderately slow to moderate |
| Soil depth | 20–60 in |
| Surface fragment cover <=3" | 0–15% |
| Surface fragment cover >3" | 0–5% |
| Available water capacity (0-40in) | 3–6.3 in |
| Calcium carbonate equivalent (0-40in) | 0–14% |
| Electrical conductivity (0-40in) | 0–8 mmhos/cm |
| Sodium adsorption ratio (0-40in) | 0–12 |
| Soil reaction (1:1 water) (0-40in) | 7.4–8.2 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–15% |
| Subsurface fragment volume >3" (Depth not specified) | 0–10% |

## Ecological dynamics

Potential vegetation on this site is dominated by mid-stature cool-season perennial grasses. Other significant vegetation includes Wyoming Big Sagebrush, and a variety of forbs. The expected potential composition for this site

is 75% grasses, 10% forbs, and 15% woody plants. The composition and production will vary naturally due to historic use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as Sandberg bluegrass, blue grama, and Wyoming big sagebrush will increase. Cool-season grasses such as rhizomatous wheatgrass, needleandthread, and Indian ricegrass will decrease in frequency and production. Continued pressure will allow plains prickly pear and weedy annuals to invade. Extended periods of drought and other climatic shifts have produced similar transitions in vegetation.

Wyoming Big Sagebrush may become dominant on areas with an absence of fire and sufficient precipitation. An extensive tap-root allows sagebrush to access deeper soil moisture and nutrients during extended dry periods, providing a competitive advantage over the shallower root systems of native grasses. In the absence of the natural regime of wildfires to encourage rejuvenation and cycling, sagebrush may increase in canopy cover and decrease in palatability and function; the actual number of individual plants may not increase significantly, but the overall size and coverage of each plant increases. The oils and tannins in the leaves of sagebrush are a deterrent for many large ungulates, rendering the plant bitter and unpalatable; these compounds increase with age, reducing the beneficial forage value even for sagebrush obligate species. Aggressive control of wildfires and change in livestock grazing has resulted in decadent and dying stands of Wyoming big sagebrush that are susceptible to insect damage and disease. Chemical control using herbicides replaced the historic role of fire for large scale control. Over the past decade, prescribed burning has regained some popularity for controlling sagebrush. Mosaic or "patch" burns are being utilized to create or enhance wildlife habitat, specifically for sage grouse and other sagebrush obligate species.

Intensity and timing of precipitation limits the resilience of Wyoming big sagebrush in this system. Once sagebrush has been removed (less than 3% canopy), especially where vigorous stands of grass are maintained, seedling establishment is hindered by the competition for limited soil moisture. The loss of structure (height) for snow catch and woody canopy for moisture retention, protection from grazing, and wind desiccation; young sagebrush seedlings are quickly stressed or grazed, reducing new establishment. Extended periods of time are required for natural re-establishment of sagebrush (beyond 25 years), limiting the feasibility as a management tool within this LRU.

Areas devoid of sagebrush are prone to encroachment of blue grama when subjected to a combination of frequent and intense grazing. Reduced infiltration rates due to compaction and crusting of the soil from hoof action or rain drop impact with the open canopy alters the hydrology of the site creating a drier, harsher environment that encourages the shallow dense root system of blue grama and threadleaf sedge. Expansion of the footprint of these sod formers alter the hydrologic cycle by diverting water away from the sod patches or clumps, increasing run off (flow patterns), and decreasing infiltration of moisture.

The ecological states and community phases as well as the dynamic processes driving the transitions between these communities have been determined by studying this ecological site under all management scenarios, including those that do not include cattle grazing. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have been used.

Review of the soils information and classification of similar soils has led to further consideration of the narrowing of the loamy ecological site concept. Coarse-loamy, Fine-loamy, and Fine particle size classes were compared to see how the plant communities varied. [Soils particle size classes are used to characterize the grain-size composition of the whole soil, including both the fine earth and the rock fragments in a soil based on percent by weight. Coarse-loamy has 15% or more of fine sands or coarser and less than 18% clay, fine-loamy have 15% or more of fine sand or coarser with 18% or greater to less than 35% clays, and fine have more than 35% but less than 60% of clay.] Data has noted a correlation between the amount of needleandthread and western wheatgrass and particle size classes. Finer textured soils hold a higher ratio of western wheatgrass to needleandthread (or Indian ricegrass) and the opposite for coarser textured soils, which hold a higher ratio of needleandthread (or Indian ricegrass) to western wheatgrass.

The narrowing of the site characteristics to 18% to 35% clay within the particle size control section has nearly eliminated the coarse-loamy and fine particle size classes from this concept. Consideration for surface texture and depth to argillic will be reviewed to further refine this concept. Communities will show variability to account for those soils that are on the margins of these breaks. Management implications will be clarified and the range of characteristics will be documented within the plant community tables.

The following State and Transition Model (STM) Diagram has five fundamental components: states, transitions, restoration pathways, community phases and community pathways. The state, designated by the bold box, is considered to be a set of parameters with thresholds defined by ecological processes. A State can be a single community phase or suite of community phases. The reference state is recognized as State 1. It describes the ecological potential and natural range of variability resulting from dynamic ecological processes occurring on the site. The designation of alternative states (State 2, etc) in STMs denotes changes in ecosystem properties that cross a certain threshold.

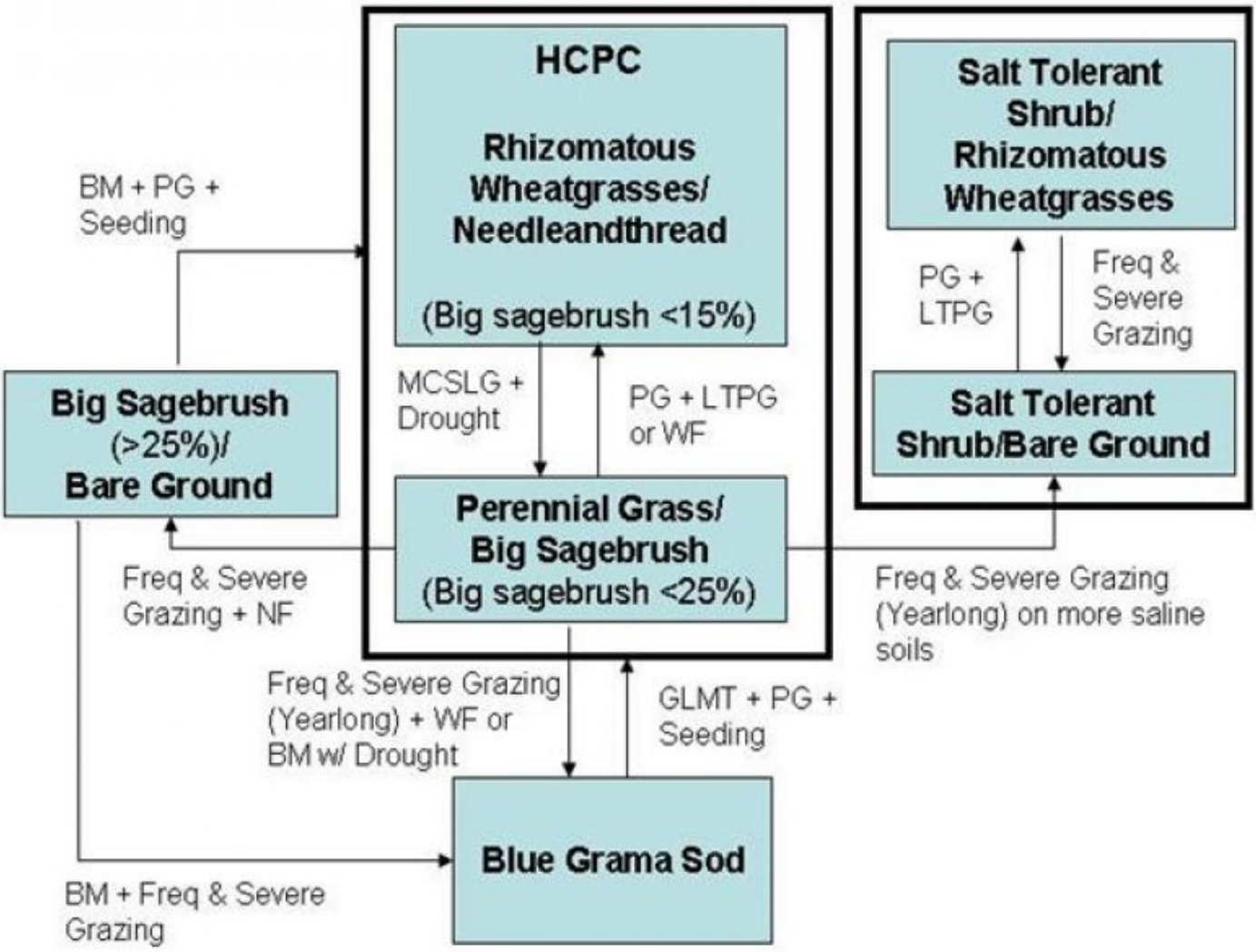
Transitions are represented by the arrows between states moving from a higher state to a lower state (State 1 -> State 2) and are denoted in the legend as a “T” (T1-2). They describe the variables or events that contribute directly to loss of state resilience and result in shifts between states. Restoration pathways are represented by the arrows between states returning back from a lower state to a higher state (State 2 -> State1 or better illustrated by State 1<- State 2) and are denoted in the Legend as an “R” (R2-1). They describe the management actions required to recover the state. Remediation is included.

Community phases, small boxes within the bold state boxes, generally have important management or ecological significance. Collectively, the community phases represent the range of variation within a state, including conditions that place the state at risk for transition. Community pathways are represented by the lighter arrows moving between community phases and are labeled with “CP” (CP1.1-1.2). They describe the causes of shifts between community phases. The community phases captured in this STM may not represent every possibility, but are the most prevalent and repeatable plant communities.

The specific ecological processes and community variability will be discussed in more detail in the plant community narratives following the diagram. The plant composition tables, shown within each community phase narrative, have been developed from the best available knowledge at the time of this revision. As more data is collected, some of these plant communities may be revised or removed, and new ones may be added.

No plant communities should necessarily be thought of as “Desired Plant Communities”. According to the USDA NRCS National Range and Pasture Handbook, Desired Plant Communities (DPC’s) will be determined by the decision-makers and will meet minimum quality criteria established by the NRCS. The main purpose for including any description of a plant community here is to capture the current knowledge and experience at the time of this revision.

## State and transition model




**BM -** Brush Management (fire, chemical, mechanical)
**Freq. & Severe Grazing** - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
**GLMT** - Grazing Land Mechanical Treatment
**LTPG** - Long-term Prescribed Grazing
**MCSLG -** Moderate, Continuous Season-long Grazing
**NU, NF** - No Use and No Fire
**PG** - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
**VLTPG** - Very Long-term Prescribed Grazing (could possibly take generations)
**WF** - Wildfire (Natural or Human Caused)

## State 1
## Mid-stature Cool-season Grasses/Sagebrush

Mid-stature Cool-season Grasses/Sagebrush State (State 1 - Reference) is characterized by the key species including: 15% or less composition by cover of Wyoming big sagebrush, with rhizomatous wheatgrasses (western and thickspike) (<30%), needleandthread, Indian ricegrass, and isolated areas of bluebunch wheatgrass. Minor component to the overall composition is made up of Sandberg bluegrass, bottlebrush squirreltail, prairie junegrass, blue grama, and threadleaf sedge.

### Community 1.1
### Rhizomatous Wheatgrass/Sagebrush

**Figure 8. Community 1.1 – Reference Site with Wyoming Big Sa**

The reference community (1.1) is declining in occurrence on the landscape. Change or shifts in timing of precipitation, temperature shifts (spring warm up/fall freeze) or lack of precipitation could be the dominant driving factors for this occurrence. This plant community is the interpretive plant community. This state evolved with grazing by large herbivores. The potential vegetation is about 75% grasses or grass-like plants, 10% forbs, and 15% woody plants. This state is dominated by cool season mid-grasses. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving occasional short periods of rest. Historically, the reference state evolved under a low fire frequency (estimated to be 195 to 235 years between burns on the same community patch, also stated was that sagebrush has a post fire recover timeframe of 50-120 years or more in arid systems – Baker 2006) and with grazing pressure by large ungulates (elk, bison, deer, and antelope). Changes in herbivory pressure by sheep and wildlife in the area have allowed Wyoming big sagebrush to become increasingly woody and decadent. The community is dominated by cool-season perennial grasses, which thrive between and within the canopy of the sagebrush and other desirable shrubby species – rubber rabbitbrush and winterfat. Overall, a stronger presence of short, warm season grasses (Blue grama) has increased across the entire basin, but has remained as a secondary canopy in the reference communities. Dominant grasses include western wheatgrass and needleandthread. Grass and grass-like species of secondary importance include Sandberg bluegrass, bottlebrush squirreltail, and blue grama. Forbs commonly found in this plant community include scarlet globemallow, desert parsley, fleabanes, and phlox. Sagebrush can make up to 15% of the annual production. The overstory of sagebrush and understory of grass and forbs provide a diverse plant community overall. The total annual production (air-dry weight) of this community phase is about 400 pounds per acre, but it can range from about 225 lbs./acre in unfavorable years to about 600 lbs./acre in above average years. Rangeland Health Implications/Indicators: Diversity of the plant species found on this site allows for a high drought tolerance, allowing persistence in the limiting climatic conditions of the Wind River Basin. The structural diversity of Wyoming big sagebrush in conjunction with the mid-bunchgrasses (needleandthread and bluebunch wheatgrass), rhizomatous species (western wheatgrass and thickspike wheatgrass) and the short-bunchgrasses (prairie junegrass, Sandberg bluegrass, and bottlebrush squirreltail) helps to provide snow catch and shade to capture and hold onto moisture to maximize availability during the growing season. This assistance to the hydrologic factor as well as the ability of each of these species to adapt to shifts in timing of precipitation helps to provide cover, although varying in composition, through a variety of conditions. Needleandthread is dependent on early spring moisture to perform well; years with late spring early summer moisture will produce minimal to no Needleandthread but will have an excellent cover of prairie junegrass. Whereas a year with late fall moisture and a slow warm up with spring moisture

will produce an excellent cover of Sandberg bluegrass but minimal production for prairie junegrass and needleandthread. The persistence and adaptability from year to year of these species allows for quick recovery once normal precipitation returns. This variability will shift between phase 1 and 2 with extended periods of drought, use changes, and other natural and human derived impacts; but is not at risk of transitioning into a different state unless a catastrophic impact occurs. This community, as reference, is indicative of rangeland health which is based on: site/soil stability, watershed function, and biologic integrity.

**Table 5. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 190 | 325 | 440 |
| Shrub/Vine | 30 | 55 | 120 |
| Forb | 5 | 20 | 40 |
| **Total** | **225** | **400** | **600** |

**Table 6. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 0% |
| Shrub/vine/liana basal cover | 0% |
| Grass/grasslike basal cover | 0% |
| Forb basal cover | 0% |
| Non-vascular plants | 0% |
| Biological crusts | 0-5% |
| Litter | 5-15% |
| Surface fragments >0.25" and <=3" | 0-20% |
| Surface fragments >3" | 0-10% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 20-30% |

**Table 7. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.5 | – | 1-10% | 1-5% | 1-5% |
| >0.5 <= 1 | – | 1-15% | 1-25% | 1-2% |
| >1 <= 2 | – | – | – | – |
| >2 <= 4.5 | – | – | – | – |
| >4.5 <= 13 | – | – | – | – |
| >13 <= 40 | – | – | – | – |
| >40 <= 80 | – | – | – | – |
| >80 <= 120 | – | – | – | – |
| >120 | – | – | – | – |

**Figure 10. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Community 1.2
## Perennial Native Grasses/Sagebrush

**Figure 11. Reference Community 1.2 - Loamy 5-9” Mesic site wi**

This site is very similar to the Reference community (1.1). The community can be found on areas that are currently or were historically mis-used or that had impacts slightly outside the normal disturbance regime. The community has seen the Needleandthread as well as western wheatgrass decline in vigor and abundance while Wyoming big sagebrush, Sandberg bluegrass and blue grama have increased in the system. The vegetation composition has shifted to 65% grasses or grass-like plants, 10% forbs, and 25% woody plants. This state still holds to a dominance of cool season mid-stature grasses. The major grasses include Sandberg bluegrass, prairie junegrass, bottlebrush squirreltail and blue grama. Western wheatgrass, needleandthread, and Indian ricegrass have declined, but are still occupying this state. A variety of forbs and half-shrubs also occur, as shown in the following table. Wyoming Big sagebrush is a conspicuous element of this state, occurring in a mosaic pattern, and comprising 15 to 25% of the annual production. Blue grama and threadleaf sedge have increased in percent canopy on site, making up at least 5-10% of the understory, this has a significant impact the site hydrology by accelerating the run-off due to the dense shallow root systems. Plains prickly pear cactus will also have increased, but occurs only in small patches. Indian ricegrass has decreased and may occur in only trace amounts under the sagebrush canopy or within the patches of prickly pear. Bluebunch wheatgrass is not visible on the site, in some instances, remnant populations persist in the protective canopy of woody species. The total annual production (air-dry weight) of this community is about 350 lbs/acre, but it can range from about 180 lbs./acre in unfavorable years to about 620 lbs./acre in above average years. Rangeland Health Implications/Indicators: This plant community is resistant to change. The overall canopy is adequate, but bare ground has increased on the landscape due to the arid nature and increasing woody cover. Bare ground averages 30 to 45%, woody coverage has increased (due to reduced herbaceous cover, to an average of 15 to 25% cover. Litter overall appears to be similar across this State, similarly the biological crust cover does not vary. The herbaceous species present are well adapted to grazing and are intact. Plant vigor and replacement capabilities are sufficient, but are limited by precipitation. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal, and soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

**Table 8. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 125 | 210 | 340 |
| Shrub/Vine | 50 | 120 | 240 |
| Forb | 5 | 20 | 40 |
| **Total** | **180** | **350** | **620** |

**Table 9. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 0% |
| Shrub/vine/liana basal cover | 0% |
| Grass/grasslike basal cover | 0% |

| | |
|---|---|
| Forb basal cover | 0% |
| Non-vascular plants | 0% |
| Biological crusts | 0-5% |
| Litter | 5-15% |
| Surface fragments >0.25" and <=3" | 0-20% |
| Surface fragments >3" | 0-5% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 25-35% |

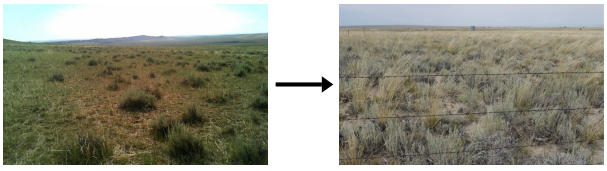
**Table 10. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.5 | – | 1-10% | 1-5% | 1-5% |
| >0.5 <= 1 | – | 1-20% | 1-20% | 1-2% |
| >1 <= 2 | – | – | – | – |
| >2 <= 4.5 | – | – | – | – |
| >4.5 <= 13 | – | – | – | – |
| >13 <= 40 | – | – | – | – |
| >40 <= 80 | – | – | – | – |
| >80 <= 120 | – | – | – | – |
| >120 | – | – | – | – |

**Figure 13. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Pathway 1.1A
## Community 1.1 to 1.2



**Rhizomatous Wheatgrass/Sagebrush**

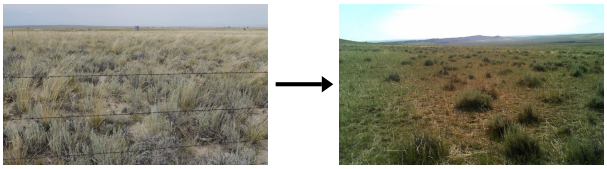
**Perennial Native Grasses/Sagebrush**

Timing of grazing, Drought, Climatic shifts – Although the full understanding of the decline or absence of bluebunch wheatgrass and increase in blue grama in this system is not understood, inferences can be made on part of the drivers for this shift. Historically, this site was used during the late fall, winter, and spring before livestock could be moved on to USDI-BLM and/or US Forest Service summer allotments (continuous spring use). The repetitive use of sensitive species would have slowly removed this plant from the system. Long periods of drought and shifts in spring precipitation patterns have weakened and impacted the productivity and vigor of most species, leaving a hostile climate for sensitive species to establish. Although the species of herbivory and timing has changed with the installation of more grazing management, drought and other climatic patterns still pose a continual threat to the integrity of the plant communities.

### Conservation practices

| |
|---|
| Fence |
| Heavy Use Area Protection |
| Spring Development |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Upland Wildlife Habitat Management |
| Prescribed Grazing |
| Stream Crossing |
| Invasive Plant Species Control |
| Herbaceous Weed Control |

### Pathway 1.2A
### Community 1.2 to 1.1



**Perennial Native Grasses/Sagebrush**

**Rhizomatous Wheatgrass/Sagebrush**

Long-term Prescribed Grazing, Brush Management - With integration of a rest-rotational grazing system or deferred rotation, and with management to reduce shrub canopy, the native bunchgrasses will begin to re-establish in this community, but it may take 5 to 10 years before significant change is noticed. Spring rest is needed to encourage the recovery of this site. Prescribed grazing, especially following sagebrush canopy treatments helps to remove woody debris and exposes a seedbank to encourage the native species. Allowing rest during critical seedling establishment stages and reducing competition of more competitive native species will help recovery. Hoof action helps to break up duff layers and open the seedbed to allow the desired wheatgrasses and bunchgrasses such as western wheatgrass, bluebunch wheatgrass, and needleandthread to reestablish or to increase, driving the recovery to the reference community (1.1). This hoof action, and brush treatment can be a tool to break up mat forming species to aid in addressing the hydrologic cycle, holding the water on the site rather than allowing it to move off. A long-term management strategy may be required before any trend towards reference is noticed. The overstory of Wyoming big sagebrush is the factor that could require mechanical manipulation to reduce canopy and composition to the desired 15%. The sod forming species are still low enough in cover, that management and animal impact should help to maintain or reduce their cover.

**Conservation practices**

| |
|---|
| Fence |
| Heavy Use Area Protection |
| Spring Development |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Prescribed Grazing |
| Invasive Plant Species Control |

## State 2
## Wyoming Big Sagebrush/Bare Ground

Wyoming big sagebrush creates a niche for most herbaceous understory to persist and maintain some vigor in difficult conditions by utilizing the moisture and shelter provided by the canopy as well as protection from grazing.

Persistence of drought and/or frequent over use by livestock and/or wildlife leads to a decline of the herbaceous species, creating the Wyoming Big Sagebrush and *Bare Ground* State. This state can be exacerbated by insects and other human disturbances. The total woody canopy cover does not necessarily always increase with this community, but the percent composition by cover and production is swayed by the decrease of herbaceous vegetation and the relative stability of production by the woody species, creating the appearance of increased canopy by sagebrush. Risk of wildfire within this state is minimal due to the lack of fine fuels within the understory, but the canopy of the woody vegetation can easily carry a fire under certain climatic conditions. Depending on the prescription of use, trailing and other erosional patterns are highly visible in this state. Protection from wildfire and use, on a long-term perspective, can aid in the transition of a reference community (1.1 or 1.2) to this state as sagebrush becomes dense and decadent reducing the ability for the herbaceous component to maintain vigor; leading to a high amount of bare ground and sagebrush cover. As the herbaceous cover declines and the site continues to weaken, the sagebrush cover is susceptible to attack by insects, disease, and general old age that can remove it from the system creating a system that is at risk of invasion or transition to a more degraded state. There is a high level of variability of species in this State, which will shift in response to precipitation or in response to past management. Only one well defined community will be provided, with discussion of transitions or variances from this community.

## Community 2.1
## Wyoming Big Sagebrush/Bare Ground

**Figure 14. Sagebrush Dominated Community with minimal coverag**

This plant community is the result of frequent and severe grazing and/or protection from fire. Sagebrush dominates this plant community, as the annual production of sagebrush exceeds 25%. Wyoming big sagebrush is a significant component of the plant community and the native mid-stature cool season bunchgrasses have been eliminated or greatly reduced. The dominant grasses are Sandberg bluegrass and rhizomatous wheatgrasses. Prickly pear cactus often increases. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. As compared with the Reference Plant community 1.1, the annual herbaceous production is reduced, but the shrub production compensates for the decline in the herbaceous production. This community is vulnerable to invasive weeds such as cheatgrass, Russian knapweed, and leafy spurge if a seed source is available. The total annual production (air-dry weight) of this state averages 250 pounds per acre, but it can range from 100 lbs./acre in unfavorable years to 400 lbs./acre in above average years. Rangeland Health Implications/Indicators: This plant community is resistant to change as the sagebrush canopy becomes more decadent, but is at-risk due to the susceptibility to invasive species. This plant community may be more resistant to fire as less fine fuels are available and bare ground increases. Continued frequent and severe grazing or the removal of grazing does not seem to affect the composition or structure of the plant community. Plant diversity is moderate to poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of mid-stature cool-season bunchgrasses. Plant litter has the appearance of being noticeably less when compared to the Reference Plant Community, but is variable and is not a stable indicator for a community shift in this case. Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

**Table 11. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 45 | 150 | 250 |
| Shrub/Vine | 50 | 75 | 100 |
| Forb | 5 | 25 | 50 |
| **Total** | **100** | **250** | **400** |

**Figure 16. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## State 3
## Sod-formers

The dominant sod-forming grass that currently exists within this LRU is blue grama with intermixed areas of threadleaf sedge. Both are species that persist as a component of the perennial vegetation naturally (in reference communities) within the ecological site. The general tendency is for these species to increase with prolonged drought or under grazing pressure, becoming dominant. Hydrology of the site is altered by increased surface runoff from the dense shallow root system that inhibits the movement of water through the soil. The sod patches will direct surface flow around the edge of the mat concentrating flow into channel like patterns, creating a difficult or hostile environment for native grass species and forbs to persist. The mechanisms to transition this state back to State 1 or State 2 requires mechanical and chemical processes to break up the sod and allow/encourage the mid-stature cool-season grasses. Many times, a seed source is not sufficient to allow this to occur so seeding may be required to produce the restoration pathway. No successful restorations have occurred with native species, so has not been described below.

### Community 3.1
### Sod/Sagebrush

**Figure 17. Blue grama and Threadleaf sedge with Sagebrush**

This plant community is the result of continuous season-long grazing, repeated overuse, or prolonged drought, which has adversely affected the perennial grasses and shrub component creating an open canopy to encourage the mat forming plants to expand. The natural effect of blue grama and threadleaf sedge, with the short stature dense root structure, is a decrease of water infiltration increasing channelization of runoff between vegetation patches. This with the lack of structure to hold moisture, compounded by drought can continue to reduce the shrub component. A dense sod of blue grama with patches of threadleaf sedge is the major grass component of this community. Incidental occurrences of other perennial natives occur generally within the sagebrush canopy or the protective ring of the prickly pear cactus clumps. Overall, Wyoming big sagebrush has been reduced in vigor and abundance across this site, but it still persists on the landscape (average of 3-5% canopy cover). When compared to the Reference Plant Communities 1.1 and 1.2, blue grama has increased significantly, comprises 30 to 60% of

the foliar cover. Prickly pear cactus has invaded the site, and other cool season mid-stature grasses, perennial forbs, and most shrubs have been greatly reduced. Production has significantly decreased and bare ground may not vary or will increase (linear extents of bare ground between densely vegetated areas). The total annual production (air-dry weight) of this state is about 175 pounds per acre, but it can range from about 60 lbs./acre in unfavorable years to about 350 lbs./acre in above average years. The higher productivity is generally in response to Sandberg bluegrass or sagebrush production on the site. Rangeland Health Implications/Indicators: This community is at-risk of transitioning to a completely sod-bound community with no woody vegetation. The dense root mats are extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure. The shrub component will be degraded and eventually removed from the plant community under either scenario. The biotic integrity of this state is not functional and plant diversity is extremely low. The plant vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool- season grasses. This sod-bound plant community is very resistant to water infiltration. While the sod protects the site itself, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in areas of bare ground and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites. This community has the ability to recover with management and some mechanical manipulation, once the sagebrush component has been lost, recovery or transition is not as feasible. The potential to recover compared to the potential to shift into a stable state of a sod-bound community creates the “at-risk” label. The threshold crossed to enter this state, the composition of sod-forming grasses and the lack of significant cover by other perennial grass forms, leaves these two communities (3.1 and 3.2) as similar communities with minimal shift between them.

**Table 12. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 45 | 120 | 225 |
| Shrub/Vine | 15 | 50 | 100 |
| Forb | 0 | 5 | 25 |
| **Total** | **60** | **175** | **350** |

**Figure 19. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Community 3.2
## Sod/Cactus

Transitioning from the Sod/Sagebrush community phase (3.1) to the Sod/Cactus community phase (3.2) occurs relatively easily after the initial transition into a sod-former state through drought or continued pressure on the remaining shrubs. A dense sod of Blue grama with Threadleaf sedge intermixed, is dominant with increasing Prickly pear cactus in the community. Cactus density has the potential to increase to a level that inhibits the ability for livestock to move through or graze the available forage. Wyoming big sagebrush has been generally removed from the community with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but may persist on the landscape. When compared to the Reference State (1.1 and 1.2), Blue grama and Prickly pear cactus has increased. All cool-season mid-stature grasses, forbs, and most shrubs have been greatly reduced or removed. Production has been significantly decreased. The ability for the sedges, as well as species such as Sandberg bluegrass that persist in the community, to respond to spring moisture allows for a significant range in production. Study plots have documented a range in production of less than 55 pounds one year and with no change in density/frequency, produce over 150 pounds the next year based only on timing and amount of precipitation. So production is provided as an average or medial number and is not intended to cover the full range of production potential for this community. Sod-forming species such as threadleaf sedge and blue grama are able to tolerate high levels of use and will maintain as other native species decline. This decline creates a sagebrush – sod-former community that is resistant to change with management. Impacts to sagebrush by disease or insect damage will shift this to the secondary community phase. The total annual production (air-dry weight) of this state is 175 pounds

per acre, but it can range from 55 lbs./acre in unfavorable years to 320 lbs./acre in above average years. Rangeland Health Implications/Indicators: This sod-bound community is extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure of the plant community. The biotic integrity of this state is not functional, plant diversity is extremely low, and vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool-season grasses. The dense root mat of this community is resistant to water infiltration, but can protect and hold water within the root zone; however, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in the bare ground areas and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

**Table 13. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 40 | 115 | 200 |
| Forb | 15 | 50 | 100 |
| Shrub/Vine | 0 | 10 | 20 |
| **Total** | **55** | **175** | **320** |

**Figure 21. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Pathway 3.1A
## Community 3.1 to 3.2

Intensive Brush Management, Fire, Frequent or Severe Grazing, Drought – In a sod dominant community, the hydrology has been altered drying the soils and reducing the potential for seedling establishment by many native grasses and shrubs. Once sagebrush is removed from this community by intense grazing pressure, drought and insect damage or by fire (rare), wild or prescribed, the community will phase into a complete sod community. The Wyoming big sagebrush component of this community is the at risk species. Drought alone, or with grazing pressure through season or year-long patterns, will create a sagebrush canopy that is decadent and dying. The sod-dominated community reduces the ability for sagebrush to propagate, leading to a further decline of sagebrush. Fire has little influence on this community due to the lack of fine fuels to carry it; but in rare circumstances, isolated areas may burn within the shrub canopy. In some cases, rubber rabbitbrush will persist or increase slightly on a site as sagebrush diminishes. It is also noted that with periods of drought there is a decrease in the health and vigor of threadleaf sedge and blue grama.

## State 4
## Invaded/Sagebrush

Cheatgrass or Downy brome (*Bromus tectorum*) is the invader that has the greatest concern for most land managers. This invader has an aggressive growth habit that creates a hostile environment for most native species, including sagebrush. Multiple growth cycles throughout a year leaves a thick litter (duff) layer and builds a significant seedbank; the ability for this annual to persist through the winter under a blanket of snow and sprout early gives it the advantage of all early spring precipitation and snowmelt. Shifts in climatic patterns, changes in management, and exposure to human activity are a few of the explanations for the current flush and rapid expanse across the western United States. Although cheatgrass is the threat most prevalent to rangelands on a large scale, a variety of knapweeds (namely spotted and Russian) and whitetop (hoary cress) are increasing in density and frequency, producing their own set of challenging management issues. As more species are found within the Basin or as other species become more prevalent on a large scale, the community dynamics in this state will shift in response to the concerns of the identified species. This state is characterized by the presence of an invasive/non-native species. Extended periods of drought alone or in combination with misuse, insect damage or wildfire has weakened the native composition of the community opening the canopy for invasion. The competitive nature of

annuals and other invasive species, creates a complex environment that inhibits control, and makes it implausible to attain complete eradication once an invasive species has established on the landscape.

### Community 4.1
### Native Grasses/Invasive Species/Sagebrush

The Perennial Grasses/Invasive Species/Wyoming big sagebrush community phase (4.1) has maintained a representative sample of native perennial grasses and forbs that are key to this particular ecological site with the accompanying Wyoming big sagebrush component. Although this community phase is very vulnerable of becoming an invader driven system, if native grasses can maintain at least a 50% composition, there is still a chance that the community can be improved, extent of improvement and exuberant costs and labor required limit the economic feasibility. This community phase is characterized by a significant presence of invasive species composition (5% or greater) on the landscape, and are prominent on the site (referring to a more wide scale composition, not one small patch in an isolated portion of the landscape). The litter or duff layer created by many of the known invasive species, but specifically cheatgrass, is significantly higher than the native community. This duff layer creates a barrier that can impede water infiltration and increase runoff, accelerating erosion. This is aggravated with increased slope. The duff layer creates an extreme hot zone during wildfires that can sterilize the soil through volatilization of needed nutrients or by the formation of an ash cap that seals the soils, preventing water infiltration and seed penetration, reducing the ability for re-vegetation post-disturbance. Production yields of the perennial grasses and forbs are reduced but the total production will maintain or may be slightly elevated due to the overall biomass and expanded growth potential of many of the annual or invasive species. A specific production range is not provided due to the variability of composition that will effect overall production. Rangeland Health Implications/Indicators: This plant community is prone to fire in response to the increase in fine fuels from the added biomass (litter) produced by the invaders. Plant diversity is moderate for this phase because the native perennials and woody shrubs have maintained composition. The plant vigor can be variable and is generally only slightly diminished at this stage and replacement capabilities are limited due to the added competition for limited moisture and nutrients available after cheatgrass has sprouted. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated. This variability also applies to water flow patterns and pedestalling. Infiltration is unaltered or slightly reduced; however as the duff layer or litter builds infiltration will decrease and runoff will increase.

**Figure 22. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

### Community 4.2
### Invasive Species/Sagebrush

As the native populations of perennial grasses and forbs are lost through excessive use or disturbance, the site becomes invader driven. Continued environmental or management derived impacts to the shrub component places this community at risk of crossing a threshold transitioning to State 5, Invaded/Annuals. At this point, hydrologically and biotically it will become irreversible without complete reclamation, which makes this community phase, the At-Risk community. Wyoming big sagebrush is able to compete and maintain a strong community under a heavy infestation level of most invasive species, unless fire or similar disturbance removes the woody cover. The canopy of the sagebrush serves as a protective niche in the system for native grasses and forbs, allowing remnant populations to persist. But the system is low in resistance and even lower in resilience. The fine fuels or biomass produced by most invasive species, with the most obvious being cheatgrass, fire is a significant threat and frequent occurrence. Strategies to control or manage for invasive species, namely cheatgrass, are being researched readily across the western United States. High intensity grazing with chemical control and the use of biological agents are techniques that have been trialed, with varying levels of success. The key management strategy needs to be to maintain the remnant populations of native grasses, and to reduce the risk of fire to allow the persistence of Wyoming big sagebrush. This will maintain the biotic integrity (maintaining species richness providing structure and a range of growth traits allowing adaptability of the site to varying climatic swings) and help support the hydrologic function (providing snow catchment, and shade to allow a slow release of winter precipitation during spring melt providing a longer moist season for optimal growth of native species) of the location. Each location will need to be

addressed individually to determine the best management strategies to utilize the native species present in the system and to determine the limitations of the resources. Rangeland Health Implications/Indicators: This plant community is resistant to change in relation to returning to a native dominant system, but as the stand becomes more decadent it loses its resistance as it shifts to an invader only community. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased with increased biomass and plant density of the annual invaders. Plant diversity is poor. The plant vigor is diminished and adaptability/replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that establishes on this site.

**Figure 23. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Pathway 4.1A
## Community 4.1 to 4.2

Frequent or Severe Grazing, Wildfire, Drought – Drought, wildfire, or other climatic stresses on the system will continue to hinder the native species, reducing their ability to maintain their footprint in the plant community. This continued stress or the complication with frequent or severe grazing pressure from wildlife and livestock can reduce the native composition to an unviable or unsustainable population and allow the invasive species to be dominant. The fleshy growth of native species are generally preferred over the thin straw like growth of cheatgrass. During initial spring green up while natives are still dormant, wildlife and cattle will utilize the cheatgrass, but once the natives begin to green up, the animals will switch back to the preferred natives.

## Pathway 4.2A
## Community 4.2 to 4.1

Integrated Pest Management/Weed Control and Long-term Prescribed Grazing - Control of invasive species and managing grazing to allow use of the invasive species with minimal impact to the native population, will allow the community to regain or maintain potential. But at this time it is not possible to eradicate the invasive species. Sustained control requires intensive inputs over the course of several years. To maintain the system with no further degradation requires a dual approach of both long-term prescribed grazing with an intensive weed management (integrated pest management) plan. No one single practice can sustain this phase, it requires intensive management to prevent the transition to State 6 - Invaders/Annuals.

**Conservation practices**

| |
|---|
| Critical Area Planting |
| Livestock Pipeline |
| Grazing Land Mechanical Treatment |
| Range Planting |
| Heavy Use Area Protection |
| Spring Development |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Upland Wildlife Habitat Management |
| Early Successional Habitat Development/Management |
| Livestock Use Area Protection |
| Native Plant Community Restoration and Management |

| |
|---|
| Prescribed Grazing |
| Invasive Plant Species Control |
| Herbaceous Weed Control |

### State 5
### Invaded Annuals

The transition of an Invaded/Sagebrush community into the Invaded state, is typically a result of wildfire, a failed controlled burn or other event that removes the sagebrush from the site and allows a readily available seed bank or seed source of the undesirable species to flourish. The most common community that is found in the Wind River Basin and much of the surrounding regions is Cheatgrass. There are other threats present, such as knapweeds and whitetop, which can develop into near monoculture stands. The loss of diversity, changes to the potential of a site due to allelopathy or other deterrent characteristics of invasive species, and risks or land use capabilities associated with the various invasive species creates a hostile environment for both native species and grazers. The resilience and resistance of the invaders create a management road block that is usually financially driven. Many times, once an invasion reaches this point, many land managers have no choice but to learn to utilize what they have rather than to try to treat or improve the site, specifically in relation to cheatgrass control.

### Community 5.1
### Invasives (Annual Grasses)

Downy Brome, better known as cheatgrass (*Bromus tectorum*), is able to emerge and grow late into the fall and green up early spring before snowmelt. This early and late growth pattern allows cheatgrass to utilize fall and spring resources that are otherwise stored for the cool season perennial vegetation before the native species can begin to break dormancy. Seeds are able to persist for long periods of time until growing conditions are optimal, allowing growth before most native species. The plant's ability to grow quickly utilizing minimal available resources, the ability to produce large quantities of seed quickly, and to reproduce in poor conditions are what drives this plant above the natives and many improved varieties of grasses. The morphology of the seed allows for easy dispersal and longevity creating a widespread and long-term seed bank. These traits create a management challenge that has not been successfully met at this time. Once this species has a niche on a landscape it is resistant and resilient to change. In this community, with the absence of sagebrush, there may be native species that will persist in small scattered populations or sparsely under the canopy of the cheatgrass. Certain climatic conditions will allow natives to show their resiliency and respond to the available resources (typically mid spring moisture), but are generally unable to out-compete the annual invader, and remain secondary in the community. The ability for cheatgrass to emerge, bolt, produce seed and mature out two to three times within a year utilizes all available soil nutrients and moisture resources. Chemical control is difficult to attain and maintain success without lasting effects on the native grasses in the area. Chlorosis of wheatgrasses, stunted plants, and loss of certain forbs are a few of the residual chemical effects (Plateau is what has been observed in this region.) This generally comes from the chemical composition and its ability to bind to the chemistry or nutrients in the soil inhibiting the uptake by roots. The fine fuels/biomass load created by cheatgrass can increase the fire frequency interval and reduces infiltration of precipitation, inhibiting establishment of sagebrush and other woody species, and has negative impacts on many of the native herbaceous species in the understory. Although there are sites that have burned multiple times (greater than 2 times), a fire frequency interval has not been calculated for the Wind River Basin. Management, land use, and opportunity (lightening, human causes) are all factors that influence this interval. The grazing potential is limited due to the unpalatable and harsh environment that the mature seeds create with their long awns and chaff. If grazed in early spring or late fall some of this can be avoided, but general use through the middle of the growing season is difficult, and defeats the purpose of intensively grazing the location. In smaller invaded sites or under certain conditions, grazing can be used as a tool within the integrated pest management toolbox, but it is not effective alone. Rangeland Health Implications/Indicators: This plant community is resistant to change. Plant diversity is poor. The plant vigor is diminished and replacement capabilities are non-existent due to the loss of cool-season grasses. Plant litter is noticeably more when compared to reference communities in response to the dense duff layer created by Cheatgrass. Soil erosion is generally reduced in response to the litter accumulation; however, the annual nature of this plant accentuates the water flow patterns and pedestalling. Infiltration is reduced and runoff is increased with the loss of perennial vegetation and root depth and density. Overall biotic integrity is lost in this community.

**Figure 24. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## State 6
## Altered

The arid nature of this region has played a major role in the development and transitions in land use over time. Landscapes accessible by irrigation water and equipment were farmed and many were later abandoned and left to return to rangeland. Other landscapes were treated with a variety of prescriptions to manage or eradicate sagebrush. Tillage of the soil, change in hydrology caused by the loss of vegetative structure, constant climatic fluctuations, and advancements in seed sources have created this altered state. Once a soil has been disturbed, whether it was mechanical, cultural, or natural the change in soil structure, hydrologic function, and possibly stability prevent a site from supporting the native vegetation or responding to management the same as an undisturbed site. Reclamation or restoration of an area will not replace the original function and factors that made the original location respond as it did. So these "altered" lands may, after significant inputs and time, look similar to the Reference communities (1.1 or 1.2), but they will not be able to respond/function as the Reference community will. The Disturbed or degraded state could be drafted as a stand-alone box within the state and transition model diagram. No matter what state a location is classified, once the site has experience an event that has altered the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered. To consider this as an alternate ecological site would not be unreasonable. In some cases (site by site consideration), a re-correlation of a location may be the best solution. But in many cases, the soils have not been altered out of the current site characteristics, but the potential has shifted enough that it is no longer truly comparable to the reference state. The extent and type of soil disturbance as well as the species selection used to revegetate the site determine the extent of alterations that limit this site. Even in the case of minimal tillage or ground disturbance, the surface crust and cryptogrammic crusts are displaced or destroyed altering the infiltration and nutrient flow within the soil (degradation of the biota within the soil). The loss of soil structure changes the holding capacity of the soil, removing the argillic or clay bulge, increasing the movement through the soil, and reducing the water holding capacity. The time required for soil to rebuild structure, biological crusts to regrow on the site, and the impact to chemistry and plant variety are highly variable depending on the climatic conditions following the event. The initial flush of vegetation following a disturbance is kochia. Russian thistle and mustards. Although they are only successional species, they provide organic material, nutrient flow and erosional protection; however, they lack the perennial structure and root system to fully stabilize the site. When the seeded section establishes, the site may become similar in composition to reference, but the integrity of the soil is altered, changing potential of the site. So a dynamic state was captured to detail the altered communities that exist on the landscape.

### Community 6.1
### Disturbed/Degraded Lands

Disturbed or degraded lands are characterized by alteration of the soils to a degree that the functionality (erosional, depositional, hydrological or chemical) and potential of the soils has been impacted. Site specific evaluations need to be completed to determine the level of effect. The method and severity of alternation, as well as the spatial extent of the disturbance will determine vegetation response and management needs. Linear disturbances, such as trails and roads, will hold a different risk than patchwork or polygonal disturbances, such as well-pads or parking areas. Small scale or isolated disturbances (spot fires, prairie dog town) can be just as significant of a risk as a large scale disturbance (mine lands). The growth curve of this plant community will vary depending on the successional or seeded species that are able to establish in an area. On locations that were seeded with non-native species, the growth curve will vary from the native community. But in the case of an early successional community, the growth curve may be similar. For a more accurate growth curve, a site specific species inventory and documentation of the climatic tendencies should be collected. Rangeland Health Implications/Indicators: The plant community is variable and depending on the age of the stand and the stage of successional tendencies that the location is in will determine how stable (resilient/resistant) the community is. Plant diversity of these successional communities is generally strong, but is usually lacking in the structural groups that are desired on the site. In areas of new or frequent disturbance, annual weedy species or early successional plants will be the dominant cover, providing a strong diversity, but has minimal structural cover for some wildlife. As the site matures or as the period between

disturbances is lengthened, perennial or taller statured, stronger rooted species will increase providing protection and help to improve the hydrologic process and provide for grasses and shrubs to begin to establish. This flexibility within the community creates a variable level of biotic integrity. Soil erosion is dependent on the disturbance regime and the biotic integrity of the community. The variability of the community also affects the water flow, infiltration, runoff, and pedestalling risk. Other factors that are more prevalent or influential for these sites are surface roughness and brokenness (tire tracks, hoof action, smoothed, denuded surfaces, trails that may concentrate water flow).

**Figure 25. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 50 | 25 | 5 | | 10 | | | |

## Community 6.2
## Reclaimed Lands

Shifts in reclamation practices over the last several decades have altered the success and stability of reclaiming a site. Crested wheatgrass was a species used frequently for reclamation throughout Wyoming; and across the state, many of these communities persist today. These stands are stable and generally persist as a monoculture until a disturbance creates a niche for native species to establish. Crested wheatgrass is creeping out into native communities as readily as native species are moving into the Crested wheatgrass stands. Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses are used in mixes to help increase establishment on these sites. Although the success of vegetative seedings are low to moderate in this LRU, due to the variable amounts and timing of precipitation events, limited areas along pipeline corridors, well sites or pad sites, and along transportation corridors have succeeded. Current interpretations of reclaimed or restored refers to the establishment of native species in a composition as close to a natural (pre-disturbance) plant community as possible. This excludes the use of non-native species and allows for a more similar ecological response than what is expected with non- native species. Although native species are used in reclamation, these plantings will not replicate the reference community in response to management due to the change in soil dynamics with mechanical disturbance (seedbed preparation and seeding), but they may be similar. The growth curve of this plant community will vary depending on the species that are selected for the reclamation seed mix. For a more accurate growth curve the species used and the climatic tendencies of the region must be considered. Rangeland Health Implications/Indicators: Seeding mixtures will determine the plant community's resistance to change and resilience against the threat of invasive species and to erosion. Many of the stands established during seeding are diversity poor, but are better than the monocultures that were seeded historically. Many seeded sites may be prone to fire because of the increased production as they mature (more biomass and possibly more litter) providing abundant fine fuels to carry a fire. Soil erosion is variable depending on the establishment of the seeding, how it is seeded, and mechanical procedures put in place. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that comprise the community and the method of seeding (site preparation and seeding practice). The challenge to establish shrubby species to the density they were pre-disturbance, and the general difficulty to reseed sagebrush, has also limited the recovery of the hydrologic cycle.

## Pathway 6.1A
## Community 6.1 to 6.2

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing management – With proper mechanical improvements and follow-up maintenance, a disturbed site can be improved and utilized for the intended purpose. However, climatic limitations affects the success of seedings. Depending on the location, seedings are slow to establish and invasive species are a risk, creating a moderately low success potential for this process. Proper preparation of a location to be seeded or once a site is seeded, integrated pest management becomes crucial to allow seedling establishment and to prevent invasive species from invading the area. Brush management may be required to open areas that can readily be seeded.

**Conservation practices**

| |
|---|
| Brush Management |
| Prescribed Burning |

| |
|---|
| Critical Area Planting |
| Fence |
| Livestock Pipeline |
| Grazing Land Mechanical Treatment |
| Range Planting |
| Heavy Use Area Protection |
| Spring Development |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Upland Wildlife Habitat Management |
| Early Successional Habitat Development/Management |
| Livestock Use Area Protection |
| Native Plant Community Restoration and Management |
| Prescribed Grazing |
| Invasive Plant Species Control |
| Herbaceous Weed Control |

### Pathway 6.2A
### Community 6.2 to 6.1

No use, No Fire, Long Term Prescribed Grazing, Frequent or Severe Grazing - In general, if a site is not maintained with the conditions of which the species are adapted under, a decline in vigor and a corresponding shift in composition will occur. Since the soils are altered from reference state due to plowing, mining, or other similar disturbances, the plant community will not follow the same expected shifts as the native community. Monitoring and trend over time need to be recorded to determine if a location is degrading or adjusting with the climatic variables of the site. The initial establishment phase of a reclaimed site is crucial to determine success, but at any stage of a seeding, degradation or further disturbance can occur forcing the site to phase back to the disturbed community.

### Transition T1A
### State 1 to 2

Frequent and Severe Grazing (Year-long) or Drought - Frequent or high intensity herbivory on a community weakens the ability for the grasses to persist, especially during prolonged drought. With the weakened grasses and with prevention or lack of fire, the composition will shift to mostly sagebrush, and with time sagebrush will increase in cover preventing the recovery without intervention. The conversion to a Wyoming Big Sagebrush/*Bare Ground* plant community is a response to extended periods of stress, both climate and/or human induced. Intensive grazing with minimal to no recovery period begins to transition the community. With added climatic stress, species diversity and productivity is lost, and the community crosses into the Sagebrush/Bare ground State. The illusion of crossing the threshold to State 2 can be found during drought periods in communities that are dominant in needleandthread, with fluctuating precipitation patterns affecting production within this system from year to year. The loss of herbaceous species density as well as diversity and increased bare ground with lack of litter are the indicators that a true transition has occurred.

### Transition T1B
### State 1 to 3

Frequent Grazing (Yearlong), Brush Management or Fire with Drought – Severe and frequent grazing reduces vigor and presence of key species. As the rhizomatous wheatgrasses, and needleandthread begin to decline, shorter statured grasses become dominant. Animal disturbance (hoof impact) caused by long duration, high intensity herbivory reduces the bunchgrass component through repeated defoliation as well as physical damage to the crown and growth points of the plants; weakening and over time removing select species. The loss of mid-stature grasses

reduces ground cover for insulation and snow catch, reducing recovery potential. The open canopy and hoof impact encourages species that are tolerant to high traffic and that can utilize the small shots of summer moisture, these species are generally mat or sod-forming species such as blue grama and threadleaf sedge. Prolonged drought stresses the plants, and opens the canopy for these two sod forming plants to fill in the interspaces. The shallow, dense root mats will continue to spread over time. The added removal of sagebrush with animal impacts, fire or brush management may open the canopy more and aid in establishing this sod-bound community. Season of use and intensity of grazing (time and timing) is a trigger that can reduce the risk of transitioning, or if done without consideration of the plant growth requirements can force the transition to occur rapidly.

### Restoration pathway R2A
### State 2 to 1

Prescribed Grazing with Brush Management or Wildfire - Treatment to thin the canopy to allow the native vegetation to respond to improved moisture and sunlight followed by prescribed grazing to prevent overuse of the exposed grasses will help this community recover. Treatment will vary depending on the exact composition of grasses remaining and the potential threats to the location. Removal or thinning of the sagebrush within this community will help to reduce competition, encouraging grasses and forb recovery if the disturbance or over-use (recreational or grazing pressure) is reduced. Drought may prolong the time required for recovery. Mowing or mulching sagebrush trials have shown a strong response by grasses with little to no recovery time post treatment. The resulting community with these treatments is driven by the dominant species within the community pre-treatment, or climatic and treatment conditions during and following the fire. It is crucial to investigate the immediate and surrounding area around treatment site to ensure no invasive species (cheatgrass) are present.

**Conservation practices**

| |
|---|
| Brush Management |
| Fence |
| Livestock Pipeline |
| Grazing Land Mechanical Treatment |
| Heavy Use Area Protection |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Upland Wildlife Habitat Management |
| Controlled Livestock Lounging Area |
| Controlled Stream access for Livestock Watering |
| Livestock Use Area Protection |
| Prescribed Grazing |

### Transition T2A
### State 2 to 3

Drought, disease or insect damage, over-use, or fire - Sod-forming species such as blue grama and threadleaf sedge are able to tolerate high levels of use and will maintain as other native species decline. Hoof action or compaction inhibits more desirable native species, allowing the sod-formers to become more dominant on the landscape. This decline creates a sagebrush – sod-former community that is resistant to change with management. Impacts to sagebrush by disease or insect damage, as well as drought or herbivory, will shift this to the secondary community phase with cactus as a subdominant cover with blue grama.

### Transition T2B
### State 2 to 4

Fire (wild), Frequent or Severe Grazing, Drought with Insect Damage/Brush Management – Throughout most of this LRU there is a seed source present for cheatgrass, knapweed, and other invasive species. Stress to the native

community from drought; events such as wildfire or prescribed burning and other forms of brush management; or ground/soil disturbance including impacts by grazing large herbivores or recreation that open the canopy and break the surface of the soil, creates a niche for invasion by undesirable or weedy species. Documentation has shown that many times the invasion starts with one or two isolated plants, that if caught can be treated and a full infestation avoided; however, when unseen or ignored, the population soon grows exponentially as further stress or disturbance occurs. In some cases the invasive species, once established, can create its own habitat, forcing the weaker native species out. The open canopy of the Sagebrush/*Bare Ground* State is vulnerable to invasive species without further influence. With continued over-use, drought, insect damage or fire, the invasive species will establish and quickly dominate a location. The threshold species in this system is Wyoming big sagebrush, which protects the remnants of the perennial natives, allowing them to persist on the landscape.

### Transition T2C
### State 2 to 5

Wildfire, Drought, Disease/Insects – When wildfires, prolonged drought with over use by large herbivores or large scale land disturbance occurs in areas where invasive species are present, the exposed soil and lack of native vegetation from already stressed communities creates the environment for the invasive species to establish as a monoculture with only small isolated remnants of native species possible. The canopy of Wyoming big sagebrush is the stabilizer for this community. Once it is removed, it is extremely difficult to re-establish. Wyoming big sagebrush may require 25 years or greater to establish naturally, and in many cases will require outside assistance. The open raw landscape with minimal native species provides the perfect opportunity for invasive species, primarily cheatgrass, to establish and take over. Drought or insects and disease serve to exacerbate the situation. Once the sagebrush is affected by the altered (shortened) fire frequency of this state due to the invasive species (primarily cheatgrass), this community can be transitioned to the Invaded/Annuals state suddenly by prescribed burns or wildfire.

### Transition T3A
### State 3 to 4

Frequent and Severe Grazing, Drought, Disturbance with a seed source present - The chance of wildfire is reduced with the loss of fine fuels and reduced sagebrush canopy. Increased pressure from over use and drought work to weaken the sod or mat-like community of low stature grasses, opening the sod to annuals and other invaders, such as cheatgrass and knapweeds. If a seed source is available, ground disturbance by herbivores or man-induced, allows invasive species to find a way into the community. Once established in the community, it is extremely difficult to manage and may not be feasible to completely remove them from the community. Once the invasive species have become prevalent (>5% composition) on the landscape, the community crosses the threshold into the Invaded/Sagebrush State (State 4).

### Transition T4A
### State 4 to 5

Fire, Drought, Ground Disturbance, Over Use - Once a community has been compromised by a notable composition of an invasive species, stress or ground disturbance of any means can cause the invasive species to take over and dominate the site. Wildfire, extreme drought and the accompanying disease and insect damage, as well as frequent and intense use by large herbivores are the impacts most commonly seen to insight a weed infestation. Any action that reduces or damages the existing sagebrush canopy exposing the sensitive native grass population will start the transition. Drought, further disturbance or ill-planned grazing (grazing when the natives are trying to break boot and grow), will remove the competition and finish the transition.

### Restoration pathway R5A
### State 5 to 6

Integrated Pest Management, with Seeding - Integrated pest management plan and intense weed control after and possibly before seedbed preparation will be necessary to overcome a severe weed infestation. Working the soil and preparing a seedbed at a location and using either improved varieties, native seed, or in some cases an introduced species suited for the management use intended may be the only way to overcome some invasive species. Success of re-establishing a native or desired plant community on a large scale is not documented. Small scale attempts are

rated to be low and highly variable for the rate of control of most species. It is a consensus that the site in theory could be brought to a community that looks similar to an at-risk community within the reference state, but that it is not possible to reach the reference community condition once annuals have established on a site. This is due to the need to work the soil or to do seedbed preparation to seed in the native species which reduces soil stability by breaking down soil structure, and alters the hydrologic cycle by changing the infiltration and percolation rates of the soil. The alteration of the soils, the change in the plant community and the risk of re-invasion of the site will never allow it to react the same to management and environmental changes the same as a truly native community and so remains in a reclaimed state.

**Conservation practices**

| |
|---|
| Brush Management |
| Critical Area Planting |
| Fence |
| Livestock Pipeline |
| Grazing Land Mechanical Treatment |
| Range Planting |
| Heavy Use Area Protection |
| Spring Development |
| Integrated Pest Management (IPM) |
| Watering Facility |
| Upland Wildlife Habitat Management |
| Early Successional Habitat Development/Management |
| Livestock Use Area Protection |
| Native Plant Community Restoration and Management |
| Prescribed Grazing |
| Invasive Plant Species Control |
| Herbaceous Weed Control |

## Transition T6A
## State 6 to 5

No Use, Fire (wild or prescribed), Frequent or severe Grazing, Drought with seed source present – In the reclamation or restoration process, or after a land disturbance occurs, if no management is put into place to prevent a reoccurrence or a new infestation of weeds, the community will revert back or transition to an invaded state. Wildfire, prescribed burning, drought, or frequent and severe miss-use by large herbivores can be a source of the disturbance that either opens the canopy and/or introduces the species to the location. Extended periods of non-use creates a decadent community with a large proportion of dead growth persisting around the crown of the plants, reducing vigor and production. As the plants begin to die-back, the community becomes vulnerable to weed invasions. Opposite of the non-use scenario, it has been found that frequent or severe grazing, drought, or fire can open the canopy to invasion as well. This invasion triggers the transition to an invaded state.

## Additional community tables

**Table 14. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Rhizomatous Wheatgrasses** | | | 80–160 | |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 80–160 | 20–40 |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 80–160 | 20–40 |

| | | | | | |
|---|---|---|---|---|---|
| | western wheatgrass | PSSM | *Pascopyrum smithii* | 60–100 | 20–40 |
| 2 | | | | 40–100 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 40–100 | 10–25 |
| 3 | | | | 20–40 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 20–40 | 5–10 |
| 4 | | | | 20–40 | |
| | squirreltail | ELEL5 | *Elymus elymoides* | 20–40 | 5–10 |
| 5 | **Miscellaneous Grasses/Grass-likes** | | | 20–60 | |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–20 | 0–5 |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 0–20 | 0–5 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 0–20 | 0–5 |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–20 | 0–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–20 | 0–5 |
| **Forb** | | | | | |
| 6 | **Perennial Forbs** | | | 20–40 | |
| | Forb, perennial | 2FP | *Forb, perennial* | 0–20 | 0–5 |
| | textile onion | ALTE | *Allium textile* | 0–20 | 0–5 |
| | Missouri milkvetch | ASMI10 | *Astragalus missouriensis* | 0–20 | 0–5 |
| | wavyleaf Indian paintbrush | CAAPM | *Castilleja applegatei ssp. martinii* | 0–20 | 0–5 |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–20 | 0–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 0–20 | 0–5 |
| | little larkspur | DEBI | *Delphinium bicolor* | 0–20 | 0–5 |
| | erigenia | ERIGE | *Erigenia* | 0–20 | 0–5 |
| | bigseed biscuitroot | LOMA3 | *Lomatium macrocarpum* | 0–20 | 0–5 |
| | leafy wildparsley | MUDI | *Musineon divaricatum* | 0–20 | 0–5 |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 0–20 | 0–5 |
| | white locoweed | OXSES2 | *Oxytropis sericea var. speciosa* | 0–20 | 0–5 |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–20 | 0–5 |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–20 | 0–5 |
| **Shrub/Vine** | | | | | |
| 7 | | | | 20–60 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 20–60 | 5–15 |
| 8 | | | | 0–20 | |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 0–20 | 0–5 |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 0–20 | 0–5 |
| 9 | **Miscellaneous Shrubs** | | | 20–40 | |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–20 | 0–5 |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 0–20 | 0–5 |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–20 | 0–5 |

**Table 15. Community 1.2 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 1 | **Rhizomatous Wheatgrasses** | | | 40–120 | |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 40–120 | 10–30 |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 40–120 | 10–30 |
| 2 | | | | 40–100 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 40–100 | 10–25 |
| 3 | | | | 5–20 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 5–20 | 1–5 |
| 4 | | | | 20–40 | |
| | squirreltail | ELEL5 | *Elymus elymoides* | 20–40 | 5–10 |
| 5 | | | | 20–80 | |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–20 | 0–5 |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 0–20 | 0–5 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 0–20 | 0–5 |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–20 | 0–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–20 | 0–5 |
| **Forb** | | | | | |
| 6 | **Perennial Forbs** | | | 0–20 | |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–20 | 0–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 0–20 | 0–5 |
| | erigenia | ERIGE | *Erigenia* | 0–20 | 0–5 |
| | bigseed biscuitroot | LOMA3 | *Lomatium macrocarpum* | 0–20 | 0–5 |
| | leafy wildparsley | MUDI | *Musineon divaricatum* | 0–20 | 0–5 |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 0–20 | 0–5 |
| | white locoweed | OXSE | *Oxytropis sericea* | 0–20 | 0–5 |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–20 | 0–5 |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–20 | 0–5 |
| | American vetch | VIAM | *Vicia americana* | 0–20 | 0–5 |
| | Forb, perennial | 2FP | *Forb, perennial* | 0–20 | 0–5 |
| | textile onion | ALTE | *Allium textile* | 0–20 | 0–5 |
| | wavyleaf Indian paintbrush | CAAPM | *Castilleja applegatei ssp. martinii* | 0–20 | 0–5 |
| 7 | **Annual Forbs** | | | 0–20 | |
| | Forb, annual | 2FA | *Forb, annual* | 0–20 | 0–5 |
| **Shrub/Vine** | | | | | |
| 8 | | | | 40–180 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 40–180 | 10–40 |
| 9 | | | | 0–20 | |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 0–20 | 0–5 |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 0–20 | 0–5 |
| 10 | **Miscellaneous Shrubs** | | | 0–40 | |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–20 | 0–5 |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 0–20 | 0–5 |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–20 | 0–5 |

**Table 16. Community 2.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Rhizomatous Wheatgrasses** | | | 60–120 | |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 60–120 | 15–30 |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 60–120 | 15–30 |
| 2 | | | | 20–60 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 20–60 | 5–15 |
| 3 | | | | 0–20 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 0–20 | 0–5 |
| 4 | | | | 0–20 | |
| | squirreltail | ELEL5 | *Elymus elymoides* | 0–20 | 0–5 |
| 5 | | | | 40–80 | |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–20 | 0–5 |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 0–20 | 0–5 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 0–20 | 0–5 |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–20 | 0–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–20 | 0–5 |
| **Forb** | | | | | |
| 6 | **Perennial Forbs** | | | 20–40 | |
| | Forb, perennial | 2FP | *Forb, perennial* | 0–20 | 0–5 |
| | textile onion | ALTE | *Allium textile* | 0–20 | 0–5 |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–20 | 0–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 0–20 | 0–5 |
| | bigseed biscuitroot | LOMA3 | *Lomatium macrocarpum* | 0–20 | 0–5 |
| | leafy wildparsley | MUDI | *Musineon divaricatum* | 0–20 | 0–5 |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 0–20 | 0–5 |
| | white locoweed | OXSE | *Oxytropis sericea* | 0–20 | 0–5 |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–20 | 0–5 |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–20 | 0–5 |
| | American vetch | VIAM | *Vicia americana* | 0–20 | 0–5 |
| 7 | **Annual Forbs** | | | 0–20 | |
| | Forb, annual | 2FA | *Forb, annual* | 0–20 | 0–5 |
| **Shrub/Vine** | | | | | |
| 8 | | | | 40–200 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 40–200 | 10–40 |
| 9 | | | | 0–20 | |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 0–20 | 0–5 |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 0–20 | 0–5 |
| 10 | **Miscellaneous Shrubs** | | | 20–40 | |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–20 | 0–5 |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 0–20 | 0–5 |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–20 | 0–5 |

**Table 17. Community 3.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Sod Formers** | | | 80–160 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 80–160 | 20–40 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 80–160 | 20–40 |
| 2 | | | | 20–40 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 20–40 | 5–10 |
| 3 | **Rhizomatous Wheatgrasses** | | | 0–20 | |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 0–20 | 0–5 |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 0–20 | 0–5 |
| 4 | | | | 0–20 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 0–20 | 0–5 |
| | squirreltail | ELEL5 | *Elymus elymoides* | 0–20 | 0–5 |
| 5 | **Miscellaneous Grasses** | | | 0–20 | |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–20 | 0–5 |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–20 | 0–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–20 | 0–5 |
| **Forb** | | | | | |
| 6 | **Perennial Forbs** | | | 20–40 | |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 0–40 | 5–10 |
| | white locoweed | OXSE | *Oxytropis sericea* | 0–20 | 0–5 |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–20 | 0–5 |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–20 | 0–5 |
| | American vetch | VIAM | *Vicia americana* | 0–20 | 0–5 |
| | Forb, perennial | 2FP | *Forb, perennial* | 0–20 | 0–5 |
| | textile onion | ALTE | *Allium textile* | 0–20 | 0–5 |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–20 | 0–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 0–20 | 0–5 |
| | bigseed biscuitroot | LOMA3 | *Lomatium macrocarpum* | 0–20 | 0–5 |
| | leafy wildparsley | MUDI | *Musineon divaricatum* | 0–20 | 0–5 |
| 7 | **Annual Forbs** | | | 0–20 | |
| | Forb, annual | 2FA | *Forb, annual* | 0–20 | 0–5 |
| **Shrub/Vine** | | | | | |
| 8 | | | | 20–60 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 20–60 | 5–15 |
| 9 | | | | 0–20 | |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 0–20 | 0–5 |
| 10 | **Miscellaneous Shrubs** | | | 0–20 | |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–20 | 0–5 |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 0–20 | 0–5 |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–20 | 0–5 |

**Table 18. Community 3.2 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Sod-formers** | | | 40–200 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 40–200 | 30–60 |
| | threadleaf sedge | CAFI | *Carex filifolia* | 5–120 | 1–30 |
| 2 | | | | 0–40 | |
| | needle and thread | HECO26 | *Hesperostipa comata* | 0–40 | 0–10 |
| 3 | | | | 0–20 | |
| | thickspike wheatgrass | ELLAL | *Elymus lanceolatus ssp. lanceolatus* | 0–20 | 0–5 |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 0–20 | 0–5 |
| 4 | | | | 0–20 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 0–20 | 0–5 |
| 5 | **Miscellaneous Grasses/Grass-likes** | | | 0–20 | |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–20 | 0–5 |
| | squirreltail | ELEL5 | *Elymus elymoides* | 0–20 | 0–5 |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–20 | 0–5 |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–20 | 0–5 |
| **Forb** | | | | | |
| 6 | | | | 20–100 | |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 20–100 | 5–25 |
| | white locoweed | OXSE | *Oxytropis sericea* | 0–20 | 0–5 |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–20 | 0–5 |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–20 | 0–5 |
| | American vetch | VIAM | *Vicia americana* | 0–20 | 0–5 |
| | Forb, perennial | 2FP | *Forb, perennial* | 0–20 | 0–5 |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–20 | 0–5 |
| | tapertip hawksbeard | CRAC2 | *Crepis acuminata* | 0–20 | 0–5 |
| | bigseed biscuitroot | LOMA3 | *Lomatium macrocarpum* | 0–20 | 0–5 |
| | leafy wildparsley | MUDI | *Musineon divaricatum* | 0–20 | 0–5 |
| 7 | **Annual Forbs** | | | 0–20 | |
| | Forb, annual | 2FA | *Forb, annual* | 0–20 | 0–5 |
| **Shrub/Vine** | | | | | |
| 8 | | | | 0–20 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 0–20 | 0–5 |
| 9 | | | | 0–20 | |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 0–20 | 0–5 |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 0–20 | 0–5 |
| 10 | | | | 0–20 | |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–20 | 0–5 |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 0–20 | 0–5 |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–20 | 0–5 |

## Animal community

Animal Community – Wildlife Interpretations:

1.1 – RhizomatousWheatgrasses/Needleandthread/Wyoming Big Sagebrush (Reference Community): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. When found adjacent to sagebrush dominated states (1.2 or 3.1), this plant community provides brood rearing/foraging areas for sage grouse, as well as lek sites. The mosaic pattern of varying density of sagebrush in a smaller scale, provides cover and line of site to forage and yet escape quickly when predators approach. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland obligate small mammals would occur here.

1.2 – Perennial Native Grasses/Wyoming Big Sagebrush (At-Risk Community): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. This plant community provides brood rearing/foraging areas for sage grouse, as well as lek sites. The mosaic pattern of varying density of sagebrush in a smaller scale, provides cover and line of site to forage and yet escape quickly when predators approach. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland obligate small mammals would occur here.

2.1 - Wyoming Big Sagebrush/*Bare Ground* Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

3.1 - Sod-formers/Wyoming Big Sagebrush Plant Community: This community provides limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse where reference state community phases are limited. Generally, these are not target plant communities for wildlife habitat management.

3.2 - Sod-formers/Cactus Plant Community: This community provides limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse if proximal to woody cover and if the Reference Plant Community or the rhizomatous wheatgrasses/Perennial Grasses/Sod- formers/Wyoming Big Sagebrush Plant Community are limited. Generally, these are not target plant communities for wildlife habitat management.

4.1- Native Grasses/Invasive Species/Wyoming Big Sagebrush Plant Community: The retained combination of sagebrush and the added diversity with the invasive grasses and/or forbs provide an extended plant community for wildlife. The similarities to Community Phase 1.2 (Perennial Native Grasses/Wyoming Big Sagebrush) are to some extent enhanced for some species with the added forage provided by the invasive species. But as the invasive species increase, decreasing the desirable species, the wildlife species benefits are decreased as well.

4.2- Invasive Species/Wyoming Big Sagebrush Plant Community: Limited nesting and cover is provided by the existing overstory cover of the Wyoming big sagebrush.

5.1 - Invaded/Annual Grasses Plant Community: Early spring and fall green up of Cheatgrass provides foraging opportunities for many of our grazers and mixed feeders.

6.1 - Disturbed/Degraded Lands Plant Community and 6.2 - Restored/Reclaimed Lands Plant Community: The variability of this site prevents a detailed review of wildlife benefits. However, many of the introduced grasses, forbs and shrubs can provide adequate cover, feed and nesting sites for those wildlife species that would have selected the site prior to disturbance. Limitations and enhancements need to be considered by specific locations.

Animal Community – Grazing Interpretations:

The following table lists suggested stocking rates for cattle under continuous season-long grazing with normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of

the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor.

Plant Community Production Carrying Capacity*

The carrying capacity is calculated as the production (normal year) X .25 harvest efficiency factor / 912.5 # / AUM to calculate the AUM's/Acre.
Plant Community Description/Title Lbs./Acre AUM/Acre* Acre/AUM
Below Ave. Normal Above Ave.
1.1 Rhizomatous Wheatgrasses/Wyoming Big Sagebrush 225 400 600 0.11 9.09
1.2 Perennial Native Grasses/Wyoming Big Sagebrush 180 350 620 0.10 10.0
2.1 Wyoming Big Sagebrush/*Bare Ground* 100 250 400 0.07 14.29
3.1 Sod-formers/Wyoming Big Sagebrush 60 175 350 0.05 20.0
3.2 Sod-formers/Cactus 55 175 320 0.04 25.0
4.1 Native/Invasive/Wyoming Big Sagebrush ** ** ** ** **
4.2 Invasives/Wyoming Big Sagebrush ** ** ** ** **
5.1 Invasives ** ** ** ** **
6.1 Disturbed/Degraded ** ** ** ** **
6.2 Restored/Reclaimed ** ** ** ** **

* - Carrying Capacity is figured for continuous, season-long grazing by cattle under average growing conditions.
** - Sufficient data for invaded and reclaimed communities has not be collected or evaluated, at this time, so no projection of a stocking rate recommendation or production range will be established at this time.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage for cattle, sheep, or horses. During the dormant period, the forage for livestock use needs to be supplemented with protein because the quality does not meet minimum livestock requirements.

Distance to water, shrub density, and slope can affect carrying capacity (grazing capacity) within a management unit. Adjustments should be made for the area that is considered necessary for reduction of animal numbers. For example, 30% of a management unit may have 25% slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30% of the unit (i.e. 50% reduction on 30% of the management unit).

Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of graze-able acres within a management unit. Adjustments should be made that incorporate these factors when calculating stocking rates.

## Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where short-grasses form a strong sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non- existent. Cryptogrammic crusts are present, but only cover 1-2% of the soil surface.

## Recreational uses

This site provides hunting opportunities for upland game species. The wide varieties of plants which bloom from spring until fall have an aesthetic value that appeals to visitors. Outside of plants, the extent offers a variety of culture resources to view on the landscape based on the location of many of these sites on higher ground on the benches and fans which also provides a rich source of geology for exploration. The extent of this ecological site is found within the Boysen State Park and the Wind River Indian Reservation. These entities have served to protect and provide cultural significance to this ecological site. This ecological site has minimal limitations when associated with roadways and trails, and provides a sound base for travel and camping in relation to erosion potential and functionality.

## Wood products

No appreciable wood products are present on the site.

## Other products

Herbs: The forb species of the Loamy Ecological site have medicinal characteristics and have been used by the Native Americans in this area and more recently by the naturopathic profession.

Ornamental Species: The forbs commonly found as well as the shrub component of these communities have been used in landscaping and xeriscaping.

## Inventory data references

Information presented in the original site description was derived from NRCS inventory data. Field observations from range trained personnel were also used. Those involved in developing the original site include: Chris Krassin, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, USDI and USDA Interpreting Indicators of Rangeland Health Version 3, and USDA NRCS Soil Surveys from various counties.

Information presented here has been derived from NRCS inventory data, Field observations from range trained personnel, and the existing range site descriptions. Those involved in developing the Loamy range site include: Chris Krassin, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist.

Those involved in the development of the new concept for Sandy Ecological site include: Jim Haverkamp, Area Range Management Specialist, NRCS; Mandi Hirsch, Range Management Specialist/Sage Grouse Coordinater, Popo Agie Conservation District; John Likins, Range Management Specialist, Retired USDI-BLM; Daniel Wood, MLRA Soil Survey Leader, NRCS; Jane Karinen, Soil Data Quality Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS.

Quality control and quality assurance completed by: John Hartung, Wyoming State Rangeland Management Specialist, NRCS; Scott Woodall, Regional Quality Assurance Ecological Site Specialist, NRCS.

Inventory Data References:
Ocular field estimations observed by trained personnel were completed at each site. Then sites were selected where a 100 foot tape was stretched and the following sample procedures were completed by inventory staff. For full sampling protocol and guidelines with forms please refer to the Wyoming ESI Operating Procedures, compiled in 2012 for the Powell and Rock Springs Soil Survey Office, USDA-NRCS.
• Double Sampling Production Data (9.6 hoop used to estimate 10 points, clipped a minimum of 3 of these estimated points, with two 21 foot X 21 foot square extended shrub plots).
• Line Point Intercept (over story and understory captured with soil cover). Height of herbaceous and woody cover is collected every three feet along established transect.)
• Continuous Line Intercept (Woody Canopy Cover, with minimum gap of 0.2 of a foot for all woody species and succulents. Intercept height collected at each measurement.),
• Gap Intercept (Basal Gap measured with a minimum gap requirement of 0.7 foot.),
• Sample Point (10 – 1 meter square point photographs taken at set distances on transect. Read using the sample point computer program established by the High Plains Agricultural Research Center, WY).

• Soil Stability (Slake Test – surface and subsurface samples collected and processed according to the soil stability guidelines provided by the Jornada Research Center, NM.)

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## Contributors

Marji Patz

## Approval

Kirt Walstad, 3/04/2025

## Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

| | |
|---|---|
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| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** Bare ground can range from 25-35%.

2. **Presence of water flow patterns:** Barely observable

3. **Number and height of erosional pedestals or terracettes:** Rare to non-existent

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 25-35% occurring in small areas throughout site.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present

6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent.

7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous litter expected to move only in small amounts (to leeward side of shrubs). Large woody debris from sagebrush will show no movement.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 1 (interspaces) to 6 (under plant canopy), but average values should be 5.0 or greater.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Refer to soil series description and map unit information for specific information. Described A-horizons vary from 1-5 inches (3-12 cm) with OM of 1 to 2%.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The plant community consists of 60-75% grasses, 10% forbs and 15-30% shrubs. Evenly distributed plant canopy (35-55%) and litter plus moderate to moderately rapid infiltration rates result in minimal runoff. Basal cover is typically less than 8% for this site and does very little to effect runoff on this site. Canopy cover is sufficient to reduce raindrop impact.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction layer or soil surface crusting should be present.

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant: Cool season, mid-stature grasses >>

    Sub-dominant: Perennial shrubs >

    Other: Short stature grasses/grass-likes > Forbs

    Additional: Cool Season mid stature grasses >> Shrubs > Short stature grasses/grass-likes > Forbs

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence, typically associated with shrub component of the canopy cover.

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14. **Average percent litter cover (%) and depth ( in):** Litter ranges from 20-30% of total canopy measurement with total litter (including beneath the plant canopy) from 30-70% expected. Herbaceous litter depth typically ranges from 3-7 mm. Woody litter can be up to a couple inches (2-5 cm).

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** English: 225 - 600 lbs/ac (400 lbs/ac average); Metric: 252 - 673 kg/ha (448 kg/ha average).

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** The increase of bare ground above 35% is an indicator that a threshold is being crossed. Corresponding increase will be noted in one or more of the following species is common: blue grama, Sandberg bluegrass, prickly pear cactus, Wyoming big sagebrush, and broom snakeweed. Annual weeds such as kochia, mustards, lambsquarter, Russian thistle, and pepperweeds are common invasive species in disturbed sites. Common noxious weeds that invade are: Cheatgrass (Downy brome), knapweeds, whitetop and others found on the Noxious Weed List for Wyoming and Fremont County.

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17. **Perennial plant reproductive capability:** All species are capable of reproducing, except in drought years.

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