USDA Natural Resources Conservation Service

Ecological site DX032X02B150
Sandy (Sy) Wind River Basin Rim

Last updated: 2/22/2019
Accessed: 05/19/2024

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.

MLRA notes

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

Land Resource Unit (LRU):

32X02B (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 the rim of the Wind River Basin and is comprised of eroded fan remnants and stream terraces. This subset is driven by the relation to the mountains creating 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 current subset or LRU boundary. Many of the map units are correlated to ecological sites outside of this MLRA, but will be reviewed and corrected during mapping update projects.

Moisture Regime: Ustic Aridic
Temperature Regime: Mesic
Dominant Cover: Rangeland, with sagebrush steppe intermixed with saltbush flats, is the dominant vegetative cover.
Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm)
RV Frost-Free Days: 85-115 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 Macro group
G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group
A3182 Artemisia tridentata ssp. wyomingensis Mesic Steppe & Shrubland Alliance
CEGL001051 - Artemisia tridentata ssp. wyomingensis/Hesperostipa comata 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

• Receives no additional water.
• Slope is <30%
• Soils are:
o Textures range from loamy sand to very fine sandy loam in top 4” (10 cm) of mineral soil surface
o Clay content is =18% 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% clay.
o Moderately deep to very deep (20-80+ in. (50-200+ cm)
o <3% stone and boulder cover and 20% or less 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 Sandy ecological site concept is based on minimal influence from 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 that is coarse textured with less than 18% clay throughout the soil profile; the dominant soil textural classes are loamy sand to sandy loam in the subsurface. The plant community transitions as the control section increases above 18% clays with increased rhizomatous wheatgrasses, additional forb species, and increased ground cover.

The sandy site can be found in several different catenas throughout the basin. In an escarpment catena it 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 inter-bedded sandstone and shale; or in areas where the parent material is alluvial. Locations controlled by primarily sandstone bedrock, sandy sites can be found in structural-controlled stable areas adjacent to sandstone rock outcrop. In these stable areas yucca, shadscale and spiny hopsage are common, generally occurring closer to rock outcrop. These shrub species are also common in the sands ecological site, a site characterized by no/minimal soil development.

Associated sites

R032XY246WY	**Sands (Sa) 5-9” Wind River Basin Precipitation Zone** The Sands ecological site lacks the structure and stability of the Sandy ecological site. The Sands site occurs on relatively flat locations or concave positions that collects eolian materials. Productivity is lower and generally higher diversity of forbs are found on this site.
R032XY304WY	**Clayey (Cy) 10-14" East Precipitation Zone** 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 sites tend to fall along alluvial drainages or below shale outcrops/outwashes.
R032XY312WY	**Gravelly (Gr) 10-14" East Precipitation Zone** Gravelly sites have the potential for bluebunch wheatgrass and fringed sagewort. The site lacks the production that Sandy sites hold, and are higher in forbs, especially “pincushion” forbs. A distinct difference is the gravel lag that covers the soil surface on gravelly sites.
R032XY322WY	**Loamy (Ly) 10-14" East Precipitation Zone** Loamy sites will also be similar in production, but again response to management, disturbance and climatic shifts will vary. Loamy sites are generally found in the central or posterior edge of a landform such as alluvial fans, fan aprons, outwashes, and pediments.
R032XY328WY	**Lowland (LL) 10-14" East Precipitation Zone** 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, allowing the site to have Basin big sagebrush, Basin wildrye and other water demanding plants.
R032XY344WY	**Saline Upland (SU) 10-14" East Precipitation Zone** 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.

R032XY366WY	**Shallow Sandy (SwSy) 10-14" East Precipitation Zone** Shallow Sandy 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 will see bluebunch wheatgrass start to occur, but overall the site has a marked reduction in production and increased bare ground.

Similar sites

R032XY350WY	**Sandy (Sy) 10-14" East Precipitation Zone** This site was all-encompassing for the 10-14" precipitation zone in Wyoming following the removal of MLRA 46. Shifting lines to move only the frigid band of 10-14” precipitation to the foothills, and creating a mesic 10-14” band (D150) will narrow the concept for C150, and allow a frigid specific community.
R032XY250WY	**Sandy (Sy) 5-9” Wind River Basin Precipitation Zone** The Wind River Basin Core Site (5-9” precipitation, Mesic) was updated to C150, but is similar to the XY250 site. This site will be lower in productivity with a higher presence of bare ground in comparison to D150 (current site description). The species composition is very similar with only small shifts in forb species, and recovery ability.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata subsp. wyomingensis*
Herbaceous	(1) *Hesperostipa comata* (2) *Achnatherum hymenoides*

Legacy ID

R032XD150WY

Physiographic features

The Sandy ecological site generally occurs on slopes ranging from nearly level to moderately steep (0% to 30%). Fan remnants, hillsides/ridges, and alluvial fans are the major landforms where this site exists. The site also occurs on relict stream terraces, with minimal or no active soil deposition occurring. Large contiguous landforms within this landscape create a situation where one landform crosses climatic gradients. Variability in plant species can be observed across the climactic gradient.

The complexes of soil components mapped on these landforms are typically separated by depth to rock fragments in the soil profile or depth to bedrock (lithic or paralithic). Many of these landforms are erosional remnants and have soils ranging from shallow to very deep. 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. Higher infiltration rates associated with the Sandy ecological site result in leaching of salts, carbonates, and other chemistry to a depth that no longer influences this plant community. Therefore the sandy ecological site is common on both non-calcareous and calcareous sandstone because of the leaching. As you transition across the landform positions, soils will shift with the deposition of calcareous material or salt laden materials or with the overflow of chemistry laden runoff. With these transitions, the break between one ecological site and another (and the representative plant community for each) is often a broad and non-descript band between the two sites. This can make it difficult, when on the landscape, to clearly identify which site is dominant for a specific point along that transitional gradient.

Depth to water table occurs greater than 60 inches (150 cm) from the soil surface, meaning there is no indication of a water table within this depth at any point throughout the calendar year. This site is also characterized by no additional moisture capture from runoff.

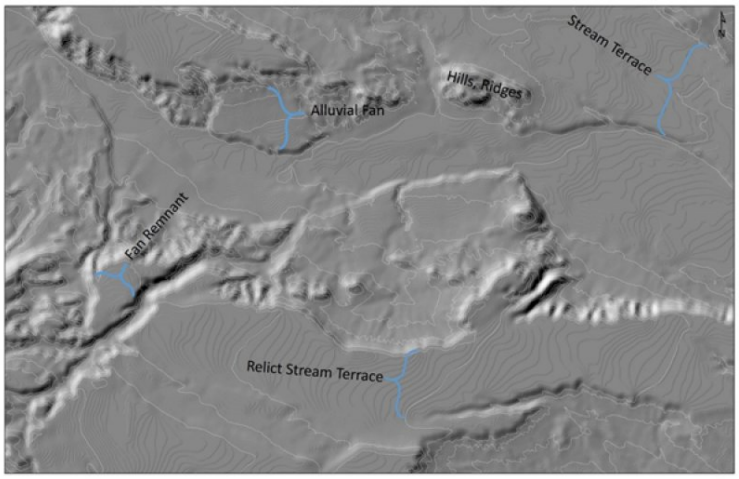


Figure 1. Aerial perspective using hill shade to show Sandy

Table 2. Representative physiographic features

Landforms	(1) Fan remnant (2) Hill (3) Alluvial fan
Elevation	1,530–1,960 m
Slope	0–30%
Ponding depth	0 cm
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 10 to 14 inches (254 – 356 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.

Average 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 30 year trend data for average temperature, as well as average precipitation, indicates there has been a warming trend. The last 12 years graphed; however, show temperatures have swayed high and low, but overall have maintained a steady trajectory, neither increasing nor decreasing. On the moisture side, the trajectory in trend has been a slow decline. The swings of when spring warm up and first frost hit, combined with the decline in average precipitation, have produced a drought effect where the moisture is not being received when the plants and soils are able to utilize the moisture. 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 have 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/. “Burris” and "Diversion Dam" are the representative weather stations within LRU D. 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)	86 days
Freeze-free period (average)	115 days
Precipitation total (average)	229 mm

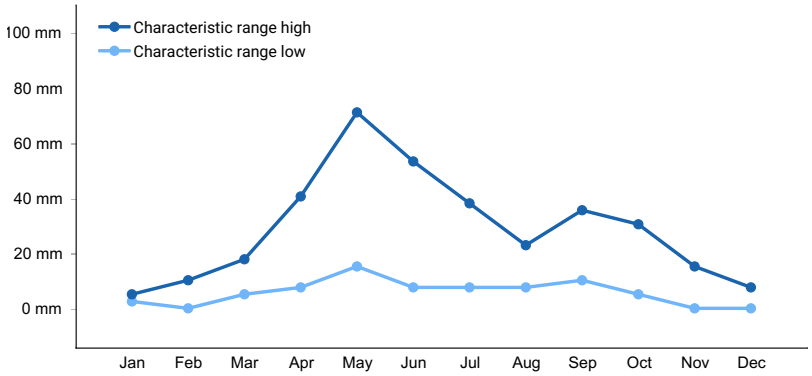


Figure 2. Monthly precipitation range

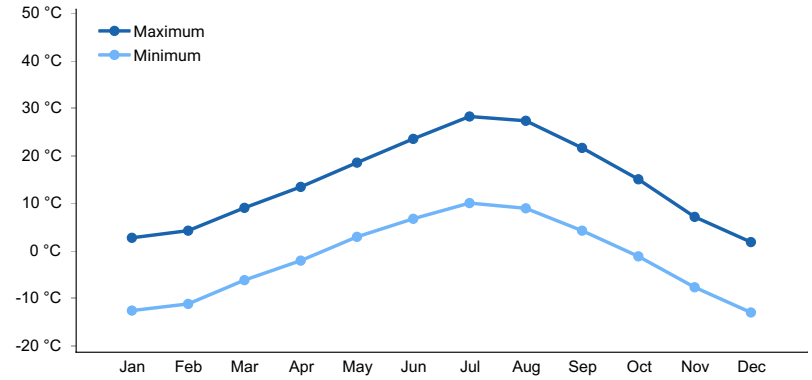


Figure 3. Monthly average minimum and maximum temperature

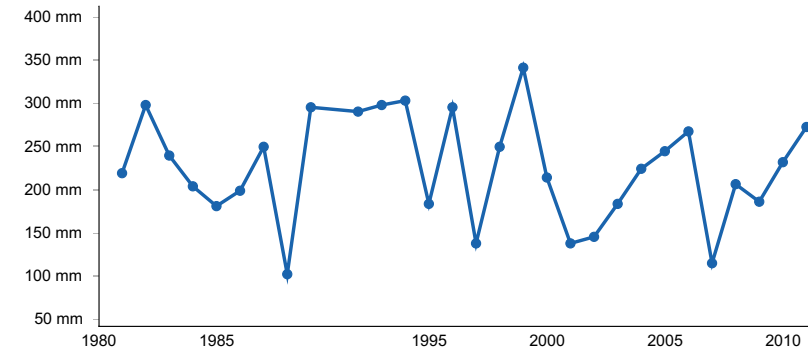


Figure 4. Annual precipitation pattern

Climate stations used

- (1) BURRIS [USC00481284], Crowheart, WY
- (2) DIVERSION DAM [USC00482595], Kinnear, 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 overflow is not a suitable fit. No streams are classified within this ecological site.

Soil features

The soils of this site are moderately deep to very deep (greater than 20 inches (51 cm) to bedrock), well to somewhat excessively well drained, and have moderate to rapid permeability. The soil characteristics having the most influence on the plant community is the permeability of the soil, which allows water to rapidly infiltrate into the soil profile and become available for plant use. The permeability also influences the soil chemistry by the leaching of salts, calcium carbonate, and other influencing chemistry out of the zone of plant influence.

The general soil profile has a loamy fine sand or sandy loam surface. The subsurface consists of loamy sand to sandy loam. These soils may have an alluvial layer (gravel or coarse sands) or interbedded sandstone and shale lower in the profile (below 20 inches (51 cm)). If the soil has an alluvial parent material, alluvial gravels can be present on the soil surface (20% or less) and throughout the soil profile of less than 35% by volume. For this ecological site, salts and calcium carbonate 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. Chemical characteristics for this site are listed below. Increases outside of the stated ranges of calcium carbonates or other soluble salts are potential transitions to a different ecological site.

Major soil series correlated to this site include: Bowbac, Hiland, Keeline, Terro, and Vonalee. This list of soil series is subject to change upon completion and correlation of the initial soil surveys: WY647; as well as revisions to completed soil surveys: WY613, WY713, WY625, and WY677.

Typical Pedon - VONALEE SERIES

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Ustic Haplargids. Vonalee fine sandy loam-on north facing hillslope of 6 percent, utilized as rangeland.

GEOGRAPHIC SETTING: Vonalee soils are on ridges, hills, alluvial fans, fan remnants and high terraces. Slopes are 0 to 30 percent. The soils formed in coarse and moderately coarse alluvium or eolian deposits derived largely from calcareous sandstone. Elevations are 3,500 to 6,500 feet. Precipitation ranges from 10 to 14 inches with over half of the annual precipitation falling in April, May, and June and less than one inch falling in each month of July, August, September, and October. The mean annual air temperature ranges from 44 to 49 degrees F. The frost-free season is about 105 to 130 days.

A--0 to 3 inches; yellowish brown (10YR 5/4) fine sandy loam, brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots throughout and common medium throughout; noneffervescent; neutral; clear smooth boundary. (2 to 6 inches thick).

Bt1--3 to 12 inches; yellowish brown (10YR 5/4) fine sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots throughout and common medium throughout; few distinct discontinuous dark brown (10YR 3/3) clay bridging between sand grains; noneffervescent; neutral; clear smooth boundary.

Bt2--12 to 24 inches; light yellowish brown (10YR 6/4) fine sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; few distinct discontinuous dark brown (10YR 3/3) clay bridging between sand grains; noneffervescent; slightly alkaline; clear smooth boundary. (Combine Bt horizons 6 to 26 inches thick).

Bk1--24 to 29 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; carbonates are disseminated throughout; slightly effervescent; slightly alkaline; clear smooth boundary.

Bk2--29 to 60 inches; very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; few fine irregular light gray (10YR 7/2) carbonate threads throughout; strongly effervescent; moderately

alkaline.

RANGE IN CHARACTERISTICS:
• Rock fragments typically are less than 5 percent but may range to 15 percent.
• Depth to continuous carbonate accumulation ranges from 11 to 40 inches, but the soils are typically calcareous above 30 inches.
• Depth to bedrock is greater than 60 inches.
• The soil is dry in the moisture control section more than half the time cumulative that the soil temperature at a depth of 20 inches is 41 degrees F.
• It is dry in all parts of the moisture control section for at least 60 consecutive days from July 15 to October 25 and for at least 90 cumulative days during this period.
• The mean annual soil temperature is 47 to 51 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F., or more for 175 to 192 days.
• Some pedons have a Bw or BA horizon. When present, they have hue of 7.5YR, 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4.
• Texture is sandy loam or fine sandy loam. Reaction is neutral or slightly alkaline.
• Organic staining on ped faces is common in some pedons.
• A horizon - hue of 7.5YR, 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Texture typically is loamy sand, loamy fine sand, sandy loam or fine sandy loam. Reaction is neutral or slightly alkaline.
• Bt horizon - hue of 7.5YR, 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Texture typically is sandy loam or fine sandy loam with 8 to 18 percent clay. Some pedons may have thin strata of loamy sand or loamy fine sand. Clay commonly occurs as bridges between sand grains and occasionally as films on faces of peds. Reaction is typically neutral or slightly alkaline but may be moderately alkaline when calcium carbonate occurs above 20 inches. Some pedons have a Btk horizon.
• Bk horizon (C horizon when present) - hue of 7.5YR, 10YR or 2.5Y, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. Reaction is slightly to strongly alkaline. Textures are loamy sand, loamy fine sand, fine sandy loam or sandy loam. Where eolian deposits overlie older surfaces, loam or sandy clay loam textures may occur below 40 inches.

TYPE LOCATION: Campbell County, Wyoming; about 600 feet east and 250 feet north of the southwest corner of Sec. 9, T 41 N, R 72 W.; USGS Turnercrest, SE, WY topographic quadrangle; lat. 43 degrees 2 minutes 2 seconds N. and long. 105 degrees 1 minutes 15 seconds W. Series established for the soil survey in Converse County, Wyoming, North Part; 1983.

Figure 6. Soils Profile Image.—

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone (2) Residuum–sandstone and shale
Surface texture	(1) Gravelly sandy loam (2) Loamy sand (3) Fine sandy loam

Family particle size	(1) Sandy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate to rapid
Soil depth	51–152 cm
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–15%
Available water capacity (0-101.6cm)	3.05–16 cm
Calcium carbonate equivalent (0-101.6cm)	0–4%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.2
Subsurface fragment volume <=3" (Depth not specified)	0–34%
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, winterfat, and a variety of forbs. The expected potential composition for this site is 75% grasses, 15% forbs, and 10% 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 blue grama, threadleaf sedge, prairie junegrass, and Wyoming big sagebrush will increase, and cool-season grasses such as needleandthread and Indian ricegrass will decrease in frequency and production. Continued pressure will allow plains pricklypear and weedy annuals to invade. Extended periods of drought and other climatic shifts have produced similar transitions in the vegetation.

Wyoming big sagebrush may increase expression in this ecosystem under limited use and lack of fire; however, the risk of sagebrush dominating the site is lower than on finer or heavier textured sites in response to the decreased moisture storage potential of the soils. 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, but extended drought will cause stress and decadence or death in sagebrush quicker than in finer/heavier textured soils.

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, and 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, 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 affects young sagebrush seedlings. New plants quickly stressed or grazed, reducing new establishment. Considering the extended periods of time required for natural re-establishment of sagebrush (beyond 25 years), natural recovery of sagebrush has a minimal feasibility as a management tool.

Encroachment of blue grama and threadleaf sedge occurs with a combination of disturbances (hoof action, defoliation, and compaction) or shift in climate (extended drought). Initial assumptions placed over utilization or improper management as the cause of this community shift. But the wide-spread occurrence with transitions occurring across management strategies, supports the concept of a portion of this shift occurring in relation to time/timing of precipitation, and other climatic changes that are occurring. Further discussion will follow.

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.

Studies support the need to revise the original sandy ecological site to narrow the concept. The depth to a skeletal or gravel layer is considered to occur within this new concept only if it occurs below 20 inches (50 cm.) Soils with a sandy cap over a pronounced argillic horizon (bulge in clay) and then decrease in clay content are excluded. And soils must remain below the 18% clay content throughout the top 20 inches (50 cm) of the soil profile. A correlation is observed with the amount of needleandthread and western wheatgrass with the fine-loamy and coarse-loamy particle size classes. Finer textured soils hold a higher ratio of western wheatgrass to needleandthread with Indian ricegrass; whereas coarser textured soils hold the opposite, with a higher ratio of needleandthread and Indian ricegrass to western wheatgrass. [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.]

The narrowing of the site characteristics to less than18% clay within the particle size control section has eliminated the fine-loamy and fine particle size classes from this concept. Communities will show variability to account for those soils that are on the margins of these breaks. The variability of the vegetative community is also related to the soil surface structure. Those soils with a platy surface structure appear to have slightly heavier texture with response to rain impact as well as vegetative responses. 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.

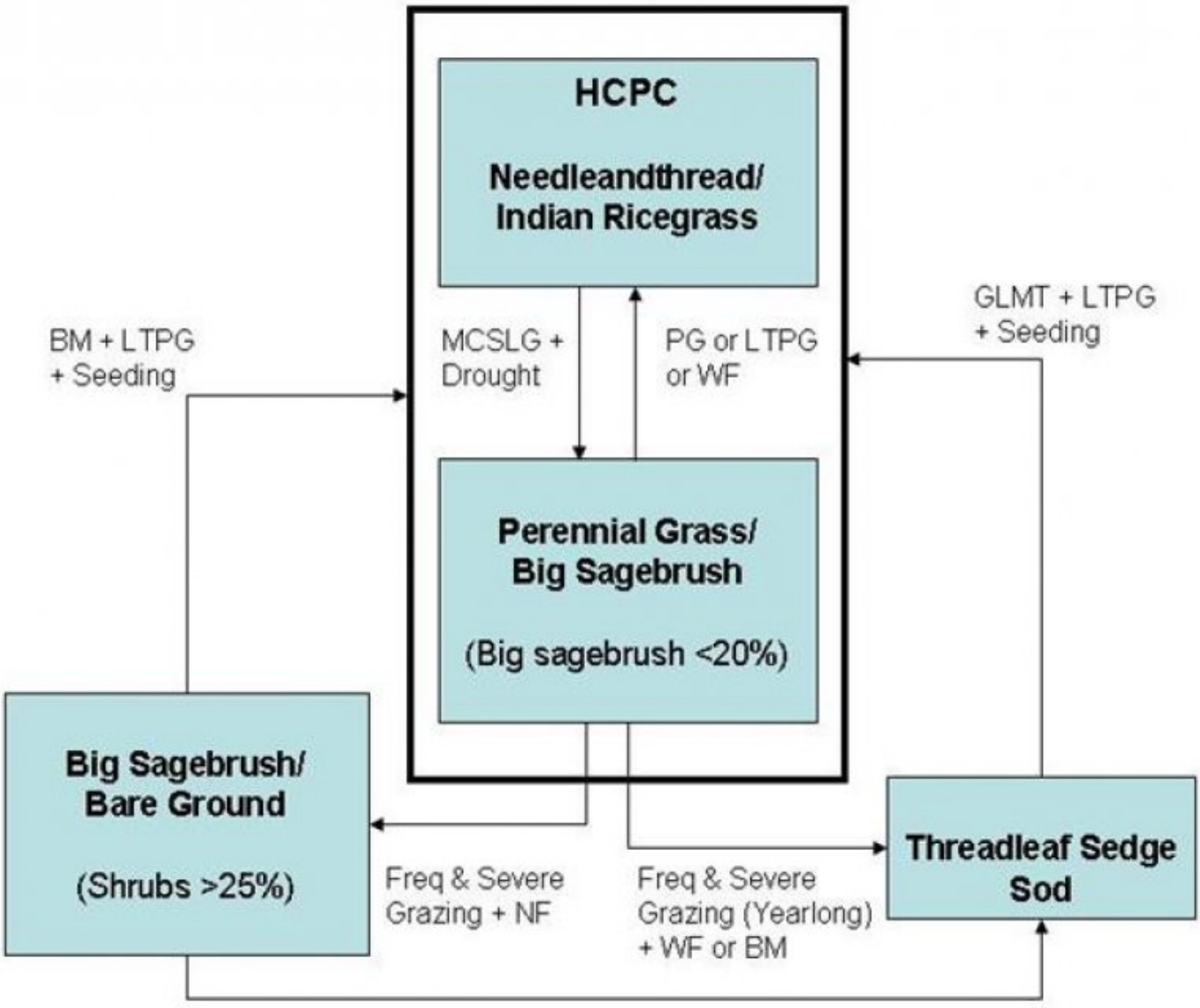
Transitions are represented by the arrows between states moving from a higher state to a lower state (State 1 -> State 2) and are denoted in the legend as a “T” (T1-2). They describe the variables or events that contribute directly to loss of state resilience and result in shifts between states. Restoration 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
Bunchgrass/Sagebrush

Bunchgrass/Sagebrush State (State 1 - Reference) is characterized by the following key species: 10% or less composition by cover of Wyoming big sagebrush, with Needleandthread (15-30% composition), Indian ricegrass, and isolated areas of western wheatgrass and prairie sandreed. Minor component to the overall composition is made up of prairie junegrass, bottlebrush squirreltail, prairie sandreed, sand dropseed, threeawns, blue grama, and threadleaf sedge. Bluebunch wheatgrass is highlighted as a key species in the historic range site documentation, but is not found to be prevalent within the Wind River Basin.

Community 1.1
Needleandthread/ Indian Ricegrass

Figure 7. Community 1.1 – Reference Site with Needleandthrea

This community (1.1) is captured as the reference plant community; however, it 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 state evolved with grazing by large herbivores. The potential vegetation is about 70% grasses or grass-like plants, 20% forbs, and 10% woody plants. Dominant grasses include needleandthread, Indian ricegrass, and western wheatgrass. Grasses and grass-like species of secondary importance include prairie junegrass, prairie sandreed, Sandberg bluegrass, blue grama, and threadleaf sedge. A variety of forbs are found in this community including fleabanes, wildparsley, lemon scurfpea, and scarlet gaura. Wyoming big sagebrush, fringed sagewort, and winterfat are conspicuous components of the community, and can make up to 10% 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 510 lbs./acre, but it can range from about 375 lbs./acre in unfavorable years to about 680 lbs./acre in above average years. 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 with grazing pressure by large ungulates (elk, bison, deer, and antelope); as well as 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). 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 Indian ricegrass), mid-rhizomatous species (western wheatgrass and thickspike wheatgrass) and the short-bunchgrasses (prairie junegrass, Sandberg bluegrass, and threeawns) 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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	364	448	532
Shrub/Vine	50	84	140
Forb	6	45	90
Total	**420**	**577**	**762**

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	0-2%
Litter	5-20%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	20-35%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-5%	1-5%
>0.15 <= 0.3	–	1-15%	1-15%	1-5%
>0.3 <= 0.6	–	1-10%	1-10%	–
>0.6 <= 1.4	–	–	0-5%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

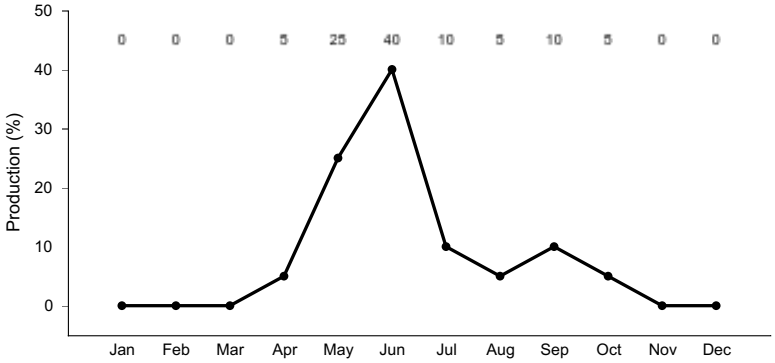


Figure 9. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 1.2
Perennial Native Grasses/Sagebrush

Figure 10. Reference Community 1.2 - Sandy 10-14" Mesic site

The secondary community phase (1.2) of the Reference State 1, is similar with slight shift in the percent of species composition and function. The community can be found on areas that are within the scope of historic disturbances but have been impacted by a shift in climate or management to an extent to that the system is out of balance, impacting the plant community and production potential. The vegetation composition is 65% grasses or grass-like plants, 10% forbs, and 25% woody plants. This state is dominated by cool season mid-stature grasses. The major understory of grasses and grass-like plants includes needleandthread, prairie junegrass, rhizomatous wheatgrasses, threadleaf sedge, blue grama, and Sandberg bluegrass. The variety of forbs and half-shrubs commonly found include scarlet globemallow, lemon scurfpea, scarlet gaura, and spiny phlox. Wyoming big sagebrush can make up 25% of the annual production. The overstory of Wyoming big sagebrush and understory of grasses and forbs provide a diverse plant community. Threadleaf sedge and blue grama have increased within this community, as has Wyoming big sagebrush and yucca when present; however, they are not the most prevalent species, but they have an impact on moving/changing the hydrology of the site. Plains pricklypear 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 pricklypear; needleandthread and winterfat have remained as a common component in this community. The total annual production (air-dry weight) of this community is about 525 lbs./acre, but it can range from about 375 lbs./acre in unfavorable years to about 700 lbs./acre in above average years. Rangeland Health Implications/Indicators: This plant community is resistant to change. The herbaceous cover is intact, and plant vigor and replacement capabilities are sufficient to maintain during periods of moderate grazing pressure with recovery periods; however, species composition can be altered through long-term overgrazing or increased intensity of defoliation. The overall canopy is adequate, but the shift in structure of cover and increase in bare ground opens niches for weedy species as well as slightly reduces the infiltration of snow melt (loss to evaporation). Although minor, this altered arid nature relates to the lack of taller structure, increase in bare ground, shallower rooted species, and woody cover. Bare ground averages 25 to 35%, woody cover has increased to an average of 10 to 25% cover. Litter overall appears to be similar across this state (State 1), similarly the biological crust cover does not vary. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal, and soils are mostly stable with only

minimum evidence of soil loss. The watershed is functioning and the biotic community is intact.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	359	409	448
Shrub/Vine	56	129	235
Forb	6	50	101
Total	**421**	**588**	**784**

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 (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-15%	1-5%
>0.15 <= 0.3	–	1-15%	1-15%	1-5%
>0.3 <= 0.6	–	1-10%	1-5%	–
>0.6 <= 1.4	–	–	0-5%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

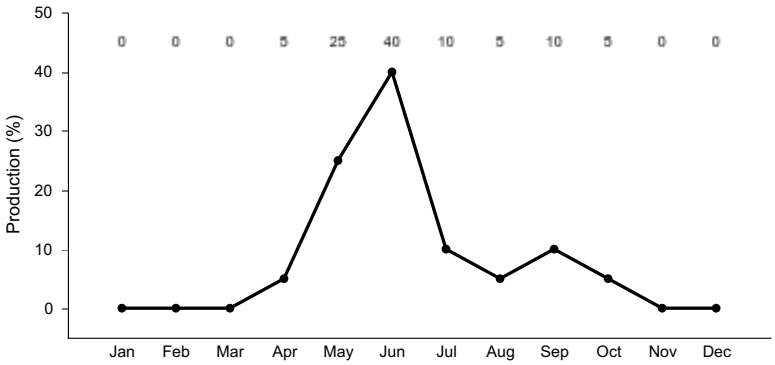
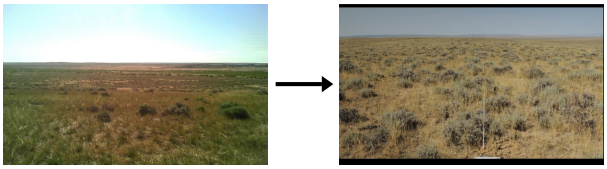


Figure 12. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Pathway CP 1.1-1.2
Community 1.1 to 1.2

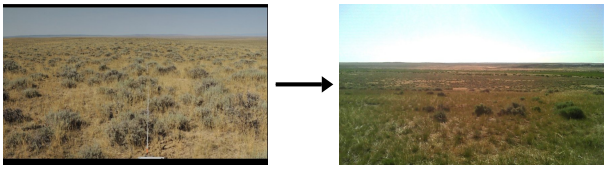


Needleandthread/ Indian Ricegrass

Perennial Native Grasses/Sagebrush

Timing of grazing, Drought, Climatic shifts – Although the full understanding of the increase in blue grama in this system is not fully understood, inferences can be made on part of the drivers for this shift. Historically, the large expanses of federal lands were used during the summer exclusively or were utilized in the spring and then again in fall as sheep were trailed to forest allotments and then home again. The repetitive timing of use would have slowly removed more desirable species from the system, encouraging the low growing grasses. Long periods of drought and shifts in spring precipitation patterns have weakened and impacted the productivity and vigor of most species, and has encouraged the low growing cool season grass-like and warm season grass species – threadleaf sedge and blue grama. 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 this plant community. The shift in this community is marked by the decline of Indian ricegrass, with an increase in prairie junegrass, threadleaf sedge and blue grama. Changes in herbivory pressure by sheep and wildlife in the area have allowed Wyoming big sagebrush to become increasingly woody and decadent. Although this has created a slight perception of increased woody canopy, the community is still dominated by cool-season perennial grasses. Overall, a stronger presence of short-stature grasses and grass-likes (Blue grama – warm season; Threadleaf sedge – cool season) has increased across the entire basin, but has remained as a secondary component in these reference communities.

Pathway CP 1.2-1.2
Community 1.2 to 1.1



Perennial Native Grasses/Sagebrush

Needleandthread/ Indian Ricegrass

Long-term Prescribed Grazing, Brush Management - Integration of a rotational grazing system or rest-rotation, and with management to reduce or improve quality of the shrub canopy, will encourage the native bunchgrasses to re-establish in this community. An extended period of time (estimated at 5 to 10 years) may pass before significant change is noticed. 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/ or incorporate seed to allow the desired bunchgrasses (needleandthread, Indian ricegrass) and western wheatgrass, prairie junegrass, and prairie sandreed to re-establish 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, reducing runoff. A long-term management strategy may be required before any trend towards reference is noticed. The overstory of Wyoming big sagebrush may be the one factor that could require further manipulation to reduce canopy and composition to the desired 10% cover.

Conservation practices

Prescribed Burning
Range Planting
Heavy Use Area Protection

Spring Development
Integrated Pest Management (IPM)
Watering Facility
Water Well
Upland Wildlife Habitat Management
Prescribed Grazing
Invasive Plant Species Control

State 2
Sagebrush/Bare Ground

Extended periods of drought across much of the Wind River Basin (as well as most of Wyoming) has taken a toll on many communities. Persistence of drought and/or frequent over use of the grasses leads to a decline of the herbaceous species, creating the Wyoming Big Sagebrush and *Bare Ground* state. Wyoming big sagebrush creates a zone of protection for herbaceous understory to persist and maintain vigor in difficult conditions, providing shade, moisture reserves, and protection from herbivory. This state can be exacerbated by insects and other human disturbances. The total woody canopy cover does not necessarily increase with this community, but the percent composition by cover and production is influenced by the decrease of herbaceous vegetation and the relative stability of the woody species production, creating the appearance of increased canopy cover of sagebrush. Risk of wildfire 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 specific weather conditions. Depending on the prescription of use, trailing and other erosional patterns are highly visible in this state. The loose or coarser texture of these soils allows for increased wind scour and drifting/mounding to occur with more open ground between canopy “patches”, that further hinders fire movement. 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. The loss of herbaceous cover leads to increased bare ground and sagebrush cover. As the site continues to weaken, the sagebrush cover is susceptible to attack by insects, disease, and old age; which can remove it from the system increasing the risk of invasion or transition to a more degraded state. The level of variability of species in this state (State 2) remains abundant, however, only one well defined community will be provided, with discussion of transitions or variances from this community. The overall arid nature of coarse textured soils exacerbates the impact of drought and reduces the resilience and resistance of this site during extended dry periods. Yucca’s presence on this site is not frequent, but when it does occur, it can easily become a concern, especially if grazed in the winter frequently. Its growth habits produce pedestalling and drift/scour patterns on the landscape.

Community 2.1
Wyoming Big Sagebrush/Bare Ground

Figure 13. Sagebrush Dominated Community with minimal coverag

This plant community is the result of the degradation of the herbaceous understory and subsequent dominance of

Wyoming big sagebrush. Annual production of sagebrush exceeds 25% of the total annual production, and is a significant component of the plant community by cover. Remnant populations of the mid-stature cool-season grasses exist but have been greatly reduced. In response to the coarser textured soils, Yucca may be a component of this community. The dominant grasses and grass-likes are needleandthread, Sandberg bluegrass, threadleaf sedge and blue grama. Patches of plains pricklypear cactus are more noticeable on the landscape. 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 production is similar, as the shrub production compensates for the decline in the herbaceous production. Although this is the only noted community phase within this state, it is determined to be “At Risk” due to its vulnerability to invasive weeds such as cheatgrass, Russian knapweed, or leafy spurge, if a seed source is available. The total annual production (air-dry weight) of this state averages 475 pounds per acre, but it can range from 310 lbs./acre in unfavorable years to 700 lbs./acre in above average years. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand 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 grasses. Plant litter is noticeably less when compared to the Reference Plant Community. 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 (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	252	308	364
Shrub/Vine	84	168	280
Forb	11	56	140
Total	**347**	**532**	**784**

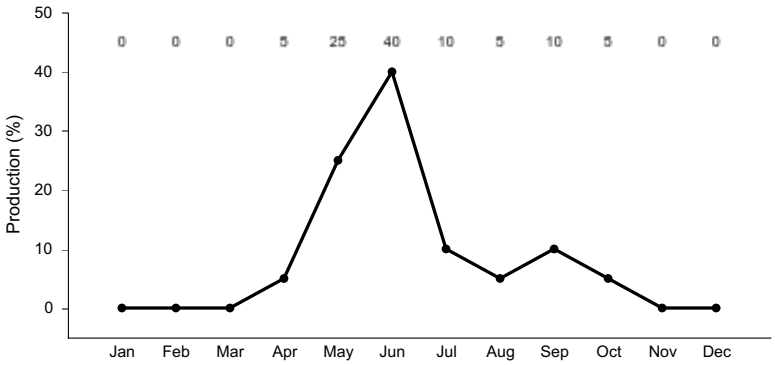


Figure 15. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

State 3
Sod-formers

Blue grama and threadleaf sedge are the dominant sod-forming grasses/grass-likes that currently exist within this LRU. Both species are a native component of the reference community. The general tendency is for these species to increase with prolonged drought or under grazing pressure, becoming dominant. As the dominant species, they alter the hydrology of the site by increasing the surface runoff from the dense shallow root system that inhibits the movement of water through and funnels surface flow around the edge of the “clump”, concentrating flow into channel like patterns, creating a drier environment for native grass species and forbs to persist.

Community 3.1
Sod/Sagebrush

Figure 16. Blue grama with Sagebrush

The loss of mid and low-stature cool-season bunchgrasses and the persistence of sagebrush are the major characteristics of this sod dominated community. The low, mat-forming grass and grass-like species respond and fill the voids in this plant community due to continuous season-long grazing, recurrent over utilization, or prolonged drought. The effect of blue grama and threadleaf sedge, with their short stature and dense root structure, is a decrease of water infiltration which increases channelization of runoff between vegetation patches. This effect coupled with the lack of structure to hold moisture, and further compounded by drought will continue to reduce the shrub component. A dense sod of interspersed patches of blue grama and threadleaf sedge is the major component of this community. Incidental occurrences of other perennial natives occur generally within the sagebrush canopy or the protective ring of the plains pricklypear cactus clumps. Overall, Wyoming big sagebrush has been reduced in vigor and abundance across this community phase, but it still persists (average density of 5-10% canopy cover). When compared to the Reference Plant Communities 1.1 and 1.2, blue grama has increased significantly, making up 30 to 60% of the canopy. Plains pricklypear cactus is prevelant on the site, and other mid-stature cool-season grasses, perennial forbs, and most shrubs have been greatly reduced. Production has significantly decreased and bare ground may not vary or will increase (longer extents of bare ground between densely vegetated areas). The total annual production (air-dry weight) of this state is about 250 lbs./acre, but it can range from about 125 lbs./acre in unfavorable years to about 425 lbs./acre in above average years. The higher productivity is generally in response to Wyoming big sagebrush; however, rubber rabbitbrush and other woody species may be present as well, influencing overall production. 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; so, continued frequent and severe grazing, or the removal of grazing does not seem to have any further affect on 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 mid-stature cool-season bunchgrasses. This sod-bound plant community hinders water infiltration. While the sod protects the rooted area, edge 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 prominent 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 improve with intensive management requiring mechanical manipulation. However, 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 grasses, leaves these two communities (3.1 and 3.2) as similar communities with only one marked shift – the presence of sagebrush in the community. Drought stress on these sod species can cause the plant to die back; and during extended periods of drought, large areas of blue grama will die leaving an area sensitive to hoof action. When the blue grama plant dies, it tends to die from the center out, but will remain intact until disturbed (trampling, vehicle traffic, ground disturbances). Once disturbed, the plants quickly degrade leaving the surface vulnerable to erosion. This vulnerability opens a potential for native species, as well as invasive species, to gain a “toe-hold” in the community.

Table 12. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	196	308
Shrub/Vine	22	56	112
Forb	6	28	56
Total	**140**	**280**	**476**

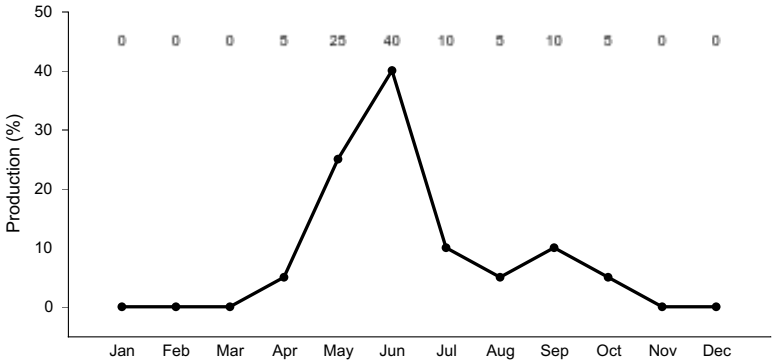


Figure 18. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 3.2
Sod/Cactus

Figure 19. Blue grama Community with Cactus.

The phase step from Sod/Sagebrush community phase (3.1) to the Sod/Cactus community phase (3.2) is a change in composition from an overstory of Wyoming big sagebrush to an understory of plains pricklypear cactus. The loss of sagebrush is the driving factor. The dense sod of blue grama with threadleaf sedge intermixed, is dominant with increasing plains pricklypear 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 removed from the community with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but may persist. When compared to the Reference State (1.1 and 1.2), blue grama and plains pricklypear cactus have increased. All cool-season mid-stature grasses, forbs, and most shrubs have been greatly reduced or replaced. Production has been significantly decreased. The dense and frequent clumps of cactus provides a niche for small, remnant populations of the mid-stature cool-season grasses to persist in the community. The ability for low stature sod-formers to respond to amount and timing of precipitation is not as significant as other mid-stature cool season grasses, such as needleandthread and Sandberg bluegrass; however, there is still a marked swing in average production between wet and dry years. The production of seedheads and tillars is a more prominent response for these short stature grasses. Production is provided as an average or mean, and is not intended to cover the full range of production potential for this community. The resilience and resistance capacity of this community is high because of the low stature grasses and cactus's ability to tolerate high levels of use and ability to maintain as other native species are depleted, including Wyoming big sagebrush. Extended periods of drought have proven to be

detrimental to the health and vigor of blue grama stands across the area; however, there has been no documentation to show what species may recover in this damaged community. Studies and further observation needs to be documented to determine what the recovery potential id for a sod-bound community following significant drought die-off. Total average annual production is 275 lbs./acre, but it can range from 125 lbs./acre in unfavorable years to 450 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 mid-stature cool-season grasses and the loss of height and structure (woody component for shade/snow catch). Shallow, tight root mats of both blue grama and threadleaf sedge reduce infiltration and increase runoff that affects off-site areas with excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in the bare ground interspaces 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. The added competition and rooting nature of cactus produces a threat of invasion of cactus. Although not documented in this LRU at this time, it has been noted in other areas of Wyoming, that plains pricklypear cactus can form in dense patches that inhibit animal movement through the area preventing the use for grazing and hindering wildlife movement and use as well. Surface disturbance (hoof action, large equipment (vehicular/tractors), or other human impacts) can initially reduce the density of cactus, but the risk of re-rooting of the disturbed pads, may cause a rapid increase in density across an area of impact.

Table 13. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	196	308
Forb	28	84	140
Shrub/Vine	–	28	56
Total	**140**	**308**	**504**

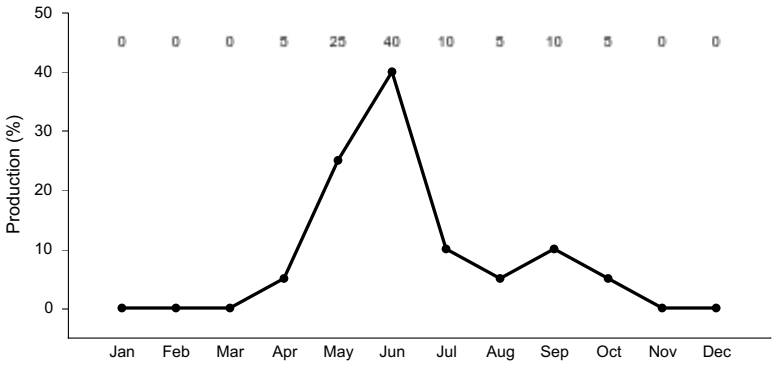
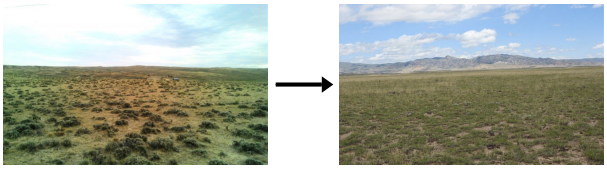


Figure 21. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Pathway CP 3.1-3.2
Community 3.1 to 3.2



Sod/Sagebrush **Sod/Cactus**

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 of many native grasses and shrubs. 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. Once sagebrush is removed from this community by intense grazing pressure, drought and insect damage or by fire (rare), sagebrush is replaced in dominance by plains pricklypear cactus, and the community will phase into a sod/cactus community. In some cases, rubber

rabbitbrush will persist or increase slightly on a site as sagebrush diminishes.

State 4
Invaded

Cheatgrass or downy brome (*Bromus tectorum*) has quickly become the greatest threat to much of the rangelands across the west, including Wyoming. This annual 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. Cheatgrass's ability to persist through the winter under a blanket of snow and grow early allow it to take advantage of early spring precipitation and snowmelt (winter annual). 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 most prevalent large scale threat for rangeland managers, a variety of thistles and knapweeds, in combination with other aggressive invaders such as whitetop (hoary cress), black henbane, field bindweed, and leafy spurge are increasing in density and frequency, producing their own set of challenging management issues. As more species are found 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 (not necessarily the dominance) of invasive/non-native species. Extended periods of drought alone or in combination with over utilization, 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/Invasives/Sagebrush

Figure 22. Native and Invasive species within the Sagebrush

The Perennial Grasses/Invasive Species/Wyoming big sagebrush community phase has maintained a representative composition 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 the invader can be maintained at 5 to 10% composition, the probability of the community persisting and possibly improving remains. However, extent of improvement is limited, and the cost and labor required limit the economic feasibility. Further degradation of this site increases the cost and decreases the feasibility of restoring a desired community, which makes this community phase, the "At-Risk" community. This community phase (4.1) is characterized by a significant composition of invasive species (5% or greater) on the landscape. These invasive species have a wider scale of distribution; rather than one isolated patch in an isolated portion of the landscape. The litter or duff layer, specifically associated with cheatgrass, is significantly higher than the native community; which 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 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 as fine fuels increase with the added biomass and litter produced by the invaders. Plant diversity is moderate for this phase, with the perennial grasses, forbs, and shrub components are still present, sustaining the diversity of the community. The plant vigor is reduced and replacement capabilities are limited due to the 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 minimal, but will vary with species; as is the 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.

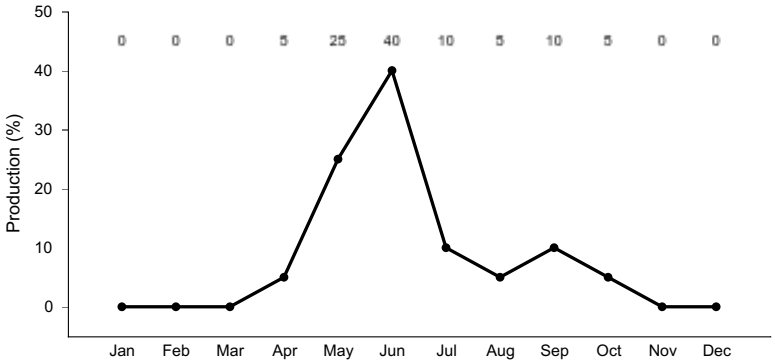


Figure 23. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 4.2
Invasives/Sagebrush

As the native populations of perennial grasses and forbs are lost through over-use or disturbance, the site becomes invader driven. Wyoming big sagebrush is able to compete and maintain a footprint in this community, even 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. The fine fuels or biomass produced by cheatgrass and other invasive species raises a significant threat of fire and increases the potential for fire to occur, and the possible intensity of the fire. 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, at this phase, is to reduce the fire risk, maintain the existing Wyoming big sagebrush and native perennial grass species. This will maintain the minimal 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 to becoming an invader only community. These areas are prone to fire as fine fuels are more available; however, the bare ground between sagebrush plants has decreased with increased biomass of 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. Soil erosion is species dependent and associated litter accumulations. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that persist within the community.

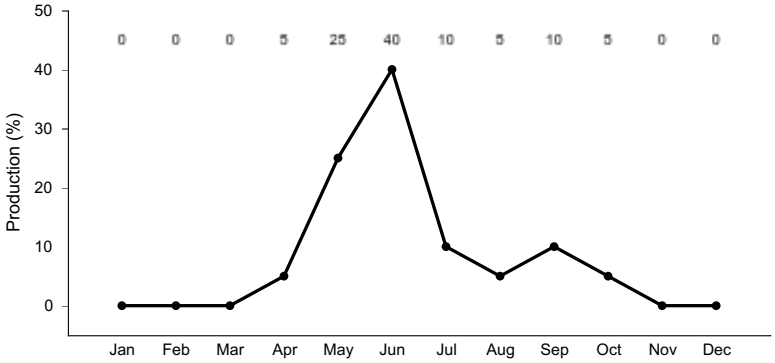


Figure 24. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 4.3
Invasives (Annual Grasses)

Cheatgrass's ability to grow quickly utilizing minimal available resources and 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 grass. 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. The absence of sagebrush, limits the protection for native species and hinders their ability to persist. Plains pricklypear cactus provides a niche for natives to thrive to a lesser extent. Variability in spring storms and temperature shifts, offers an opportunity for native grasses to express their resiliency, but they are not able to "compete" the invaders in the long term, without assistance from integrated pest management. 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 that have been observed in aerial treatment trials. 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 increased fire frequency/interval, prevents sagebrush and other woody species from establishing on the site, and has negative impacts on many of the native herbaceous species in the understory, through further depletion of soil nutrients. The grazing potential is limited due to the unpalatable nature of mature plants (chaff, prominent awns, no forage value). 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 structure and 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.

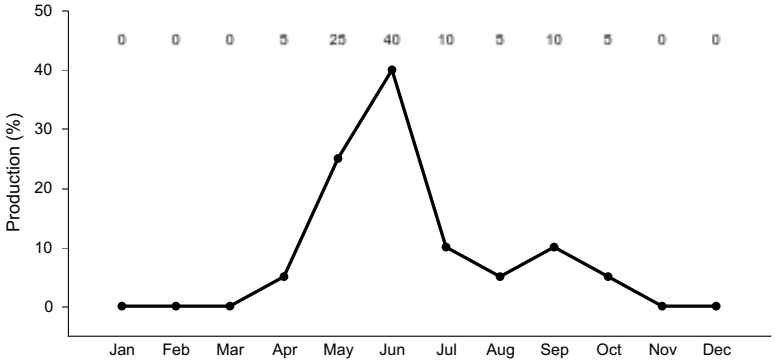


Figure 25. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Pathway CP 4.1-4.2
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 dominate. 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 CP 4.1-4.3
Community 4.1 to 4.3

Frequent or Severe Grazing, Wildfire, Drought - The loss of the sagebrush brush canopy due to fire, drought, or herbivory, opens the potential for extensive invasion by weedy species especially cheatgrass following a fire. Continued over utilization by large herbivores or continued drought will further stress the native grasses leaving no barrier against invasive species.

Pathway CP 4.2-4.1
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, and 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 Community 4.3 – Invaders (Annuals).

Conservation practices

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
Water Well
Early Successional Habitat Development/Management
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control

Pathway CP 4.2-4.3
Community 4.2 to 4.3

Catastrophic Disturbance - The loss of the sagebrush and native grass canopy due to intense fire, land clearing, or

similar event, opens the potential for a significant invasion by weedy species especially cheatgrass following a fire. In many cases it has been seen that the native species appear non-existent on the landscape. But after further evaluation, generally small remnants can be found under the canopy of cheatgrass or knapweeds, etc. Further disturbance or with the lack of control, the native species will remain hidden and may, over time, weaken and be removed completely from the community. The ability for this community to revert back to a less degraded community within this state is not feasible without implementation of an integrated pest management plan.

State 5
Altered

Lack of season long, dependable water sources for irrigation has limited the cultivation use of this landscape. Isolated areas along the lower edge of the rim may have limited access for irrigation, but the larger land use (excluding livestock) is energy development and wildlife/recreation. The broken nature of the rim provides more topographic relief for movement of wild game, yet access is still easy to moderate for wheeled traffic. Although the disturbance footprints within this LRU are smaller scale, old homestead locations, abandoned crop fields, and energy development has left their mark. Disturbance to these highly erodible soils (whether it was mechanical, cultural, or natural), changes soil structure, hydrologic function, and possibly stability. The loss of resilience or resistance to support native vegetation or the ability to respond to management the same as an undisturbed site, occurs as these factors are changed (structure, hydrology, stability). 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. This state can be achieved with one disturbance of any state or community within the State and Transition Model or diagram. Once the site has experienced an event that has altered the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered. The soils have not been altered to the extent that they are outside the site characteristics, but the potential has shifted enough that it is no longer truly comparable to the reference state. Location or site specific investigation may need to occur to determine if a disturbed/reclaimed area still meets site characteristics. To illustrate this concept, visualize an area that was impacted by drought removing the native grasses leaving a dense and decadent stand of Wyoming big sagebrush. A few weak (low vigor) needleandthread and blue grama plants persist within the crown of the sagebrush, but are not able to repopulate the area in a reasonable time. The landowner decides to seed the site using a small rototiller behind a tractor to prepare small areas within the sagebrush to broadcast a native seed mix. He then hand-raked the seed and used a roller barrel to compact the seedbed. The species selection he used was an assortment of native grass seed collected from neighboring sites. The tillage was minimal, but broke up the structure of the soil, mixing the loose surface with the blocky and slightly heavier subsurface. The change is reflected in the available water capacity of the soil, increasing infiltration slightly, but creating a limitation in permeability with the “plow pan”. The exposure to air, dries the mixed zone rapidly, wicking salts and carbonates to the surface that were otherwise not prevalent in the soil. The site is prone to erosion during the establishment period, and experiences soil movement. The time required to allow the re-development of structure and the cryptogrammic crust, as well as any impact to chemistry, is beyond the natural function of management. The initial flush of vegetation is kochia and Russian thistle and mustards, a successional plant community. So the site begins its own recovery, but the time required to return to the original conditions (pre-disturbance) is outside of feasible consideration. The site, however, may become similar in composition to reference, but the integrity of the soil is altered, changing potential of the site.

Community 5.1
Disturbed/Degraded

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. (non-native species vary from natives/improved varieties, but either may resemble the early successional community.) For an accurate growth curve, a site specific species inventory and documentation of the climatic tendencies should be collected. Rangeland Health Implications/Indicators: This plant community is variable and depending on the age of the stand and the stage of

successional tendencies of the location determines 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 some diversity, but has minimal structural cover for 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 hydrologic process and general cover 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).

Community 5.2
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 exist as a monoculture, until age or further weakening occurs creating a niche for native species to establish. Crested wheatgrass is creeping out into native communities, and native species are moving into the crested wheatgrass stands, or are recovering under the wheatgrass canopy. Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses are used in mixes to help increase establishment on these sites. Although success for vegetative seeding is low to moderate in this LRU, due to the variable amounts and timing of precipitation, 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 non-native species, allowing for a similar ecological response. Although native species are used in reclamation, these plantings will not replicate but may be similar to the reference community response to management due to the change in soil dynamics with mechanical disturbance (seedbed preparation and seeding). 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 determine the resistance to change and resilience against invasive species and 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 practices).

Pathway CP 5.1-5.2
Community 5.1 to 5.2

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing – The erosive nature of this site once the soil is disturbed increases the need to stabilize the site, but selectivity needs to be used in determining the best practice or method for improvement. Species selection is key, and may require a cover crop initially and then direct seeding to allow establishment of grasses within the residue of the cover crop. The arid nature of this site will create its own challenge with the lack of moisture and narrow window for seeding. The general nature of native seeds common for these sites are difficult to drill. Mulching or wind stops may be required to prevent loss of seed to wind.

Conservation practices

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
Water Well
Upland Wildlife Habitat Management
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control

Pathway CP 5.2-5.1
Community 5.2 to 5.1

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 recording the range trend over time helps 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 T 1-2
State 1 to 2

Frequent and Severe Grazing (Year-long) or Drought with the absence of Brush Management or Wildfire - Frequent or high intensity herbivory weakens the ability for the grasses to persist, especially during prolonged drought. With the weakened herbaceous cover and with prevention or lack of fire, the composition will shift to predominantly Wyoming big sagebrush. Over extended periods of time, the sagebrush canopy will increase in density 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 is captured with fluctuating precipitation patterns affecting production of prominent plants within this system. The loss of species diversity and increased bare ground with lack of litter are the indicators that a true transition has occurred. It is important to recognize that the number of actual sagebrush plants may not increase to cause this shift. Rather the loss of herbaceous composition and increase in the canopy cover of woody species is the larger factor (creates the illusion of increased number of plants when it is the size and age that is more likely to change).

Transition T 1-3
State 1 to 3

Frequent Grazing (Yearlong), Brush Management or Fire with Drought – Severe and frequent grazing (by livestock or any other large ungulates) reduces vigor and presence of key species. As needleandthread and Indian ricegrass begin to decline, shorter statured grasses become dominant. Animal disturbance (hoof impact) caused with long duration, high intensity herbivory reduces the bunchgrass component by allowing repeated defoliation of the desirable species, reducing recovery potential and ground cover for insulation and snow catch, as well as physical damage to the crown and growth points of the plants; weakening and over time removing select species. The open canopy and hoof impact encourages species that are tolerant to trampling and that can utilize the small bursts of spring and 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 short stature grasses 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 community. When the sagebrush component of this community has been degraded or removed, by drought or heavy use, the transition has a high probability of occurrence on the landscape. Season of use and intensity of grazing (time and timing) is a trigger that can reduce the risk of transitioning, or if done poorly can force the transition to occur rapidly. The reference state (1.1 and 1.2) is dominated by cool season species. Provided the area receives good spring moisture, growth and maturity of these plants can happen quickly within the first two weeks of June, while blue grama is just beginning. By alternating when the community is grazed, providing periods of rest during the critical initial green-up and growth in the spring, and allowing recovery time before the community is grazed again within the year, allows the bunchgrasses and rhizomatous grasses to maintain vigor and production. This also allows for summer use when the warm season grasses are growing (blue grama) which will help to utilize this species and maintain a low cover.

Restoration pathway R 2-1
State 2 to 1

Prescribed Grazing with Brush Management or Wildfire - Treatment to thin or rejuvenate the sagebrush canopy is needed to allow and encourage native perennial grasses 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 current 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 grass 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. Climate and treatment conditions during and following a fire has a larger impact on the community. It is crucial to investigate the immediate and surrounding areas of a treatment site to ensure no invasive species (cheatgrass) are present.

Conservation practices

Brush Management
Prescribed Burning
Fence
Livestock Pipeline
Spring Development
Integrated Pest Management (IPM)
Watering Facility
Water Well
Upland Wildlife Habitat Management
Prescribed Grazing
Invasive Plant Species Control

Transition T 2-3
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 dominant. This decline creates a sagebrush/sod community that is resistant to change by grazing management. Impacts to sagebrush by disease or insect damage, as well as drought or herbivory, will shift this community to the secondary community phase with cactus as a subdominant cover with blue grama/threadleaf sedge. Extended periods of drought in combination with a change in the amount and timing of precipitation and spring snowmelt has allowed the warm season grass, blue grama, to out-compete other cool season natives such as needleandthread. Climate change is widely debated and speculated; however, the documented shifts in climatic curves, as well as large scale transitions to this community under different management scenarios, highlights climate as a key player – not just

use and management. Further research is needed to identify the factor for each site specific transition.

Transition T 2-4
State 2 to 4

Fire (wild/prescribed), 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 by a disturbance (fire, drought, disease/insect damage to sagebrush, or ground/soil disturbance including impacts by grazing large herbivores or recreational activities) that opens the canopy and breaks the surface of the soil, creates a niche for invasion by undesirable weeds. Invasions start with one or two isolated plants, that if caught can be treated and an infestation avoided; however, when unseen or ignored, the population grows exponentially with time. In some cases once the invasive species are established, they can create their own habitat; reducing the ability for native species to compete for the limited resources. The open canopy of the Sagebrush/*Bare Ground* state is vulnerable to invasive species without further influence. With continued over-use, drought, or insect damage/disease, 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 native grasses, allowing them to persist.

Transition T 3-4
State 3 to 4

Frequent and Severe Grazing, Drought, Disturbance with a seed source present - The chance of wildfire is minimal with the lack of fine fuels and reduced sagebrush canopy leading to the assumption this community/state is safe from invasion. The increased interspatial pattern of these communities leaves exposed soil that is vulnerable to invasion by undesirable species. Increased pressure from over use and drought work to weaken the sod or mat-like community of low stature grasses, opening more surface to 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, the extent of spread is limited, but it is still extremely difficult to manage and eradication is not feasible. Once the invasive species have become prevalent on the landscape (>5% composition), the community crosses the threshold into the Invaded/Sagebrush State (State 4).

Restoration pathway R 4-5
State 4 to 5

Integrated Pest Management, with Seeding - Integrated pest management and intense weed control after and if possible before seedbed preparation will be necessary to overcome a severe weed infestation. Seedbed preparations of the target area 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. The limited success and difficulties in re-establishing sagebrush also limit the site potential. Due to the need to till/turn the soil for seedbed preparation 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 treatment area, prevents the soils from reacting the same to management and environmental changes as an undisturbed/native community and so remains in a reclaimed or altered state (State 5).

Conservation practices

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
Water Well
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control

Transition T 5-4
State 5 to 4

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 over utilization by 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 stand, with significant dead growth inhibiting the crown of the plants, reducing vigor and production. As die-back occurs, the community becomes vulnerable to weed invasions; as seen with the frequent or severe grazing, drought, or fire. 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 (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				140–280	
	needle and thread	HECO26	*Hesperostipa comata*	140–280	30–50
2				67–112	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	67–112	15–25
3				34–56	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	34–56	5–10
	western wheatgrass	PASM	*Pascopyrum smithii*	34–56	5–10
4	**Miscellaneous Grasses/Grass-likes**			45–90	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–22	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–22	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–22	0–5
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–22	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–22	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					

5				6–90	
	parsnipflower buckwheat	ERHE2	*Eriogonum heracleoides*	0–22	0–5
	fleabane	ERIGE2	*Erigeron*	0–22	0–5
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	0–5
	white locoweed	OXSES2	*Oxytropis sericea var. speciosa*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	textile onion	ALTE	*Allium textile*	0–22	0–5
	Franklin's sandwort	ARFR	*Arenaria franklinii*	0–22	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–22	0–5
	wavyleaf Indian paintbrush	CAAPM	*Castilleja applegatei ssp. martinii*	0–22	0–5
	castilla	CASTI	*Castilla*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–22	0–5
	cutleaf daisy	ERCO4	*Erigeron compositus*	0–22	0–5
Shrub/Vine					
6				28–56	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–56	5–10
7				0–28	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
8	**Miscellaneous Shrubs**			28–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	0–5
	silver sagebrush	ARCA13	*Artemisia cana*	0–28	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–28	0–5
	skunkbush sumac	RHTR	*Rhus trilobata*	0–28	0–5
	yucca	YUCCA	*Yucca*	0–28	0–5

Table 15. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				84–168	

	needle and thread	HECO26	*Hesperostipa comata*	84–168	20–30
2	**Rhizomatous Wheatgrasses**			28–84	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–84	0–15
	western wheatgrass	PASM	*Pascopyrum smithii*	0–84	0–15
3				6–56	
	threadleaf sedge	CAFI	*Carex filifolia*	6–56	1–10
	blue grama	BOGR2	*Bouteloua gracilis*	11–45	1–10
4				6–45	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–45	1–10
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
5	**Miscellaneous Grasses/Grass-likes**			45–90	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–22	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–22	0–5
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–22	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
Forb					
6	**Perennial Forbs**			6–90	
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	textile onion	ALTE	*Allium textile*	0–22	0–5
	Franklin's sandwort	ARFR	*Arenaria franklinii*	0–22	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–22	0–5
	wavyleaf Indian paintbrush	CAAPM	*Castilleja applegatei ssp. martinii*	0–22	0–5
	castilla	CASTI	*Castilla*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–22	0–5
	parsnipflower buckwheat	ERHE2	*Eriogonum heracleoides*	0–22	0–5
	erigenia	ERIGE	*Erigenia*	0–22	0–5
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5
7	**Annual Forbs**			0–22	
	Forb, annual	2FA	*Forb, annual*	0–22	0–5

Shrub/Vine					
8				28–168	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–168	5–25
9				0–28	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
10	**Miscellaneous Shrubs**			28–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	0–5
	silver sagebrush	ARCA13	*Artemisia cana*	0–22	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–22	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5
	yucca	YUCCA	*Yucca*	0–22	0–5

Table 16. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				22–90	
	needle and thread	HECO26	*Hesperostipa comata*	22–90	5–20
2	**Rhizomatous Wheatgrasses**			22–90	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–90	0–20
	western wheatgrass	PASM	*Pascopyrum smithii*	0–90	0–20
3	**Sod-formers**			6–45	
	blue grama	BOGR2	*Bouteloua gracilis*	6–45	1–10
	threadleaf sedge	CAFI	*Carex filifolia*	0–45	0–10
4				0–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
5	**Miscellaneous Grasses/Grass-likes**			22–90	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–22	0–5
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–22	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–22	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					
6	**Perennial Forbs**			6–45	
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	textile onion	ALTE	*Allium textile*	0–22	0–5
	Franklin's sandwort	ARFR	*Arenaria franklinii*	0–22	0–5
	castilla	CASTI	*Castilla*	0–22	0–5

	castilla	CASTI	*Castilla*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–22	0–5
	erigenia	ERIGE	*Erigenia*	0–22	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	0–5
7	**Annual Forbs**			0–22	
	Forb, annual	2FA	*Forb, annual*	0–22	0–5
Shrub/Vine					
8				45–224	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	45–224	10–50
9				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
10				22–45	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	0–5
	silver sagebrush	ARCA13	*Artemisia cana*	0–22	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–22	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5

Table 17. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Sod Formers**			56–168	
	blue grama	BOGR2	*Bouteloua gracilis*	56–168	20–50
	threadleaf sedge	CAFI	*Carex filifolia*	56–168	20–50
2				11–28	
	needle and thread	HECO26	*Hesperostipa comata*	11–28	5–10
3	**Rhizomatous Wheatgrasses**			0–28	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–28	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–28	0–5
4				0–22	
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5

	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	0–5
5	**Miscellaneous Grasses**			0–56	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–22	0–5
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					
6	**Perennial Forbs**			6–56	
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–45	5–10
	white locoweed	OXSE	*Oxytropis sericea*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	textile onion	ALTE	*Allium textile*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	0–5
7	**Annual Forbs**			0–22	
	Forb, annual	2FA	*Forb, annual*	0–22	0–5
Shrub/Vine					
8				11–56	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	6–56	1–10
9				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
10	**Miscellaneous Shrubs**			0–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5

Table 18. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Sod-formers**			56–168	
	blue grama	BOGR2	*Bouteloua gracilis*	56–168	10–50
	threadleaf sedge	CAFI	*Carex filifolia*	56–168	10–50
2				0–56	
	needle and thread	HECO26	*Hesperostipa comata*	0–56	0–10

3				0–28	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–28	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–28	0–5
4				0–28	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–28	0–5
5	**Miscellaneous Grasses/Grass-likes**			0–28	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–22	0–5
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–22	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					
6	**Perennial Forbs**			28–140	
	plains pricklypear	OPPO	*Opuntia polyacantha*	28–140	5–25
	white locoweed	OXSE	*Oxytropis sericea*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	0–5
7	**Annual Forbs**			0–22	
	Forb, annual	2FA	*Forb, annual*	0–22	0–5
Shrub/Vine					
8				0–28	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	0–28	0–5
9				0–28	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
10	**Miscellaneous Shrubs**			0–22	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 - Needleandthread/Indian Ricegrass (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-sight to forage and yet escape cover 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 (At-Risk 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 (At-Risk 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 (At-Risk Community): Limited nesting and cover is provided by the existing overstory cover of the Wyoming big sagebrush.

4.3 - Invaded (Annuals) Grasses Plant Community: Early spring and fall green up of cheatgrass provides foraging opportunities for many of our grazers and mixed feeders.

5.1 - Disturbed/Degraded Lands Plant Community and 5.2 - 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 efficiency factor / 912.5 # / AUM to calculate the AUM's/Acre.
Plant Community Description/Title Lbs./Acre AUM/Acre* Acres/AUM*
Below Ave. Normal Above Ave.
1.1 Needleandthread/Indian Ricegrass 375 510 680 0.14 7.14
1.2 Perennial Native Grasses/Wyoming Big Sagebrush 375 525 700 0.14 7.14
2.1 Wyoming Big Sagebrush/*Bare Ground* 310 475 700 0.13 7.69
3.1 Sod-formers/Wyoming Big Sagebrush 125 250 425 0.07 14.29
3.2 Sod-formers/Cactus 125 275 450 0.08 12.5
4.1 Native/Invasive/Wyoming Big Sagebrush ** ** ** ** **
4.2 Invasives/Wyoming Big Sagebrush ** ** ** ** **
4.3 Invasives ** ** ** ** **
5.1 Disturbed/Degraded ** ** ** ** **
5.2 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 (time and timing of precipitation) is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B, with localized areas in hydrologic group C. Infiltration potential for this site varies from moderately rapid to rapid depending on soil hydrologic group and ground cover. Runoff varies from low to moderate. 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 cultural 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 Wind River Indian Reservation. The tribal entities have served to protect and provide cultural significance to this ecological site. This ecological site has moderate to high limitations when associated with roadways and trails due to erodibility, but provides a sound base for travel and camping during wet periods.

Wood products

No appreciable wood products are present on the site.

Other products

Herbs: The forb species of the Sandy 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.

Rare and Sensitive Species:
Oryzopsis contracta – Contracted ricegrass (also known as Wyoming ricegrass) was listed as a sensitive or species of concern in 1994, however, this species is not found on the sensitive species lists updated in 2012. This plant is found along the dry sandy soils of this ecological site. It is very similar in appearance to Indian Rice grass (Oryzopsis hymenoides, currently listed as achnatherum hymenoides). It was found that this species was being miss-identified regular for A. hymenoides. But is a sensitive decreaser with grazing pressure and disturbance. Species accounts were made in the Big Horn Basin, but a higher occurrence was seen in Wind River Basin and foothills.
Cryptantha subcapitata - Owl Creek Miner's Candle is identified as a sensitive species related specifically to the Wind River Basin along the Owl Creek Mountain Range. It thrives on the sandy and gravelly slopes and desert ridges of the Wind River (Sandstone) Formation.
Ericameria discoidea var. linearis – Narrowleaf goldenweed is a shrub that is found along the sandy and gravelly bars of dry floodplains, stream terraces along with sagebrush and up into the forested sites. This shrub is not a preferred browse species by wildlife, and is mostly disturbed by recreation.

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 Sandy 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 Hirsche, Range Management Specialist/Sage Grouse Coordinator, Popo Agie Conservation District; John Likins, Range Management Specialist (Retired), USDI-BLM; and Marji Patz, Ecological Site Specialist, NRCS.

Quality control and quality assurance completed by: Dan Mattke, Area Resource Soil Scientist, NRCS; Daniel Wood, MLRA Soil Survey Leader, NRCS; John Hartung, Wyoming State Rangeland Management Specialist, NRCS; James Bauchert, Wyoming State Soil Scientist, NRCS; Scott Woodall, Regional Quality Assurance Ecological Site Specialist, NRCS.

For specific data inquiries, contact the Powell, Wyoming Soil Survey Office (USDA-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.)

Type locality

Location 1: Fremont County, WY	
Township/Range/Section	T4N R2E S25
UTM zone	N
UTM northing	4796772
UTM easting	694888
Latitude	43° 17′ 54″
Longitude	108° 35′ 50″
General legal description	NW1/4 NW1/4 Sec. 25 T4N R2E; 328 meters south and 92 meters east of the Northwest corner of section.

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Approval

Scott Woodall, 2/22/2019

Acknowledgments

The original Generation 1 ESD, and foundation for this site description was first published by Everet Bainter.

This version of the ESD has been reviewed and edited by Dan Mattke, Resource Soil Scientist; James Bauchert, State Soil Scientist; Daniel Wood, MLRA Soil Survey Leader; Ray Gullion, Multi-county Rangeland Management Specialist; John Likins, Retired BLM; and Leah Yandow, Wildlife Biologist - BLM. A sincere thank you is sent to each of these folks for their efforts to improve the quality and depth of this description.

Further Quality Assurance review was provided by Scott Woodall. His insight has helped to ensure a technically sound tool.

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.

Author(s)/participant(s)	Marji Patz, Ray Gullion, E. Bainter
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Date	12/21/2016
Approved by	Scott Woodall
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rare to nonexistent. Where present, short and widely spaced.

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

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3. **Number and height of erosional pedestals or terracettes:** Rare to nonexistent.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 20-30%.

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

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

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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 3.0 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 1-6 inches (3-15 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, 20% forbs and 10-25% 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. 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 of soil surface crusting should be present. A coarse, dry subsurface will often refuse a probe, causing misidentification of a compaction layer. Most soil profiles must be described by hand dug holes.

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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:

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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: 375 - 680 lbs/ac (510 lbs/ac average); Metric: 420 - 762 kg/ha (572 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 30% 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, threadleaf sedge, Fendler threeawn, plains pricklypear 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.
