USDA Natural Resources Conservation Service

Ecological site DX032X02A150
Sandy (Sy) Wind River Basin Core

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.

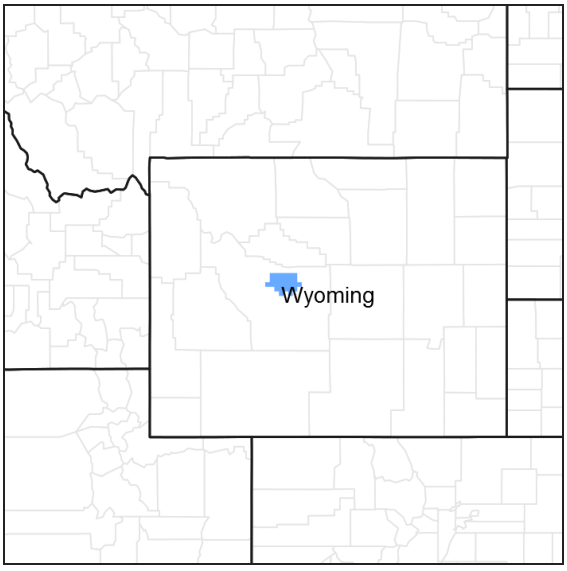


Figure 1. Mapped extent

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

MLRA notes

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

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

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

LRU notes

Land Resource Unit (LRU):

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

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

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

Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):
3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
3.B Cool Semi-Desert Scrub & Grassland Subclass
3.B.1 Cool Semi-Desert Scrub & Grassland formation
3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division
M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup
G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group
A3182 Artemisia tridentate ssp. Wyomingensis Mesic Steppe & Shrubland Alliance
CEGL001051 - Artemisia tridentata ssp. wyomingensis/Hesperostipa comate Shrubland

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

Ecological site concept

• Site receives no additional water.
• Slope is <30%
• Soils are:
o Textures range from loamy sand to very fine sandy loam in top 4" (10 cm) of mineral soil surface
o Clay content is or = 18% in top 4" (10 cm) of mineral soil surface
o 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% 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, coarse textured soil with less than 18% clay throughout the profile; the dominant soil textural classes are loamy sand to sandy loam in the subsurface. The plant community shifts away from the Sandy ecological site as the control section increases above 18% clays with increased rhizomatous wheatgrasses, additional forb species, and increased bare ground.

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 interbedded sandstone and shale; or in an area 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

R032XY222WY	**Loamy (Ly) 5-9” Wind River Basin 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.
R032XY228WY	**Lowland (LL) 5-9” Wind River Basin 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 so have Basin big sagebrush, and other water demanding plants.
R032XY244WY	**Saline Upland (SU) 5-9” Wind River Basin Precipitation Zone** Saline upland sites commonly occur intermixed with Loamy sites, especially along marine shale deposits or escarpments with inter-bedded shales and sandstones. Saline uplands are dominated by short saltbush species and limited productivity from saline soils.
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 found on this site.
R032XY266WY	**Shallow Sandy (SwSy) 5-9” Wind River Basin 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 higher percentage of bluebunch wheatgrass, but a marked reduction in production and increased bare ground.
R032XC130WY	**Overflow 5-9” Mesic Wind River Basin** Overflow ecological sites will have associated hydrology (additional moisture from overland flow) that influences production (increases potential production) and alters the plant community to favor Basin Wildrye, silver sagebrush, basin big sagebrush, and more water demanding species. Will see Overflow sites in micro sites or depressions within a sandy site.
R032XY204WY	**Clayey (Cy) 5-9” Wind River Basin 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 tend to fall along alluvial drainages or below shale outcrops/outwashes.
R032XY212WY	**Gravelly (Gr) 5-9” Wind River Basin Precipitation Zone** Gravelly sites have a higher rate of bluebunch wheatgrass, lack production that Sandy sites hold, and are higher in forb especially pincushion forbs occurs on gravelly sites.

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 will narrow the concept for C150.
R032XY250WY	**Sandy (Sy) 5-9” Wind River Basin Precipitation Zone** The current description is a division of the original 32XY250 site. The separation was based on landforms, parent material, structure and depth to gravel. Sandy soils without an argillic, derived from sandstone, and with only minimal gravels are stable and produce more than other similar soils that were originally grouped in this site concept.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata subsp. wyomingensis*

Herbaceous	(1) *Hesperostipa comata* (2) *Achnatherum hymenoides*

Legacy ID

R032XC150WY

Physiographic features

The Sandy ecological site generally occurs on slopes ranging from nearly level to moderately steep of up to 30%. Alluvial fans, stream terraces and hillsides/ridges are the major landforms where this site exists. The site also occurs on relict stream terraces or fan remnants, with minimal or no active soil deposition occurring. 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 identify clearly 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.

Sandy sites may occur in small drainage ways or depressional areas where historically, additional moisture may have been received as runoff from the adjacent upland areas, but the additional moisture has been limited or removed from the site to inhibiting the overflow plant community (Basin Wildrye). Larger drainage ways can also have a sandy site as a component, if the hydrologic regime has been altered (became drier) due to down-cutting, lack of flooding, or lack of runoff. With the lack of "additional moisture", both situations will correlate to a sandy site; however, production trends appear on the higher end of the range.

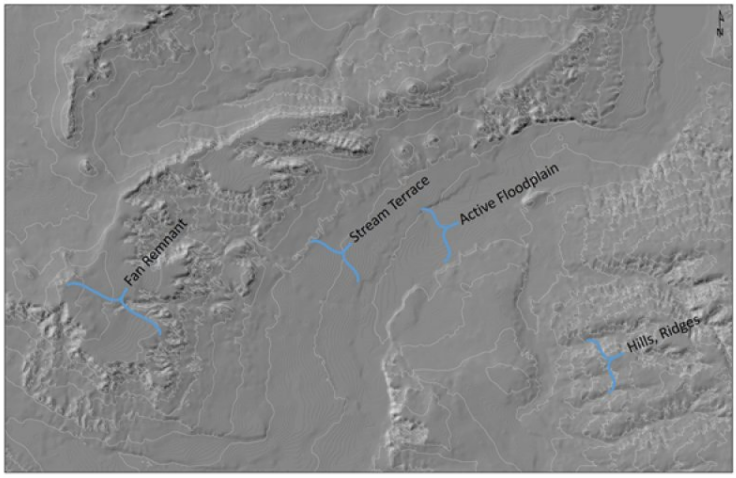


Figure 2. Physiographic Image.—Aerial View of landforms with

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Hill (3) Stream terrace
Flooding frequency	None
Ponding frequency	None
Elevation	1,440–1,951 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 5 to 9 inches (127 – 229 mm). The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50% of the mean annual precipitation. Much of the moisture that falls in the latter part of the summer is lost by evaporation and much of the moisture that falls during the winter is lost by sublimation. Average snowfall is about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

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 shift in timing of spring warm up and first frost, 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 mid-stature 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/. “Riverton” and "Pavillion" are the representative weather stations within LRU C. The following graphs and charts are a collective sample representing the averaged normals and 30 year annual rainfall data for the selected weather stations from 1981 to 2010.

Table 3. Representative climatic features

Frost-free period (average)	107 days
Freeze-free period (average)	128 days
Precipitation total (average)	203 mm

Climate stations used

- (1) PAVILLION [USC00487115], Pavillion, WY

- (2) RIVERTON [USC00487760], Riverton, 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). 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: Apron, Wallson, Worland, Enos, and Wall. This list of soil series is subject to change upon completion and correlation of the initial soil surveys: WY647 and WY617; as well as revisions to completed soil surveys: WY613, WY713, WY625, and WY677.

Typical Pedon - WALL SERIES

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Typic Haplocambids. The Wall series consists of very deep, well drained soils. Slope gradients range from about 1 to 20 percent.

GEOGRAPHIC SETTING: Wall soils are on gently to moderately sloping alluvial fans or valley sideslopes. The soils formed in alluvial fan sediments derived principally from sandstone. At the type location the average annual precipitation is 7 inches with peak periods of precipitation during the spring and summer months. Mean annual temperature is 44 degrees F. and mean summer temperature is 66 degrees F.

A--0 to 6 inches; light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; soft, very friable; neutral (pH 7.2); clear smooth boundary. (4 to 10 inches thick)

Bw1--6 to 22 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; soft, very friable; some of the sand grains have bridges of gelatinous material between them; slightly alkaline (pH 7.4); clear wavy boundary. (8 to 24 inches thick)

Bw2--22 to 28 inches; dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; soft, very friable; calcareous; moderately alkaline (pH 8.0); gradual wavy boundary. (3 to 6 inches thick)

Bk--28 to 60 inches; light brownish gray (10YR 6/2) light sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft very friable; some visible secondary calcium carbonate occurring as concretions and in thin seams and streaks; calcareous; moderately alkaline (pH 8.2).

RANGE IN CHARACTERISTICS:
• Depth to calcareous material ranges from 8 to 20 inches.
• Thickness of solum ranges from 15 to 40 inches.
• The weighted average organic carbon content in the upper 15 inches ranges from 0.1 to 0.4 percent.

• The sand/clay ratio ranges from 4 to 18.
• The 10 to 40 inch control section is typically sandy loam but clay ranges from 5 to 18 percent, silt from 5 to 35 percent, and sand from 5 to 80 percent with more than 35 percent fine sand or coarser and excluding any loamy sand from the above range.
• The sand is mainly fine and medium and there is less than 25 percent coarse and very coarse sand.
• Rock fragments range from 0 to 15 percent, but are typically less than 10 percent.
• Mean annual soil temperature ranges from 47 degrees to 51 degrees F., and mean summer soil temperature ranges from 60 degrees to 68 degrees F.
• A horizon - Hue of 2.5Y or 10YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 or 3. It is neutral or mildly alkaline (pH 7.0 to 7.8). The horizon is soft or slightly hard.
• Bk horizon - Hue of 2.5Y through 10YR. It is moderately or strongly alkaline (pH 8.0 to 8.6), and has 2 to about 8 percent calcium carbonate equivalent.

TYPE LOCATION: Fremont County, Wyoming; about 280 feet north and 80 feet east of the center of sec. 20, T. 3 N., R. 1E. Series was established in Fremont County, (Riverton Irrigated Area), Wyoming; 1969.

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone (2) Residuum–sandstone and shale
Surface texture	(1) Sandy loam (2) Loamy fine sand (3) 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"	0–5%
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 70% grasses, 15% forbs, and 15% woody plants. The composition and production will vary naturally due to historic use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as blue grama, prairie junegrass, and Wyoming big sagebrush will increase. Weedy annuals will invade and cool-season grasses such as needleandthread and Indian ricegrass will decrease in frequency and production. Continued pressure will allow plains prickly pear and weedy annuals to invade. Extended

periods of drought and other climatic shifts have produced similar transitions in the vegetation.

Wyoming Big Sagebrush is limited in this system due to lack of moisture and lower water holding capacity of the soils; this also relates to a lower fire frequency and lower risk of fire due to reduced fine fuels and total woody canopy. Extended drought will cause stress and decadence or death in sagebrush quicker than in finer/heavier textured soils water holding capacity. In the absence of the natural disturbance regimes to encourage rejuvenation and cycling, sagebrush will begin to decrease in palatability and function, and increase in total canopy cover; however, the actual number of individual plants may not increase significantly, but the overall size and coverage of each plant increases. It is interjected that changes in historic grazing use patterns have resulted in decadent/dying stands of sagebrush. Mosaic or "patch" burns and/or mowing are being utilized to rejuvenate aged stands of sagebrush, 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 grasses have the resources to be competitive, 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 and protection from grazing and wind desiccation, young sagebrush seedlings are quickly stressed or grazed, reducing new establishment. Extended periods of time are required for natural re-establishment of sagebrush (beyond 25 years), limiting the function of natural recovery 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). The dense sod causes a shift in hydrology that creates a drier, harsher environment that continues to support the dense root system that can respond and capture moisture in the surface before it is lost. As these plants establish and continue to increase, they further alter the hydrologic cycle by diverting more water off site and increasing run off with the dense tight root system.

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. Current and historical site development data has noted a correlation 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 (or Indian ricegrass) and the opposite for coarser textured soils, which hold a higher ratio of Needleandthread (or 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 structure appear to have a slightly heavier textures 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.

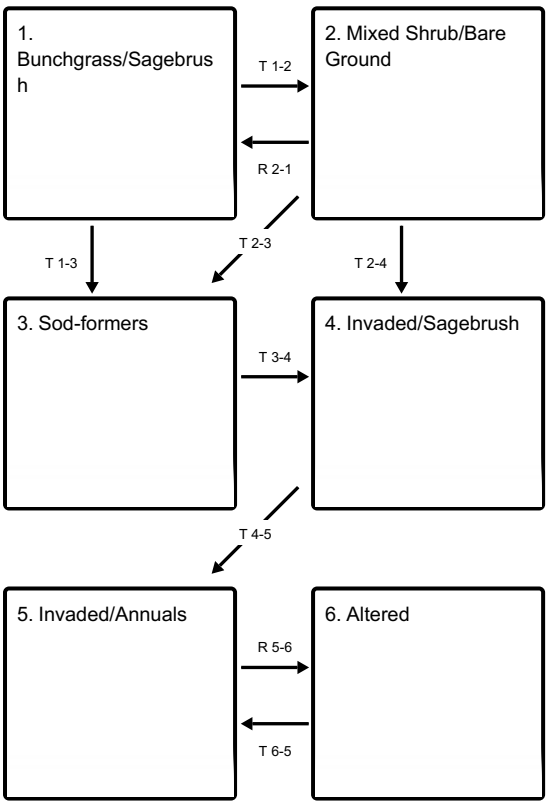
Community phases, small boxes within the bold state boxes, generally have important management or ecological significance. Collectively, the community phases represent the range of variation within a state, including conditions that place the state at risk for transition. Community pathways are represented 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.

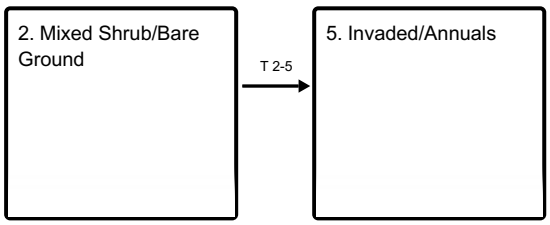
No plant communities should necessarily be thought of as “Desired Plant Communities”. According to the USDA NRCS National Range and Pasture Handbook, Desired Plant Communities (DPC’s) will be determined by the decision-makers and will meet minimum quality criteria established by the NRCS. The main purpose 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

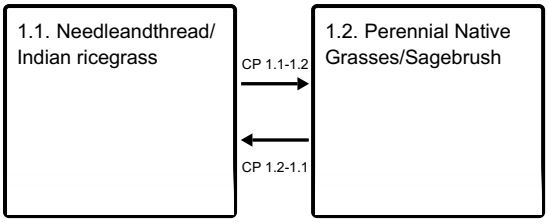
Ecosystem states



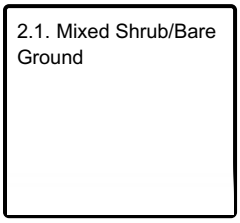
States 2 and 5 (additional transitions)



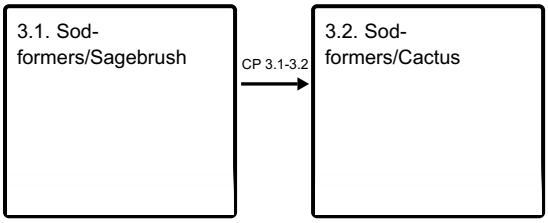
State 1 submodel, plant communities



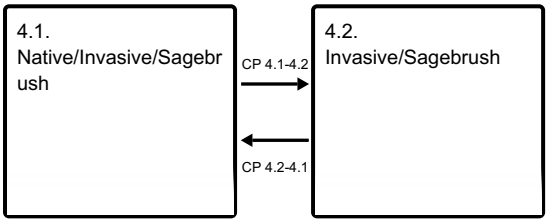
State 2 submodel, plant communities



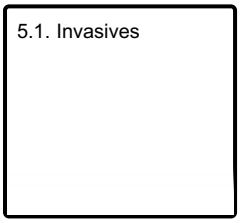
State 3 submodel, plant communities



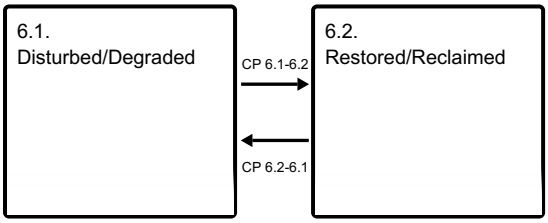
State 4 submodel, plant communities



State 5 submodel, plant communities



State 6 submodel, plant communities



State 1
Bunchgrass/Sagebrush

Bunchgrass/Sagebrush State (State 1 - Reference) is characterized by the key species including: 10% or less composition by cover of Wyoming big sagebrush, with Needleandthread (30-50% composition), Indian ricegrass, and isolated areas of western wheatgrass. Minor components to the overall composition are Prairie junegrass, Bottlebrush squirreltail, Prairie sandreed, sand dropseed, threeawns, blue grama, and threadleaf sedge.

Community 1.1
Needleandthread/ Indian ricegrass

Figure 7. Community 1.1 – Reference Site located south of Sh

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 loss. State 1, including Community Phase 1.1, evolved with grazing by large herbivores. The potential vegetation is about 70% grasses or grass-like, 20% forbs, and 10% woody plants. This plant community can be found on areas that are properly managed with grazing and/or ecosystem based management tools, with natural disturbance regimes and on areas receiving occasional short periods of rest. Historically, the reference state evolved under a low fire frequency (estimated to be 195 to 235 years between burns on the same community patch, also stated was that sagebrush has a post fire recover timeframe of 50-120 years or more in arid systems – Baker 2006) and with grazing pressure by large ungulates (elk, bison, deer, or antelope). 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, warm season grasses (blue grama) has increased across the entire basin, but has remained as a secondary component in this reference communities. 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, threadleaf sedge, and threeawns. A variety of forbs are found in this community including fleabanes, fringed sagewort, wildparsley, lemon scurfpea, and scarlet gaura. Wyoming big sagebrush 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 400 pounds per acre, but it can range from about 225 lbs./acre in unfavorable years to about 600 lbs./acre in above average years. Rangeland Health Implications/Indicators: Diversity of the plant species found on this site allows for a high drought tolerance, allowing persistence in the limiting climatic conditions of the Wind River Basin. The structural diversity of Wyoming big sagebrush in conjunction with the mid-bunchgrasses (needleandthread and 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	224	342	471
Shrub/Vine	22	62	112
Forb	6	45	90
Total	**252**	**449**	**673**

Table 6. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0%
Grass/grasslike basal cover	0%
Forb basal cover	0%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
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	–	0%	1-5%	1-5%
>0.15 <= 0.3	–	1-25%	1-25%	1-5%
>0.3 <= 0.6	–	–	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

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

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

Community 1.2
Perennial Native Grasses/Sagebrush

Figure 10. Reference Community 1.2 - Sandy 5-9” Mesic site wi

The secondary phase of the Reference community (1.2), is similar with only minor shifts in composition and function. The community can be found on areas that are within the scope of historic disturbances such as herbivory by large ungulates and sporadic wildfires. Properly managed locations with grazing with periodic short intervals of rest support this 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, rhizomatous wheatgrasses, blue grama, threadleaf sedge, prairie junegrass and Sandberg bluegrass. The variety of forbs and half-shrubs commonly found include scarlet globemallow, fringed sagewort, lemon scurfpea, sulfur buckwheat, hairy goldaster, 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 maintain the diverse structure of the plant community. Blue grama and threadleaf sedge 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 prickly pear cactus will also have increased, but occurs only in small patches. Indian ricegrass has decreased and may occur in only trace amounts under the sagebrush canopy or within the patches of prickly pear; where as needleandthread and winter fat have maintained and are a common component in this community. The total annual production (air-dry weight) of this community is about 320 lbs/acre, but it can range from about 180 lbs./acre in unfavorable years to about 480 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 a niche for weedy species, and may intensify the droughty nature of the soils with increased water demands by the woody species as well as shallower rooted annuals. Bare ground averages 30 to 45%, woody coverage has increased (due to reduced herbaceous cover, to an average of 20 to 35% 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	174	269	336
Shrub/Vine	22	50	112
Forb	6	39	90
Total	**202**	**358**	**538**

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	0-2%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	25-40%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-1%	1-5%	5-10%
>0.15 <= 0.3	–	1-25%	5-20%	1-5%
>0.3 <= 0.6	–	–	0-5%	–
>0.6 <= 1.4	–	–	0-1%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 12. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

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

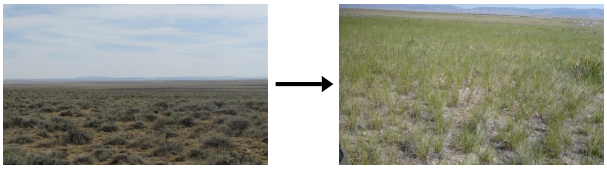
Pathway CP 1.1-1.2
Community 1.1 to 1.2

Needleandthread/ Indian ricegrass

Perennial Native Grasses/Sagebrush

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

Pathway CP 1.2-1.1
Community 1.2 to 1.1



Perennial Native Grasses/Sagebrush

Needleandthread/ Indian ricegrass

Long-term Prescribed Grazing, Brush Management - With integration of a rotational grazing system or rest-rotation, and with management to reduce shrub canopy, the native bunchgrasses will begin to re-establish in this community, but it may take an extended period of time (estimated at 5 to 10 years) 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 open the seedbed to allow the desired bunchgrasses (needleandthread, Indian ricegrass) and western wheatgrass, prairie junegrass, and prairie sandreed to reestablish or to increase, driving the recovery to the reference community (1.1). This hoof action, and brush treatment can be a tool to break up mat forming species to aid in addressing the hydrologic cycle, holding the water on site rather than allowing it to move off. A long-term management strategy may be required before any trend towards reference is noticed. The overstory of Wyoming big sagebrush may be the one factor that could require further manipulation to reduce canopy and composition to the 10% that is desired.

Conservation practices

Brush Management
Prescribed Burning
Fence
Integrated Pest Management (IPM)
Prescribed Grazing

State 2
Mixed Shrub/Bare Ground

Wyoming big sagebrush creates a niche for most herbaceous understory to persist and maintain some vigor in difficult conditions by utilizing the moisture and shade provided by the canopy as well as protection from grazing. Persistence of drought and/or frequent over use by livestock and/or wildlife leads to a decline of the herbaceous species, creating the Wyoming Big Sagebrush and *Bare Ground* state. This state can be exacerbated by insects and other human disturbances. The total woody canopy cover does not necessarily always increase with this community, but the percent composition by cover and production is swayed by the decrease of herbaceous vegetation and the relative stability of production by the woody species, creating the appearance of increased canopy by sagebrush. Risk of wildfire within this state is minimal due to the lack of fine fuels within the understory, but the canopy of the woody vegetation can easily carry a fire under certain weather conditions. 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. Depending on the prescription of use, trailing and other erosional patterns are highly visible in this state. Protection from wildfire and use, on a long-term perspective, can aid in the transition of a reference community (1.1 or 1.2) to this state as sagebrush becomes dense and decadent reducing the ability for the herbaceous component to maintain vigor; leading to high amounts of bare ground and sagebrush cover. As the herbaceous cover declines and the site continues to weaken, the sagebrush cover is susceptible to attack by insects, disease, and general old age that can remove it from the system leaving it at risk of invasion or transition to a more degraded state. There is a high level of variability of species in this state (State 2), that will shift with precipitation patterns or as a response to past management. Only one well defined community will be provided, with discussion of transitions or variances from this community. The overall droughty nature of coarse textured soils exacerbates the impact of droughty conditions and reduces the resilience and resistance of this site to further shift during extended dry periods. Yucca’s presence on this site is not

frequent, but when it does occur, it can easily become prominent, specifically for winter grazing allotments. Yucca's growth habits produce a more pronounced pedestalling and drift/scour pattern on the landscape than seen with sagebrush.

Community 2.1
Mixed Shrub/Bare Ground

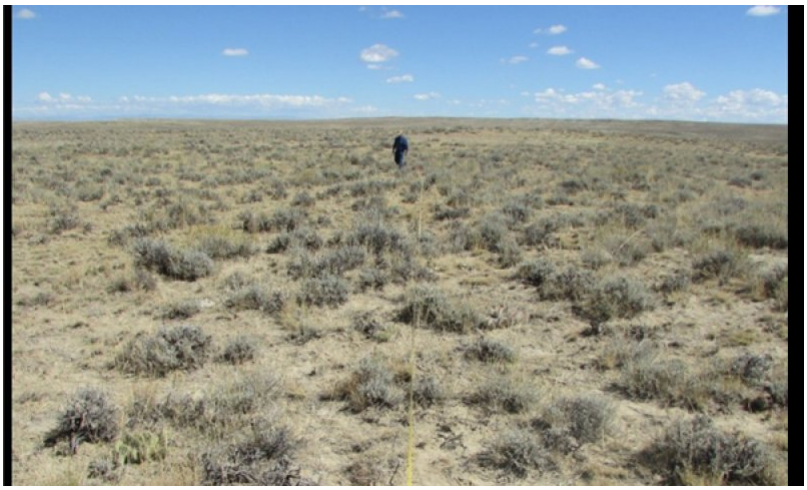


Figure 13. Sagebrush Dominated Community with minimal coverag

This plant community is the result of frequent and severe grazing and/or protection from fire. Wyoming big sagebrush dominates this plant community, as the annual production of sagebrush exceeds 25%. Wyoming big sagebrush is a significant component of the plant community and the desirable mid-stature cool-season grasses have been greatly reduced. In response to the coarser textured soils, Yucca can be a major component of this community. The dominant grasses and grass-likes are needleandthread, Sandberg bluegrass, threadleaf sedge and blue grama. Patches of prickly pear 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. This community is vulnerable to invasive weeds such as cheatgrass, Russian knapweed, or leafy spurge if a seed source is available, so is at risk of further degradation. The total annual production (air-dry weight) of this state averages 300 pounds per acre, but it can range from 200 lbs./acre in unfavorable years to 450 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)
Shrub/Vine	67	140	252
Grass/Grasslike	151	174	207
Forb	6	22	45
Total	**224**	**336**	**504**

Figure 15. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

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

State 3
Sod-formers

The dominant sod-forming grasses/grass-likes that currently exists within this LRU are blue grama and threadleaf sedge. Both are species that persist as a component of the perennial vegetation naturally (in reference communities) within this ecological site. The general tendency is for these species to increase with prolonged drought or under grazing pressure, becoming dominant. Together 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 or will direct 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-formers/Sagebrush

Figure 16. Blue Grama with Wyoming Big Sagebrush

This plant community is the result of continuous season-long grazing, recurrent over utilization, or prolonged drought, which has adversely affected the perennial grasses and shrub component, in turn encouraging the low stature sod forming grasses to expand. The effect of blue grama and threadleaf sedge with their short, dense root structure, is a decrease of water infiltration which increases channelization of runoff between vegetation patches. Decreased infiltration coupled with the lack of structure to hold moisture and compounded by drought will reduce the shrub component further. Dense, interspersed patches of blue grama and threadleaf sedge sod is the major component of this community. Incidental occurrences of other perennial natives occur within the sagebrush canopy or the protective ring of the prickly pear cactus clumps. Overall, Wyoming big sagebrush has been reduced in vigor and abundance across this community phase, but it still persists on the landscape (average 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. Prickly pear cactus is prevalent on the site, and other cool-season mid-stature grasses, perennial forbs, and most shrubs have been greatly reduced. Production has significantly decreased and bare ground may not vary or will increase (longer extents of bare ground between densely vegetated areas). The total annual production (air-dry weight) of this community phase is about 150 pounds per acre, but it can range from about 60 lbs. /acre in unfavorable years to about 300 lbs. /acre in above average years. The higher productivity is generally in response to Wyoming big sagebrush production on the site. Rubber rabbitbrush and other woody species are present as well (5-10%), influencing overall production. Rangeland Health Implications/Indicators: This community is at-risk of transitioning to a sod-bound community with no woody vegetation. The dense root mats are extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to have an added affect to 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 community phase 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 is very resistant to 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 community phase 3.2 (stable and most degraded) 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 minimal shift between them. Drought stress on these sod species can create a die off or die back of plants; and during extended periods of drought, large areas of die-back leaves the 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.

Table 12. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	56	112	224
Shrub/Vine	11	50	84
Forb	–	6	28
Total	**67**	**168**	**336**

Figure 18. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

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

Community 3.2
Sod-formers/Cactus

Figure 19. Blue Grama Community with Prickly Pear Cactus

Transitioning from the Sod/Sagebrush community phase (3.1) to the Sod/Cactus community phase (3.2) occurs relatively easily after the initial transition into a sod-former state through drought or continued pressure on the remaining shrubs. A dense sod of blue grama with threadleaf sedge intermixed, is dominant with increasing prickly pear cactus in the community. Cactus density has the potential to increase to a level that inhibits the ability for livestock to move through or graze the available forage. Wyoming big sagebrush has been generally removed from the community with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but may persist on the landscape. Sod-forming species such as threadleaf sedge and blue grama, as well as plains prickly pear cactus are able to tolerate high levels of use and will persist as other native species are removed from the community, including Wyoming big sagebrush. This decline creates a sod/cactus community that is resistant to change with management. The loss of Wyoming big sagebrush as well as other woody species by herbivory, disease or insect damage will create the shift to the secondary community phase 3.2. When compared to the Reference State (1.1 and 1.2), blue grama and plains prickly pear cactus have increased. All cool-season mid-stature grasses, forbs, and most shrubs have been greatly reduced or removed. Production has been significantly decreased. The dense and frequent clumps of cactus does offer a niche for some native cool-season grasses to persist in the community, but suppressed in expression. The ability of low stature sod-formers to respond to the 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 substantial seedheads and tillars is a more prominent response for these short-stature grasses. Production is provided as an average or mean number and is not intended to cover the full range of production potential for this community. Total average annual production is 175 lbs./acre, but it can range from 55 lbs./acre in unfavorable years to 350 lbs./acre in above average years. Rangeland Health Implications/Indicators: This sod bound community is extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure of the plant community. The biotic integrity of this state is not functional, plant diversity is extremely low, and vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool-season grasses. The dense root mat of this community is resistant to water infiltration, and off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in the bare ground areas and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites. The added competitive 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 prickly pear 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 by intense hoof action, large equipment (vehicular/tractors), or other human impacts can cause the tearing and re-rooting of cactus causing a rapid increase across an area of impact.

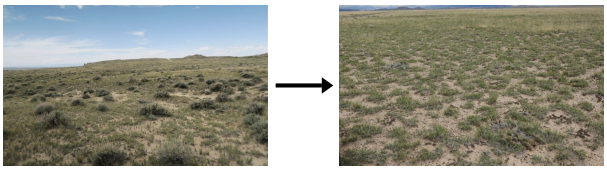
Table 13. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	39	123	252
Forb	22	62	112
Shrub/Vine	–	11	28
Total	**61**	**196**	**392**

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

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

Pathway CP 3.1-3.2
Community 3.1 to 3.2



Sod-formers/Sagebrush Sod-formers/Cactus

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

State 4
Invaded/Sagebrush

Cheatgrass or downy brome (*Bromus tectorum*) has quickly become the greatest threat to much of the rangelands across Wyoming. 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 sprout early gives it the advantage. Shifts in climatic patterns, changes in management, and exposure to human activity are a few of the explanations for the current flush and rapid expansion across the western United States. Although cheatgrass is the most prevalent large scale threat for rangeland managers, a variety of knapweeds (spotted, Russian, etc.), 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 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/Invasive/Sagebrush

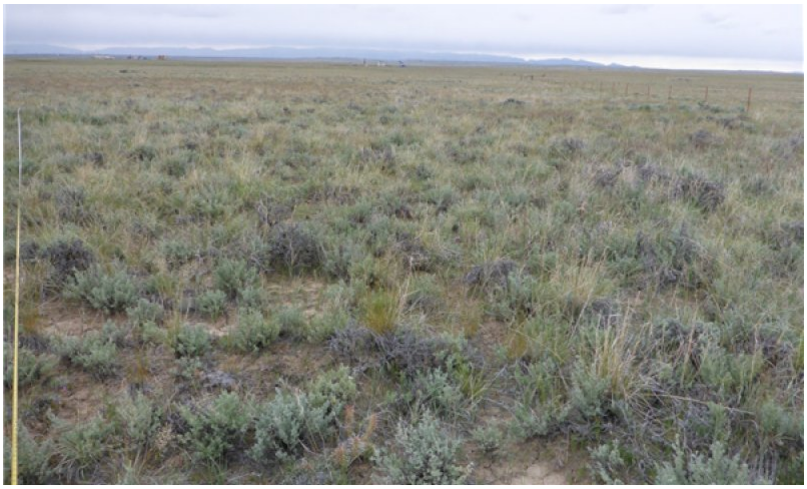


Figure 22. Native and Invasive species within the Sagebrush

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 to persists and possibly improvement is retained. However, extent of improvement and exorbitant costs and labor required limit the economic feasibility. Further degradation of this site increases the cost and reduces feasibility of restoring a desired community, which makes this community phase, the At-Risk community. This community phase is characterized by a significant composition of invasive species (5% or greater) on the landscape; with a wide scale distribution, not one isolated patch in an isolated portion of the landscape). The litter or duff layer created by many of the known invasive species, but specifically cheatgrass, is significantly higher than the native community. This duff layer creates a barrier that can impede water infiltration and increase runoff, accelerating erosion. This is aggravated with increased slope. The duff layer creates an extreme hot zone during wildfires that can sterilize the soil through volatilization of 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 (focusing mainly on cheatgrass). Plant diversity is moderate for this phase as the remnant perennials and the maintained composition of woody shrubs keeps a

diverse community. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses and 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 variable depending on the species of invasion and the litter accumulation thus associated. This variability also applies to water flow patterns and pedestalling. Infiltration is unaltered or slightly reduced; however, as the duff layer or litter builds infiltration and runoff will increase.

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

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

Community 4.2
Invasive/Sagebrush

As the native populations of perennial grasses and forbs are lost through heavy use or disturbance, the site becomes invader driven. Continued environmental or management derived impacts to the shrub component places this community at risk of crossing a threshold transitioning to State 5, Invaded(Annuals). At this point, hydrologically and biotically it will become irreversible without complete reclamation. Wyoming big sagebrush is able to compete and maintain a strong community under a heavy infestation level of most invasive species, unless fire or similar disturbance removes the woody cover. The canopy of the sagebrush serves as a protective niche in the system for native grasses and forbs, allowing remnant populations to persist. But the system is low in resistance and even lower in resilience. The fine fuels or biomass produced by cheatgrass and others raises a significant threat of fire and increases the potential frequency of occurrence and intensity. Strategies to control or manage for invasive species, namely cheatgrass, are being researched readily across the western United States. High intensity grazing with chemical control and the use of biological agents are techniques that have been trialed, with varying levels of success. The key management strategy needs to be to maintain the remnant populations of native grasses, and to reduce the risk of fire to allow the persistence of Wyoming big sagebrush. This will maintain the 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 as it shifts to an invader only community. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased with increased biomass and plant density of the annual invaders. Plant diversity is poor. The plant vigor is diminished and adaptability/replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that establishes on this site.

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

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

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. This is more typical in species such as knapweeds, whitetop, and specifically cheatgrass (downy brome).

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 State 5 – Invaders (Annuals).

Conservation practices

Prescribed Burning
Critical Area Planting
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control

State 5
Invaded/Annuals

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

Community 5.1
Invasives

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

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

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

State 6
Altered

The arid nature of this region has played a major role in the development and transitions in land use over time. Landscapes accessible by irrigation water and equipment were farmed and many were later abandoned and left to return to rangeland. Other landscapes were treated with a variety of prescriptions to manage or eradicate sagebrush. Tillage of the soil, change in hydrology caused by the loss of vegetative structure, constant climatic fluctuations, and advancements in seed sources have created this altered state. Once a soil has been disturbed, whether it was mechanical, cultural, or natural the change in soil structure, hydrologic function, and possibly stability prevent a site from supporting the native vegetation or responding to management the same as an undisturbed site. Reclamation or restoration of an area will not replace the original function and factors that made the original location respond as it did. So these "altered" lands may, after significant inputs and time, look similar to the Reference communities (1.1 or 1.2), but they will not be able to respond/function as the Reference community will. The disturbed or degraded state could be drafted as a stand-alone box within the state and transition model diagram. No matter what state a location is classified, once the site has experienced an event that has altered the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered. To consider this as an alternate ecological site would not be unreasonable. In some cases (site by site consideration), a re-correlation of a location may be the best solution. But in many cases, the soils have not been altered out of the current site characteristics, but the potential has shifted enough that it is no longer truly comparable to the Reference state (State 1). The species selection, extent or occurrence of tillage, and the resulting loss of structure, degradation of the biota within the soil, drying of the soil, changing of the infiltration and water holding capacity of the soil, and change in permeability are all factors that affect a planted site. The time required for structure and biota to rebuild, altered hydrology and chemistry, as well as plant variety establishment are highly variable in succession of the site depending on the climatic conditions following the event. The initial flush of vegetation is kochia and Russian thistle and mustards. Although they provide organic material, nutrient flow and erosional protection, they lack the structure and root system to fully stabilize the site. With time, the site may become similar in composition to reference, but the

integrity of the soil is altered, changing potential of the site. So a dynamic state was captured to detail the altered communities that exist on the landscape.

Community 6.1
Disturbed/Degraded

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

Figure 26. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

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

Community 6.2
Restored/Reclaimed

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

mature (more biomass and possibly more litter) providing abundant fine fuels to carry a fire. Soil erosion is variable depending on the establishment of the seeding, how it is seeded, and mechanical procedures put in place. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that comprise the community and the method of seeding (site preparation and seeding practice).

Figure 27. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

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

Pathway CP 6.1-6.2
Community 6.1 to 6.2

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

Conservation practices

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

Pathway CP 6.2-6.1
Community 6.2 to 6.1

No use, No Fire, Long Term Prescribed Grazing, Frequent or Severe Grazing - In general, if a site is not maintained with the conditions of which the species are adapted under, a decline in vigor and a corresponding shift in composition will occur. Since the soils are altered from reference state due to plowing, mining, or other similar disturbances, the plant community will not follow the same expected shifts as the native community. Monitoring and 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, and with time sagebrush will increase 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 woody cover is a factor of the number of plants as well as canopy cover. In some instances, the number of actual sagebrush plants may not increase to cause this shift, but the change in composition or vigor of the wood canopy, as well as the loss of herbaceous canopy, creates the illusion of increased number of plants when it is more the size and age that is more likely to shift.

Transition T 1-3
State 1 to 3

Frequent Grazing (Yearlong), Brush Management or Fire with Drought – Severe and frequent grazing reduces vigor and presence of key species. As needleandthread and Indian ricegrass continue 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 short bursts of spring and summer precipitation, these species are generally mat or sod-forming species such as blue grama and threadleaf sedge. Prolonged drought stresses the plants, and opens the canopy for these two plants to fill in the interspaces. The shallow, dense root mats will continue to spread over time. The added removal of sagebrush with animal impacts, fire or brush management may open the canopy more and aid in establishing this sod 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 improperly can force the transition to occur rapidly. The added or increase in blue grama adds an element of mid-summer growth that extends the active growing season grazing window. But this window, if lacking adequate moisture, does not provide sufficient growth to prevent use or overuse of the cool-season species and could further degrade the community.

Restoration pathway R 2-1
State 2 to 1

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

Conservation practices

Brush Management
Prescribed Burning

Critical Area Planting
Fence
Livestock Pipeline
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Spring Development
Integrated Pest Management (IPM)
Watering Facility
Native Plant Community Restoration and 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 on the landscape. This decline creates a sagebrush/sod community that is resistant to change with management. Impacts to sagebrush by disease or insect damage, as well as drought or herbivory, will shift this to the secondary community phase with cactus as a subdominant cover with blue grama.

Transition T 2-4
State 2 to 4

Fire (wild), Frequent or Severe Grazing, Drought with Insect Damage/Brush Management – Throughout most of this LRU there is a seed source present for cheatgrass, knapweed, and other invasive species. Stress to the native community from fire, drought, disease/insect damage to sagebrush, or ground/soil disturbance including impacts by grazing large herbivores or recreational uses; opens the canopy and breaks the surface of the soil, creating a niche for invasion by undesirable plants/invasive weeds. One or two isolated plants of an invasive species, if caught, can be treated and a full infestation avoided; however, when unseen or ignored, the population soon grows exponentially as further stress or disturbance occurs. In some cases once the invasive species are established, they can create their own habitat; this reduces the competitive ability of native species. 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 on the landscape.

Transition T 2-5
State 2 to 5

Brush Management, Fire, or Other Disturbance with Seed Sources - Removal of the sagebrush by mechanical, chemical or fire with a seed source available for weedy species, will lead to this community. Even if remnant populations of the native perennial desired species are present, disturbance allows the weedy species to out compete native species. When the sagebrush canopy has been removed, the soils are droughty and prone to wind and sun, affecting the ability for new seedlings to establish. This limits the ability of this community to recover, even with weed control plans in place. Catastrophic disturbances that remove all shrub cover and open the site to complete invasion by weedy species, most commonly cheatgrass, require significant time and resources to restore to a native community.

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, exposing soil further to annuals and other invaders, such as cheatgrass and knapweeds. If seed source is available, ground disturbance by herbivores or man-induced, allows invasive species to find a way into the community. Once established in the community, it is extremely difficult to manage and may not be feasible to completely remove them from the community. Once the invasive species have become prevalent on the landscape (>5% composition), the community crosses the threshold into the Invaded/Sagebrush State (State 4).

Transition T 4-5
State 4 to 5

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

Restoration pathway R 5-6
State 5 to 6

Integrated Pest Management, with Seeding - Integrated pest management plan and intense weed control after and possibly before seedbed preparation will be necessary to overcome a severe weed infestation. Working the soil and preparing a seedbed at a location and using either improved varieties, native seed, or in some cases an introduced species suited for the management use intended may be the only way to overcome some invasive species. Success of re-establishing a native or desired plant community on a large scale is not documented. Small scale attempts are rated to be low and highly variable for the rate of control of most species. It is a consensus that the site in theory could be brought to a community that looks similar to an at-risk community within the reference state, but that it is not possible to reach the reference community condition once annuals have established on a site. This is due to the need to work the soil or to do seedbed preparation to plant the native species which reduces soil stability by breaking down soil structure, and alters the hydrologic cycle by changing the infiltration and percolation rates of the soil. The alteration of the soils, the change in the plant community and the risk of re-invasion of the site will never allow it to react the same to management and environmental changes the same as a truly native community and so remains in a reclaimed state.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Fence
Livestock Pipeline
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Spring Development
Integrated Pest Management (IPM)
Watering Facility

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

Transition T 6-5
State 6 to 5

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

Additional community tables

Table 14. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				135–224	
	needle and thread	HECO26	*Hesperostipa comata*	135–224	30–50
2				67–112	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	67–112	15–25
3				22–45	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	22–45	5–10
	western wheatgrass	PASM	*Pascopyrum smithii*	22–45	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
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					
5	**Perennial Forbs**			45–90	
	castilla	CASTI	*Castilla*	0–22	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–22	0–5
	American vetch	VIAM	*Vicia americana*	0–22	0–5

	leafy wildparsley	MUDI	*Musineon divaricatum*	0–22	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	–
	white locoweed	OXSES2	*Oxytropis sericea var. speciosa*	0–22	–
	spiny phlox	PHHO	*Phlox hoodii*	0–22	–
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	–
	bastard toadflax	COUM	*Comandra umbellata*	0–22	–
	little larkspur	DEBI	*Delphinium bicolor*	0–22	–
	cutleaf daisy	ERCO4	*Erigeron compositus*	0–22	–
	threadleaf fleabane	ERFI2	*Erigeron filifolius*	0–22	–
	parsnipflower buckwheat	ERHE2	*Eriogonum heracleoides*	0–22	–
	fleabane	ERIGE2	*Erigeron*	0–22	–
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–22	–
	Forb, perennial	2FP	*Forb, perennial*	0–22	–
	textile onion	ALTE	*Allium textile*	0–22	–
	Franklin's sandwort	ARFR	*Arenaria franklinii*	0–22	–
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–22	–
	wavyleaf Indian paintbrush	CAAPM	*Castilleja applegatei ssp. martinii*	0–22	–
Shrub/Vine					
6				22–45	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	22–45	5–10
7				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
8	**Miscellaneous Shrubs**			22–45	
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5
	skunkbush sumac	RHTR	*Rhus trilobata*	0–22	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	–
	silver sagebrush	ARCA13	*Artemisia cana*	0–22	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–22	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	–

Table 15. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				90–135	
	needle and thread	HECO26	*Hesperostipa comata*	90–135	20–30
2	**Rhizomatous Wheatgrasses**			22–67	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–67	5–15
	western wheatgrass	PASM	*Pascopyrum smithii*	0–67	5–15

3				6–45	
	blue grama	BOGR2	*Bouteloua gracilis*	11–45	1–10
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
4				6–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–22	1–5
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				22–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	22–112	5–25
9				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5

	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
10	**Miscellaneous Shrubs**			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 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
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
Forb					
6	**Perennial Forbs**			22–45	
	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
	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
	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				45–224	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	45–224	10–40
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**			90–179	
	blue grama	BOGR2	*Bouteloua gracilis*	90–179	20–40
	threadleaf sedge	CAFI	*Carex filifolia*	45–112	10–25
2				22–45	
	needle and thread	HECO26	*Hesperostipa comata*	22–45	5–10
3	**Rhizomatous Wheatgrasses**			0–22	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–22	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–22	0–5
4				0–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
5	**Miscellaneous Grasses**			0–45	
	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**			6–45	
	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				22–45	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	22–45	5–10
9				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
10	**Miscellaneous Shrubs**			0–22	
	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

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**			45–179	
	blue grama	BOGR2	*Bouteloua gracilis*	45–179	30–60
	threadleaf sedge	CAFI	*Carex filifolia*	22–135	5–30
2				0–45	
	needle and thread	HECO26	*Hesperostipa comata*	0–45	0–10
3				0–22	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–22	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–22	0–5
4				0–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
5	**Miscellaneous Grasses/Grass-likes**			0–22	
	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**			22–112	
	plains pricklypear	OPPO	*Opuntia polyacantha*	22–112	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				0–22	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	0–22	0–5
9				0–22	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	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. 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. 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 – Mixed Shrub/*Bare Ground* Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

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

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

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

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

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

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

Animal Community – Grazing Interpretations:

The following table lists suggested stocking rates for cattle under continuous season-long grazing with normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor.

Plant Community Production Carrying Capacity*

The Carrying capacity is calculated as the production (normal year) X .25 efficiency factor / 912.5 # / AUM to calculate the AUM's/Acre.

Plant Community Description/Title	Lbs./Acre Below Ave.	Normal	Above Ave.	AUM’s/Acre*	Acres/AUM
1.1 Needleandthread/Indian Ricegrass	225	400	600	0.11	9.09
1.2 Perennial Native Grasses/Wyoming Big Sagebrush	180	320	480	0.09	11.11
2.1 Mixed Shrubs/*Bare Ground*	200	300	450	0.08	12.50
3.1 Sod-formers/Wyoming Big Sagebrush	60	150	300	0.04	25.00

3.2 Sod-formers/Cactus 55 175 350 0.05 20.00
4.1 Native/Invasive/Wyoming Big Sagebrush ** ** ** ** **
4.2 Invasives/Wyoming Big Sagebrush ** ** ** ** **
5.1 Invasives ** ** ** ** **
6.1 Disturbed/Degraded ** ** ** ** **
6.2 Restored/Reclaimed ** ** ** ** **

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

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

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

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

Hydrological functions

Water (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 Boysen State Park and the Wind River Indian Reservation. These entities have served to protect and provide cultural significance to this ecological site. This ecological site has minimal limitations when associated with roadways and trails, and provides a sound base for travel and camping in relation to erosion potential and functionality.

Wood products

No appreciable wood products are present on the site.

Other products

Herbs: The forb species of the 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 Senstaive 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	T37N R94W S3
UTM zone	N
UTM northing	4787977
UTM easting	734630
Latitude	43° 12′ 29″
Longitude	108° 6′ 42″
General legal description	SW1/4 NW1/4 Sec. 3 T37N R94W; 420 meters south and 79 meters east of the NW corner of Section. Universal Transverse Mercator (UTM) system: WGS 84

Other references

Baker, William L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin 34(1): 177-185.

Bestelmeyer, B., and J. R. Brown. 2005. State-and-transition models 101: a fresh look at vegetation change. The Quivira Coalition Newsletter, Vol. 7, No. 3.

Bestelmeyer, B., J. R. Brown, K. M. Havstad, B. Alexander, G. Chavez, J. E. Herrick. 2003. Development and use of state and transition models for rangelands. Journal of Range Management 56(2):114-126.

Bestelmeyer, B., J. E. Herrick, J. R. Brown, D. A. Trujillo, and K. M. Havstad. 2004. Land management in the American Southwest: a state-and-transition approach to ecosystem complexity. Environmental Management 34(1):38-51.

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005. Monitoring manual for grassland, shrubland and savanna Ecosystems. Volume I Quick Start. USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico.

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005. Monitoring manual for grassland, shrubland and savanna Ecosystems. Volume II: Design, supplementary methods and interpretation. USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico.

NRCS. 2014. (electronic) National Water and Climate Center. Available online at http://www.wcc.nrcs.usda.gov/

NRCS. 2014. (electronic) Field Office Technical Guide. Available online at http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=WY NRCS. 2009. Plant Guide: Cheatgrass. Prepared by Skinner et al., National Plant Data Center.

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health. Version 4. Technical Reference 1734-6. USDI-BLM. Ricketts, M. J., R. S. Noggles, and B. Landgraf-Gibbons. 2004. Pryor Mountain Wild Horse Range Survey and Assessment. USDA-Natural Resources Conservation Service.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE. (http://soils.usda.gov/technical/fieldbook/)

Stringham, T. K. and W. C. Krueger. 2001. States, transitions, and thresholds: Further refinement for rangeland applications. Agricultural Experiment Station, Oregon State University. Special Report 1024.

Stringham, T. K., W. C. Kreuger, and P. L Shaver. 2003. State and transition modeling: an ecological process approach. Journal of Range Management 56(2):106-113.

United States Department of Agriculture. Soil Survey Division Staff. 1993. Soil Survey Manual, United States Department of Agriculture Handbook No. 18, Chapter 3: Examination and Description of Soils. Pg.192-196.

USDA, NRCS. 1997. National Range and Pasture Handbook. (http://www.glti.nrcs.usda.gov/technical/publications/nrph.html)

Trlica, M. J. 1999. Grass growth and response to grazing. Colorado State University. Cooperative Extension. Range. Natural Resource Series. No. 6.108.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS). 2007. The PLANTS Database (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS), Soil Survey Staff. 2010. Keys to Soil Taxonomy, Eleventh Edition, 2010.

USDA/NRCS Soil survey manuals for appropriate counties within MLRA 32X.
Western Regional Climate Center. (2014) (electronic) Station Metadata. Available online at: http://www.wrcc.dri.edu/summary/climsmwy.html.

Contributors

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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.

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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.

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

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

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

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

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

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

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

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

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

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

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/grasslikes > Forbs

    Additional: Mid-stature Cool-season Bunchgrasses >> Shrubs > Forbs > Mid-stature Rhizomatous Grasses > Short-stature Grasses/Grasslike

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

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

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

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

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