USDA Natural Resources Conservation Service

Ecological site DX032X01B150
Sandy (Sy) Big Horn Basin Rim

Last updated: 2/10/2020
Accessed: 05/03/2024

General information

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

MLRA notes

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

Major Land Resource Area (MLRA):

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 Land Resource Units (LRUs) to allow individual ecological site descriptions (ESD). 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 further individualize these two basins.

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):

32X01B (WY): This LRU is the Big Horn Basin within MLRA 32. This LRU is lower in elevation, slightly warmer and receives slightly less overall precipitation than the Wind River Basin (LRU 02). LRU 01 was originally divided into two LRUs - LRU A which was the core and LRU B which was the rim. With the most current standards, this LRU is divided into two Subsets. This subset is Subset B, referred to as the Rim, is a transitional band between the basin floor and the lower foothills. The subset encircles Subset A (originally LRU A). As the LRU shifts towards the south and tracks east, changes in geology and relation to the mountain position, creates a minor shift 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 digitized boundary. Many of the noted soils are provisional and will be reviewed and corrected in mapping update projects. Other map units are correlated as small inclusions within other MLRA’s/LRU’s based on elevation, landform, and biological references.

Moisture Regime: Ustic Aridic – Prior to 2012, many of the soils within this group were correlated as Frigid Ustic Aridic or as Mesic Typic Aridic, with few mapped within this cross over zone. As progressive soil survey mapping continues, these “crossover” or transitional areas are being identified and corrected.

Temperature Regime: Mesic
Dominant Cover: Rangeland, with Saltbush flats the dominant vegetative cover for this LRU/ESD.
Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm)
RV Frost-Free Days: 105-125 days

Classification relationships

Relationship to Other Established Classification Systems:

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

Ecoregions (EPA):
Level I: 10 North American Deserts
Level II: 10.1 Cold Deserts
Level III: 10.1.18 Wyoming Basin
Level IV: 10.1.18.b Big Horn Basin (and)
10.1.18.d Foothill Shrublands and Low Mountains (and)
10.1.18.g Big Horn Salt Desert Shrub Basin

Ecological site concept

• The Sandy ecological site (ES) receives no additional water.
• The slope is less than 30 percent

• Soils in the Sandy ES:
o Have textures ranging from loamy sand to very fine sandy loam in the top 4” (10 cm) of the mineral soil surface
o Have a clay content of less than or equal to 18 percent in the top 4” (10 cm) of mineral soil surface
o Have a weighted average of 18 percent clay in all subsurface horizons in the particle-size control section. (The particle-size control section is the segment of the profile from either the start of an argillic horizon for 50 cm or from 25-100 cm).
o Are moderately deep to very deep (20-80+ in. or 50-200+ cm)
o Have more than 3 percent stone and boulder cover and 20 percent or less cobble and gravel cover
o Are not skeletal (less than 35 percent rock fragments) within 20” (50 cm) of the mineral soil surface
o Have none to slight effervescence throughout the top 20” (50 cm) of the mineral soil surface
o Are non-saline, sodic, or saline-sodic

The Sandy ecological site concept is based on minimal (none to slight) influence from salts, carbonates, gypsum, or other chemistry within the top 20 inches (50 cm) of the mineral soil surface. The main soil characteristic is a moderately deep to very deep soil that is coarse in texture with less than 18percent clay throughout the soil profile; the dominant soil textural classes range from loamy sand to sandy loam in the subsurface. The plant community transitions from sandy to loamy as the control section increases above 18 percent clays with increased rhizomatous wheatgrasses, additional forb species, and increased ground cover.

The Sandy ecological site can be found in several different catena throughout the basin. In an escarpment catena, it occurs with shallow and very shallow soils. Hillslope catena have sandy and loamy soils occurring in a complex mosaic pattern where the geology is controlled by interbedded sandstone and shale; or in areas where the parent material is alluvial. Locations controlled primarily by sandstone bedrock support Sandy ecological sites in stable areas, with soil development (weak structure) adjacent to sandstone rock outcrop. Yucca, shadscale, and spiny hopsage are common in these stable areas and generally occur closer to rock outcrop. These shrub species are also common in the Sands ecological site, which is characterized by no or minimal soil development.

Associated sites

R032XY312WY	**Gravelly (Gr) 10-14" East Precipitation Zone** Gravelly sites have the potential for bluebunch wheatgrass, and lack production that Sandy sites hold, and are higher in “pincushion” forbs.
R032XY304WY	**Clayey (Cy) 10-14" East Precipitation Zone** The Clayey ecological site has similar production potential; however, responses to disturbance, management and climatic changes will be different. Location on the landscapes are similar, but Clayey sites tend to fall along alluvial drainages or below shale outcrops/outwashes.
R032XY322WY	**Loamy (Ly) 10-14" East Precipitation Zone** Loamy sites will also be similar in production, but again response to management, disturbance and climatic shifts will vary. Loamy sites are generally found in the central or posterior edge of a landform such as alluvial fans, fan aprons, outwashes, and pediments.
R032XY328WY	**Lowland (LL) 10-14" East Precipitation Zone** The Lowland site will have similar soils, outside of the presence of a water-table during parts of the year at a depth. This water-table influences the vegetation so have Basin big sagebrush, and other water demanding plants.
R032XY366WY	**Shallow Sandy (SwSy) 10-14" East Precipitation Zone** Shallow Sandy sites are generally located on the break of slopes, on or surrounding rock outcrops before it transitions into more gently rolling landforms with deeper soils. Similar plant communities with more pincushion forbs and a higher percentage of bluebunch wheatgrass, but a marked reduction in production and increased bare ground.
DX032X01B146	**Sands (Sa) Big Horn Basin Rim** 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.
DX032X01B145	**Saline Upland Sandy (SUS) Big Horn Basin Rim** Saline upland sites commonly occur intermixed with Loamy sites, especially along marine shale deposits or escarpments with interbedded shales and sandstones. Saline uplands are dominated by short saltbush species and limited productivity from saline soils.

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 (B150) will narrow the concept and allow for a clearer community concept.
R032XY150WY	**Sandy (Sy) 5-9” Big Horn Basin Precipitation Zone,** The Big Horn Basin Core Site (5-9” precipitation, Mesic) was updated to A150, but is similar to the XY150 site. This site will be lower in productivity with a higher presence of bare ground in comparison to B150 (current site description). The species composition is very similar with only small shifts in forb species, and recovery ability.

Table 1. Dominant plant species

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

Legacy ID

R032XB150WY

Physiographic features

The Sandy ecological site generally occurs on slopes ranging from nearly level to moderately steep (0-20 percent). Fan remnants, hillsides, ridges, and alluvial fans are the major landforms where this site exists. The site also occurs on relict stream terraces, with minimal or no active soil deposition.

The relict landforms generally have a higher chemistry than what is classified in this site concept. Currently, data does not sufficiently support the requisite for a “Sandy Calcareous” ecological site. But with further review, there may be a warranted demand for this development. Until such times, it will be at the discretion of the land manager to determine the best fit (loamy calcareous or sandy) for these locations.

The complexes of soil components mapped across most landforms typically are 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.

The variability of soils will create pockets of calcareous, saline, or 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. But as previously stated, there are areas where there is a higher level of chemistry in the soil than generally accepted.

The Sandy ecological site is most prominent on the upper extents of fans or at the base of rock outcrop. Loamy and Clayey ecological sites increase in occurrence as the landscape shifts away from steeper slopes with prominent rock outcrop, towards the distal end of the landform. Wind effects are common with this site and can relate to the proximity to taller landforms.

Figure 1.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Fan remnant (2) Intermontane basin > Hillslope (3) Intermontane basin > Fan piedmont (4) Intermontane basin > Alluvial fan
Runoff class	Negligible to medium
Elevation	1,463–1,966 m
Slope	0–30%
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 10 to 14 inches (254–355 mm). The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50 percent 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 totals about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. High winds are generally blocked from the basin by high mountains, but can occur in conjunction with an occasional thunderstorm. Growth of native cool-season plants begins about April 1 and continues to about July 1. Cool weather and moisture in September may produce some green-up of cool-season plants that will continue to late October. For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/. Clark 3NE, Cody, Cody 12SE, Heart Mtn, and Powell Fld Stn are the representative weather stations within LRU D. The following graphs and charts are a collective sample representing the averaged normals and 30-year annual rainfall data for the selected weather stations from 1981 to 2010.

Table 3. Representative climatic features

Frost-free period (characteristic range)	87-97 days
Freeze-free period (characteristic range)	113-123 days
Precipitation total (characteristic range)	229-279 mm
Frost-free period (actual range)	83-108 days
Freeze-free period (actual range)	111-125 days
Precipitation total (actual range)	178-305 mm
Frost-free period (average)	93 days
Freeze-free period (average)	118 days
Precipitation total (average)	254 mm

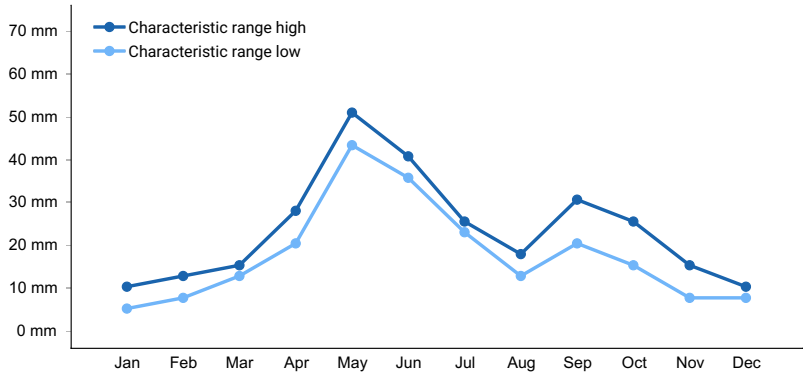


Figure 2. Monthly precipitation range

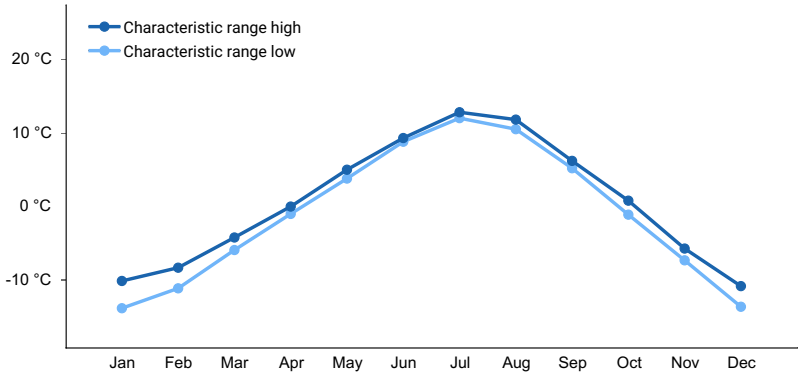


Figure 3. Monthly minimum temperature range

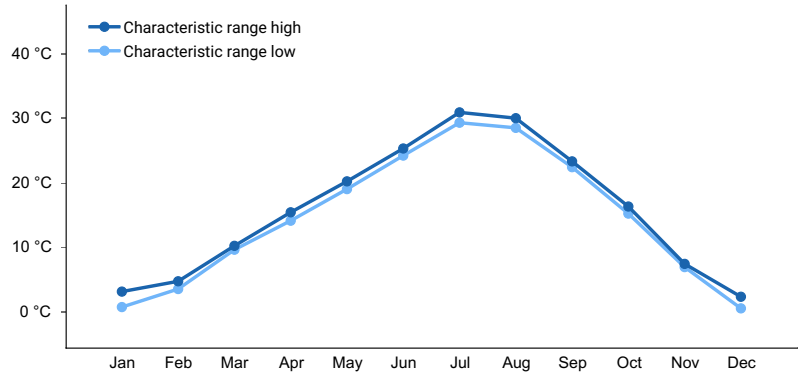


Figure 4. Monthly maximum temperature range

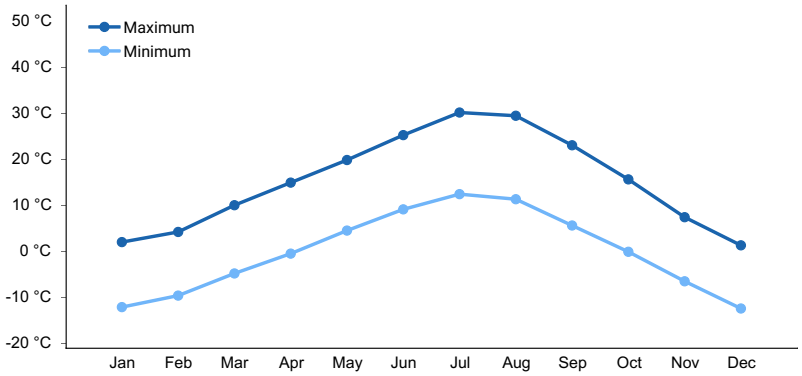


Figure 5. Monthly average minimum and maximum temperature

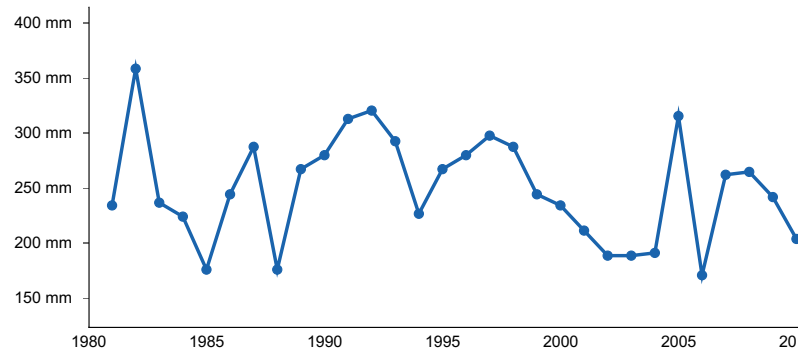


Figure 6. Annual precipitation pattern

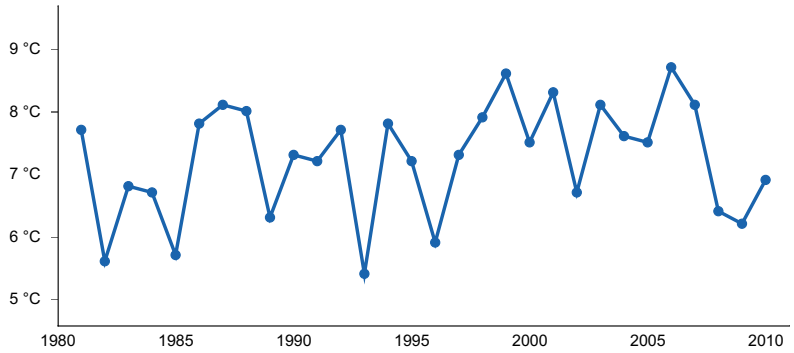


Figure 7. Annual average temperature pattern

Climate stations used

- (1) HEART MTN [USC00484411], Powell, WY
- (2) CODY [USC00481840], Cody, WY
- (3) CODY 12SE [USC00481850], Meeteetse, WY
- (4) THERMOPOLIS 9NE [USC00488884], Thermopolis, WY
- (5) POWELL FLD STN [USC00487388], Powell, WY
- (6) SHELL 1NE [USC00488124], Shell, WY

Influencing water features

The characteristics of these upland soils have no influence from ground water (water table below 60 inches or 150 cm) and have minimal influence from surface water or overland flow. There may be isolated features that are affected by snowpack that persists longer than surrounding areas due to position on the landform (shaded or protected pockets), but overflow is not a suitable fit. No streams are classified within this ecological site.

Soil features

The soils of the Sandy ecological site are moderately deep to very deep (greater than 20 inches or 51 cm to bedrock), well drained to somewhat excessively well drained, and have moderate to rapid permeability. The soil characteristic that has 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 or 51 cm). If the soil has an alluvial parent material, alluvial gravels can be present on the soil surface (20 percent or less) and throughout the soil profile of less than 35 percent by volume.

For this ecological site, salts and calcium carbonate occur below the depth of plant influence (20 inches or 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 included the standard properties by depth table.

Increases outside of the stated ranges of calcium carbonates or other soluble salts are potential transitions to a different ecological site. In instances where the sites are calcic or calcareous, and there is a shift in the identified plant community common to the Loamy Calcareous ecological site (predominately bluebunch wheatgrass), then it may be necessary to assign the community to that ecological site. A review is in process to determine if a “Sandy Calcareous” ecological site or an expansion of Loamy Calcareous is warranted.

Major soil series correlated to this site include: Asherton, Begay, Bessler, Bidman, Chugcity, Claprych, Hiland-like, Kamms, Keeline, Mughut, Olney, Ralstonflats, Remmit, Remmit-like, Roberstondraw, Terro, Terry, Turnback, Turnback-like, Turnercrest, Vonalee, Vonid, Windwhistle, and Windwhistle-like. This list of soil series is subject to change upon completion and correlation of the initial soil surveys in the area: WY629, WY603, and WY617; as well as revisions to completed soil surveys in the area: WY043 and MT611.

Figure 8. Soils profile image of a typical sandy soil profile.

Table 4. Representative soil features

Parent material	(1) Alluvium–sedimentary rock (2) Residuum–sandstone (3) Eolian deposits–sedimentary rock
Surface texture	(1) Gravelly sandy loam (2) Fine sandy loam (3) Loamy very fine sand (4) Loam
Family particle size	(1) Coarse-loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate to rapid
Soil depth	51–152 cm
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–15%
Available water capacity (0-101.6cm)	3.05–16 cm
Calcium carbonate equivalent (0-101.6cm)	0–4%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.2
Subsurface fragment volume <=3" (Depth not specified)	0–30%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

Potential vegetation on this site is dominated by mid-statured cool-season perennial grasses. Other significant vegetation includes Wyoming big sagebrush, winterfat, and a variety of forbs. The expected potential composition for this site is 75 percent grasses, 15 percent forbs, and 10 percent woody plants. The composition and production will vary naturally due to historic use, fluctuating precipitation, and other disturbances.

As this site deteriorates, species such as blue grama and threadleaf sedge to increase and Wyoming big sagebrush will be more prominent; while cool-season grasses such as needle and thread and Indian ricegrass will decrease in frequency and production. Continued pressure will allow plains pricklypear and weedy annuals to invade. Extended periods of drought and other climatic shifts have produced similar transitions in the vegetation.

Studies support the necessity 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 a decrease in clay content are excluded. And soils must remain below the 18 percent clay content throughout the top 20 inches (50 cm) of the soil profile.

A correlation is observed with the amount of needle and thread and western wheatgrass with the fine-loamy and coarse-loamy particle-size classes. Finer-textured soils hold a higher ratio of western wheatgrass to needle and thread with Indian ricegrass; whereas coarser-textured soils hold the opposite, with a higher ratio of needle and thread and Indian ricegrass to western wheatgrass. [Soils particle-size classes are used to characterize the grain-size composition of the whole soil, including both the fine earth and the rock fragments in a soil based on percent by weight. Coarse-loamy soil has 15 percent or more of fine sands or coarser and less than 18 percent clay; fine-loamy soils have 15 percent or more of fine sand or coarser with 18 percent or greater to less than 35 percent clays; and finely textured soils have more than 35 percent but less than 60 percent of clay.]

The narrowing of the site characteristics to less than18 percent clay within the particle-size control section has eliminated the fine-loamy and fine particle-size classes from this concept. There will be a fuzzy boundary as the site transitions into heavier-textured soils. Variability of the vegetative community also relates to the soil surface structure. Those soils with a platy surface structure appear to have a slightly heavier texture with response to rain impact and plant vigor. Management implications will be clarified, and the range of characteristics will be documented within the plant community tables.

Wyoming big sagebrush may increase expression in this ecosystem under limited use and lack of fire; however, the risk of sagebrush dominating the site is lower than on finer- or heavier-textured soils because of the decreased moisture storage potential of the soils. The actual number of individual plants may not increase significantly, but the overall size and coverage of each plant increases. An extensive taproot allows sagebrush to access deeper soil moisture and nutrients during extended dry periods providing a competitive advantage over the shallower root systems of native grasses, but extended drought will cause stress and decadence or death in sagebrush quicker than in finer- or heavier-textured soils.

Wide-scale changes in livestock grazing patterns and species as well as the control of wildfires has resulted in an aging and low vigor stands of Wyoming big sagebrush that are susceptible to insect damage and disease. Chemical control using herbicides replaced the historic role of fire for large-scale control. Over the past decade, prescribed burning has regained some popularity for controlling sagebrush. Mosaic or "patch" burns are being utilized to create or enhance wildlife habitat, specifically for sage grouse and other sagebrush-obligate species. In the absence of sagebrush manipulation, the oils and tannins in the leaves of sagebrush increase with age, rendering the plant bitter and unpalatable, reducing the beneficial forage value even for sagebrush-obligate species.

Fire recovery in this arid, warm system is very slow with extensive (long-duration) fire return cycles. With the slow recovery of sagebrush and difficulty of seedling establishment, fire is not the major contributor to the changes in sagebrush health that it once was labeled. However, fire is a natural regime that encourages rejuvenation and cycling of sagebrush and does have a roll in this landscape, just too a much lower degree than initially determined.

Intensity and timing of precipitation limits the resilience of Wyoming big sagebrush in this system. Once sagebrush has been removed, especially where vigorous stands of grass are maintained, seedling establishment is hindered by the competition for limited soil moisture. The loss of structure (height) for snow catch and woody canopy for moisture retention, protection from grazing, and wind desiccation affects young sagebrush seedlings. New plants are susceptible to stress and herbivory, reducing new establishment. Considering the extended periods of time required for natural reestablishment of sagebrush (beyond 25 years), natural recovery of sagebrush has a minimal feasibility as a management tool.

Encroachment of blue grama and threadleaf sedge occurs with a combination of disturbances (hoof action,

defoliation, and compaction) or shift in climate (extended drought). Initial assumptions placed overutilization or improper management as the cause of this community shift. But the wide-spread occurrence with transitions occurring across management strategies, supports the concept of a portion of this shift occurring in relation to the timing of precipitation and other climatic changes that are occurring.

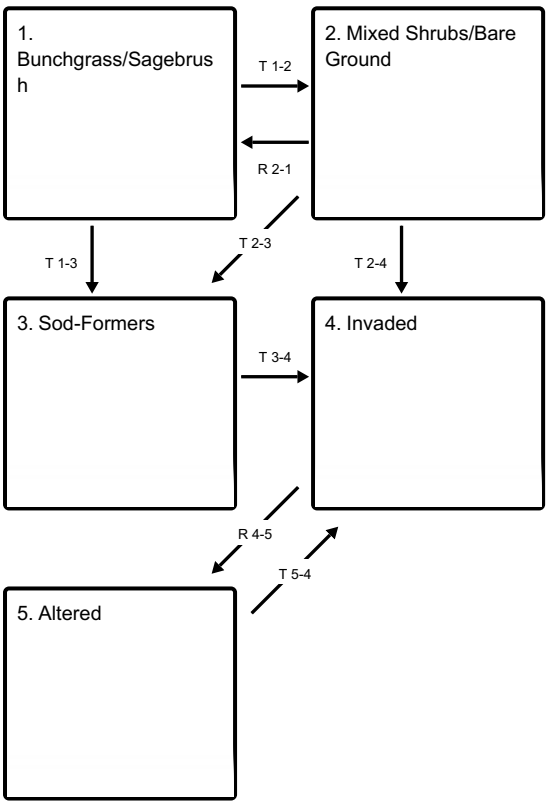
The ecological states and community phases as well as the dynamic processes driving the transitions between these communities have been determined by studying this ecological site under all management scenarios, including those that do not include cattle grazing. Trends in plant communities going from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

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 from a lower state to a higher state (State 2 - State1 or better illustrated by State 1

State and transition model

Ecosystem states



T 1-2 - Frequent or high-intensity herbivory on a community weakens the ability for the grasses to persist, especially during prolonged drought. Low vigor in grasses and lack of fire shifts the composition to a more pronounced sagebrush community. In time, sagebrush will increase in density (lack of perennial grass cover), preventing the recovery without intervention.

T 1-3 - Long duration, high-intensity grazing reduces the bunchgrass component and encourages threadleaf sedge and blue grama. Prolonged drought stresses the plants, opening the canopy, and allows these short-statured sod-forming grasses to fill in the interspaces. The shallow, dense root mats will continue to spread over time. The removal of sagebrush with animal impacts, fire or brush management aids in establishing this sod-former community.

R 2-1 - Removal or thinning of the sagebrush by mechanical or chemical means, or by fire, leaving remnant populations of desired native perennial grass species allows the recovery to the Reference State, if climatic variables cooperate and rest occurs for seed development and seedling establishment.

T 2-3 - Sod-forming species such as threadleaf sedge and blue grama can tolerate high levels of use and will maintain as other native species decline. This decline creates a sagebrush–sod-former community that is resistant to change with management. Impacts to sagebrush by disease or insect damage will shift this to the secondary community phase.

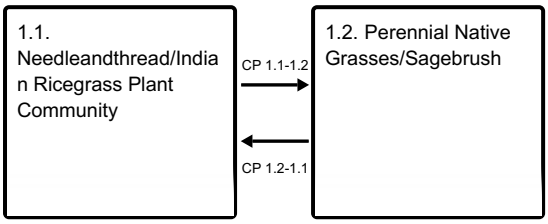
T 2-4 - Seed sources are prevalent for cheatgrass, knapweed, and other invasive species. Stress to the native community from drought; events such as wildfire (prescribed burning) and other forms of brush management; or ground/soil disturbance, including impacts by grazing large herbivores or recreation creates a niche for invasive or undesirable weeds. This invasion will start small and spread each year if not addressed immediately.

T 3-4 - The interstitial spaces within the patchy canopy of sod-formers leaves areas for weedy species to establish, especially with disturbance or within high traffic areas.

R 4-5 - Integrated pest management plan or other intense weed control program with seeding will be necessary to overcome a severe weed infestation. Preparing the seedbed and using improved varieties, native seed, or introduced species suited for the management use intended may be the only way to overcome some invasive species.

T 5-4 - In the reclamation or restoration process, or after land disturbance, 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 overutilization can be a disturbance that either opens the canopy or introduces the species to the location.

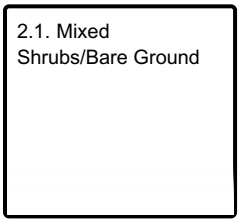
State 1 submodel, plant communities



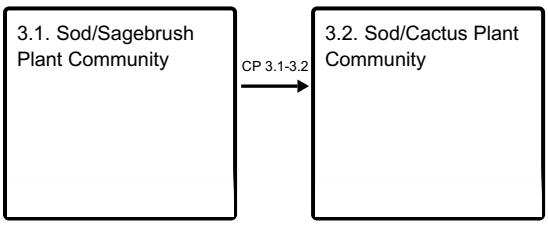
CP 1.1-1.2 - Historic use patterns, drought, and climatic shifts have attributed to the decline in needle and thread and Indian ricegrass. As bare ground increases, species such as prairie Junegrass, blue grama, and threadleaf sedge increase as well as the canopy of sagebrush.

CP 1.2-1.1 - Removal of the historic use patterns in favor of a rest rotation system, and the implementation of wildlife management programs has helped to reduce the grazing pressure and allow rest for recovery. The use of dormant season grazing to thin sagebrush, by reducing overall canopy and encouraging rejuvenation of growth. This also allows grasses the opportunity to spread out from the crown of the sagebrush plant and increase in density within the interspaces.

State 2 submodel, plant communities

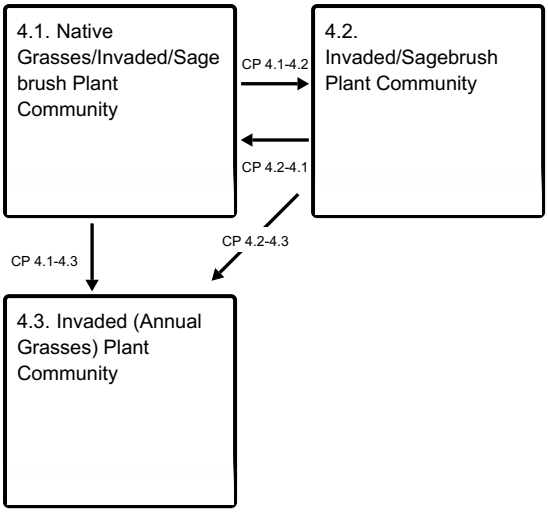


State 3 submodel, plant communities



CP 3.1-3.2 - 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 or insect damage and disease, the community will move towards a complete sod community. Cactus increases in this transition due to the open interspaces between patches of sod-formers.

State 4 submodel, plant communities



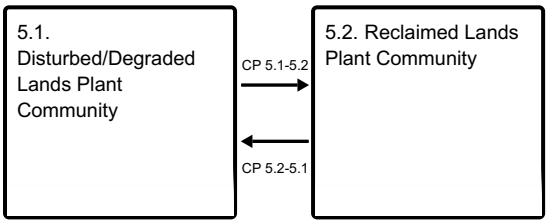
CP 4.1-4.2 - The competition for limited resources by invasive species, coupled with the weakening of natives with continued drought stress or grazing pressure, will allow the invasive species to become dominant on the site, leaving only remnant populations of natives. Non-use allows soils to become loose and vulnerable to invasive species in these stressed conditions, allowing expansion as the natives decline.

CP 4.1-4.3 - Removal of sagebrush by fire, drought, or overuse opens the potential for invasion by weedy species, especially by cheatgrass following a fire. Continued overutilization or continued drought will further stress the native grasses, opening the canopy to the threat of invasive species.

CP 4.2-4.1 - The integration of a pest management and weed control plan to reduce competition in conjunction with intensive grazing management over time will encourage the remnant populations of native species protected within the crown of the sagebrush to expand their footprint in the community. In some instances, it may be natives from surrounding communities that will creep back into a weed dominated site. Eradication of the invasive species may not be possible, but it is possible to encourage natives to persist on the site.

CP 4.2-4.3 - A catastrophic disturbance (intense or large-scale fire) resulting in the loss of sagebrush and native grasses opens the potential for invasion by weedy species, especially by cheatgrass following a fire.

State 5 submodel, plant communities



CP 5.1-5.2 - Rangeland seeding, and mechanical treatments, can be used to establish native species back to the community. With integrated pest management and intensive weed control and management this site can be maintained.

CP 5.2-5.1 - Abandoned sites or heavily impacted areas will become weedy quickly. If a reclaimed site is not managed properly, abused or left unused, the community will degrade back to early successional or other invasive weedy species.

State 1
Bunchgrass/Sagebrush

The reference state (State 1) for the Sandy ecological site is dominated by mid-stature, cool-season bunchgrasses. This state persisted under grazing by large ungulates and was a resource for forage and habitat for a variety of wildlife.

Characteristics and indicators. The Bunchgrass/Sagebrush State (State 1□Reference) is characterized by the prominent cover of needle and thread (15-30 percent composition) and Indian ricegrass. Rhizomatous wheatgrasses and prairie Junegrass are common, with 10 percent or less cover of Wyoming big sagebrush. Minor components to the overall composition is made up of Sandberg bluegrass, bottlebrush squirreltail, sand dropseed, threeawn, blue grama, and threadleaf sedge.

Resilience management. Prescribed grazing or managed use to provide forage removal and to help incorporate litter helps for this suit of communities to persist on the landscape and to maintain vigor.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- Indian ricegrass (*Achnatherum hymenoides*), grass
- needle and thread (*Hesperostipa comata*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass

Community 1.1
Needleandthread/Indian Ricegrass Plant Community

This community (1.1) is captured as the Refere nce Plant Community; however, it is declining in occurrence on the landscape. Change or shifts in timing of precipitation, temperature shifts (spring warm-up or fall freeze), or lack of precipitation could be the dominant driving factors for this occurrence. This state evolved with grazing by large herbivores. The potential vegetation cover is about 70 percent grasses or grass-like plants, 20 percent forbs, and 10 percent woody plants. Dominant grasses include needle and thread, Indian ricegrass, prairie Junegrass, and rhizomatous wheatgrasses. Grasses and grass-like species of secondary importance include Sandberg bluegrass, sand dropseed, threeawn, blue grama, and threadleaf sedge. A variety of forbs are found in this community including fleabanes, wild parsley, lemon scurfpea, and scarlet gaura. Wyoming big sagebrush, fringed sagewort, and winterfat are conspicuous components of the community, and can make up to 10 percent of the annual production. The total annual production (air-dry weight) of this community phase is about 500 lbs./acre, but it can range from about 375 lbs./acre in unfavorable years to about 675 lbs./acre in above-average years. This plant community can be found on areas that are properly managed with grazing or other means of defoliation, and on areas receiving occasional short periods of rest. Historically, the Reference State evolved with grazing pressure by large ungulates (elk, bison, deer, and antelope); as well as under a low fire frequency (estimated to be 195 to 235 years between burns on the same community patch; sagebrush has a post fire recover timeframe of 50-120 years or more in arid systems. Baker, 2006).

Resilience management. Rangeland Health Implications/Indicators: Species diversity of this community provides a high tolerance to drought, allowing persistence in the limiting climatic conditions of the Big Horn Basin. The structural diversity of Wyoming big sagebrush in conjunction with the mid-statured bunchgrasses (needle and thread and Indian ricegrass), rhizomatous species (western wheatgrass and thickspike wheatgrass), and the short-statured bunchgrasses (prairie Junegrass, Sandberg bluegrass, and threeawn) helps to provide snow catch and shade, to capture and hold moisture in order to maximize availability during the growing season. This key to the hydrologic function as well as the adaptability of the community to the variability in timing of precipitation helps to provide cover, through a variety of conditions. Needle and thread is dependent upon early spring moisture to perform well; years with late spring early summer moisture will produce minimal to no needle and thread, 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 needle and thread. The persistence and adaptability from year to year of these species allows for quick recovery once normal precipitation returns. This natural variability will cause the transition between phase 1.1 and 1.2, but is not at risk of transitioning into a different state unless a significant (catastrophic) impact occurs. Extended periods of drought, use changes, and other natural and human-derived impacts further force this change. This community, as Reference, is indicative of rangeland health which is based on site and soil stability, watershed function, and biologic integrity.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- Indian ricegrass (*Achnatherum hymenoides*), grass
- needle and thread (*Hesperostipa comata*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	364	448	560
Shrub/Vine	50	67	112
Forb	6	45	84
Total	**420**	**560**	**756**

Table 6. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	30-60%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-20%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	20-35%

Table 7. 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	5-20%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	20-35%

Table 8. Canopy structure (% cover)

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

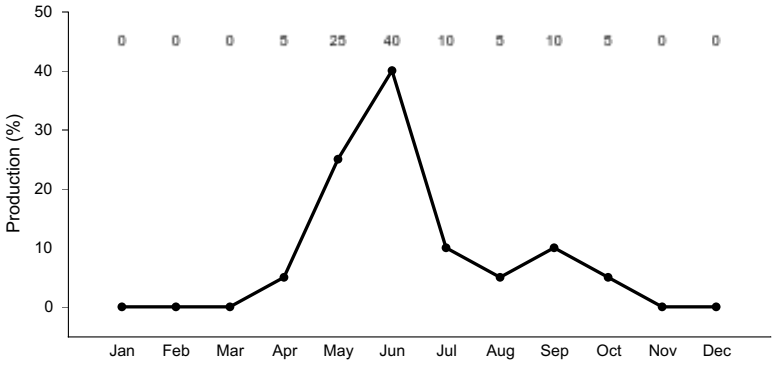
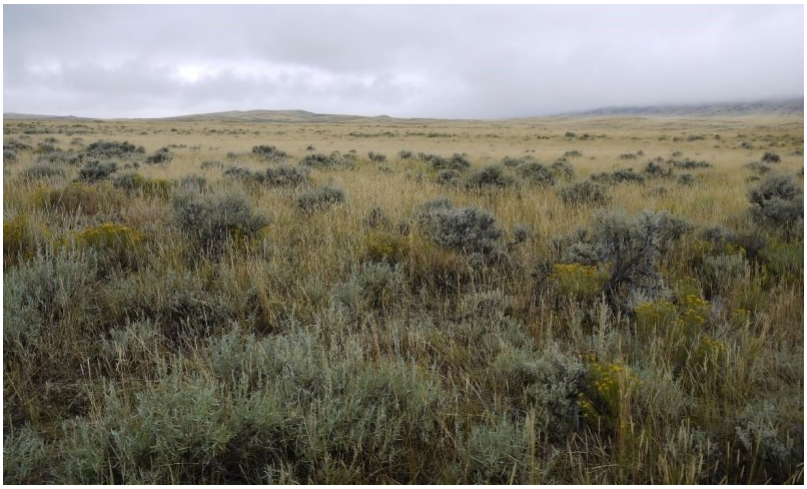


Figure 10. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 1.2
Perennial Native Grasses/Sagebrush



The secondary community phase (1.2) of the Reference State 1, is characterized by the loss of Indian ricegrass and the increase in composition by weight of Wyoming big sagebrush. Otherwise, the shift in in species composition and function is minor. The community can be found on areas that are within the scope of historic disturbances but have been impacted by a shift in climate or management, stability of the site and production potential. The vegetation composition is 65 percent grasses or grass-like plants, 10 percent forbs, and 25 percent woody plants. This community is still dominated by cool-season mid-statured grasses. The major understory of grasses and grass-like plants includes needle and thread, prairie Junegrass, rhizomatous wheatgrasses, threadleaf sedge, blue grama, and Sandberg bluegrass. The variety of forbs and half-shrubs commonly found include scarlet globemallow, lemon scurfpea, scarlet gaura, and spiny phlox. Wyoming big sagebrush can make up 25 percent of the annual production. The overstory of Wyoming big sagebrush and understory of grasses and forbs provide a diverse plant community. Threadleaf sedge and blue grama have increased within this community; however, they are not the most prevalent species, but they have an impact on moving or changing the hydrology of the site.

Wyoming big sagebrush and yucca, when present, have increased in composition by weight, but that does not correlate to a composition by cover. Plains pricklypear cactus will also have increased but occurs only in small patches. Indian ricegrass has decreased and may occur in only trace amounts under the sagebrush canopy or within the patches of pricklypear; needle and thread and winterfat have remained as a common component in this community. The total annual production (air-dry weight) of this community is about 525 lbs./acre, but it can range from about 375 lbs./acre in unfavorable years to about 725 lbs./acre in above-average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is relatively resistant to change but is at-risk of transitioning with continued stress. 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 overutilization or increased intensity of defoliation. The overall canopy is adequate, but the shift in structure of cover and increase in bare ground opens niches for weedy species as well as slightly reduces the infiltration of snowmelt (loss to evaporation). Although minor, an increase in bare ground, shallower-rooted species, and woody cover reduces the site resiliency. Bare ground averages 25 to 35 percent, and woody cover has increased to an average of 10 to 25 percent. Litter and biological crust cover overall appears to be similar across this state (State 1). Water flow patterns and litter movement are minimal but are slightly more pronounced 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.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- needle and thread (*Hesperostipa comata*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass
- prairie Junegrass (*Koeleria macrantha*), grass

Table 9. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	353	392	448
Shrub/Vine	56	140	252
Forb	11	56	112
Total	**420**	**588**	**812**

Table 10. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-25%
Grass/grasslike foliar cover	30-40%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	25-35%

Table 11. Soil surface cover

Tree basal cover	0%

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

Table 12. Canopy structure (% cover)

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

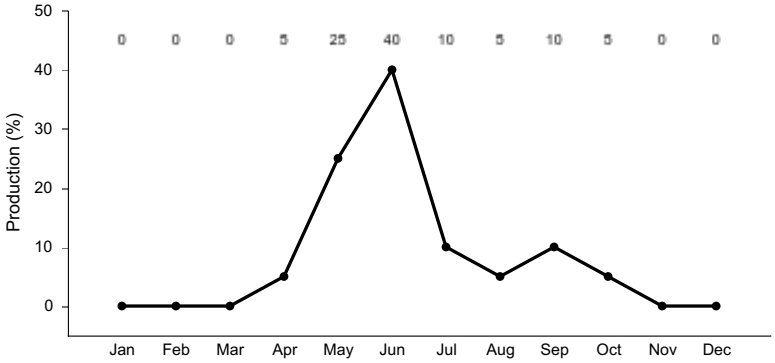
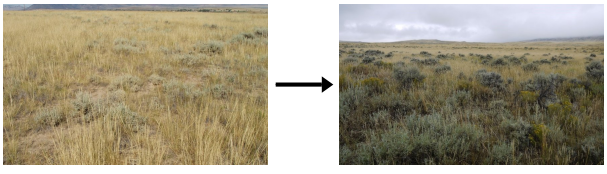


Figure 12. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Pathway CP 1.1-1.2
Community 1.1 to 1.2



Needleandthread/Indian Ricegrass Plant Community

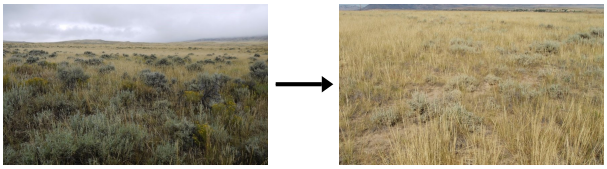
Perennial Native Grasses/Sagebrush

Timing of grazing, Drought, Climatic shifts – Historically, the large expanses of federal lands were used during the summer exclusively or were utilized in the spring and then again in fall as sheep were trailed to forest allotments

and then home again. The repetitive timing of use would have slowly removed more desirable species from the system, encouraging the rhizomatous and low-statured bunchgrasses. Long periods of drought and shifts in spring precipitation patterns have weakened and impacted the productivity and vigor of most species and has encouraged the low-statured cool-season grass-like and warm-season grass species – threadleaf sedge and blue grama. Although the species of herbivory and timing has changed with the installation of more grazing management, drought and other climatic patterns still pose a continual threat to the integrity of this plant community. The shift in this community is marked by the decline of Indian ricegrass, with an increase in rhizomatous wheatgrasses, prairie Junegrass, threadleaf sedge, and blue grama.

Context dependence. 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-statured grasses and grass-likes (blue grama, threadleaf sedge) have increased across the entire basin but has remained as a secondary component in these reference communities.

Pathway CP 1.2-1.1
Community 1.2 to 1.1



Perennial Native Grasses/Sagebrush

Needleandthread/Indian Ricegrass Plant Community

Long-term Prescribed Grazing, Brush Management - Integration of a rotational grazing system or rest-rotation with management to reduce or improve quality of the shrub canopy, will encourage the native bunchgrasses to reestablish in this community. An extended period of time (estimated at 5 to 10 years) may pass before significant change is noticed. Prescribed grazing, especially following sagebrush canopy treatments, helps to remove woody debris and expose the existing seedbank, encouraging native species. Allowing rest during critical seedling establishment and reducing competition will help recovery. Hoof action helps to incorporate the seed and litter to allow the desired bunchgrasses (needle and thread, Indian ricegrass) and rhizomatous wheatgrasses 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 limit mat-forming species, maintaining the hydrologic cycle, reducing runoff. A long-term management strategy may be required before any trend towards the Reference State is noticed. The overstory of Wyoming big sagebrush may be the one factor that could require further manipulation to reduce canopy and composition to the desired 10 percent cover.

Conservation practices

Brush Management
Prescribed Burning
Grazing Land Mechanical Treatment
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management
Prescribed Grazing
Grazing Management Plan

State 2
Mixed Shrubs/Bare Ground

Persistence of drought with frequent overuse leads to a decline of the herbaceous species, creating the Wyoming Big Sagebrush/*Bare Ground* State. Wyoming big sagebrush creates a zone of protection for understory of herbaceous species. Sagebrush and other woody species provide shade, moisture reserves, and protection from herbivory. A select array of herbaceous cover will persist in this understory and may maintain vigor in difficult conditions.

Characteristics and indicators. Sagebrush or woody vegetative cover is the prominent characteristic of this state. The understory of herbaceous cover is generally lacking or sparse in the woody cover interspaces. The woody canopy does provide a "niche" for some herbaceous species to persist.

Resilience management. This state can be exacerbated by insects and other human disturbances. The total woody canopy (foliar) cover does not necessarily increase in this community, but the percent composition by weight (annual production) is influenced by the decrease of herbaceous vegetation and the relative stability of the woody species production, creating the appearance of increased canopy cover of sagebrush. Risk of wildfire is minimal due to the lack of fine fuels within the understory, but the canopy of the woody vegetation can easily carry a fire under specific weather conditions. Depending on the prescription of use, trailing and other erosional patterns are highly visible in this state. The loose or coarser texture of these soils allows for increased wind scour and drifting/mounding to occur with more open ground between canopy “patches,” that further hinders fire movement. Protection from wildfire and use, on a long-term perspective, can aid in the transition of a Reference Community (1.1 or 1.2) to this state as sagebrush becomes dense and decadent reducing the ability for the herbaceous component to maintain vigor. The loss of herbaceous cover leads to increased bare ground and sagebrush cover. As the site continues to weaken, the sagebrush cover is susceptible to attack by insects, disease, and old age; which can remove it from the system increasing the risk of invasion or transition to a more degraded state. The overall arid nature of coarse textured soils exacerbates the impact of drought and reduces the resilience and resistance of this site during extended dry periods. The presence of yucca on this site is not frequent, but when it does occur, it can easily become a concern, especially if frequently grazed in the winter. The growth habits of the yucca plant produces pedestalling and drift/scour patterns on the landscape. The level of variability of species in this state (State 2) remains abundant; however, only one-well defined community will be provided here, with discussion of transitions or variances from this community.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub

Community 2.1
Mixed Shrubs/Bare Ground

This plant community is the result of the degradation of the herbaceous understory and subsequent dominance of Wyoming big sagebrush. Annual production of sagebrush exceeds 25 percent of the total annual production and is a significant component of the plant community by cover. Remnant populations of the mid-statured cool-season grasses exist but have been greatly reduced. Yucca and spiny hopsage may be components of this community in response to the coarse textures and the potential to mound on the leeward side of sagebrush. The dominant grasses and grass-likes are needle and thread, Sandberg bluegrass, threadleaf sedge, and blue grama. Plains pricklypear cactus is more prominent on landscape. Plant interspaces have increased with the more prevalent bare ground. In comparison to the Reference Plant Community 1.1, the annual production is slightly reduced, with the shrub production increasing to compensate for the decline in herbaceous production. Although this is the only noted community phase within this state, there is a range of variability. This community is determined to be “At-Risk” due to its vulnerability to invasive weeds such as cheatgrass, Russian knapweed, or leafy spurge, if a seed source is available. The total annual production (air-dry weight) of this state averages 475 pounds per acre, but it can range

from 310 lbs./acre in unfavorable years to 700 lbs./acre in above-average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change because of the loss of herbaceous species. Increased bare ground and increased interspaces has left this community at-risk and is 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-statured 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 downslope.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- prairie sagewort (*Artemisia frigida*), shrub

Table 13. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	112	168	336
Grass/Grasslike	224	308	336
Forb	11	56	112
Total	**347**	**532**	**784**

Table 14. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-35%
Grass/grasslike foliar cover	15-25%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-2%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	35-50%

Table 15. 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	5-10%

Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	35-50%

Table 16. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-1%	1-15%	1-5%
>0.15 <= 0.3	–	1-15%	1-10%	1-5%
>0.3 <= 0.6	–	1-10%	0-5%	0-1%
>0.6 <= 1.4	–	0-5%	0-2%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

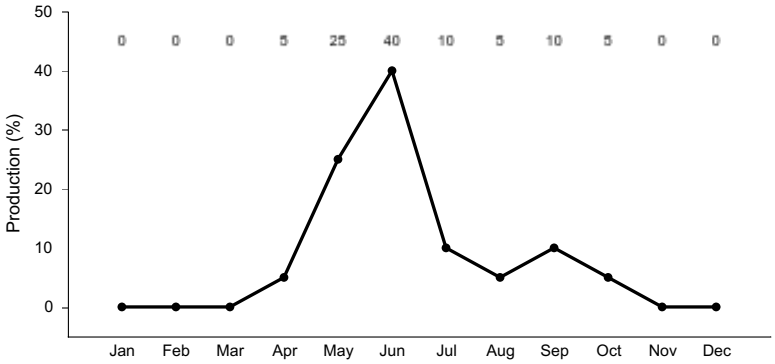


Figure 14. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

State 3
Sod-Formers

Tillering, mat-, or sod-forming species are native and common in many communities within the Big Horn Basin. Blue grama and threadleaf sedge are the dominant grass or grass-like species within this functional group. Both species are a native component of the Reference Community; however, the tendency is for these species to increase with prolonged drought or under grazing pressure, becoming dominant. As the dominant species, they alter the hydrology of the site, increasing surface runoff. The dense and restrictive root system inhibits movement of water through and funnels surface flow around the edge of the “grass clumps,” concentrating flow into channel-like patterns, creating a drier environment for native grass species and forbs to persist.

Characteristics and indicators. The major canopy cover is comprised of blue grama and threadleaf sedge. Sagebrush and yucca may be present as well as a few other shrubs; however, most woody canopy and other herbaceous species are few. Pricklypear cactus tends to increase in this State.

Resilience management. Blue grama and threadleaf sedge tend to be resistant to management once established on the landscape. Mechanical treatment of the soil is one of the few tools found to have a strong success in altering this community once established.

Dominant plant species

- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass

Community 3.1
Sod/Sagebrush Plant Community

The loss of mid- and low-statured cool-season bunchgrasses and the persistence of sagebrush are the major characteristics of this sod-dominated community. The low, mat-forming grass and grass-like species respond and fill the voids in this plant community due to continuous season-long grazing, recurrent overutilization, prolonged drought, or shifts in climate. The effect of blue grama and threadleaf sedge, with their short-stature and dense root structure, is a decrease of water infiltration which increases channelization of runoff between vegetation patches. This effect coupled with the lack of structure to hold moisture, and further compounded by drought will continue to reduce the shrub component. A dense sod of interspersed patches of blue grama and threadleaf sedge is the major component of this community. Incidental occurrences of other perennial natives occur generally within the sagebrush canopy or the protective ring of the plains pricklypear cactus clumps. Overall, Wyoming big sagebrush has been reduced in vigor and abundance across this community phase, but it persists (average density of 5-10 percent canopy cover). When compared to the Reference Plant Communities 1.1 and 1.2, blue grama has increased significantly, making up 30 to 60 percent of the canopy. Plains pricklypear cactus is prevalent on the site, and other mid-stature cool-season grasses, perennial forbs, and most shrubs have been greatly reduced. Production has significantly decreased, and bare ground may not vary or will increase (longer extents of bare ground between densely vegetated areas). The total annual production (air-dry weight) of this state is about 275 lbs./acre, but it can range from about 125 lbs./acre in unfavorable years to about 400 lbs./acre in above-average years. The higher productivity is generally in response to Wyoming big sagebrush; however, yucca and other woody species may be present as well, influencing overall production.

Resilience management. Rangeland Health Implications/Indicators: This community is at-risk of transitioning to a completely sod-bound community with no woody vegetation. The dense root mats are extremely resistant to change, with management scenarios have minimal effect (frequent and severe grazing, or the removal of grazing does not seem to have any further effect on the plant composition or structure). The shrub component will be degraded and eventually removed from the plant community under either scenario. The biotic integrity of this state is not functional and plant diversity is extremely low. The plant vigor is significantly weakened, and replacement capabilities are limited due to the reduced number of mid-stature cool-season bunchgrasses. This sod-bound plant community hinders water infiltration. While the sod protects the rooted area, edge areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in areas of bare ground and pedestalling is prominent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites. This community can improve with intensive management requiring mechanical manipulation. However, once the sagebrush component has been lost, recovery or transition is not as feasible. The potential to recover compared to the potential to shift into a stable state of a sod bound community creates the at-risk label. The threshold crossed to enter this state, the composition of sod-forming grasses and the lack of significant cover by other perennial grasses, leaves these two communities (3.1 and 3.2) as similar communities with only one marked shift – the presence of sagebrush in the community. Blue grama, threadleaf sedge and other tillering species will suffer a “die-back” during drought or other stressed conditions. The trend is for the central growth of these species to become decadent and then die. The plant will

remain intact until disturbed (trampling, vehicle traffic, ground disturbances). Once disturbed, the plants quickly degrade leaving a central ring where the soil surface is vulnerable to erosion. This vulnerability opens a potential for native species, as well as invasive species, to gain a “toe-hold” in the community.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass

Table 17. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	95	196	280
Shrub/Vine	34	84	112
Forb	11	28	56
Total	**140**	**308**	**448**

Table 18. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	30-50%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-2%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	30-45%

Table 19. 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	5-10%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	30-45%

Table 20. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-1%	10-30%	1-5%
>0.15 <= 0.3	–	1-10%	1-15%	1-5%
>0.3 <= 0.6	–	0-5%	0-5%	0-1%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

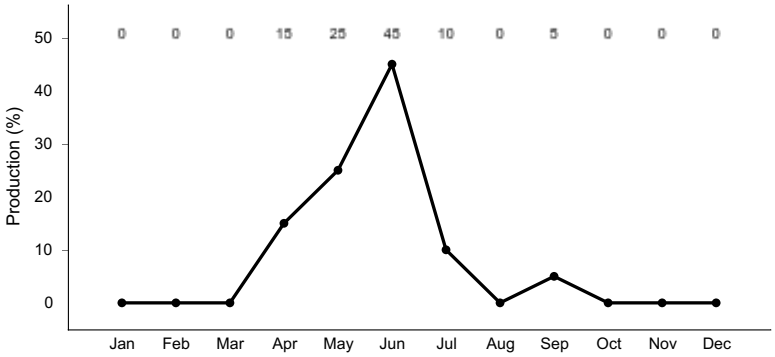


Figure 16. Plant community growth curve (percent production by month). WY0504, 5-9 BH Upland Sites Warm Season Dominate. Monthly percentages of total annual growth based on a predominately C4 warm season plant community with shrubs and some C3 plants. Generally sod-forming community..

Community 3.2
Sod/Cactus Plant Community

The phase step from Sod/Sagebrush Community Phase (3.1) to the Sod/Cactus Community Phase (3.2) is a change in composition from an overstory of Wyoming big sagebrush to an understory of plains pricklypear cactus. The loss of sagebrush is the driving factor. Blue grama sod, with threadleaf sedge intermixed, has an increasing prominence of plains pricklypear cactus in the community. Cactus density has the potential to increase to a level that restricts the ability for livestock to move through or graze the available forage. Wyoming big sagebrush has been removed from the community with only isolated occurrences. Rubber rabbitbrush is significantly reduced but may persist. When compared to the Reference State (1.1 and 1.2), blue grama and plains pricklypear cactus have increased. All cool-season mid-statured grasses, forbs, and most shrubs have been greatly reduced or replaced. Production has been significantly decreased. The dense and frequent clumps of cactus provide a niche for small,

remnant populations of the mid-statured cool-season grasses to persist in the community. The ability for low-statured sod-formers to respond to amount and timing of precipitation is not as significant as other cool-season grasses, such as needle and thread and Sandberg bluegrass; however, there is still a marked swing in average production between wet and dry years. The focused production of the inflorescence and tillers is a more prominent response for these short-statured grasses. Production is provided as an average or mean and is not intended to cover the full range of production potential for this community. The resilience and resistance capacity of this community is high because of the low-statured grasses and the ability of cactus to tolerate high levels of use and the ability to maintain as other native species are depleted, including Wyoming big sagebrush. Extended periods of drought have proven to be detrimental to the health and vigor of blue grama stands across the area; however, there has been no documentation to show what species may recover in this damaged community. Studies and further observation needs to be documented to determine what the recovery potential is for a sod-bound community following significant drought die-off. Total average annual production is 225 lbs./acre, but it can range from 110 lbs./acre in unfavorable years to 425 lbs./acre in above-average years.

Resilience management. Rangeland Health Implications/Indicators: This sod-bound community is extremely resistant to change. Management (continued frequent and severe grazing to the removal of grazing) does not seem to affect the composition or structure of the plant community. The biotic integrity of this state is not functional, plant diversity is extremely low, and vigor is significantly weakened, and replacement capabilities are limited due to the reduced number of mid-statured cool-season grasses and the loss of height and structure (woody component for shade and snow catch). The dense root mats of both blue grama and threadleaf sedge reduce infiltration and increase runoff. Off-site areas can be affected and degraded with excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in the bare ground interspaces and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and downslope. The watershed may or may not be functioning, as runoff may affect adjoining sites. The added competition and rooting nature of cactus produces a threat of invasion of cactus. Although not documented in this LRU at this time, it has been noted in other areas of Wyoming, that plains pricklypear cactus can form in dense patches that inhibit animal movement through the area preventing the use for grazing and hindering wildlife movement and use as well. Surface disturbance (hoof action, large equipment such as vehicules and tractors, or other human impacts) can initially reduce the density of cactus, but the risk of rerootin g of the disturbed pads, may cause a rapid increase in density across an area of impact.

Dominant plant species

- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass

Table 21. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	95	140	280
Forb	28	84	140
Shrub/Vine	–	28	56
Total	**123**	**252**	**476**

Table 22. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0-5%
Grass/grasslike foliar cover	30-50%
Forb foliar cover	5-15%
Non-vascular plants	0%
Biological crusts	0-2%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%

Bedrock	0%
Water	0%
Bare ground	30-45%

Table 23. 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	5-10%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	30-45%

Table 24. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-1%	10-30%	1-10%
>0.15 <= 0.3	–	0-5%	1-15%	1-5%
>0.3 <= 0.6	–	0-1%	0-5%	0-1%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

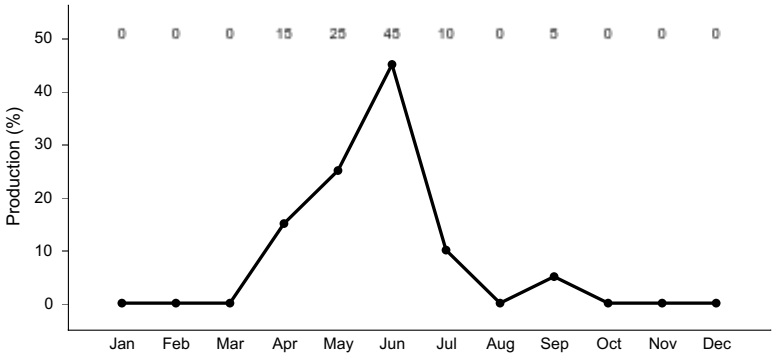


Figure 18. Plant community growth curve (percent production by month). WY0504, 5-9 BH Upland Sites Warm Season Dominate. Monthly percentages of total annual growth based on a predominately C4 warm season plant community with shrubs and some C3 plants. Generally sod-forming community..

Pathway CP 3.1-3.2

Community 3.1 to 3.2

Sod/Sagebrush Plant Community

Sod/Cactus Plant Community

Intensive Brush Management, Fire, Frequent or Severe Grazing, Drought – The altered hydrology of a sod dominated community creates a dryer soil environment. The droughty conditions of this community reduces the vigor and over time will reduce the composition of sagebrush and other woody species within the community. The drier conditions and patchwork dynamics of the sod community reduces the potential for seedling establishment of many native grasses and shrubs. Fire has little influence on this community due to the lack of fine fuels to carry it; but in rare circumstances, isolated areas may burn within the shrub canopy. Once sagebrush is removed from this community by intense grazing pressure, drought and insect damage or by fire (rare), sagebrush is replaced in dominance by plains pricklypear cactus, and the community will phase into a sod/cactus community. In some cases, rubber rabbitbrush will persist or increase slightly on a site as sagebrush diminishes.

State 4
Invaded

Cheatgrass or downy brome (*Bromus tectorum*) is an aggressive annual invader that threatens rangelands across the west, including Wyoming. The ability of cheatgrass to persist through the winter under a blanket of snow and grow early allow it to take advantage of early spring precipitation and snowmelt (winter annual). Multiple growth cycles throughout a year leaves a thick litter (duff) layer and builds a significant seedbank. This annual invader has an aggressive growth habit that creates a hostile environment for most native species, including sagebrush. Climatic shifts, changes in management, and exposure to human activity are a few of the explanations for the current flush and rapid expanse across the western United States. Although cheatgrass is the most prevalent large-scale threat for rangeland managers, a variety of thistles and knapweeds, in combination with other aggressive invaders such as whitetop (hoary cress), black henbane, field bindweed, and leafy spurge are increasing in density and frequency. Each species produces their own set of challenging management issues. As new species are identified, 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.

Characteristics and indicators. This state is characterized by the presence and then dominance of invasive/non-native species. 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. Increased access, increased travels of individuals, and other natural and man-made disturbances has opened the door for invasion in most native communities.

Resilience management. The lack of tools to achieve complete eradication, and variable success on long-term reduction of most invasive species has led to this state being resilient and resistant to change.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass

Community 4.1
Native Grasses/Invaded/Sagebrush Plant Community

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 ecological site with the accompanying Wyoming big sagebrush component. This community phase (4.1) is characterized by a significant composition of invasive species (5 percent or greater) on the landscape. These invasive species have a wider scale of distribution; rather than one isolated patch in an isolated portion of the landscape. Although this community phase is susceptible to further invasion (becoming an invader driven system), if measures are taken to maintain the undesirable species at 5 to 10 percent composition, the probability of the native population persisting and possibly improving remains. However, extent of improvement is limited, and the cost and labor required determine the economic feasibility. Further degradation of this community phase increases the cost and decreases the feasibility of restoring a desired community, which makes this community phase, the “At-Risk” community. Litter cover within this phase is increasing with the duff layer specifically associated with cheatgrass. This duff layer creates a barrier that can impede water infiltration and increase runoff, accelerating erosion. This is aggravated with increased slope. The age and extent of the cheatgrass stand will determine the extent of duff in the system. 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 affect overall production.

Resilience management. Rangeland Health Implications/Indicators: Plant diversity is moderate for this phase, with perennial grasses, forbs, and shrub components still present, sustaining the diversity of the community. The plant vigor is reduced, and replacement capabilities are limited due to the limited moisture and nutrients available after cheatgrass has sprouted. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is minimal but will vary with species; as is the water flow patterns and pedestalling. Infiltration is unaltered or slightly reduced; however, as the duff layer or litter builds, infiltration will decrease, and runoff will increase.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- cheatgrass (*Bromus tectorum*), grass
- needle and thread (*Hesperostipa comata*), grass

Community 4.2
Invaded/Sagebrush Plant Community

As the native populations of perennial grasses and forbs are lost through overuse or disturbance, the site becomes invader-driven. Wyoming big sagebrush can compete and maintain a footprint in this community, even under a heavy infestation level of most invasive species, unless fire or similar disturbance removes the woody cover. The canopy of the sagebrush serves as a protective niche in the system for native grasses and forbs, allowing remnant populations to persist. The fine fuels or biomass produced by cheatgrass and other invasive species raises a significant threat of fire and increases the potential for fire to occur, and the possible intensity of the fire. The litter or duff layer, specifically associated with cheatgrass, is significantly higher than the native community; which creates a barrier that can impede water infiltration and increase runoff, accelerating erosion. This is aggravated with increased slope. The duff layer creates an extreme hot zone during wildfires that can sterilize the soil through volatilization of nutrients or by the formation of an ash cap that seals the soils, preventing water infiltration and seed

penetration, reducing the ability for revegetation post-disturbance. New or improved strategies for invasive species control are actively researched across the western United States. High-intensity grazing with chemical control and the use of biological agents are techniques that have been trialed locally, with varying levels of success. The key management strategy, at this phase, is to reduce the fire risk and maintain the existing Wyoming big sagebrush and native perennial grass species. Maintaining the limited biotic integrity by maintaining species richness provides structure and a range of growth traits allowing adaptability of the site to varying climatic swings. Supporting the hydrologic function with the remaining woody species provides 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. Each location must 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.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change in relation to returning to a native dominant system, but as the stand becomes more decadent it loses its resistance to becoming an invader-only community. This phase is prone to fire as fine fuels are more available; however, the bare ground between sagebrush plants has decreased with increased biomass of annual invaders. Plant diversity is poor, and vigor is diminished. The adaptability or replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more. Soil erosion is species-dependent and associated litter accumulates. The variability of the water flow and pedestalling, as well as infiltration and runoff, is determined again by the species that persist within the community.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- cheatgrass (*Bromus tectorum*), grass

Community 4.3
Invaded (Annual Grasses) Plant Community

Cheatgrass can grow quickly, utilizing limited resources provides a competitive advantage against mature native species. The ability of cheatgrass to produce large quantities of seed quickly, to reproduce in poor conditions, and the significant duff layer it produces limits the ability for native seedlings to establish, even when resources are available. The morphology of the seed allows for easy dispersal and longevity, creating a widespread and long-term seed bank. These traits create a management challenge that has not been successfully met at this time. Once this species has a niche on a landscape it is resistant and resilient to change. The absence of sagebrush in this community put the remnant populations of native herbaceous species at risk. However, the ability of the native cover to remain quiet under the cheatgrass canopy does allow it to persist. Plains pricklypear cactus provides a niche for natives to thrive to a lesser extent. Variability in spring storms and temperature shifts offer an opportunity for native grasses to express their resiliency, but they are not able to “outcompete” the invaders in the long term without assistance from integrated pest management. The ability for cheatgrass to emerge, bolt, produce seed, and mature out two to three times within a year utilizes all available soil nutrients and moisture resources. Chemical control is difficult to attain and maintain success without lasting effects on the native grasses in the area. Chlorosis of wheatgrasses, stunted plants, and loss of certain forbs are a few of the residual chemical effects that have been observed in aerial treatment trials. This generally comes from the chemical composition and the way it binds to the chemistry or nutrients in the soil, inhibiting the uptake by roots. The increased fire frequency or interval prevents

sagebrush and other woody species from establishing on the site, and has negative impacts on many of the native herbaceous species in the understory. The grazing potential is limited due to the unpalatable nature of mature cheatgrass plants (chaff, prominent awns, no forage value). If grazed in early spring or late fall some of this can be avoided, but it is difficult to achieve an effective level of intensity of grazing to maintain cheatgrass, let alone reduce or eradicate cheatgrass. 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.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. Plant diversity is poor. The plant vigor is diminished, and replacement capabilities are non-existent due to the loss of structure and cool-season grasses. Plant litter is noticeably more when compared to Reference Communities in response to the dense duff layer created by cheatgrass. Soil erosion is generally reduced in response to the litter accumulation; however, the annual nature of this plant accentuates the water flow patterns and pedestalling. Infiltration is reduced, and runoff is increased with the loss of perennial vegetation and root depth and density. Overall biotic integrity is lost in this community.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass

Pathway CP 4.1-4.2
Community 4.1 to 4.2

Frequent or Severe Grazing, Wildfire, Drought – Climatic stress (drought, changes in timing of precipitation), wildfire, or other natural disturbances will hinder the native species, reducing their ability to maintain their footprint in the plant community. Continued, long-term, 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. Grazing management to reduce invasive species can be effective. Utilizing the early green up and the late growth habits of cheatgrass can be an added benefit for native species as well as control further spread of invasive species. However, if timing of this grazing or intensity is not done properly, further degradation to the native community can occur, allowing invasive species to become more dominant in the community.

Pathway CP 4.1-4.3
Community 4.1 to 4.3

Native Grasses/Invaded/Sagebrush Plant Community

Invaded (Annual Grasses) Plant Community

Frequent or Severe Grazing, Wildfire, Drought - The loss of the sagebrush brush canopy due to fire, drought, or herbivory, opens the potential for extensive invasion by weedy species especially cheatgrass. Continued over utilization by large herbivores or extended periods of drought will further stress the native grasses leaving no barrier against invasive species. Once the sagebrush canopy is lost, resulting changes in hydrology inhibit or prevent recovery of the system without major inputs.

Pathway CP 4.2-4.1
Community 4.2 to 4.1

Integrated Pest Management/Weed Control and Long-term Prescribed Grazing - Prescribed grazing to allow use of the invasive species with minimal impact to the native population, in conjunction with invasive species control will allow the community to regain or maintain potential. Currently, eradication of invasive species has not been achieved on a large-scale basis, and sustained control requires intensive inputs over the course of several years. To maintain the system with no further degradation requires a dual approach of both long-term prescribed grazing with an intensive weed management (integrated pest management) plan. No one single practice can sustain this phase, it requires intensive management to prevent the transition to Community 4.3 – Invaders (Annuals).

Conservation practices

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
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Herbaceous Weed Control

Pathway CP 4.2-4.3
Community 4.2 to 4.3

Catastrophic Disturbance – Removal of sagebrush and desirable herbaceous cover by fire, land clearing, or similar events, provides the opportunity for a significant invasion by weedy species especially cheatgrass. Large-scale invasions, especially after catastrophic wildfires, leave the landscape barren of all native species. Isolated remnants may be found in pockets throughout the landscape. However, if no attempt to apply weed control or with further disturbances (multiple fires), the native species will remain hidden or will be removed completely from the community. The ability for this community to revert to a less degraded community within this state is not feasible without implementation of an integrated pest management plan.

State 5
Altered

Difficulties in maintaining delivery systems and dependable supply of irrigation water has limited the economic feasibility to maintain all farmed lands. Increased energy development and the expansion of recreational land uses (including hunting) has changed the face of rangelands. The broken nature of the rim provides more topographic relief for movement of wild game, yet access is still easy to moderate for wheeled traffic. Although the disturbance footprints within this LRU are not as contiguous as within the core, old homestead locations, abandoned crop fields, roads, recreational facilities, and energy development have left their marks. Disturbance to these highly erodible soils (whether it was mechanical, cultural, or natural) reduced the resilience or resistance to support native vegetation or the ability to respond to management in the same manner as an undisturbed site. Changes to soil structure and hydrologic processes reduce the stability and ability to recover. Reclamation or restoration of an area will not replace the original function and factors to an undisturbed state. These "altered" lands may, after significant inputs and time, resemble the Reference Communities (1.1 or 1.2), but they will respond and function the same as the Reference State. One catastrophic event or several smaller disturbances can lead to the transition to the Altered State from any identified state within the State-and-Transition Model. The soils have not been altered to the extent that they are outside the site characteristics, but the potential has shifted enough that it will not respond the Reference State. Location or site-specific investigation is needed to determine if a disturbed or reclaimed area still meets site characteristics. The time required to allow the redevelop ment of structure and the cryptogrammic crust, as well as any impact to chemistry, is beyond the natural function of management. The initial flush of vegetation is kochia and Russian thistle and mustards, a successional plant community. The site begins its own recovery, but the time required to return to the original conditions (pre-disturbance) is outside of feasible consideration. The site, however, may become similar in composition to the Reference State, but the integrity of the soil is altered, changing the potential of the site.

Characteristics and indicators. This state is characterized by a landscape that has been mechanically manipulated or had significant soil disturbance. Early successional plant communities, evidence of farming (field edges, cultivation rows, etc.) or the presence of introduced species (crested wheatgrasses, russian wildrye, etc.) are indicators of this state.

Community 5.1
Disturbed/Degraded Lands Plant Community

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 upon the successional or seeded species that are able to establish in an area. For an accurate growth curve, a site-specific species inventory and documentation of the climatic tendencies should be collected.

Resilience management. Rangeland Health Implications/Indicators: This plant community is variable and, depending upon the age of the stand and the stage of successional tendencies, determines how stable (resilient/resistant) the community is. Plant diversity is high for successional communities but is usually lacking in the structural/functional groups. This flexibility within the community creates a variable level of biotic integrity. In areas of new or frequent disturbance, annual weedy species or early successional plants will be the dominant cover, providing some diversity, but gives minimal structural cover for wildlife. As the site matures or as the period between disturbances is lengthened, perennial or taller-statured, stronger-rooted species will increase providing protection and help to improve hydrologic processes and stability to allow grasses and shrubs to begin to establish. Soil erosion is dependent on the disturbance regime and the biotic integrity of the community which determines water flow, infiltration, and runoff. Other factors that are influential are surface roughness and brokenness (tire tracks, hoof action, smoothed, denuded surfaces, trails that may concentrate water flow).

Community 5.2
Reclaimed Lands Plant Community

Shifts in reclamation practices over the last several decades have altered the success and stability of reclaiming a site. The historic use of crested wheatgrass created stable stands that persist long-term, however palatability and vigor decrease with time. Species creep into surrounding native communities as well as native species recovering within crested wheatgrass stands have been documented within this LRU. Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses were used more recently in mixes to help increase diversity and longevity of seedings. But now, on federal lands specifically the use of native species is required. Although success for vegetative seeding is low to moderate in this LRU, due to the variable amounts and timing of precipitation, limited areas along pipeline corridors, well sites or pad sites, and along transportation corridors have succeeded. 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.

Resilience management. Rangeland Health Implications/Indicators: Seeding prescriptions determine the resistance to change and resilience against invasive species and erosion. 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 seedling density, how it is seeded, and mechanical procedures put in place. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that comprise the community and the method of seeding (site preparation and seeding practices).

Pathway CP 5.1-5.2
Community 5.1 to 5.2

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing – Planning and selection of best practices for site improvement need to be implemented to stabilize this site. The erosive nature of the soil one disturbed increases the need to stabilize the site quickly. Species selection is key and may require a cover crop to prevent erosion prior to seedling establishment. Direct seeding or minimal soil tillage may be the best approach to allow establishment of grasses within the residue of the cover crop. The arid nature of this site will create its own challenge with the lack of moisture and narrow window for seeding. The general nature of native seeds common for these sites are difficult to drill. Mulching may be required to prevent loss of moisture and wind scour (loss of seed).

Context dependence. The success or outcome of this transition is contingent on the inputs involved. These inputs will include - soil manipulation (seedbed prep), seed selection, seeding methods, and post seeding treatments. Climate and management are secondary factors affecting this transition.

Conservation practices

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
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Herbaceous Weed Control

Pathway CP 5.2-5.1
Community 5.2 to 5.1

No use, No Fire, Long Term Prescribed Grazing, Frequent or Severe Grazing – Maintenance of a seeded community is needed to prevent a decline in vigor and a corresponding shift in composition. The altered soil properties by mechanical or natural disturbance prevents the plant community from responding like the native community. Monitoring 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- The conversion to a Wyoming Big Sagebrush/*Bare Ground* Plant Community is a response to extended periods of stress, both climatic and human-induced. Frequent or high-intensity herbivory weakens the ability for desirable grasses to persist, especially during periods of prolonged drought. The composition will shift to predominantly Wyoming big sagebrush as the herbaceous cover declines. Over extended periods of time, the sagebrush canopy will increase in density, preventing the recovery without intervention. The illusion of crossing the threshold to State 2 is captured with fluctuating precipitation patterns affecting production of prominent plants within this system. A marked loss of herbaceous cover and diversity, increased bare ground, and lack of litter over multiple monitoring cycles provides the evidence that the transition to State 2 has occurred, and is not an annual climatic response. It is important to recognize that the number of actual sagebrush plants may not increase to cause this shift. Rather the loss of herbaceous composition and increase in the canopy cover of woody species is the larger factor (creates the illusion of increased number of plants when it is the size and age that is more likely to change).

Constraints to recovery. The possible lack or limited seed-sources for the key mid-stature, cool-season bunchgrasses is the major recovery constraint for this State.

Transition T 1-3
State 1 to 3

Frequent grazing (yearlong), brush management, or fire with drought Severe and frequent grazing (by livestock or any other large ungulates) reduces vigor and presence of key species. As needle and thread and Indian ricegrass begin to decline, shorter-statured grasses become dominant. Animal disturbance (hoof impact) reduces the bunchgrass component through damage to the crown of the plant, but also in some instance by allowing repeated defoliation of the desirable species, reducing recovery potential and ground cover for insulation and snow catch. The damage and repeated defoliation weakens, and over time, removes select species. The open canopy and hoof impact encourages species that are tolerant to trampling and that can utilize the small bursts of spring and summer moisture, these species are generally mat or sod-forming species such as blue grama and threadleaf sedge. Prolonged drought stresses the plants and opens the canopy for these short-statured grasses to fill in the interspaces. The shallow, dense root mats will continue to spread over time. The added removal of sagebrush with animal impacts, fire, or brush management may open the canopy more and aid in establishing this sod community. Season of use and intensity of grazing (time and timing) is a trigger that can reduce the risk of transitioning, or if done poorly can force the transition to occur rapidly. The Reference State (1.1 and 1.2) is dominated by cool-season species. Provided the area receives good spring moisture, growth and maturity of these plants can happen quickly within the first two weeks of June, while blue grama is just beginning. By alternating when the community is grazed, providing periods of rest during the critical initial green-up and growth in the spring, and allowing recovery time before the community is grazed again within the year, allows the bunchgrasses and rhizomatous grasses to maintain vigor and production. This also allows for summer use when the warm-season grasses are growing (blue grama) which will help to utilize this species and maintain cover.

Constraints to recovery. The resiliency of the mat-forming (sod-forming) grasses is the recovery constraint for this transition. Blue grama and threadleaf sedge, once established in significant composition, are resistant to management changes and require some level of mechanical manipulation to allow other native species to increase (re-establish) in this 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 is necessary to allow and encourage native perennial grasses to respond to improved moisture and sunlight. Prescribed grazing is required in conjunction with brush management to prevent overuse of the exposed grasses allowing this community to recover. Treatment will vary depending on the current composition of grasses remaining and the potential threats to the location. Removal or thinning of the sagebrush within this community will help to reduce competition, encouraging grass and forb recovery if the disturbance or overuse (recreational or grazing pressure) is reduced. Drought may prolong the time required for recovery. Mowing or mulching sagebrush trials have shown a strong response by grasses with little to no recovery time post-treatment. The resulting community

with these treatments is driven by the dominant species within the community pre-treatment. Climate and treatment conditions during and following a fire has a larger impact on the community. It is crucial to investigate the immediate and surrounding areas of a treatment site to ensure no invasive species (cheatgrass) are present.

Context dependence. In some instances, when sagebrush canopy is not excessive but the understory of herbaceous species is lacking, seeding of native cultivars may be necessary to encourage the grasses to re-establish.

Conservation practices

Brush Management
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
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Grazing Management Plan

Transition T 2-3
State 2 to 3

Drought, disease or insect damage, overuse, or fire Sod-forming species such as blue grama and threadleaf sedge can 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, creating a sagebrush/sod community that is resistant to change by grazing management. Impacts to sagebrush by disease or insect damage, as well as drought or herbivory, will shift this community to the secondary community phase with cactus as a subdominant cover with blue grama and threadleaf sedge. Extended periods of drought in combination with a change in the amount and timing of precipitation and spring snowmelt has allowed the warm-season grass, blue grama, to out-compete cool-season natives such as needle and thread. Climate change is widely debated and speculated; however, the documented shifts in climatic curves, as well as large-scale transitions to this community under different management scenarios, highlights climate as a key player – not just use and management. Further research is needed to identify the factor for each site-specific situation.

Constraints to recovery. The loss of or lack of woody canopy, primarily sagebrush, and the need for mechanical treatment to reduce/remove the sod-formers are the major constraints for recovery of this state.

Transition T 2-4
State 2 to 4

Fire (wild or prescribed), frequent or severe grazing, drought with insect damage/brush management Throughout most of this LRU, there are seed sources present for cheatgrass, knapweed, and other invasive species. Removal or thinning of the canopy and displacement of the soil surface by disturbance (fire, drought, disease/insect damage to sagebrush, or ground/soil disturbance including impacts by grazing large herbivores or recreational activities), creates a niche for invasive/undesirable weeds. Invasions start with one or two isolated plants, that if caught can be treated and an infestation avoided; however, when unseen or ignored, the population grows exponentially with time. In some cases, once the invasive species are established, they can create their own habitat, reducing the ability for native species to compete for the limited resources. The open canopy of the Sagebrush/*Bare Ground* State is

vulnerable to invasive species without further influence. With continued overuse, drought, or insect damage or 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.

Constraints to recovery. The inability to eradicate or achieve long-term control of most invasive species is the constraint to recovery for this State transition.

Transition T 3-4
State 3 to 4

Frequent and severe grazing, drought, disturbance with a seed source present Resistance to invasion of the sod-dominated community is presumed due to the lack of extensive bare ground and the aggressive and persistent nature of blue grama and threadleaf sedge. This community also has a minimal risk of wildfire because of the lack of fine fuels and reduced sagebrush canopy. The increased interspatial pattern of these communities leaves exposed soil that is vulnerable to invasion by undesirable species. Increased pressure from overuse and drought work to weaken the sod or mat-like community of low-statured grasses, opening more surface to invaders, such as cheatgrass and knapweeds. If a seed source is available, ground disturbance by herbivores or man-induced, allows invasive species to find a way into the community. Once established in the community, the extent of spread is limited, but it is still extremely difficult to manage, and eradication is not feasible. Once the invasive species have become prevalent on the landscape (>5 percent composition), the community crosses the threshold into the Invaded/Sagebrush State (State 4).

Constraints to recovery. The lack of sufficient tools to eradicate or gain long-term control of most invasive species is the constraint to recovery for this state.

Restoration pathway R 4-5
State 4 to 5

Integrated pest management, with seeding Integrated pest management and intense weed control as part of seedbed preparation and after seeding will be necessary to overcome a severe weed infestation. Preparation of the target area and utilization of improved varieties, native seed, or (where appropriate) introduced species suited for intended land use increase the success of removing the invasive species. Success of reestablishing a native or desired plant community on a large scale is not documented. Small-scale attempts are rated to be low and highly variable for the rate of control of most species. The limited success and difficulties in reestablishing sagebrush also limit the site potential. Due to the need to till (turn the soil) for seedbed preparation reduces soil stability by breaking down soil structure and alters the hydrologic cycle by changing the infiltration and percolation rates of the soil. The alteration of the soil properties prevents the soils from reacting the same to management and environmental changes, so transitions to a reclaimed or altered state (State 5).

Conservation practices

Critical Area Planting
Grazing Land Mechanical Treatment
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Herbaceous Weed Control

Transition T 5-4
State 5 to 4

No use, fire (wild or prescribed), frequent or severe grazing, drought with seed source present□Post-disturbance and during reclamation processes, management is required to prevent a reoccurrence or a new infestation of weeds. Wildfire, prescribed burning, drought, or frequent and severe overutilization by herbivores can be a source of the disturbance that either opens the canopy or introduces the species to the location. Extended periods of non-use can create loose soils, reducing vigor and health of the native population. The resulting die-back allows the community to become vulnerable to weed invasions. This invasion triggers the transition to the Invaded State.

Constraints to recovery. The inability to or the financial cost of the inputs to eradicate or successfully control invasive species is one contraint to recovery. Another is the seed selection to compete with the invasive species that are affecting the site.

Additional community tables

Table 25. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-stature, Cool-season Bunchgrass**			224–448	
	needle and thread	HECO26	*Hesperostipa comata*	168–308	30–50
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	56–112	15–25
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
2	**Rhizomatous, Cool-season Grasses**			28–140	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	28–84	5–10
	western wheatgrass	PASM	*Pascopyrum smithii*	0–56	0–10
3	**Short-stature, Cool-season Bunchgrass**			28–84	
	prairie Junegrass	KOMA	*Koeleria macrantha*	28–56	5–10
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
4	**Mid-stature, Warm-season Bunchgrass**			0–28	
	threeawn	ARIST	*Aristida*	0–28	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	0–5
5	**Short-stature, Warm-season Tillering-grasses**			0–28	
	blue grama	BOGR2	*Bouteloua gracilis*	0–28	0–5
6	**Miscellaneous Grass and Grass-likes**			0–28	
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
Forb					
7	**Perennial Forbs**			6–84	
	sandwort	ARENA	*Arenaria*	0–28	0–5
	fleabane	ERIGE2	*Erigeron*	0–28	0–5
	desertparsley	LOMAT	*Lomatium*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–28	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5

	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–28	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
Shrub/Vine					
8	**Dominant Shrubs**			28–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–140	5–15
9	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5

Table 26. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-stature, Cool-season Bunchgrass**			84–196	
	needle and thread	HECO26	*Hesperostipa comata*	84–112	20–30
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–56	0–10
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
2	**Rhizomatous, Cool-season Grasses**			28–168	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	28–84	5–10
	western wheatgrass	PASM	*Pascopyrum smithii*	0–84	0–10
3	**Short-stature, Cool-season Bunchgrass**			0–84	
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–56	0–10
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
4	**Mid-stature, Warm-season Bunchgrass**			0–28	
	threeawn	ARIST	*Aristida*	0–28	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	0–5
5	**Short-stature, Warm-season Tillering Grass**			28–56	
	blue grama	BOGR2	*Bouteloua gracilis*	28–56	5–10
6	**Miscellaneous Grass/Grass-like**			28–56	
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
	Grass, annual	2GA	*Grass, annual*	0–28	0–5
Forb					
7	**Perennial Forbs**			11–84	
	sandwort	ARENA	*Arenaria*	0–28	0–5
	fleabane	ERIGE2	*Erigeron*	0–28	0–5

	desertparsley	LOMAT	*Lomatium*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–28	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–28	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–28	0–5
8	**Annual Forbs**			0–28	
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	Forb, annual	2FA	*Forb, annual*	0–28	0–5
Shrub/Vine					
9	**Dominant Shrubs**			56–252	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	56–252	10–25
10	**Miscellaneous Shrubs**			28–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5

Table 27. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-stature, Cool-season Bunchgrass**			22–112	
	needle and thread	HECO26	*Hesperostipa comata*	22–112	5–20
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–22	0–5
2	**Rhizomatous, Cool-season Grasses**			22–112	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	22–112	5–20
	western wheatgrass	PASM	*Pascopyrum smithii*	0–45	0–20
3	**Short-stature, Cool-season Bunchgrass**			0–67	
	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
4	**Mid-stature, Warm-season Bunchgrass**			0–22	
	threeawn	ARIST	*Aristida*	0–22	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	0–5
5	**Short-stature, Warm-season Tillering Grass**			6–45	
	blue grama	BOGR2	*Bouteloua gracilis*	6–45	1–10

6	**Miscellaneous Grass/Grass-like**			6–67	
	threadleaf sedge	CAFI	*Carex filifolia*	6–45	1–10
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	Grass, annual	2GA	*Grass, annual*	0–22	0–5
Forb					
7	**Perennial Forbs**			6–90	
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–67	0–15
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–22	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
	sandwort	ARENA	*Arenaria*	0–22	0–5
	fleabane	ERIGE2	*Erigeron*	0–22	0–5
	desertparsley	LOMAT	*Lomatium*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	textile onion	ALTE	*Allium textile*	0–22	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–22	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–22	0–5
8	**Annual Forbs**			0–22	
	woolly plantain	PLPA2	*Plantago patagonica*	0–22	0–5
	Forb, annual	2FA	*Forb, annual*	0–22	0–5
Shrub/Vine					
9	**Dominant Shrubs**			112–280	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	112–280	15–40
10	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5

Table 28. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-stature, Cool-season Bunchgrass**			6–56	
	needle and thread	HECO26	*Hesperostipa comata*	6–50	1–10
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–17	0–5
2	**Rhizomatous, Cool-season Grasses**			0–34	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–17	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–17	0–5
3	**Short-stature, Cool-season Bunchgrass**			6–34	

	squirreltail	ELEL5	*Elymus elymoides*	0–17	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	6–17	1–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–17	0–5
4	**Mid-stature, Warm-season Bunchgrass**			0–17	
	threeawn	ARIST	*Aristida*	0–17	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	0–5
5	**Short-stature, Warm-season Tillering Grass**			67–135	
	blue grama	BOGR2	*Bouteloua gracilis*	67–135	30–60
6	**Miscellaneous Grass/Grass-like**			17–50	
	threadleaf sedge	CAFI	*Carex filifolia*	17–34	5–15
	Grass, perennial	2GP	*Grass, perennial*	0–17	0–5
	Grass, annual	2GA	*Grass, annual*	0–17	0–5
Forb					
7	**Perennial Forbs**			6–56	
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–56	0–10
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–17	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–17	0–5
	sandwort	ARENA	*Arenaria*	0–17	0–5
	fleabane	ERIGE2	*Erigeron*	0–17	0–5
	desertparsley	LOMAT	*Lomatium*	0–17	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–17	0–5
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–17	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–17	0–5
	textile onion	ALTE	*Allium textile*	0–17	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–17	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–17	0–5
8	**Annual Forbs**			6–11	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	34–112	5–15
Shrub/Vine					
9	**Dominant Shrubs**			–	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	34–112	5–15
10	**Miscellaneous Shrubs**			0–34	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–22	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–22	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5

Table 29. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-stature, Cool-season Bunchgrass**			6–56	

1	**Mid-stature, Cool-season Bunchgrass**			6–56	
	needle and thread	HECO26	*Hesperostipa comata*	6–56	0–10
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–17	0–5
2	**Rhizomatous, Cool-season Grasses**			0–17	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–17	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–17	0–5
3	**Short-stature, Cool-season Bunchgrass**			6–34	
	squirreltail	ELEL5	*Elymus elymoides*	0–17	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	6–17	1–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–17	0–5
4	**Mid-stature, Warm-season Bunchgrass**			0–17	
	threeawn	ARIST	*Aristida*	0–17	0–5
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	0–5
5	**Short-stature, Warm-season Tillering Grass**			67–135	
	blue grama	BOGR2	*Bouteloua gracilis*	67–135	20–60
6	**Miscellaneous Grass/Grass-like**			17–67	
	threadleaf sedge	CAFI	*Carex filifolia*	17–50	5–15
	Grass, perennial	2GP	*Grass, perennial*	0–17	0–5
	Grass, annual	2GA	*Grass, annual*	0–17	0–5
Forb					
7	**Perennial Forbs**			22–129	
	plains pricklypear	OPPO	*Opuntia polyacantha*	22–112	5–25
	scarlet beeblossom	GACO5	*Gaura coccinea*	0–17	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–17	0–5
	sandwort	ARENA	*Arenaria*	0–17	0–5
	fleabane	ERIGE2	*Erigeron*	0–17	0–5
	desertparsley	LOMAT	*Lomatium*	0–17	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–17	0–5
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–17	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–17	0–5
	textile onion	ALTE	*Allium textile*	0–17	0–5
	lemon scurfpea	PSLA3	*Psoralidium lanceolatum*	0–17	0–5
	little larkspur	DEBI	*Delphinium bicolor*	0–17	0–5
8	**Annual Forbs**			0–11	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	0–28	0–5
Shrub/Vine					
9	**Miscellaneous Shrubs**			0–28	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	0–5
	spiny hopsage	GRSP	*Grayia spinosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 – Needle and thread/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 and foraging areas for sage grouse, as well as lek sites. The mosaic pattern of varying density of sagebrush in a smaller scale, provides cover and line-of-sight to forage and yet escape cover when predators approach. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland-obligate small mammals would occur here.

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

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

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

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

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

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

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

5.1 - Disturbed/Degraded Lands Plant Community and 5.2 - Restored/Reclaimed Lands Plant Community: The variability of this site prevents a detailed review of wildlife benefits. However, many of the introduced grasses, forbs, and shrubs can provide adequate cover, feed, and nesting sites for those wildlife species that would have selected the site prior to disturbance. Limitations and enhancements should 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 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 AUMs/Acre. (“AUM” stands for “Animal Unit Month,” and is defined as the amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.)

Plant Community Description/Title Lbs./Acre AUM/Acre* Acres/AUM*
Below Ave. Normal Above Ave.
1.1 Needle and Thread/Indian Ricegrass 375 510 680 0.14 7.14
1.2 Perennial Native Grasses/Wyoming Big Sagebrush 375 525 700 0.14 7.14
2.1 Mixed Shrub/*Bare Ground* 310 475 700 0.13 7.69
3.1 Sod-formers/Wyoming Big Sagebrush 125 250 425 0.07 14.29
3.2 Sod-formers/Cactus 125 275 450 0.08 12.5
4.1 Native/Invaded/Wyoming Big Sagebrush ** ** ** ** **
4.2 Invaded/Wyoming Big Sagebrush ** ** ** ** **
4.3 Invaded ** ** ** ** **
5.1 Disturbed/Degraded ** ** ** ** **
5.2 Restored/Reclaimed ** ** ** ** **

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

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

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

Recreational uses

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

Wood products

No appreciable wood products are present on the site.

Other products

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

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

Rare and Sensitive Species:
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.)

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.

Approval

Scott Woodall, 2/10/2020

Rangeland health reference sheet

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

Author(s)/participant(s)	Marji Patz, Ray Gullion, Everet Bainter
Contact for lead author	marji.patz@wy.usda.gov, 307-271-3130
Date	12/07/2018
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 can range from 20-30%.

---

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. As community degrades, this is a prominent indicator.

---

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 3 or greater.

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil data is limited for this site. Refer to soil series description and map unit information for specific information. Described A-horizons vary from 1-6 inches (3-15 cm) with OM of 1 to 2%.

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The plant community consists of 60-75% grasses, 20% forbs and 10-25% shrubs. Evenly distributed plant canopy (35-55%) and litter plus moderate to moderately rapid infiltration rates result in minimal runoff. Basal cover is typically less than 8% for this site and does very little to effect runoff. Canopy cover is sufficient to reduce raindrop impact.

---

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction of soil surface crusting should be present. A coarse, dry subsurface will often refuse a probe, causing mis-identification of a compaction layer. Most soil profiles must be described by hand dug holes.

---

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: Mid-stature, cool-season bunchgrasses >>

    Sub-dominant: perennial shrubs > cool-season rhizomatous grasses

    Other: perennial forbs = short-stature, cool-season bunchgrasses

    Additional:

---

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.

---

14. **Average percent litter cover (%) and depth (in):** Litter ranges from 15-30% 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).

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** English: 375 - 680 lbs/ac (510 lbs/ac average); Metric: 420 - 762 kg/ha (572 kg/ha average).

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** The increase of bare ground above 30% is an indicator that a threshold is being crossed. Corresponding increase will be noted in one or more of the following species is common: blue grama, Sandberg bluegrass, threadleaf sedge, Fendler threeawn, plains prickly pear cactus, Wyoming big sagebrush, and broom snakeweed. Annual weeds such as kochia, mustards, lambsquarter, Russian thistle, and pepperweeds are common aggressive 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 Montana, as well as on County specific lists (Big Horn, Hot Springs, Park, and Hot springs, Wyoming; and Carbon County, Montana).

---

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