Ecological site DX032X02B122
Loamy (Ly) Wind River Basin Rim

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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

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

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

LRU notes

Land Resource Unit (LRU):

32X02B (WY): This LRU is the Wind River Basin within MLRA 32X. This LRU is tends to be just a fraction higher in elevation, slightly cooler (by 1-degree Celsius), and spring snowpack tends to persist longer into the spring than the Big Horn Basin (LRU 01). This LRU was originally divided into two LRU's - LRU C which was the core and LRU D which was the rim. With the most current standards, this LRU is divided into two Subsets. This Subset is the rim of the Wind River Basin and is comprised of eroded fan remnants and stream terraces. This subset is driven by the relation to the mountains creating minor shifts in soil chemistry influencing the variety of ecological sites and plant interactions. The extent of soils currently correlated to this ecological site does not fit within the current subset or LRU boundary. Many of the map units are correlated to ecological sites outside of this MLRA but will be reviewed and corrected during mapping update projects.

Moisture Regime: Ustic Aridic
Temperature Regime: Mesic
Dominant Cover: Rangeland, with sagebrush steppe intermixed with saltbush flats, is the dominant vegetative cover.
Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm)
RV Frost-Free Days: 85-115 days

Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):
3 Xeromorphic Woodland, Scrub & Herb Vegetation Class

3.B Cool Semi-Desert Scrub & Grassland Subclass
3.B.1 Cool Semi-Desert Scrub & Grassland formation
3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division
M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macro group
G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group
CEGL001009 - Artemisia tridentata ssp. wyomingensis/Pseudoroegneria spicata Shrubland

Ecoregions (EPA):
Level I: 10 North American Deserts
Level II: 10.1 Cold Deserts
Level III: 10.1.18 Wyoming Basin
Level IV: 10.1.18.a Semi-arid Rolling Sagebrush Steppe

Ecological site concept

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

The loamy ecological site concept is based on minimal (none to slight) influence from salts, carbonates, gypsum or other chemistry within the top 20 inches (50 cm) of the mineral soil surface. The main soil characteristic is a moderately deep to very deep soil profile with textures ranging from sandy loam to clay loam and clay percentages between 18-35%. The soil surface 4 inches typically has less clay than the subsurface and ranges in texture from loamy fine sand to sandy loam. Once the lower threshold for this site (< 18% clay) is reached, the plant community will transition to a higher Indian ricegrass and needleandthread composition, with little to no rhizomatous wheatgrasses (sandy ecological site). As the upper threshold is crossed (>35% clay), increased rhizomatous wheatgrasses and bare ground occur, with a corresponding shift in forbs and loss of needleandthread (clayey ecological site).

Refining the site concept based on soils classification led to the same conclusion. The original concept bridged coarse-loamy, fine-loamy, and fine particle size classes. [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 based on percent by weight in a soil. Coarse-loamy has 15% or more of fine sands or coarser and less than 18% clay, fine-loamy have 15% or more of fine sand or coarser with 18% or greater to less than 35% clays, and fine have more than 35% but less than 60% of clay.] Data shows the same correlation above correlation between the amount of needleandthread and western wheatgrass and particle size classes. Finer textured soils support a higher ratio of western wheatgrass to needleandthread and just the opposite for coarser textured soils, which hold a higher ratio of needleandthread to western wheatgrass. The narrowing of the site characteristics to 18% to 35% clay within the particle size control section has nearly eliminated the coarse-loamy and fine particle size classes from this concept.

The loamy ecological site occurs in several different catenas (a series of distinct soils arrayed on a slope) throughout the basin. In an escarpment catena, it occurs with shallow and very shallow soils. Hillslope catenas have sandy and loamy ecological sites occurring in a complex mosaic pattern where the geology is controlled by interbedded sandstone and shale; or in an area where the parent material is alluvial. These alluvial derived catenas will also have loamy calcareous, and the interbedded catenas will have saline upland ecological sites.

A significant change from the historic loamy range site is the removal of the salt altered state (soils profile supporting a Gardner's saltbush community). Wicking of salts or carbonates to the soil surface in response to management or climatic patterns, may shift the plant community to a salt dominated composition. With overutilization or prolonged drought, soils will become salt laden or will develop a calcic layer that will further hinder the soil hydrologic cycle until it crosses a threshold for plant tolerance. The wicking effect of the arid (dry, warm) environment is still lacking the natural precipitation to flush the chemistry out of the plant root zone, but is able to move chemistry slightly lower in the root zone; rendering the reversal low in feasibility. The change in chemistry, and resulting shift in plant dynamics, altered hydrologic function and soils creates a change beyond a state, to a site correlation threshold.

Associated sites

R032XY362WY	**Shallow Loamy (SwLy) 10-14" East Precipitation Zone** Shallow Loamy sites are generally located on the break of slopes, on or surrounding rock outcrops before it transitions into more gently rolling landforms with deeper soils. Similar plant communities with more pincushion forbs and a higher percentage of bluebunch wheatgrass, but a marked reduction in production and increased bare ground.
DX032X01A122	**Loamy (Ly) Big Horn Basin Core** The Loamy site with in the 5-9" precipitation zone, now referred to as the core of the basin is similar to this site, however, the production and canopy cover is decreased from what is expected on the Rim.
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 tend to fall along alluvial drainages or below shale outcrops/outwashes.
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.
R032XY350WY	**Sandy (Sy) 10-14" East Precipitation Zone** Sandy sites will also be similar in production, but again response to management, disturbance and climatic shifts will vary. Sandy sites are generally at the base of sandstone outcrops or outwashes, and will be on terracettes within the landscape (wind deposited).
R032XY344WY	**Saline Upland (SU) 10-14" East Precipitation Zone** Saline upland sites commonly occur intermixed with Loamy sites, especially along marine shale deposits or escarpments with interbedded shales and sandstones. Saline uplands are dominated by short saltbush species and limited productivity from saline soils.
R032XY330WY	**Overflow (Ov) 10-14" East Precipitation Zone** Overflow site are found in concave areas that have concentrated flows within a loamy or other similar sites. This site is characterized by Basin big sagebrush and Basin wildrye. In areas that have burned, the community is a dense mat of cheatgrass. In other areas, it transitions to rhizomatous wheatgrasses. The concave nature with increased capture of overland flows increases productivity above a Loamy site and the transition to Basin big Sagebrush is an easy key on the landscape.

Similar sites

R032XY322WY	**Loamy (Ly) 10-14" East Precipitation Zone** This site was all encompassing for the 10-14
R032XY222WY	**Loamy (Ly) 5-9" Wind River Basin Precipitation Zone** This site is the original mesic basin (MLRA 32) landforms, 5-9
DX032X01B122	**Loamy (Ly) Big Horn Basin Rim** This site is the corresponding site within the Big Horn Basin, and is a division of the original 32XY322 site. Outside of geographics, these two sites are very similar with only minor shifts in LRU characteristics and plant communities.

Table 1. Dominant plant species

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

Legacy ID

R032XD122WY

Physiographic features

The loamy ecological site generally occurs on slopes ranging from nearly level to moderately steep (0 to 30%). Alluvial fans, stream terraces, and hillsides/ridges are identified as the major landforms where this ecological site exists. The loamy ecological site also occurs on relict stream terraces or fan remnants, with minimal or no active soil deposition occurring. Large dissected landforms within the intermountain basin landscape will cross climatic gradients, conveyed in the variability of plant species from upper to lower extents of a landform.

The complexes of soil components mapped on these landforms are typically separated by depth to rock fragments in the soil profile or depth to bedrock (lithic or paralithic). Many of these landforms are erosional remnants and have soils ranging from shallow to very deep. The variability of soils across the landform is also influenced by the geology and its inherent chemistry. This will create pockets of calcareous or saline/sodic soils as well as areas that are not influenced by chemistry. Alluvial materials that are carrying chemistry (salts, carbonates); add to the complexity as it moves across the landform. With these transitions, the break between one ecological site and another (and the representative plant community for each) is often a broad and non-descript band between the two sites. This can make it difficult to clearly identify which site is dominant for a specific point along that transitional gradient.

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

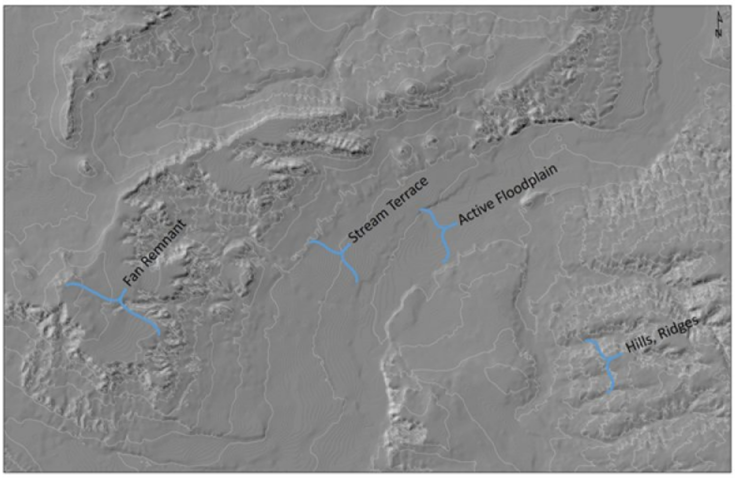


Figure 1.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Fan remnant (2) Intermontane basin > Hillside (3) Intermontane basin > Alluvial fan
Runoff class	Negligible to high
Elevation	1,530–1,960 m
Slope	0–30%
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 10 to 14 inches (254 – 356 mm). The normal precipitation pattern shows peaks in April/May and June and a secondary peak in September. This amounts to about 50% of the mean annual precipitation. Much of the moisture that falls in the latter part of the summer is lost by evaporation and much of the moisture that falls during the winter is lost by sublimation. Average snowfall is about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

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

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

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

Table 3. Representative climatic features

Frost-free period (characteristic range)	76-83 days
Freeze-free period (characteristic range)	107-118 days
Precipitation total (characteristic range)	229 mm
Frost-free period (actual range)	74-85 days
Freeze-free period (actual range)	105-120 days
Precipitation total (actual range)	203-229 mm
Frost-free period (average)	80 days
Freeze-free period (average)	113 days
Precipitation total (average)	229 mm

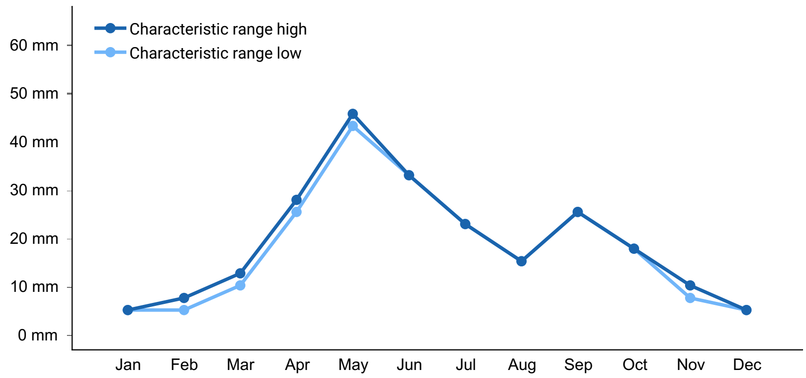


Figure 2. Monthly precipitation range

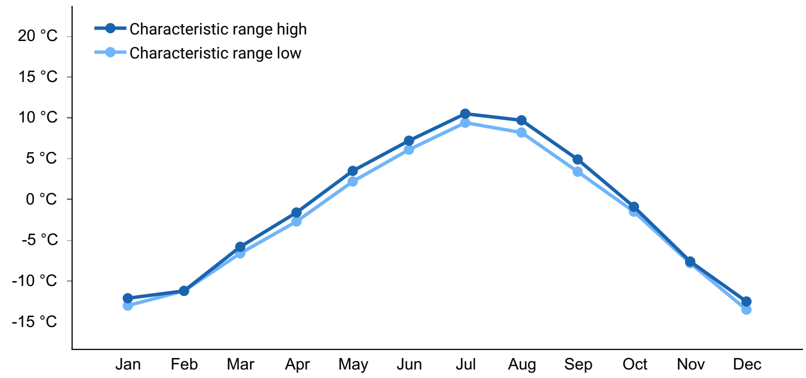


Figure 3. Monthly minimum temperature range

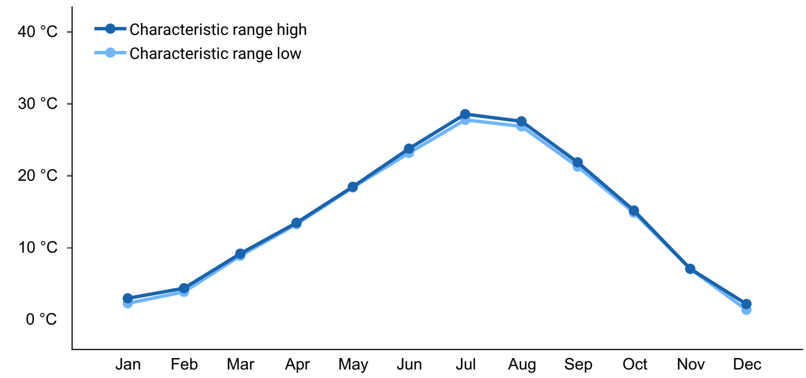


Figure 4. Monthly maximum temperature range

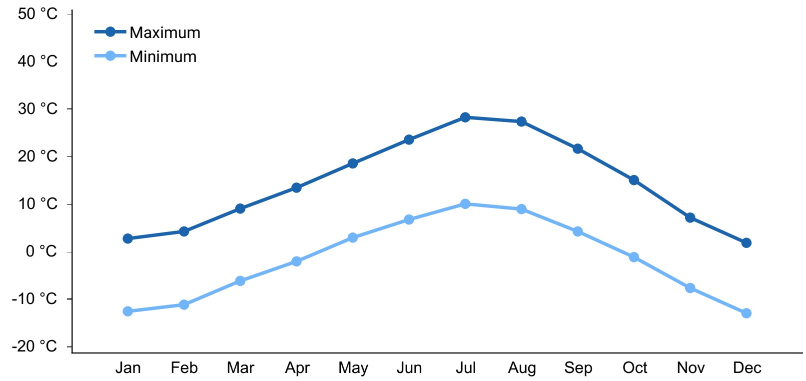


Figure 5. Monthly average minimum and maximum temperature

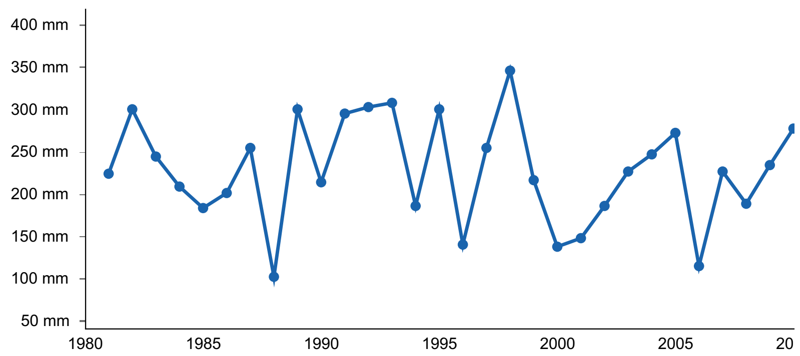


Figure 6. Annual precipitation pattern

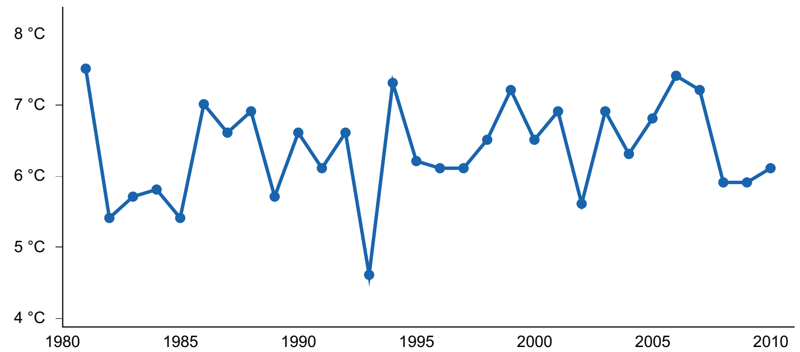


Figure 7. Annual average temperature pattern

Climate stations used

- (1) DIVERSION DAM [USC00482595], Kinnear, WY
- (2) BURRIS [USC00481284], Crowheart, WY

Influencing water features

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

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

Soil features

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

The general soil profile has a sandy loam or loam surface over a sandy clay loam to clay loam subsurface. These soils may have an alluvial layer (gravel or coarse sands) or interbedded sandstone and shales, lower in the profile (below 20 inches (51 cm)). In areas with alluvial parent material, alluvial gravels may be present on the surface (20% or less) and throughout the soil profile of less than 35% by volume.

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

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

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

Major soil series correlated to this site include Forkwood, Zigweid, Bowbac, Kishona, Cambria, Hiland, Cushman, Theedle, Diamondville, Sinkson, Forelle, and Almy. This list of soil series is subject to change upon completion and correlation of the initial soil surveys: WY647 and WY617; as well as revisions to completed soil surveys: WY613, WY713, WY625, WY656, and WY677.

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone and shale (2) Residuum–sandstone and shale
Surface texture	(1) Gravelly sandy loam (2) Loam (3) Sandy clay loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately slow to moderate
Soil depth	51–152 cm
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–5%
Available water capacity (0-101.6cm)	7.62–16 cm
Calcium carbonate equivalent (0-101.6cm)	0–14%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.2
Subsurface fragment volume <=3" (Depth not specified)	0–34%

Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

Mid-stature, cool-season grasses are the dominant potential vegetation on this site. Other significant vegetation includes Wyoming big sagebrush, and a variety of forbs. The expected potential composition for this site is 75% grasses, 10% forbs, and 15% woody plants. The composition and production will vary naturally due to historic use, fluctuating precipitation and fire frequency.

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

Wyoming big sagebrush may become dominant on areas with an absence of fire and sufficient precipitation. 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. In the absence of the natural disturbance regime to encourage rejuvenation and cycling, sagebrush may increase in canopy cover and decrease in palatability and function; the actual number of individual plants may not increase significantly, but the overall size and canopy of each plant increases. Changes in livestock grazing, shifts in wildlife populations, and to a minor extent, the aggressive control of wildfires, have resulted in woody, poor vigor, and dying stands of Wyoming big sagebrush that are susceptible to insect damage and disease. Chemical control using herbicides has replaced the historic role of fire for large scale control.

Over the past two decades, prescribed burning has regained some popularity for controlling sagebrush. However, feasibility is very limited due to the constraints on sagebrush growth habits. Mosaic or "patch" burns are being applied to create or enhance wildlife habitat, specifically for sage grouse and other sagebrush obligate species. Intensity and timing of precipitation limits the resilience of Wyoming big sagebrush in this system. Extended periods are required for natural re-establishment of sagebrush (beyond 50 years). Once sagebrush has been removed (less than 3% canopy), especially where vigorous stands of grass are maintained, seedling establishment is hindered by the competition for limited soil moisture. The loss of structure (height) for snow catch and canopy cover for moisture retention and protection from grazing and wind desiccation, young sagebrush seedlings are quickly stressed or grazed, reducing long-term establishment.

The ecological states and community phases as well as the dynamic processes driving the transitions between these communities have been clarified by examining this ecological site under all management scenarios, including those that do not include livestock grazing. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have been relied upon to develop the state and transition model discussed on the following pages.

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

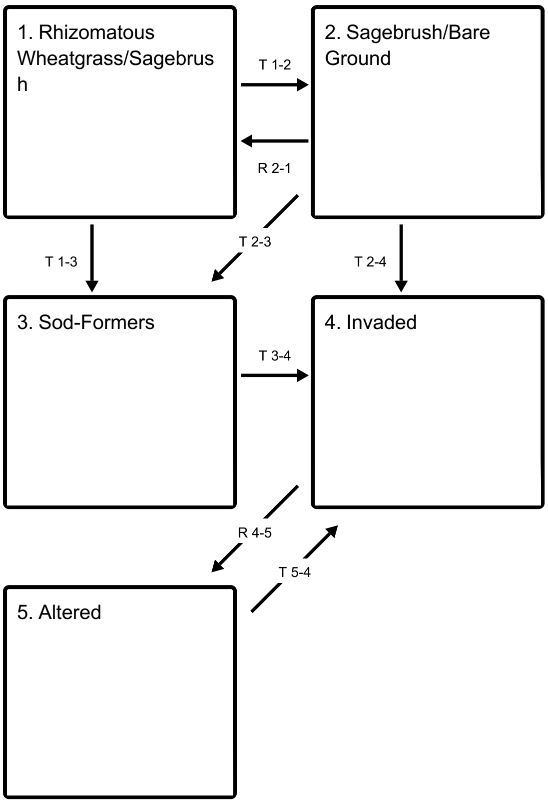
The narrowing of the site characteristics to 18% to 35% clay within the particle size control section has nearly eliminated the coarse-loamy and fine particle size classes from this concept. Consideration for surface texture and depth to argillic will be reviewed to further refine this concept. Communities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

The following state and transition model (STM) diagram has five fundamental components: states, transitions, restoration pathways, community phases and community pathways. The state, designated by the bold box, is considered 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 represents 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 designated in the legend as a "T" (T1-2). They describe the variables or events that contribute directly to loss of state resilience and result in shifts between states. Restoration pathways are represented by the arrows between states returning back from a lower state to a higher state (State 2 - State1 or better illustrated by State 1

State 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. With the weakened grasses and with prevention or lack of fire, the composition will shift to mostly sagebrush, and with time sagebrush will increase in density preventing the recovery without intervention.

T 1-3 - Long duration, high intensity grazing reduces the bunchgrass component and encourages the mat or sod-forming species such as threadleaf sedge and blue grama. Prolonged drought stresses the plants, and opens the canopy for these two quick responding plants to fill in the interspaces. The shallow, dense root mats will continue to spread over time. The added removal of sagebrush with animal impacts, fire or brush management may open the canopy more and aid in establishing this sod-former community.

R 2-1 - Removal or thinning of the sagebrush by mechanical, chemical or fire with remnant populations of the native perennial desired species will lead to this community. Provided, sufficient time is given for recovery of plants and conditions are optimal for seed development and seedling establishment. Frequent use of this community during the dormant season will work to reduce the sagebrush through trampling and grazing-tolerant. B but may encourage lower stature more tolerant species and not the more desired species.

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

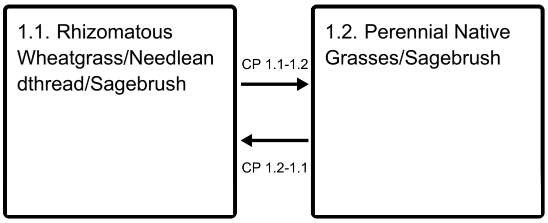
T 2-4 - Seed sources are prevalent for cheatgrass, knapweed, and other invasive species. Stress to the native community from drought; events such as wildfire or prescribed burning and other forms of brush management; or ground/soil disturbance including impacts by grazing large herbivores or recreation that open the canopy and break the surface of the soil, a niche for invasion by undesirable weeds is presented. 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 high traffic areas.

R 4-5 - Integrated pest management plan and intense weed control after and possibly before seedbed preparation will be necessary to overcome a severe weed infestation. Using either improved varieties, native seed, or in some cases, an introduced species suited for the management use intended may be the only way to overcome some invasive species.

T 5-4 - In the reclamation or restoration process, or after a land disturbance occurs, if no management is put into place to prevent a re-occurrence 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 grazing by large herbivores can be a source of the disturbance that either opens the canopy and/or introduces the species to the location.

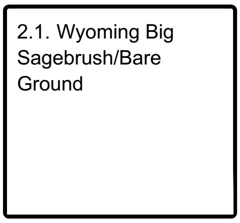
State 1 submodel, plant communities



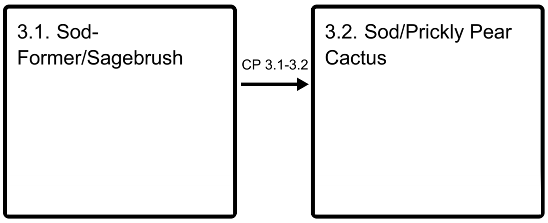
CP 1.1-1.2 - Historic use patterns, drought, and climatic shifts have attributed to the decline in needleandthread and rhizomatous wheatgrasses. As bare ground increases, species such as Sandberg bluegrass, blue grama, and bottlebrush squirreltail increase as well as the canopy of sagebrush.

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 intensity, and allow rest for recovery. The use of dormant season grazing to decrease 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

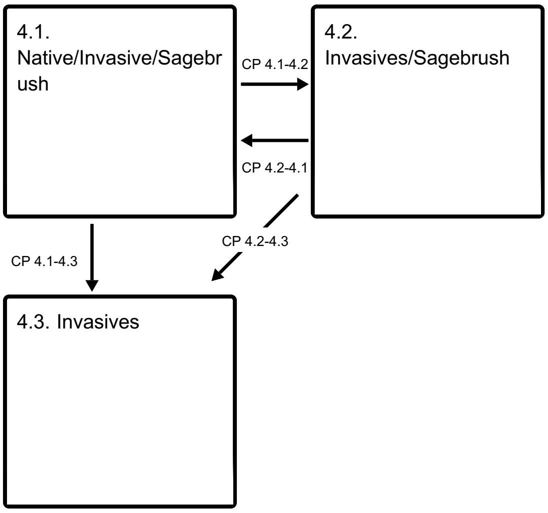


State 3 submodel, plant communities



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 phase into a complete sod community. Cactus increases in this transition due to the open interspaces between patches of sod-formers.

State 4 submodel, plant communities



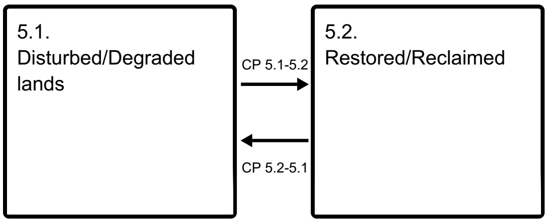
CP 4.1-4.2 - The competition for limited nutrients and spring moisture of most invasive species coupled with the weakening of natives with continued drought stress or grazing pressure will allow the invasive species to become dominant on the site, leaving only remnant populations of natives. Non-use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

CP 4.1-4.3 - Removal of sagebrush by fire, drought, or over use opens the potential for invasion by weedy species, especially cheatgrass following a fire. Continued over utilization 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 diverse pest management/weed control plan to reduce competition for limited water and nutrients 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 cheatgrass following a fire.

State 5 submodel, plant communities



CP 5.1-5.2 - Completion of a re-vegetation project with re-seeding, integrated pest management, and long-term prescribed grazing or other managed use of a landscape is needed to shift a disturbed community back to a representative or functional plant community.

CP 5.2-5.1 - If a reclaimed or restored site is not managed for the species implemented, whether with non-use or lack of restoration of natural disturbance regimes to maintain function of the system or by over-use of the community by large herbivores or humans, the community will revert back or fail to establish and will be a in a degraded community phase.

State 1
Rhizomatous Wheatgrass/Sagebrush

Figure 8. Reference State for Loamy Wind River Basin Rim.

The reference state for the Loamy Wind River Basin Core ecological site is chracterized by the dominance of rhizomatous wheatgrasses, with the scattered overstore of Wyoming big sagebrush State (State 1). This state was maintained with the grazing of large ungulates, mainly wild/feral horses, deer, and antelope; as well as domestic livestock use. This area was historically sheep and has shifted to predominately cattle, however there are still localized bands of sheep that utilize allotments within the LRU. Fire has had only a minor roll within this LRU. Small, lightening induced burns occur, but with no significant frequency.

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

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass
- needle and thread (*Hesperostipa comata*), grass

Community 1.1
Rhizomatous Wheatgrass/Needleandthread/Sagebrush

Figure 9. Reference Community (1.1) in the Loamy Wind River Basin Rim ecological site.

The reference community (1.1) is declining on the landscape. Change or shifts in timing of precipitation, temperature (spring warm up/fall freeze) or lack of precipitation could be the dominant driving factors for this occurrence. This state evolved with grazing by large herbivores. The potential vegetation composition is 75% grasses or grass-like plants, 10% forbs, and 15% woody plants. Mid-stature cool-season grasses dominate this state. This plant community can be found on areas that are properly managed with grazing, and on areas receiving occasional short periods of rest. Historically, the reference state evolved under a low fire frequency (estimated to be 195 to 235 years between burns on the same community patch, with a post fire recover timeframe of 50-120 years or more for sagebrush in arid systems – Baker 2006) and with grazing pressure by large ungulates (deer, antelope, and wild horses primarily; but isolated areas of elk). Changes in herbivory pressure from livestock and wildlife in the area have allowed Wyoming big sagebrush to become increasingly woody and low in vigor. The community is dominated by cool-season perennial grasses, which thrive between and within the sagebrush canopy and cover of other desirable shrubby species –rabbitbrush and winterfat. A stronger presence of short, warm-season grasses (blue grama) and grass-likes (threadleaf sedge) have increased across the entire basin, but has remained as secondary cover in the reference communities. Dominant grasses include western and thickspike wheatgrass and needleandthread. Grass species of secondary importance include bluebunch and Montana wheatgrass, Indian ricegrass, and bottlebrush squirreltail. Minor grasses and grass-likes include Sandberg bluegrass, threadleaf sedge, and blue grama. Forbs commonly found in this plant community include scarlet globemallow, milkvetches/sweet vetches, desert parsley, fleabanes, and phlox. Sagebrush can make up to 15% of the annual production. The overstory of sagebrush and understory of grass and forbs provide a diverse plant community. The total annual production (air-dry weight) of this community phase is about 575 pounds per acre, but it can range from about 255 lbs./acre in unfavorable years to about 825 lbs./acre in above average years.

Resilience management. The plant community diversity enables a high drought tolerance, allowing persistence in the limiting climatic conditions of the Wind River Basin. The structural diversity of Wyoming big sagebrush in conjunction with the rhizomatous species (western wheatgrass and thickspike wheatgrass), mid-stature bunchgrasses (needleandthread and Indian ricegrass), and the secondary mid-stature bunchgrasses (prairie junegrass, Sandberg bluegrass, and bottlebrush squirreltail – rare areas of bluebunch wheatgrass) helps to provide snow catch and shade to capture and hold moisture, maximizing availability during the growing season. The site hydrology in combination with the adaptability of the plants to maintain herbaceous cover in variable weather patterns, adds to the drought tolerance and resilience of this community. Unlike the relative constant presence of rhizomatous wheatgrasses, needleandthread is dependent on early spring moisture to perform well. In years with late spring early summer moisture needleandthread will remain dormant or quiet, while prairie junegrass will produce an excellent cover. Whereas years with late fall moisture and a slow warm-up with spring moisture will produce an excellent cover of Sandberg bluegrass but minimal production for prairie junegrass and needleandthread. The persistence and adaptability from year to year of these species allows for quick recovery once "normal" precipitation returns. This variability will shift the community between phase 1 and 2 with extended periods of drought, grazing use changes, and other natural and human derived impacts; but is not at risk of transitioning into a different state unless a catastrophic impact occurs. Rangeland health factors are captured as the character traits of this community (1.1) – including: site/soil stability, watershed function, and biologic integrity.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass
- needle and thread (*Hesperostipa comata*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	224	504	673
Shrub/Vine	50	112	196
Forb	11	28	56
Total	**285**	**644**	**925**

Table 6. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	5-15%
Grass/grasslike foliar cover	30-50%

Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	10-20%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-25%

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	10-20%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-25%

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-10%	0-10%	0-10%
>0.15 <= 0.3	–	0-20%	0-20%	0-2%
>0.3 <= 0.6	–	0-5%	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.2
Perennial Native Grasses/Sagebrush

Figure 11. At-risk community in the Reference State (1.2).

This site is very similar to the Reference community (1.1). The community can be found on areas that have had impacts outside the natural disturbance regime (over utilization, repetitive growing season use, or are in a positive trend with effective management). The community has seen needleandthread as well as western wheatgrass decline in vigor and abundance while Wyoming big sagebrush, Sandberg bluegrass and blue grama have increased in the system. The community composition has shifted to 65% grasses or grass-like, 10% forbs, and 25% woody species. This community (1.2) still maintains a dominance of cool season mid-stature grasses. The major grasses include Sandberg bluegrass, prairie junegrass, bottlebrush squirreltail and blue grama. Western wheatgrass and needleandthread have declined, but are still components in the system. A variety of forbs and half-shrubs also occur, as shown in the following table. Wyoming big sagebrush is a conspicuous element of this community phase, and comprises 15 to 25% of the annual production. Blue grama and threadleaf sedge have increased, making up at least 5-10% of the understory. These species have a significant impact on infiltration rates and increase runoff due to their dense shallow root systems. Plains prickly pear cactus may have increased. Woolly plantain and six-weeks fescue are beginning to establish a small footprint in this community. The total annual production (air-dry weight) of this community is about 610 lbs/acre, but it can range from about 260 lbs./acre in unfavorable years to about 875 lbs./acre in above average years.

Resilience management. This plant community is resistant to change. The overall canopy is adequate to protect the site. However, bare ground has increased on the landscape due to the arid nature and increasing woody cover. Bare ground averages 25 to 35%; woody cover has increased due to reduced herbaceous cover, to an average of 15 to 25% cover. Litter overall appears to be similar across this state. Similarly, the biological crust cover does not vary. The herbaceous species are well adapted to grazing; and plant vigor and replacement capabilities are sufficient, but are limited by precipitation. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal, and soils are mostly stable with minimum loss of the surface soil. The watershed is functioning and the biotic community is intact.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- needle and thread (*Hesperostipa comata*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- blue grama (*Bouteloua gracilis*), grass

Table 9. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	196	392	560
Shrub/Vine	112	224	280
Forb	11	28	56
Total	**319**	**644**	**896**

Table 10. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	15-30%
Grass/grasslike foliar cover	25-45%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	10-20%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
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	10-20%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
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	–	0-10%	0-20%	0-10%
>0.15 <= 0.3	–	0-20%	0-10%	0-2%
>0.3 <= 0.6	–	0-5%	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

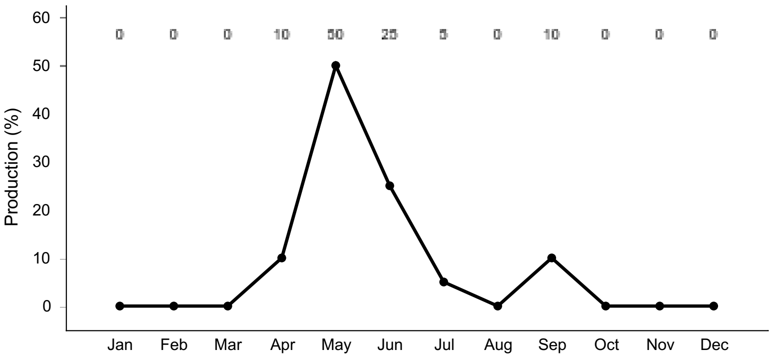


Figure 13. Plant community growth curve (percent production by month). WY0801, 5-9WR upland sites.

Pathway CP 1.1-1.2
Community 1.1 to 1.2

Rhizomatous Wheatgrass/Needleandthread/ Sagebrush

Perennial Native Grasses/Sagebrush

Timing of Grazing, Drought, Climatic shifts – The increase in blue grama and threadleaf sedge throughout the system is not well understood. However, inferences to the drivers can be made. Historically, this site was used during the spring and fall as livestock were held before moving to summer allotments (mountains and foothills). The repetitive timing of use on select species slowly reduced or removed these plants from the system. Long periods of drought and shifts in spring precipitation patterns have weakened and affected the productivity and vigor of most species, leaving a harsh climate for re-establishment of these species. The historic shift from sheep to cattle dominated grazing and changes in grazing management strategies has affected the plant communities (positively and negatively). However, drought and other climatic patterns pose a significant threat to the integrity of the reference plant community.

Pathway CP 1.2-1.1
Community 1.2 to 1.1

Perennial Native Grasses/Sagebrush

Rhizomatous Wheatgrass/Needleandthread/ Sagebrush

Long-term Prescribed Grazing, Brush Management - With integration of a rotational grazing system (i.e. rest-rotation), and with practices used to reduce shrub canopy, the native bunchgrasses will begin to reestablish in this community, but it may take 5 to 10 years before significant change is noticed. Targeted prescribed grazing, especially following sagebrush canopy treatments helps to remove woody debris and exposes a seedbank to encourage the native species. Allowing rest during critical seedling establishment stages and reducing competition of less desirable native species will help recovery. Hoof action helps to break up duff layers and open the seedbed to allow the desired wheatgrasses and bunchgrasses such as western wheatgrass, Indian ricegrass, and needleandthread to reestablish or to increase, driving the recovery to the reference community (1.1). A long-term management strategy may be required before any trend towards reference is noticed. The overstory of Wyoming big sagebrush is the factor that could require mechanical manipulation to reduce and rejuvenate the canopy and composition to the desired 15%. The sod forming species are a secondary concern in the transition away from reference. Blue grama has increased, but is still below 10% of the total composition, and can be minimized with grazing management strategies (hoof action).

Conservation practices

Livestock Pipeline
Prescribed Grazing
Grazing Land Mechanical Treatment
Heavy Use Area Protection
Watering Facility
Water Well
Planned Grazing System
Prescribed Grazing
Grazing Management Plan
Monitor key grazing areas to improve grazing management
Prescriptive grazing management system for grazed lands

State 2
Sagebrush/Bare Ground

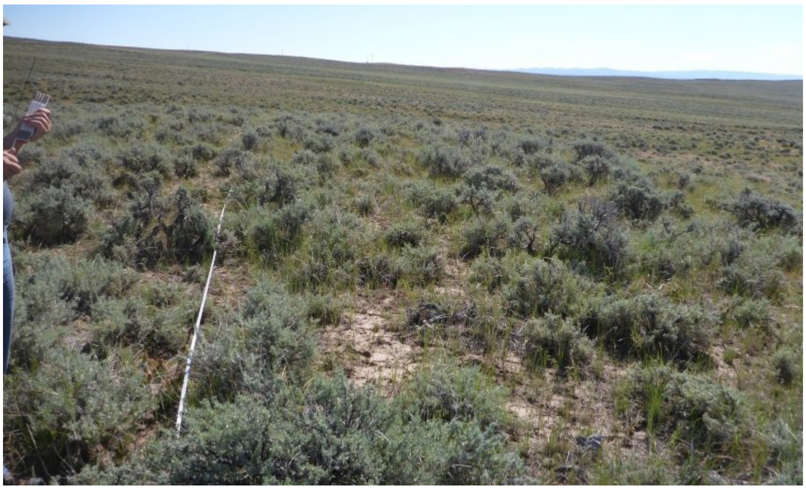


Figure 14. Sagebrush/Bare Ground State with rhziomatous wheatgrasses and sandberg bluegrass.

The remaining herbaceous understory utilizes the moisture and shelter provided by the canopy of Wyoming big sagebrush to maintain vigor in difficult conditions. Persistence of drought and/or frequent over use by livestock and/or wildlife leads to a decline of the herbaceous understory, creating the Wyoming Big Sagebrush / *Bare Ground* State. Total sagebrush canopy increases in percent composition by cover. With the decrease of herbaceous vegetation production, the canopy of sagebrush appears to increase. Lack of fine fuels to carry a fire leave this state at a minimal risk of wildfire. However, with the right weather conditions (dry, hot winds), the sagebrush canopy may easily carry a fire. Depending on the current livestock management, trailing and other erosional patterns may be highly visible in this state. The production and function of this state can be altered by the health and vigor of the sagebrush, establishment of other woody species and the intensity of the herbivory. Long-term protection from wildfire and grazing can advance the transition of a reference community (1.1 or 1.2) to this state (2). As sagebrush becomes dense and mature, the herbaceous component declines in vigor, bare ground and sagebrush cover increase. Further decline in this state, leaves the sagebrush cover susceptible to attack by insects, disease, and general old age. This community is now at risk of invasion or transition to a more degraded state. There is a high level of variability of species in this state, which will shift in response to precipitation or in response to past management. The most representative community is discussed below.

Characteristics and indicators. Wyoming big sagebrush is a significant component (> 25%) of the plant community and the preferred mid-stature cool season grasses have been eliminated or greatly reduced. Sandberg bluegrass and western wheatgrass are prominant, but usually within the crown of sagebrush or prickly pear cactus. The interspaces have expanded, leaving significant bare ground.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- thickspike wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), grass

Community 2.1
Wyoming Big Sagebrush/Bare Ground

This plant community is the result of frequent and severe grazing during the critical growing season and/or protection from fire. Sagebrush dominates this plant community, with the annual production of sagebrush exceeding 25%. Wyoming big sagebrush is a significant component of the plant community and the preferred mid-stature cool season grasses have been eliminated or greatly reduced. The dominant grasses are Sandberg bluegrass and western wheatgrass. Prickly pear cactus often increases. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. When compared to the Reference Plant community 1.1, the total annual production is similar. However, the herbaceous production is markedly lower, with the shrub production absorbing the difference. This community is vulnerable to invasive weeds such as cheatgrass, knapweeds, or whitetop if a seed source is available. The total annual production (air-dry weight) of this state averages 500 pounds per acre, but it can range from 255 lbs./acre in unfavorable years to 850 lbs./acre in above average years.

Resilience management. This plant community is resistant to change as the sagebrush stand becomes more mature, but is at-risk due to its susceptibility to invasive species. This plant community may be more resistant to fire as fewer 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 cool-season grasses. Plant litter is noticeably less when compared to the Reference Plant Community. Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- needle and thread (*Hesperostipa comata*), grass

Table 13. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	168	280	448
Shrub/Vine	112	280	336
Forb	6	28	56
Total	**286**	**588**	**840**

Table 14. Ground cover

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

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	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	30-50%

Table 16. Canopy structure (% cover)

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

State 3
Sod-Formers

Figure 16. Blue grama taking over the understory of Wyoming big sagebrush and prickly pear cactus.

The degraded condition of this State is driven by the loss of hydrologic function and species diversity with the increase of sod-forming grasses, mainly blue grama with a smaller component of threadleaf sedge. This site is the result of long-term season long grazing by large ungulates; but long term exclosures also suggest a possible response or impact of shifts in historic weather patterns.

Characteristics and indicators. The dominant sod-forming grass that currently exists within this LRU is blue grama with intermixed areas of threadleaf sedge. Both are species that persist as a component of the perennial vegetation naturally (in reference communities) within this ecological site. The general tendency is for these species to increase with prolonged drought or under grazing pressure, becoming dominant. Hydrology of the site is altered by increased surface runoff from the dense shallow root system that inhibits the movement of water through the soil. The sod patches will direct surface flow around the edge of the mat concentrating flow into channel like patterns, creating a difficult or harsh environment for native grass species and forbs to persist.

Dominant plant species

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

Community 3.1
Sod-Former/Sagebrush

Figure 17. Blue grama dominated community.

This plant community is the result of continuous season-long grazing, repeated severe grazing, or prolonged drought. Improper grazing practices have adversely affected the perennial grasses and shrub component creating an open canopy that allows the mat forming plants to expand. The natural effect of blue grama and threadleaf sedge, with their short-stature dense root structure, is a decrease of water infiltration. This decrease in infiltration expands channelization of runoff between vegetation patches. The lack of structure to hold moisture and continued drought will continue to reduce the shrub component. A dense sod of blue grama with patches of threadleaf sedge is the major grass component remaining in this community. Minor occurrences of other perennial natives are incidental within the sagebrush canopy and/or prickly pear cactus. Wyoming big sagebrush has been reduced in vigor and cover across this site. However, it will persist in small patches of 3-5% cover on the landscape. When compared to the Reference Plant Communities 1.1 and 1.2, blue grama has increased significantly, making up 30 to 60% of the canopy. Prickly pear cactus has invaded the site, and other cool-season mid-stature grasses, perennial forbs, and most shrubs have been greatly reduced. Production has significantly decreased and bare ground may not vary or will increase (longer extents of bare ground between densely vegetated areas). The total annual production (air-dry weight) of this state is about 325 pounds per acre, but it can range from about 180 lbs./acre in unfavorable years to about 575 lbs./acre in above average years.

Resilience management. This community is at-risk of transitioning to a completely sod-bound community without woody vegetation. The dense root mats are extremely resistant to change. Continued frequent or severe grazing or the removal of grazing does not seem to affect the plant composition or structure. The shrub component will decline and eventually be removed from the plant community under either scenario. The biotic integrity of this state is nonfunctional and plant diversity is extremely low. The plant vigor is reduced and replacement capabilities are limited due to the few remaining cool-season grasses. This sod-bound plant community is very resistant to water infiltration. While the sod protects the site itself, off-site areas are affected by increased runoff that can cause rills and gully erosion. Water flow patterns are obvious in areas of bare ground and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as the increased runoff may affect adjoining sites. This community has the ability to improve, but not recover to reference, with management and mechanical manipulation. Once the sagebrush component has been lost, however, recovery or transition is not as feasible. This community is considered to be “at-risk”. The potential to shift into the more degraded and stable state of a Sod/Cactus community is higher than the potential to improve. The threshold composition of sod-forming grasses and the lack of significant cover by other perennial grasses makes these two communities (3.1 and 3.2) very similar. The shift in sagebrush and cactus cover are the defining characteristics.

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	168	252	420
Shrub/Vine	28	84	168
Forb	6	28	56
Total	**202**	**364**	**644**

Table 18. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	5-15%
Grass/grasslike foliar cover	25-40%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	35-50%

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	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	35-50%

Table 20. Canopy structure (% cover)

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

Community 3.2
Sod/Prickly Pear Cactus

Figure 19. Blue grama and prickly pear cactus dominated community.

Transitioning from the Sod/Sagebrush community phase (3.1) to the Sod/Cactus community phase (3.2) may occur as a slow and steady process from the initial transition into a sod-former state through drought or continued pressure on the remaining shrubs. A dense sod of blue grama with threadleaf sedge intermixed, is dominant with increasing prickly pear cactus in the community. Cactus density has the potential to increase to a level that inhibits the ability for livestock to move through or graze the available forage. Wyoming big sagebrush has been generally removed from the community with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but persists on the landscape. When compared to the Reference State (1.1 and 1.2), blue grama and prickly pear cactus have increased. All cool-season mid-stature grasses, forbs, and most shrubs have been greatly reduced or removed. Production has been significantly decreased. The ability for upland sedges, as well as remnant species such as Sandberg bluegrass, to respond to spring moisture allows for a significant range in production. Study plots have documented a range in production of less than 160 pounds one year to over 500 pounds the next year with no change in density/frequency, based only on timing and amount of precipitation. So production is provided as an average or median number and is not intended to cover the full range of production potential for this community. The total annual production (air-dry weight) of this state is 285 pounds per acre, but it can range from 160 lbs./acre in unfavorable years to 500 lbs./acre in above average years.

Resilience management. This sod bound community is extremely resistant to change and continued frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure of the plant community. The biotic integrity of this state is not functional, plant diversity is extremely low, vigor is significantly weakened, and replacement capabilities are limited due to the reduced number of cool-season grasses. The dense root mat of this community is resistant to water infiltration, but is able to utilize the water captured by the root zone. However, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious within the bare ground (interspaces) and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

Dominant plant species

- plains pricklypear (*Opuntia polyacantha*), shrub
- 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	168	252	420
Forb	11	56	112
Shrub/Vine	–	11	28
Total	**179**	**319**	**560**

Table 22. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0-5%
Grass/grasslike foliar cover	30-50%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	35-50%

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	0-5%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-30%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	35-50%

Table 24. Canopy structure (% cover)

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

Pathway CP 3.1-3.2
Community 3.1 to 3.2

Sod-Former/Sagebrush

Sod/Prickly Pear Cactus

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

Conservation practices

Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Planned Grazing System
Grazing Management Plan

State 4
Invaded

Cheatgrass or downy brome (*Bromus tectorum*) is the invader that has the greatest concern for most land managers. This invader has an aggressive growth habit that creates a harsh environment for most native species, including sagebrush. Multiple growth cycles throughout a year leaves a thick litter (duff) layer and builds a significant seedbank. The ability to persist through the winter under snow and sprout early gives it the advantage over native species for the early spring precipitation and snowmelt. Shifts in climatic patterns, changes in management, and exposure to human activity are a few of the explanations for the current flush and rapid expanse across the western United States. Although cheatgrass is the threat most prevalent to rangelands on a large scale, a variety of thistles, knapweeds (spotted, Russian, etc.), and whitetop (hoary cress) are increasing in density and frequency, creating their own set of challenging management issues. As more or new invasive species are found or identified within the Wind River Basin, the community dynamics in this state will continue to shift in response to the species-specific concerns.

Characteristics and indicators. This state is characterized by the presence of an invasive/non-native species. Extended periods of drought alone; or in combination with severe grazing, insect damage, or wildfire has weakened the native composition of the community opening the canopy for invasion. The competitive nature of annuals and other invasive species, the loss of diversity, changes to the potential of a site due to allelopathy or other deterrent characteristics of invasive species, and risks or limitations associated with the various invasive species creates a hostile environment for both native species and grazers.

Resilience management. The resilience and resistance of the invaders create a management roadblock that is usually financially driven. Once an invasion reaches a threshold, many land managers have no choice but to learn to utilize what they have rather than to try to treat or improve the site, specifically in relation to cheatgrass control.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- cheatgrass (*Bromus tectorum*), grass

Community 4.1
Native/Invasive/Sagebrush

The Perennial Grasses/Invasive Species/Wyoming big sagebrush community phase (4.1) has maintained a representative range of native perennial grasses and forbs that are key to this particular ecological site with the accompanying Wyoming big sagebrush component. Although this community phase is very susceptible to becoming an invader driven system. If native grasses can maintain at least a 50% composition; there is still a chance that the community can be improved. However, the high costs required for improvement will limit the economic feasibility of treatment. This community phase is characterized by a significant presence of invasive species composition (5% or greater) on the landscape, and are prominent on the site (referring to a more wide scale composition, not one small patch in an isolated portion of the landscape). The litter or duff layer created by many of the known invasive species, but specifically cheatgrass, is significantly higher than the native community. This duff layer creates a barrier that can impede water infiltration and increase runoff, which accelerates erosion. This is exacerbated with increased slope. The duff layer creates an extreme hot zone during wildfires that can sterilize the soil through volatilization of needed nutrients or by the formation of an ash cap that seals the soils. This cap prevents water infiltration and seed penetration and reduces the ability for re-vegetation post-disturbance. Production of the perennial grasses and forbs is reduced. However, the total production will maintain or may be slightly higher due to the overall biomass and expanded growth potential of many of the annual/invasive species. A specific production range is not provided due to the variability of composition that will effect overall production.

Resilience management. This plant community is prone to fire in response to the increase in fine fuels from the added biomass (litter) produced by the invaders. Plant diversity is moderate for this phase because the native perennials and woody shrubs have maintained their position within the community. The plant vigor can be variable and is generally only slightly diminished at this stage. However, replacement capabilities are limited due to the added competition for moisture and nutrients available after cheatgrass has sprouted. Plant litter is noticeably higher when compared to reference communities. However, the potential biomass produced is dependent on the invasive species. Soil erosion is variable depending on the species and their associated litter accumulation. This variability also applies to water flow patterns and pedestalling. Infiltration is unaltered or slightly reduced. However, as the duff layer and litter build, infiltration will decrease and runoff will increase.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass

- Sandberg bluegrass (*Poa secunda*), grass
- needle and thread (*Hesperostipa comata*), grass
- cheatgrass (*Bromus tectorum*), grass

Community 4.2
Invasives/Sagebrush

As the native populations of perennial grasses and forbs are lost from severe grazing or other disturbance, the site becomes invader driven. Continued environmental or management derived impacts to the shrub component places this community at-risk of crossing a threshold transitioning to Community Phase 4.3. At this point, from hydrologic and biotic standpoints it will become irreversible without complete reclamation, which makes this community phase, the At-Risk community. Wyoming big sagebrush is able to compete and maintain a strong community under a heavy influx level of most invasive species, unless fire or similar disturbance removes the woody cover. The canopy of the sagebrush provides a protected position in the system for native grasses and forbs, allowing remnant populations to persist. However, the system is low in resistance and even lower in resilience. The fine fuels or biomass produced by most invasive species, with the most obvious being cheatgrass, make fire a significant threat and frequent occurrence. Strategies to control or manage for invasive species, namely cheatgrass, are being researched across the western United States. High intensity grazing with chemical control and the use of biological agents are techniques that have been tested, with varying levels of success. The key management strategy needs to maintain the remnant populations of native grasses, by reducing the risk of fire. This approach will allow Wyoming big sagebrush to persist. This strategy will also maintain the biotic integrity by maintaining species richness, which provides structure and a range of growth traits. This structure will provide adaptability of the site to varying climatic swings and help support the hydrologic function. Enhancing snow catchment and shade will allow a slow release of winter precipitation during spring melt. This will provide a longer moist season for optimal growth of native species). Each location will need to be addressed individually to determine the best management strategies to utilize the native species present in the system and to determine the limitations of the site.

Resilience management. This plant community is resistant to change in relation to returning to a native dominated system. However, as the stand becomes more decadent, it loses its resistance to shift to an invader only community. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is reduced with increased biomass and plant density of the annual invaders. Plant diversity is poor. The plant vigor has declined and adaptability/replacement capabilities are limited due to the reduced number of cool-season grasses. Noticeably more plant litter is apparent when compared to reference communities. This is caused by the additional biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the associated litter accumulation. The variability of the water flow and pedestalling as well as, infiltration and runoff is determined again by the species that establishes on this site.

Dominant plant species

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

Community 4.3
Invasives

Downy brome, better known as cheatgrass (*Bromus tectorum*), is able to emerge and grow late into the fall and green up in early spring before snowmelt. This early and late growth pattern allows cheatgrass to utilize fall and spring resources that are otherwise stored for the dormant native cool season perennial vegetation. Seeds are able to persist for long periods, allowing propagation beyond the life span of the native seed source. This plant out-competes native and many improved varieties of grasses because of its ability to quickly utilize minimal available resources, produce large quantities of seed quickly, and reproduce in poor conditions. The morphology of the seed allows for easy dispersal and longevity creating a widespread and long-lived seed bank. These traits create a management challenge that has not been successfully overcome at this time. Once cheatgrass has established on a landscape, it is resistant and resilient to change. In this community, with the absence of sagebrush, there may be native species that will persist in small scattered populations or sparsely under the canopy of the cheatgrass. Certain climatic conditions will allow natives to show their resiliency and respond to the available resources (typically mid-spring moisture), but are generally unable to out-compete the annual invader, and remain suppressed in the community. The ability for cheatgrass to emerge, bolt, produce seed and mature out two to three times within a year utilizes all available soil nutrients and moisture resources. Chemical control is difficult to attain and maintain success without lasting effects on the native grasses in the area. Chlorosis of wheatgrasses, stunted plants, and loss of certain forbs are a few of the residual chemical effects (The herbicide, Plateau, has been widely used in this region.) These effects generally come from the chemical composition and its ability to bind to the chemistry or nutrients in the soil inhibiting the uptake by roots. The extensive fine fuel load created by cheatgrass increases the fire frequency interval to an average of five years. This shorter cycle prevents sagebrush and other woody species from establishing on the site. A five-year cycle has negative impacts on many of the native herbaceous species in the understory, increasing evaporation, mineralization and vaporization of many of the nutrients, which depletes the soil. The grazing potential is limited due to the unpalatable and harsh environment that the mature seeds create with their long awns and chaff. If grazed in early spring or late fall some of this may be avoided. However, light grazing through the middle of the growing season is difficult, and defeats the purpose of intensively grazing the location. On smaller, invaded sites or under certain conditions, targeted grazing can be used as a tool within the integrated pest management toolbox, but it is not effective alone.

Resilience management. This plant community is resistant to change. Plant diversity is poor. The plant vigor is diminished and replacement capabilities are non-existent from loss of cool-season grasses. Plant litter is noticeably higher 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 has been 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 – Drought, wildfire, or other climatic stresses on the system will continue to hinder the native species, reducing their ability to maintain their position in the plant community. This continued stress combined with frequent or severe grazing pressure from wildlife and livestock can reduce the native composition to an unviable or unsustainable population. At this point, the invasive species will become dominant. The fleshy growth of native species are generally preferred over the thin straw like growth of cheatgrass. During initial spring green up while natives are still dormant, wildlife and cattle will utilize the cheatgrass. However, once the native species begin to green up, the animals will switch back to their preferred species. Inaction by the land manager will also aid in the transitioning to phase 4.2.

Pathway CP 4.1-4.3
Community 4.1 to 4.3

Fire, Drought, Ground Disturbance, Severe Grazing – Once the presence of invasive species occurs, stress or ground disturbance of any means coupled with the lack of management of the invader, allows the invasive species to occupy and dominate the site. The stressors that most commonly occur that remove the sagebrush and amplify the weed infestations are fire (wild/prescribed), drought, insect damage and disease, as well as frequent and severe grazing by large herbivores.

Pathway CP 4.2-4.1
Community 4.2 to 4.1

Integrated Pest Management/Weed Control and Long-term Prescribed Grazing - Control of invasive species and targeted grazing to utilize the invasive species with minimal impact to the native population, will allow the community to regain or maintain potential. However, at this phase it is not possible to eradicate the invasive species. Sustained control requires intensive inputs over the course of several years. To maintain the system with no further degradation requires a combined approach of both long-term prescribed grazing and intensive weed management (integrated pest management). No one single practice can sustain this phase. Maintaining this phase requires intensive management to prevent the transition to Phase 4.3 - Invaders/Annuals.

Conservation practices

Prescribed Grazing
Grazing Land Mechanical Treatment
Integrated Pest Management (IPM)
Planned Grazing System
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Prescriptive grazing management system for grazed lands

Pathway CP 4.2-4.3
Community 4.2 to 4.3

Fire, Drought, or Ground Disturbance with Severe Grazing - Once this community has been compromised by a substantial composition of invasive species, stress or ground disturbance of any means may cause the invasive species to occupy and dominate the site. Drought and related disease and insect damage will weaken and remove the remaining sagebrush canopy. Removal of this canopy leaves a near monoculture of invaders. Frequent and severe grazing by large herbivores is another impact that leads to this community. Management actions that reduce or damage the existing sagebrush canopy exposes the remaining native grass population and will start the transition. Drought or further disturbance or improperly timed grazing (grazing when the desired species are in the early boot growth stage or beginning to flower), will finish the transition.

State 5
Altered

The arid nature of this region has played a major role in the development and transitions in land use over time. Landscapes accessible by irrigation water and equipment were farmed and many were later abandoned and left to return to rangeland. Other landscapes were treated with a variety of practices to manage or eradicate sagebrush. Tillage of the soil, change in hydrology caused by the loss of vegetative structure, constant climatic fluctuations, and advancements in seed sources have created this altered state. Once a soil has been disturbed, whether it was mechanical, cultural, or natural the change in soil structure, hydrologic function, and possibly stability prevent a site from supporting the native vegetation or responding to management the same as the reference site. Reclamation or restoration of an area will not replace the original function and factors that made the original location respond as it did. So these "altered" lands may, after significant inputs and time, look similar to the Reference communities (1.1 or 1.2), but they will not be able to respond or function the same way as the Reference community. The disturbed or degraded state could be shown as a stand-alone box within the state and transition model diagram. No matter what state a location is classified, once the site has experienced an event that has altered the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered. Consideration of this state for an alternate ecological site would be reasonable. In some cases (site by site consideration), a re-correlation of a location may be the best solution. However, in many cases, the soils have not been altered beyond the current site characteristics. However, the potential has shifted enough that it is no longer truly comparable to the reference state. Tillage of a site, alters the soil structure, depletes the biota of the soil and dries the profile. The loss of soil structure changes the water holding capacity of the soil, and the mixing may remove argillic or clay bulges, which may increase the movement through the soil, and reduce the available water capacity. The time required for soil to recover and re-establish the healthy biota is highly variable depending on the climatic conditions following the event. The initial flush of weedy vegetation (kochia, Russian thistle, and mustards) is the initial step in the recovery process. Although they are only successional species, they provide organic material, nutrient flow and erosional protection. However, they lack the perennial structure and root system to fully stabilize the site. When the seeded area establishes, the site may become similar in composition to reference. However, the integrity of the soil has been altered, changing potential of the site. A dynamic state was depicted to detail the altered communities that exist on the landscape.

Characteristics and indicators. Soil disturbances, indications of seeding (rows, presence of strong stands of improved grass species or selective seeded species - crested wheatgrass, Russian wildrye, etc.), or the prominent cover of early successional plants (kochia, russian thistle, mustards) are strong indicators or characteristics of a disturbed/degraded or altered landscape.

Community 5.1
Disturbed/Degraded lands

Disturbed or degraded lands are characterized by alteration of the soils to a degree that the functionality (erosional, depositional, hydrological or chemical) and potential of the soils has been impacted. Site-specific evaluations need to be completed to determine the level of effect. The method and severity of alternation, as well as, the spatial extent of the disturbance will determine vegetation response and management needs. Linear disturbances, such as trails and roads, will hold a different risk than patch or wider disturbances, such as well pads or parking areas. Small scale or isolated disturbances (spot fires, prairie dog towns) can be just as significant of a risk as a large-scale disturbance (mine lands). The growth curve of this plant community will vary depending on the successional or seeded species that are able to establish in an area. On locations that were seeded with non-native species, the growth curve will vary from the native community. However, in the case of an early successional community, the growth curve may be similar. For a more accurate growth curve, a site-specific species inventory and documentation of the climatic trends should be collected.

Resilience management. The plant community is variable and depending on the age of the stand and the stage of succession, that the location is in will determine community resiliency. Plant diversity of these successional communities is generally strong, but is usually lacking in the structural groups that are desired on the site. In areas of new or frequent disturbance, annual weedy species or early successional plants will be the dominant cover, providing a strong diversity, but having minimal structural cover for some wildlife. As the site matures or as the period between disturbances is lengthened, perennial or taller statured, stronger rooted species will increase. By providing protection and improvement to the hydrologic process, these perennial species allow for other grasses and shrubs to begin to establish. This flexibility within the community creates a variable level of biotic integrity. Soil erosion is dependent on the disturbance regime and the biotic integrity of the community. The variability of the community also affects the water flow, infiltration, runoff, and pedestalling risk. Other factors that are more prevalent or influential for these sites are surface roughness and brokenness (tire tracks, hoof action, smoothed, denuded surfaces, or trails that may concentrate water flow).

Community 5.2
Restored/Reclaimed

Shifts in reclamation practices over the last several decades have altered the success and stability of reclaiming a site. Crested wheatgrass was a species used frequently for reclamation throughout Wyoming. Across the state, many of these communities persist today. These stands are stable and generally persist as a monoculture until a disturbance creates a niche for native species to establish. Crested wheatgrass has spread into native communities as readily as native species are persisting within crested wheatgrass stands. Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses are used in mixes to help increase establishment on these sites. The success of vegetative seeding trials are low to moderate in this LRU due to variable amounts and timing of precipitation events. However, seeding has succeeded in limited areas along pipeline corridors, well sites or pad sites, and along transportation corridors. Current interpretations of reclaimed or restored refers to the establishment of native species in a composition as close to a natural (pre-disturbance) plant community as possible. This excludes the use of non-native species, allowing a similar ecological response to the reference state. Although, to clarify, even when native species are used in reclamation, these plantings will not replicate the reference community in response to management due to the change in soil dynamics with mechanical disturbance (seedbed preparation and seeding), but they may be similar. The growth curve of this plant community will vary depending on the species that are selected for the reclamation seed mix. For a more accurate growth curve the species used and the climatic tendencies of the region must be considered.

Resilience management. Seeding mixtures will determine the plant community's resistance to change and resilience against the threat of invasive species and to erosion. Many plantings are diversity poor, but are better than the monocultures that were seeded historically. Many seeded sites may be prone to fire because of the increased production potential and basal cover of species (seeding density) as they mature (more biomass and possibly more litter) providing abundant fine fuels to carry a fire. Soil erosion is variable depending on the establishment of the seeding, how it is seeded, and mechanical procedures put in place. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that comprise the community and the method of seeding (site preparation and seeding practice). The challenge to establish shrubby species to the density they were pre-disturbance, and the general difficulty to reseed sagebrush, has limited the recovery of the hydrologic cycle.

Pathway CP 5.1-5.2
Community 5.1 to 5.2

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

Conservation practices

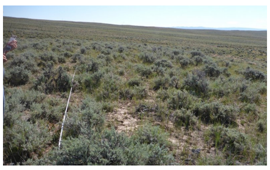
Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)
Native Plant Community Restoration and Management
Prescribed Grazing
Grazing Management Plan
Herbaceous Weed Control

Pathway CP 5.2-5.1
Community 5.2 to 5.1

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

Transition T 1-2
State 1 to 2

Rhizomatous Wheatgrass/Sagebrush



Sagebrush/Bare Ground

Frequent and Severe Grazing (Year-long) or Drought - Frequent or high intensity herbivory weakens the ability for the grasses to persist, especially during prolonged drought. The weakened herbaceous component in combination with lack of fire provides the opportunity for sagebrush to become dominant. Over time, the sagebrush density and lack of understory will prevent recovery without intervention. The conversion to a Wyoming Big Sagebrush/*Bare Ground* State is a response to extended periods of stress, both climate and/or human induced. Intensive grazing with minimal to no recovery period begins the transition, and with added climatic stress, species diversity and productivity is lost, and the community crosses into the Sagebrush/Bare ground State. The illusion of crossing the threshold to State 2 can be found during non-typical precipitation years for communities dominant in needleandthread. The loss of species density and diversity, increased bare ground and decreased litter are the indicators that a true transition has occurred.

Constraints to recovery. Lack of seed source is the only major constraint for recovery of this community.

Transition T 1-3
State 1 to 3

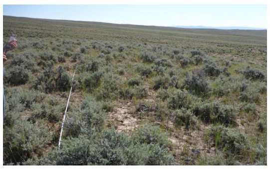
Rhizomatous Wheatgrass/Sagebrush

Sod-Formers

Frequent Grazing (Yearlong), Brush Management or Fire with Drought – Severe and frequent grazing reduces vigor and abundance of key species. As rhizomatous wheatgrasses, and needleandthread decline, short-statured grasses become dominant. Long duration, high intensity herbivory reduces the mid-stature bunchgrasses through repeated defoliation as well as physical damage to the crown and growth points of the plants. The open canopy and soil condition encourages species that are tolerant to heavy trampling and frequent defoliation. These species are generally the mat or sod-forming species of blue grama and threadleaf sedge. Prolonged drought or climatic stress may also encourage the sod-formers to fill in the interspaces. The shallow, dense root mats will continue to spread over time.

Constraints to recovery. The persistence and resilience of the root mat formed by sod-forming species as well as the alteration to hydrology make the recovery process unfeasible.

Restoration pathway R 2-1
State 2 to 1



Sagebrush/Bare Ground

Rhizomatous Wheatgrass/Sagebrush

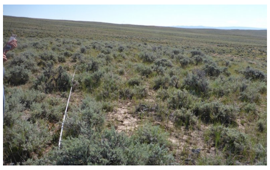
Prescribed Grazing with Brush Management or Wildfire - Treatment to thin the canopy to allow the native vegetation to respond to improved moisture and sunlight followed by prescribed grazing to prevent overuse of the exposed grasses will help this community recover. Treatment will vary depending on the specific composition of grasses remaining and the potential threats to the location. Removal or thinning of the sagebrush within this community will help to reduce competition, encouraging grasses and forb recovery. Post treatment grazing management is critical for successful long-term recovery. 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. Weather and treatment conditions during and following a wildfire will also influence the community. Prior to treatment, carefully checking the immediate and surrounding area will help ensure little or no invasive species (cheatgrass) is present.

Conservation practices

Brush Management
Fence
Livestock Pipeline
Prescribed Grazing
Pumping Plant

Grazing Land Mechanical Treatment
Heavy Use Area Protection
Spring Development
Integrated Pest Management (IPM)
Watering Facility
Water Well
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Livestock Use Area Protection
Planned Grazing System
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Pumping plant powered by renewable energy
Intensive Management of Rotational Grazing
Prescriptive grazing management system for grazed lands

Transition T 2-3
State 2 to 3



Sagebrush/Bare Ground

Sod-Formers

Drought, Disease, Insect Damage, Severe Grazing, or Fire - Sod-forming species such as blue grama and threadleaf sedge are able to tolerate high levels of grazing use and will maintain as other native species decline. Hoof action or compaction inhibits more desirable native species, allowing the sod-formers to become more dominant on the landscape. This decline creates a sagebrush / sod-former community that is resistant to change with grazing management. Impacts to sagebrush by disease or insect damage, as well as drought or herbivory, will shift state 2 to the secondary community phase with cactus as a subdominant species with blue grama.

Constraints to recovery. Compaction, altered hydrology, and the lack of seed-source are the major constraints for this site to recover. The ability to reduce the dense root-mat of a sod-former inhibits the transition back to bare ground scenario.

Transition T 2-4
State 2 to 4

Fire (wild), Frequent or Severe Grazing, Drought with Insect Damage or Brush Management – Throughout most of this LRU there is a seed source present in the soil for cheatgrass, knapweed, and other invasive species. Stress to the native plant community creates a niche for invasion by undesirable or weedy species. Several causes of stress include drought, wildfire, prescribed burning and other forms of brush management, ground and soil disturbance from intensive grazing by large herbivores, or recreational activities. Documentation has shown that often the invasion starts with one or two isolated plants. If these plants can be treated early, a full infestation of the site can be avoided. However, if these plants are undetected, ignored, or further stress or disturbance occurs, the population soon grows exponentially. In some cases the invasive species, once established, can create its own habitat, forcing the weaker native species out. The open canopy of the Sagebrush/*Bare Ground* State is vulnerable to invasive species without further influence. With continued over-use, drought, insect damage or fire, the invasive species will establish and quickly dominate a location. The threshold species in this system is Wyoming big sagebrush, which protects the remnants of the perennial cool-season native grasses, allowing them to persist on the landscape.

Constraints to recovery. The ability to recover and remain in this degraded state, is the lack of vegetation. The significance of the bare ground in State 2 is prone to or encourages invasion by non-native or aggressive species. To remove these species and then maintain their removal is difficult without shifting the community to another state completely. (State 1,3, or 5). The second constraint is the ability to control the invasive weed without the thought to susceptibility. Cheatgrass has not been successfully eradicated from a community, rendering a recovery back to state 2 impossible at this time.

Transition T 3-4
State 3 to 4

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

Constraints to recovery. The only significant constraint to recovery, is the ability to remove/eradicate the noxious weed/invasive weed that has invaded the community.

Restoration pathway R 4-5
State 4 to 5

Integrated Pest Management, with seeding - Integrated pest management plan or intense weed control after and possibly before seedbed preparation will be necessary to overcome a severe weed infestation. Preparing a seedbed (tilling) and using either improved varieties, native seed, or in some cases, an introduced species suited for the management use intended may be the only way to overcome some invasive species. Success of re-establishing a native or desired plant community on a large scale has not been documented. Small-scale attempts are rated to be low and highly variable for the rate of control of most species. Possibly, a site could be established to look similar to an at-risk community within the reference state. However, it is still not possible to reach the reference community condition once annuals have established on a site. The need to till the soil or to prepare the seedbed for planting the native species, reduces soil stability by breaking down soil structure, and alters the hydrologic cycle by changing the infiltration and percolation rates of the soil. The alteration of the soils, the change in the plant community and the risk of re-invasion of the site will prevent it from reacting in the same manner to management and environmental changes as an unaltered native community. Therefore, it remains in the reclaimed state/community phase 5.2.

Conservation practices

Critical Area Planting
Prescribed Grazing
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
Prescribed Grazing

Invasive Plant Species Control
Grazing Management Plan
Prescriptive grazing management system for grazed lands

Transition T 5-4
State 5 to 4

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

Context dependence. The disturbance of cause of the infestation and the seed sources that are available/introduced are the driving factors for the specifics of this transition.

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	**Rhizomatous, Cool-season Grasses**			84–224	
	western wheatgrass	PASM	*Pascopyrum smithii*	84–224	20–45
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	84–224	20–45
2	**Mid-stature, Cool-season Bunchgrasses**			56–196	
	needle and thread	HECO26	*Hesperostipa comata*	56–140	10–25
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–56	0–10
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
3	**Short-stature, Cool-season Bunchgrasses**			28–56	
	squirreltail	ELEL5	*Elymus elymoides*	28–56	5–10
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
4	**Mat-forming, Warm-season Bunchgrasses**			0–28	
	blue grama	BOGR2	*Bouteloua gracilis*	0–28	0–5
5	**Miscellaneous Grasses and Grass-likes**			0–28	
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
Forb					
6	**Perennial Forbs**			11–28	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	milkvetch	ASTRA	*Astragalus*	0–28	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–28	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–28	0–5
	pale bastard toadflax	COUMP	*Comandra umbellata ssp. pallida*	0–28	0–5
	Indian paintbrush	CASTI2	*Castilleja*	0–28	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–28	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	Forb (herbaceous, not grass nor grass-like)	2FORB	*Forb (herbaceous, not grass nor grass-like)*	0–28	0–5
Shrub/Vine					
7	**Dominant Shrubs**			28–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–112	5–15
8	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	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 Bunchgrasses**			112–224	
	needle and thread	HECO26	*Hesperostipa comata*	56–112	10–15
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	28–56	5–10
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	28–56	5–10
2	**Rhizomatous, Cool-season Grasses**			84–196	
	western wheatgrass	PASM	*Pascopyrum smithii*	84–196	20–40
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	84–196	20–40
3	**Short-stature, Cool-season Bunchgrasses**			28–112	
	squirreltail	ELEL5	*Elymus elymoides*	28–56	5–10
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
4	**Mat-forming, Warm-season Grasses**			0–28	
	blue grama	BOGR2	*Bouteloua gracilis*	0–28	0–5
5	**Miscellaneous Grasses and Grass-likes**			0–28	
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
Forb					
6	**Perennial Forbs**			11–28	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–28	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–28	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–28	0–5
	pale bastard toadflax	COUMP	*Comandra umbellata ssp. pallida*	0–28	0–5
	Indian paintbrush	CASTI2	*Castilleja*	0–28	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–28	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	Forb (herbaceous, not grass nor grass-like)	2FORB	*Forb (herbaceous, not grass nor grass-like)*	0–28	0–5
7	**Annual Forbs**			0–28	
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	Forb (herbaceous, not grass nor grass-like)	2FORB	*Forb (herbaceous, not grass nor grass-like)*	0–28	0–5
Shrub/Vine					
8	**Dominant Shrubs**			112–196	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	112–196	15–25
9	**Miscellaneous Shrubs**			0–56	

	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	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	**Rhizomatous, Cool-season Grasses**			56–168	
	western wheatgrass	PASM	*Pascopyrum smithii*	56–168	20–40
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	56–168	20–40
2	**Mid-stature, Cool-season Grasses**			28–84	
	needle and thread	HECO26	*Hesperostipa comata*	28–84	5–15
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–28	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
3	**Short-stature, Cool-season Bunchgrasses**			28–84	
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
4	**Mat-forming, Warm-season Grasses**			0–28	
	blue grama	BOGR2	*Bouteloua gracilis*	0–28	0–5
5	**Miscellaneous Grasses and Grass-likes**			0–28	
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
Forb					
6	**Perennial Forbs**			0–56	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–28	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–28	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–28	0–5
	pale bastard toadflax	COUMP	*Comandra umbellata ssp. pallida*	0–28	0–5
	Indian paintbrush	CASTI2	*Castilleja*	0–28	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–28	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
7	**Annual Forbs**			0–28	
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	Forb, annual	2FA	*Forb, annual*	0–28	0–5
Shrub/Vine					

8	**Dominant Shrubs**			112–280	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	112–280	15–35
9	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	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	**Mat-forming, Warm-season Grasses**			84–252	
	blue grama	BOGR2	*Bouteloua gracilis*	84–224	20–50
2	**Miscellaneous Grasses and Grass-likes**			28–168	
	threadleaf sedge	CAFI	*Carex filifolia*	28–168	5–30
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
3	**Short-stature, Cool-season Bunchgrasses**			28–56	
	Sandberg bluegrass	POSE	*Poa secunda*	28–56	5–10
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
4	**Rhizomatous, Cool-season Grasses**			28–56	
	western wheatgrass	PASM	*Pascopyrum smithii*	28–56	5–10
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	28–56	5–10
5	**Mid-stature, Cool-season Bunchgrasses**			0–56	
	needle and thread	HECO26	*Hesperostipa comata*	0–28	0–5
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–28	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
Forb					
6	**Perennial Forbs**			0–28	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–28	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–28	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–28	0–5
	pale bastard toadflax	COUMP	*Comandra umbellata ssp. pallida*	0–28	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–28	0–5
	Indian paintbrush	CASTI2	*Castilleja*	0–28	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
7	**Annual Forbs**			0–28	

	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	flatspine stickseed	LAOC3	*Lappula occidentalis*	0–28	0–5
	Forb, annual	2FA	*Forb, annual*	0–28	0–5
Shrub/Vine					
8	**Dominant Shrubs**			28–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–112	5–15
9	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	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	**Mat-forming, Warm-season Grasses**			84–224	
	blue grama	BOGR2	*Bouteloua gracilis*	84–224	20–60
2	**Miscellaneous Grasses and Grass-likes**			28–112	
	threadleaf sedge	CAFI	*Carex filifolia*	28–112	5–30
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
3	**Short-stature, Cool-season Bunchgrasses**			28–56	
	Sandberg bluegrass	POSE	*Poa secunda*	28–56	5–10
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
4	**Rhizomatous, Cool-season Grasses**			28–56	
	western wheatgrass	PASM	*Pascopyrum smithii*	28–56	5–10
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	28–56	5–10
5	**Mid-stature, Cool-season Bunchgrasses**			0–56	
	needle and thread	HECO26	*Hesperostipa comata*	0–56	5–10
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–28	0–5
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–28	0–5
Forb					
6	**Perennial Forbs**			0–28	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	textile onion	ALTE	*Allium textile*	0–28	0–5
	Missouri milkvetch	ASMI10	*Astragalus missouriensis*	0–28	0–5
	white locoweed	OXSE	*Oxytropis sericea*	0–28	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–28	0–5
	pale bastard toadflax	COUMP	*Comandra umbellata ssp. pallida*	0–28	0–5
	Indian paintbrush	CASTI2	*Castilleja*	0–28	0–5
	bigseed biscuitroot	LOMA3	*Lomatium macrocarpum*	0–28	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5

	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
7	**Succulents**			11–112	
	plains pricklypear	OPPO	*Opuntia polyacantha*	11–112	5–20
8	**Annual Forbs**			0–28	
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	flatspine stickseed	LAOC3	*Lappula occidentalis*	0–28	0–5
	Forb, annual	2FA	*Forb, annual*	0–28	0–5
Shrub/Vine					
9	**Miscellaneous Shrubs**			0–28	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	0–28	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	0–5

Animal community

Animal Community – Wildlife Interpretations:

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

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

2.1 - Wyoming Big Sagebrush/*Bare Ground* Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates. However, this community would prove to be poor nesting habitat for sage grouse due to the lack of an herbaceous component but may provide some winter habitat.

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

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

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

4.2- Invasive Species/Wyoming Big Sagebrush Plant Community: Limited nesting and cover is provided by the existing overstory cover of the Wyoming big sagebrush. The invasive species may benefit a few select species (e.g. chukars).

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

5.1 - Disturbed/Degraded Lands Plant Community and 5.2 - Restored/Reclaimed Lands Plant Community: The variability of this site prevents a detailed review of wildlife benefits. However, many of the introduced grasses, forbs and shrubs can provide adequate cover, feed and nesting sites for those wildlife species that would have selected the site prior to disturbance. Limitations and enhancements need to be considered by specific locations.

Animal Community – Grazing Interpretations:

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

Plant Community Production Carrying Capacity*

The Carrying capacity is calculated as the production (normal year) X .25 efficiency factor / 912.5 # / AUM to calculate the AUM's/Acre.
Plant Community Description/Title Lbs./Acre AUM/Acre* Acre*/ AUM
Below Ave. Normal Above Ave.
1.1 Rhizomatous Wheatgrasses/Wyoming Big Sagebrush 255 575 825 0.16 6.25
1.2 Perennial Native Grasses/Wyoming Big Sagebrush 260 610 875 0.17 5.88
2.1 Wyoming Big Sagebrush/*Bare Ground* 255 500 850 0.14 7.14
3.1 Sod-formers/Wyoming Big Sagebrush 180 325 575 0.09 11.11
3.2 Sod-formers/Cactus 160 285 500 0.08 12.5
4.1 Native/Invasive/Wyoming Big Sagebrush ** ** ** ** **
4.2 Invasives/Wyoming Big Sagebrush ** ** ** ** **
4.3 Invasives ** ** ** ** **
5.1 Disturbed/Degraded ** ** ** ** **
5.2 Restored/Reclaimed ** ** ** ** **

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

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

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

therefore, the adjustment is only calculated for 30% of the unit (i.e. 50% reduction on 30% of the management unit).

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

Hydrological functions

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

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

Recreational uses

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

Wood products

No appreciable wood products are present on the site.

Other products

Herbs: The forb species of the loamy ecological site have medicinal characteristics. In the past, they have been used by the Native Americans and more recently by the naturopathic profession.

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

Inventory data references

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

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

Those involved in the development of the new concept for the Loamy Ecological site include: Jim Haverkamp, Area Range Management Specialist, NRCS; Mandi Hirsch, Range Management Specialist/Sage Grouse Coordinator, Popo Agie Conservation District; John Likins, Range Management Specialist (retired) USDI-BLM; Leah Yandow, Wildlife Biologist, USDI-BLM; Jeremy Artery, Rangeland Management Specialist, USDI-BLM; Daniel Wood, MLRA Soil Survey Leader, NRCS; Jane Karinen, Soil Data Quality Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS.

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

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

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Contributors

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Approval

Scott Woodall, 2/22/2019

Rangeland health reference sheet

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

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Date	10/01/2018
Approved by	Marji Patz
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.

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

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Refer to soil series description and map unit information for specific information. Described A-horizons vary from 1-12 inches (3-30 cm) with OM of 1 to 2%.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The plant community consists of 60-75% grasses, 10% forbs and 15-30% shrubs. Evenly distributed plant canopy (40-60%) and litter plus moderate to moderately rapid infiltration rates result in minimal runoff. Basal cover is typically less than 10% for this site and does very little to effect runoff on this site. Canopy cover is sufficient to reduce raindrop impact.

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

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

    Dominant: Mid-stature, cool-season grasses

    Sub-dominant: perennial shrubs

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

    Additional:

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

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

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

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

Canada), whitetop and others found on the noxious weed list for Wyoming and Fremont County.

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