USDA Natural Resources
Conservation Service

Ecological site EX043B23A123
Loamy Calcareous (LyCa) Absaroka Lower Foothills

Last updated: 3/04/2024
Accessed: 05/09/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 043B–Central Rocky Mountains

43B – Central Rocky Mountains – The Central Rocky Mountains extends from northern Montana to southern extent of Wyoming and from Idaho to central Wyoming. The southern extent of 43B is comprised of a combination of metamorphic, igneous, and sedimentary mountains and foothills. Climatic changes across this extent are broad and create several unique breaks in the landscape.

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) 43B23A: Absaroka Lower Foothills

Based on the shifts in geology, precipitation patterns and other climatic factors, as well as elevations and vegetation, the Absaroka Range was divided into LRU 23. Further division of this LRU is necessary due to the gradient moving from the foothills to the summit, as well as aspect shifts (north/east face versus south/west face). Subset A is set for the lower elevations within the foothills with 10 to 14 inches of precipitation. To verify or identify the LRU A (the referenced LRU for this ecological site), refer to the Wyoming LRU matrix key contained within the Ecological Site Key. This particular LRU occurs along the eastern lower foothills of the Absaroka Range. This LRU starts north of Clark, WY and runs to the Thermopolis, WY area. Once the foothills cross into the Northern Beartooth Range, the climatic patterns and elevational changes shifts the plant community and allows for a break in LRU's near the Montana state line. As the LRU follows to the south and tracks east with the intersection of the Absaroka and Owl Creek Ranges, the face changes aspect and geology creating a shift in plant dynamics and a break in the LRU. The extent of soils currently correlated to this ecological site does not fit within the digitized boundary. Many of the noted soils are provisional and will be reviewed and corrected in mapping update projects. Other map units are correlated as small inclusions within other MLRA’s/LRU’s based on elevation, landform, and biological references.

Moisture Regime: Aridic Ustic or Ustic Aridic – Progressive Initial mapping has shown that soil correlations completed prior to 2014 were identified as ustic aridic, after further evaluation of climatic and soil taxonomy information the proper moisture regime is aridic ustic. Both are recorded here until an update project is completed to correct the previous correlations.

Temperature Regime: Frigid
Dominant Cover: Rangeland – Sagebrush Steppe (major species is Wyoming Big Sagebrush)
Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm)

RV Frost-Free Days: 80-110 days

Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):
3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
3.B Cool Semi-Desert Scrub & Grassland Subclass
3.B.1 Cool Semi-Desert Scrub & Grassland formation
3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division
M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup
G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group
CEGL001535 - Artemisia tridentata ssp. wyomingensis/Pseudoroegneria spicata Herbaceous Vegetation or
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.b Big Horn Basin and
10.1.18.d Foothills and Low Mountains

Ecological site concept

• Site does not receive any additional water.
• Slope is <30%.
• Soils are:
o Not saline or saline-sodic.
o Moderately deep, deep, or very deep
o With < 3% stone and boulder cover and < 20% cobble and gravel cover.
o Not skeletal (< 35% rock fragments) within 20” (51 cm) of mineral soil surface.
o Site begins or increases in reaction (strongly or violently effervescent) below 4” (10 cm) of the mineral soil surface.
o Textures usually range from very fine sandy loam to clay loam in the top 4” (10 cm) of the mineral soil surface.
o Site has a distinctive layer of calcium carbonate accumulation between 10-20” (25 to 51 cm), of the mineral soil surface (layer appearing whiter in color) with a Calcium Carbonate Equivalent (CCE) of > 15%.
o Clay content is = 32% in top 4” (10 cm) of the mineral soil surface. Each of the following subsurface horizons has a clay content of less than 35%.

The concept of this site is based on having a diagnostic calcic horizon or a pronounced accumulation of calcium carbonates usually identified as a white soil appearance with strong to violent effervescent starting or increasing 4 inches (10 cm) below the mineral soil surface. This site was correlated previously as a Loamy range site and the site concept absorbed the variances. But with further review, it is seen that Loamy calcareous predominately has a Bluebunch wheatgrass dominated plant community which responds in a different manner and holds a different potential with similar management than the Loamy range site. The identified breakpoint for calcium carbonate equivalent (CCE’s) for this site is 15% or greater CCE’s at a depth of 7-20 inches.

Associated sites

EX043B23A122	**Loamy (Ly) Absaroka Lower Foothills** Loamy sites will existing in concave pockets or in areas where the calcic layer formed lower in the profile or did not form at all.
EX043B23A121	**Limy Skeletal (LiSk) Absaroka Lower Foothills** Limy Skeletal will occur in the back slope of landslides where Loamy Calcareous will be ion the concave or more gently sloping segments with more soil deposition occurred or is occurring.

Similar sites

EX043B23A120	**Limy Upland (LiU) Absaroka Lower Foothills** Limy Upland is similar in traits, with the added limitation of the calcareous characteristics existing throughout the entire soil profile, not just within the lower extent of the profile. Limy upland is lower in production, higher in black sagebrush, and more erosive.
EX043B23A162	**Shallow Loamy (SwLy) Absaroka Lower Foothills** Shallow loamy will appear very similar to the Loamy calcareous because of the limiting factor of the calcic layer restricting plants much in the same way the shallow depth to rock is for Shallow Loamy.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. wyomingensis* (2) *Artemisia nova*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Elymus albicans*

Legacy ID

R043BX523WY

Physiographic features

This site occurs on nearly level to gently rolling land and on slopes generally less than 30%. Within the lower foothills this site is found to exist predominately on the gently sloping summits of erosional remnants or fan remnants, but are found on a variety of landforms. Many of these landforms cross several climatic zones and are influenced by multiple geomorphic processes, for example: alluvial fans crossed/eroded by streams/stream terraces, covered by landslides, or breached by uplifts/escarpments. On a smaller scale, this site occurs in a patch-work dynamic at the base or across the basin floor (remnants) as wind and water move and shift sediments, derived from carbonate rich parent material, across the landscape (alluvium).

Table 2. Representative physiographic features

Landforms	(1) Foothills > Eroded fan remnant (2) Foothills > Stream terrace (3) Foothills > Pediment
Runoff class	Negligible to high
Elevation	1,737–2,286 m
Slope	0–30%
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 10 to 14 inches (254 – 355 mm). The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50 percent of the mean annual precipitation. Much of the moisture that falls in the latter part of the summer is lost by evaporation and much of the moisture that falls during the winter is lost by sublimation. Average snowfall is about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. High winds are generally blocked from the basin by high mountains, but can occur in conjunction with an occasional thunderstorm. Growth of native cool-season plants begins about April 15th 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, there has been a warming trend, but as the last 12-years graphed, the temperatures have swayed high and low, but overall it has maintained a steady trajectory, neither increasing nor decreasing. Where on the moisture side, the trajectory in trend has been a slow decline. The swings of when spring warm up and first frost hit with the decline in average precipitation have produced a drought effect where the moisture is not being received when the plants and ground is able to utilize the moisture. And in some cases, the late precipitation has encouraged the warm season or mat forming species over the cool season bunchgrasses that are the drivers of the natural system. Early frosts, with dry open winters has created a more arid or desert effect on plants resulting in high rates of winter kill, loss of vigor or overall damage to the plant.

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/. Buffalo Bill Dam, Cody 21SW, Thermopolis, Thermopolis 9NE, Thermopolis 25WNW and Wapiti 1NE are the representative weather stations within the Lower Foothills. 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)	66-109 days
Freeze-free period (characteristic range)	108-145 days
Precipitation total (characteristic range)	279-305 mm
Frost-free period (actual range)	65-119 days
Freeze-free period (actual range)	103-147 days
Precipitation total (actual range)	254-305 mm
Frost-free period (average)	88 days
Freeze-free period (average)	124 days
Precipitation total (average)	279 mm

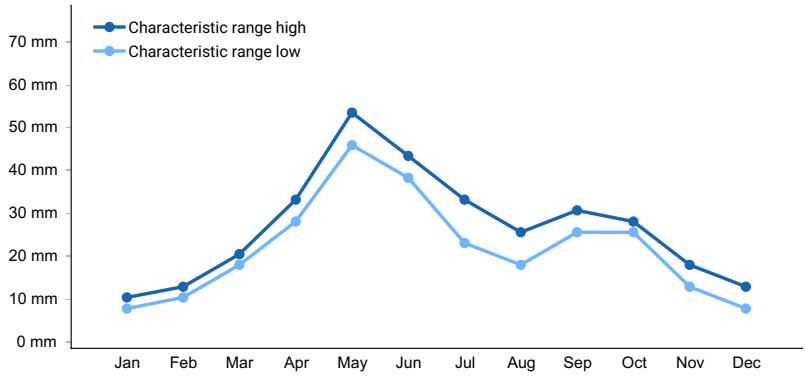


Figure 1. Monthly precipitation range

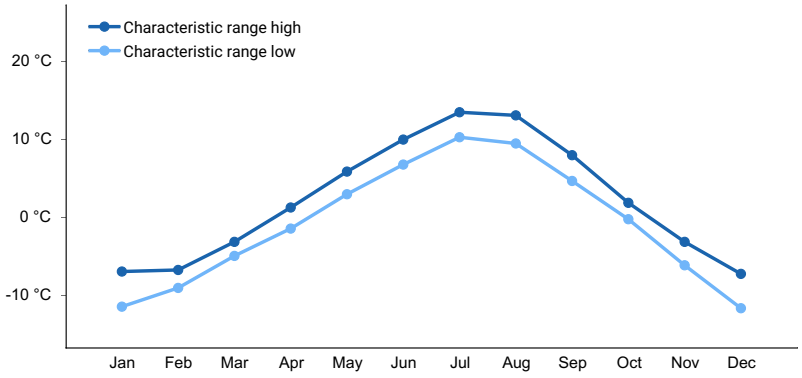


Figure 2. Monthly minimum temperature range

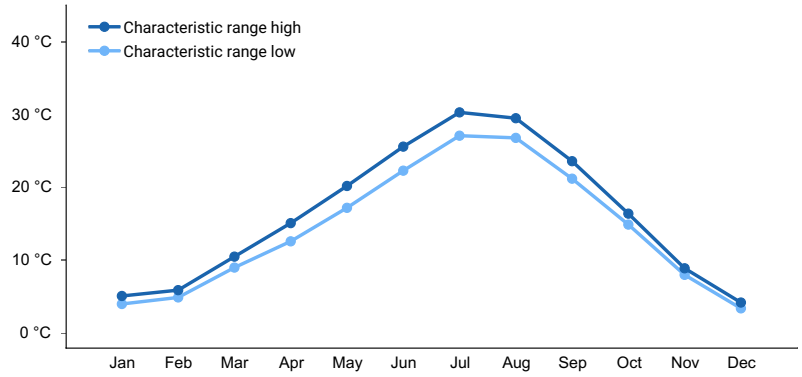


Figure 3. Monthly maximum temperature range

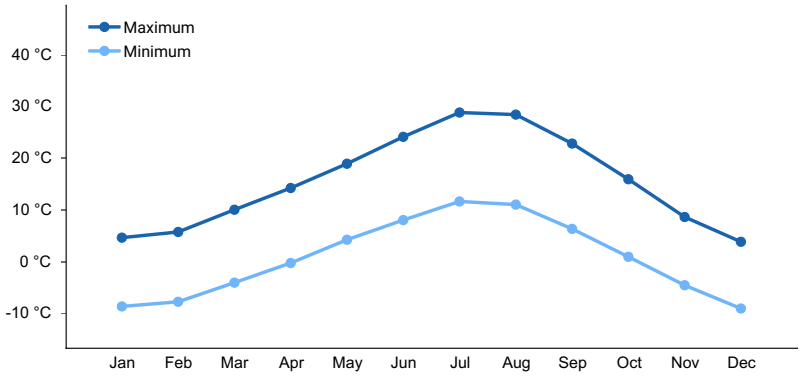


Figure 4. Monthly average minimum and maximum temperature

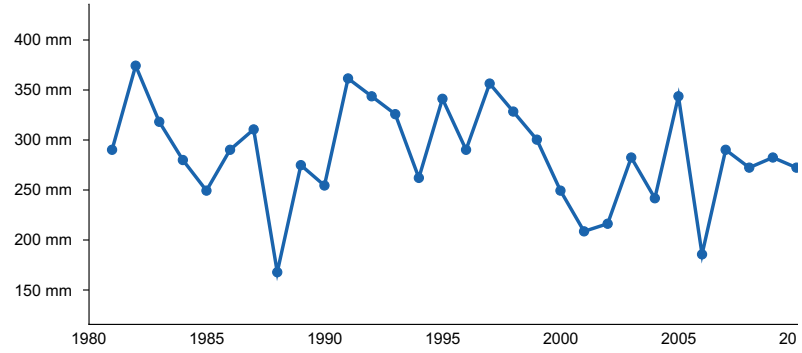


Figure 5. Annual precipitation pattern

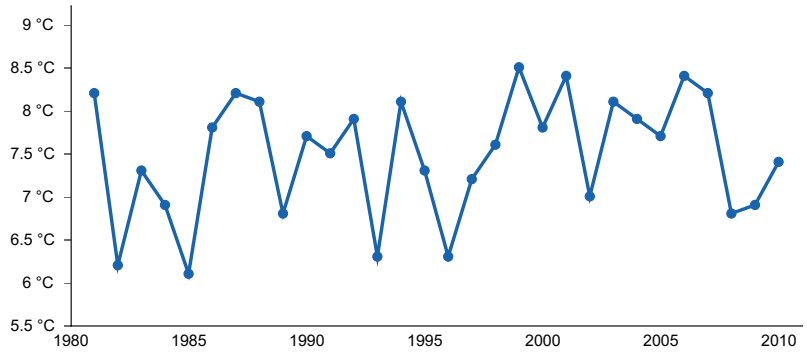


Figure 6. Annual average temperature pattern

Climate stations used

- (1) THERMOPOLIS [USC00488875], Thermopolis, WY
- (2) THERMOPOLIS 25WNW [USC00488888], Thermopolis, WY
- (3) CODY 21 SW [USC00481855], Cody, WY
- (4) WAPITI 1NE [USC00489467], Cody, WY
- (5) BUFFALO BILL DAM [USC00481175], Cody, 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).

Soil features

The soils of this site are moderately deep to very deep (greater than 20 inches to bedrock), moderately well to well drained, and permeability is moderately slow to moderate. The soil characteristic having the most influence on the plant community is available moisture and the limiting characteristics of a calcic layer. Textures range from loams to very fine sandy loam on the coarse end and light clay loam (less than 30 percent clay content) on the heavy end. The most common textures include loam and sandy clay loam. A common scenario is to have a one to three inch cap of sandy loam over a sandy clay loam due to young soil development of weathered sandstone and shale parent materials. More data is needed to quantify these characteristics specifically for this site.

Major Soil Series correlated to this site include: Bonfri-like, Chickenhill, Coyotoeflats, Coyoteflats-like, Foreleft-like, Mantlemine, Mantlemine-like, Niart-like, Potrio, Rootel, Rootel-like, Whitesage-like.

Figure 7. Hand excavated pit illustrating the calcic horizon within the lower profile.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone and sandstone (2) Residuum–dolomite (3) Slope alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Gravelly sandy clay loam (2) Fine sandy loam (3) Loam
Family particle size	(1) Fine-loamy
Drainage class	Moderately well drained to well drained
Permeability class	Moderately slow to moderate
Soil depth	51 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 (20.3-152.4cm)	15–35%
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)	7.8–8.6
Subsurface fragment volume <=3" (Depth not specified)	0–15%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

The Loamy Calcareous ecological site within the 10-14” precipitation zone was originally correlated as either a Loamy or Shallow Loamy range site. During the review of the Loamy range site, each representative reference community site visited was found to have calcareous characteristics. Historically, classification of the soils in the Big Horn Basin and Lower Foothills did not recognize the calcareous tendencies. Although this site is very similar to the Loamy and Shallow Loamy range sites, the community potential and system resilience are altered by the chemistry within the soil.

Initial correlations of these soils and communities were made to Loamy when production was prominent, or to Shallow loamy due to the dominance of bluebunch wheatgrass and reduced production expressing a “shallow” acting characteristic of the site. The soils as previously described are very deep to moderately deep, but depth to the accumulation of calcium carbonates created a discrepancy on how the site was classified. Wyoming big sagebrush, although present on this site, is generally restricted in vigor and production compared to a true Loamy ecological site. This site is characterized by six states within the model, that once the threshold is crossed, restoration to that state requires significant resource inputs. Minimal research can be found for this particular ecological site.

Potential vegetation on this site, as with the Loamy site, is dominated by mid cool-season perennial grasses. Other significant vegetation includes winterfat and Wyoming big sagebrush, black sage brush, 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 due to historic use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as threadleaf sedge, Sandberg bluegrass, and Wyoming big sagebrush will increase. Plains pricklypear and weedy annuals will invade. Cool-season grasses such as bluebunch wheatgrass,

rhizomatous wheatgrasses, needle and thread, and Indian ricegrass will decrease in frequency and production.

Wyoming big sagebrush may become dominant in areas with absence of fire and without a sufficient amount of precipitation. Wildfires have been actively controlled, resulting in persistent, aged and decadent stands of Wyoming big and black sagebrush. Chemical control was used in place of the historic role of fire on this site. Recently, prescribed burning has regained some popularity, but another popular treatment method is mowing or mulching of the sagebrush.

Due to the amount and pattern of the precipitation, in combination with soil limitations, the Wyoming big sagebrush component has a lower vigor and overall structure than loamy ecological sites within the same area. Sagebrush may not be resilient once it has been removed or severely reduced if a vigorous stand of grass exists and is maintained. Threadleaf sedge may become the dominant vegetation if the area is subjected to frequent and severe periods of grazing, especially year-long grazing. As a result, a dense sod cover of threadleaf sedge will become established.

Within the inherent variability of each and every ecological site within the correlated landscapes, the acceptance of a small population of salt tolerant species is and has historically been allowed within the Loamy and now Loamy Calcareous ecological sites. Re-evaluation of soil characteristics has led to the removal of the salt tolerant state within this ecological site dynamic. The shift from a minor presence to a dominance of salt tolerant species on an ecological site is an indicator that a site characteristic, rather than simply a threshold, has been crossed that cannot be altered without extensive management changes and inputs.

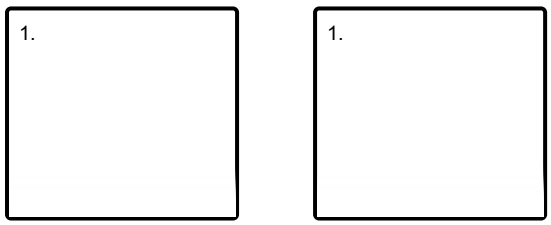
The reference plant community (description follows the plant community diagram) has been determined by study of relic rangeland sites, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have also been used.

The following is a State and Transition Model (STM) Diagram for this ecological site. An STM has five fundamental components: states, transitions, restoration pathways, community phases and community pathways. The state, designated by the bold box, is 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 the natural disturbance regime of the site. The designation of alternative states (State 2, etc) in STMs denotes changes in ecosystem properties that cross a certain threshold.

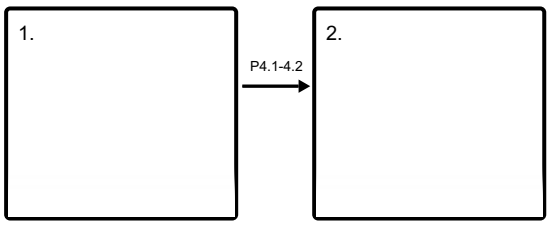
Transitions are represented by the arrows between states moving from a higher state to a lower state (State 1 - State 2) and are denoted in the legend as a “T” (T1-2). They describe the variables or events that contribute directly to loss of state resilience and result in shifts between states. Restoration pathways are represented by the arrows between states returning back from a lower state to a higher state (State 2 - State1 or better illustrated by State 1

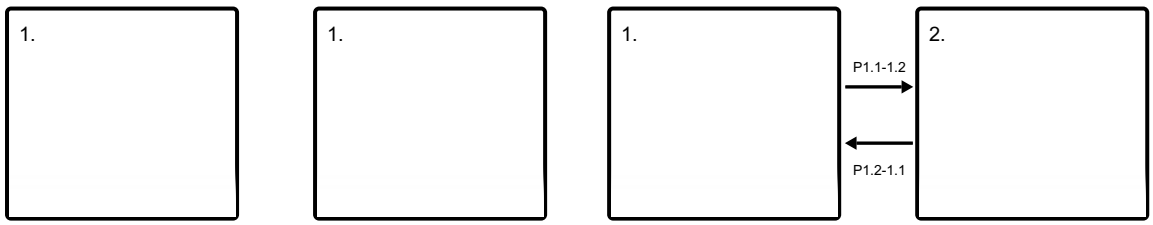
State and transition model

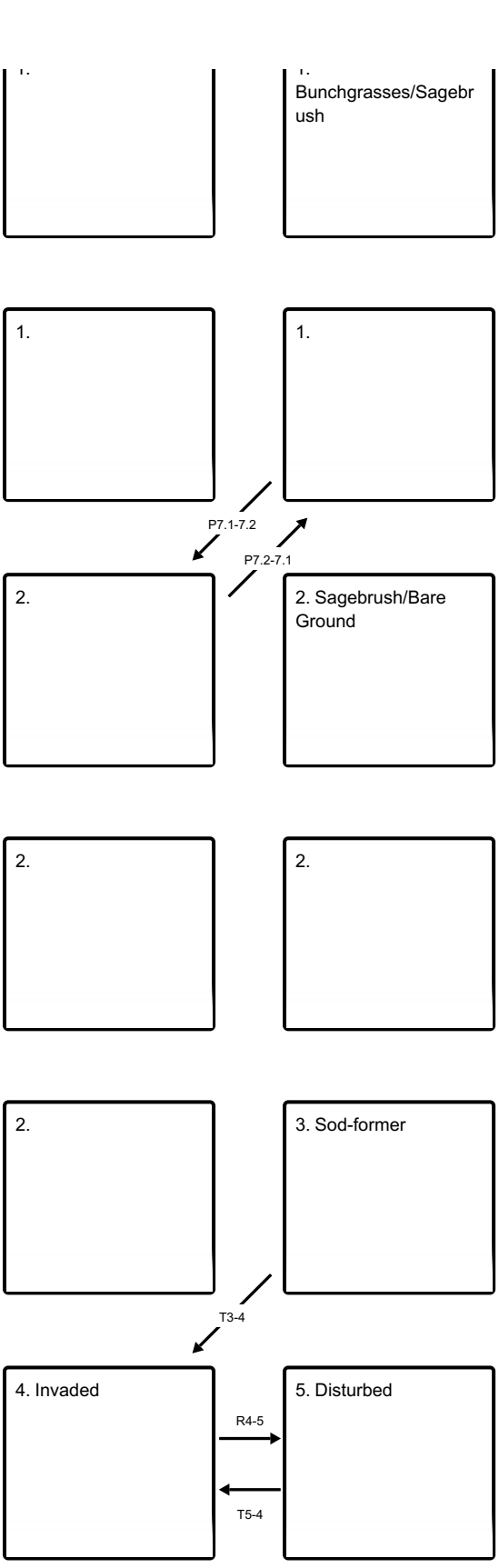
Main model



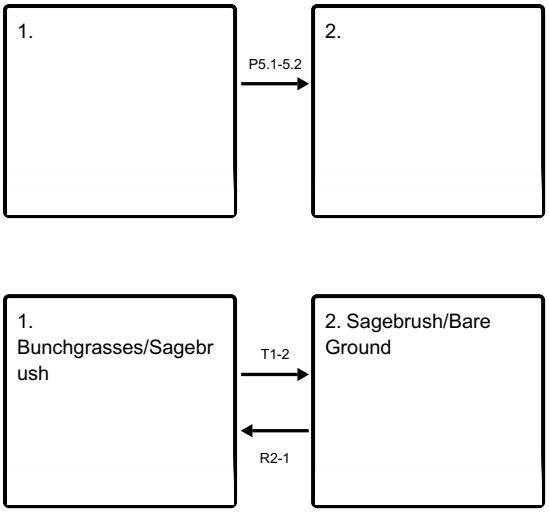
Communities 1, 2, 1 and 2 (additional pathways)



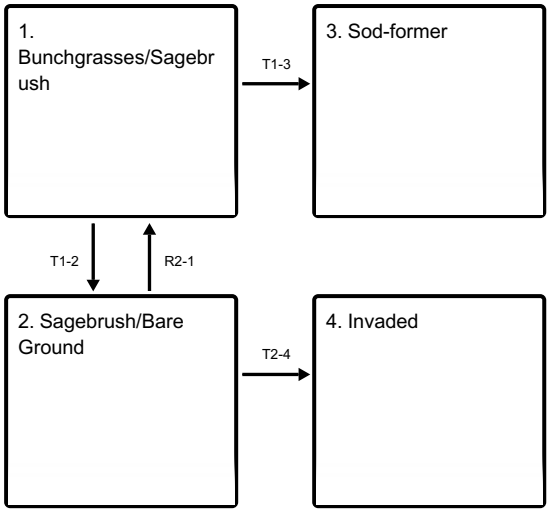



1.
1.
Bunchgrasses/Sagebrush
1.
1.
P7.1-7.2
P7.2-7.1
2.
2. Sagebrush/Bare Ground
2.
2.
2.
3. Sod-former
T3-4
4. Invaded
5. Disturbed
R4-5
T5-4

Communities 1, 2, 1 and 2 (additional pathways)



Communities 1, 3, 2 and 4 (additional pathways)



T1-2 - Frequent and severe grazing plus no fire on these droughty soils, will convert the plant community.

T1-3 - Frequent and severe grazing (yearlong grazing) plus wildfire or brush control, will convert this community to a threadleaf sedge sod.

R2-1 - Prescribed grazing with rest and time will allow this transition. Seeding and brush control may be tools to assist recovery.

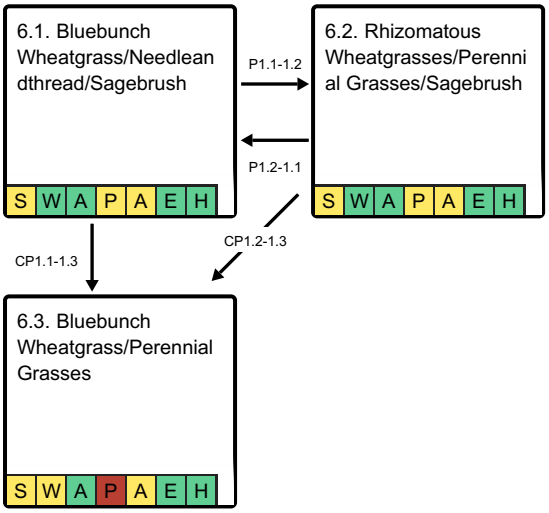
T2-4 - Frequent or Severe Grazing with wildfire or other disturbance with a seed source present transitions the community to an Invaded State.

T3-4 - Drought alone, or with frequent or severe grazing or other disturbances will open the canopy to invasive species.

R4-5 - Integrated weed control with seeding of a native mixture will assist with reclaiming this invaded community.

T5-4 - Frequent and severe grazing or any further disturbance with a see source will force the transition.

Land use 6 submodel, ecosystem states



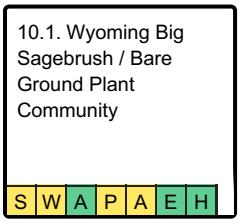
P1.1-1.2 - Moderate, continuous season-long grazing will convert the plant community to the Rhizomatous/Perennial Grass/Big Sagebrush Plant Community.

CP1.1-1.3 - Extensive Brush Management or Fire with Drought, creates a shift in the hydrology of the site preventing the re-establishment of Wyoming big sagebrush on the site without extensive management changes.

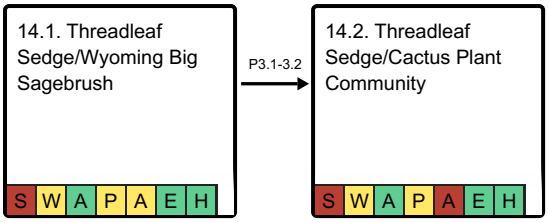
P1.2-1.1 - Prescribed grazing or possibly long-term prescribed grazing, will allow recovery of this plant community to the Reference community.

CP1.2-1.3 - Extensive Brush Management or Fire with Drought, creates a shift in the hydrology of the site preventing the re-establishment of Wyoming big sagebrush on the site without extensive management changes.

Land use 10 submodel, ecosystem states

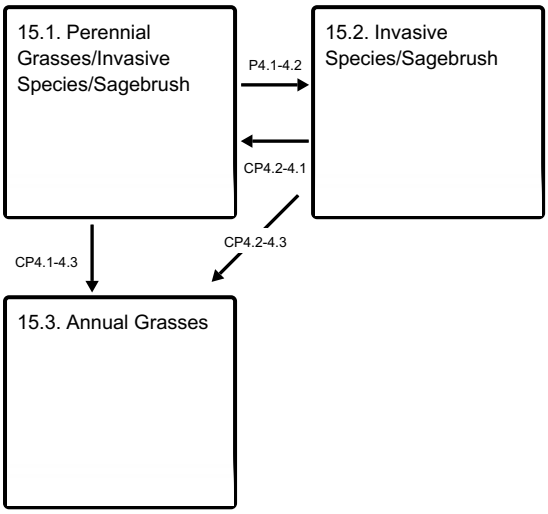


Land use 14 submodel, ecosystem states



P3.1-3.2 - Frequent and severe grazing with drought or insect damage or fire will remove the sagebrush forcing this transtion.

Land use 15 submodel, ecosystem states



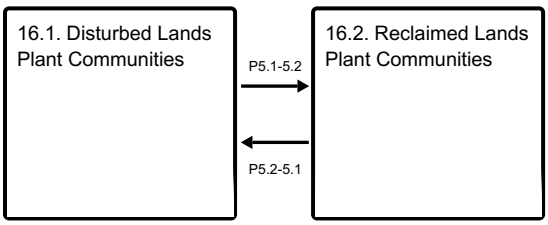
P4.1-4.2 - Frequent or severe grazing, drought, and other disturbances including fire open the community to further invasion.

CP4.1-4.3 - Fire or extended periods of drought or mechanical removal of sagebrush will create a monoculture of cheatgrass.

CP4.2-4.1 - Grazing management with weed control can help improve native species will minimizing the weed cover.

CP4.2-4.3 - Fire or extended periods of drought or mechanical removal of sagebrush will create a monoculture of cheatgrass.

Land use 16 submodel, ecosystem states



P5.1-5.2 - Seeding, brush management, integrated pest management and prescribed grazing management will help restore this community.

P5.2-5.1 - No use, no fire, long-term prescribed grazing, or frequent and severe grazing can lead to the degradation of a reclaimed community.

Community 1

Community 2

Community 3

Community 4

Community 5

State 6

Bunchgrasses/Sagebrush

The Reference State, Bunchgrasses/Sagebrush State, originated under moderate grazing by large ungulates. With continued grazing management, this community has persisted on the landscape. The State is characterized by a dominance of bluebunch wheatgrass and Wyoming big sagebrush. Occurrences of black sagebrush have been found, although not prevalent on this ecological site.

Characteristics and indicators. The reference state is characterized by the dominance of Wyoming big sagebrush, at 15 percent or less composition by weight, with bluebunch wheatgrass, at 40 percent or less composition by weight. But with these two dominant species, the site holds a healthy mix of rhizomatous wheatgrass, Western and Thickspike, as well as Indian ricegrass, needle and thread, and to a minor extent sod-formers such as threadleaf sedge.

Resilience management. These communities are drought tolerant and resistant to change unless under significant stress.

Community 6.1
Bluebunch Wheatgrass/Needleandthread/Sagebrush

Figure 8. Bluebunch wheatgrass, needle and thread, and a mixture of short-stature grasses with Wyoming big and black sagebrush dominate this community.

This plant community is extremely stable and well adapted to the climatic conditions of the Lower Foothills. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). This plant community is the interpretive plant community for this site and is considered to be the Reference Plant Community. This state evolved with grazing by large herbivores and periodic fires. The cyclical natural of the fire regime in this community prevented Wyoming big sagebrush from being the dominant landscape. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving occasional short periods of rest. The potential vegetation is about 75 percent grasses or grass-like plants, 10 percent forbs, and 15 percent woody plants. This state is dominated by cool season mid-grasses. The major grasses include bluebunch wheatgrass, rhizomatous wheatgrasses (western and Montana), needle and thread, and Indian ricegrass. Other grasses occurring in this state include bottlebrush squirreltail, prairie junegrass, and Sandberg bluegrass. Wyoming big sagebrush is a conspicuous element of this state, occurring in a mosaic pattern, and making up 5 to 15 percent of the annual production. Winterfat is a common component found on this site. A variety of forbs also occurs in this state and plant diversity is high (see Plant Composition Table). The total annual production (air-dry weight) of this state is about 525 lbs./acre, but it can range from about 300 lbs./acre in unfavorable years to about 625 lbs./acre in above average years.

Resilience management. This plant community is resilient, but is subject to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing, lack of management or use causing decadence and decrease in vigor of the cover present or natural/man-made disturbance.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- Montana wheatgrass (*Elymus albicans*), grass
- spiny phlox (*Phlox hoodii*), other herbaceous
- Indian paintbrush (*Castilleja*), other herbaceous
- milkvetch (*Astragalus*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Aggregate instability
- Plant structure and composition
- Inadequate livestock water quantity, quality, and distribution

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	269	392	420
Shrub/Vine	56	168	224
Forb	11	28	56
Total	**336**	**588**	**700**

Table 6. Soil surface cover

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

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-10%	5-15%	5-10%
>0.15 <= 0.3	–	5-15%	10-50%	0-10%
>0.3 <= 0.6	–	0-5%	0-10%	0-5%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

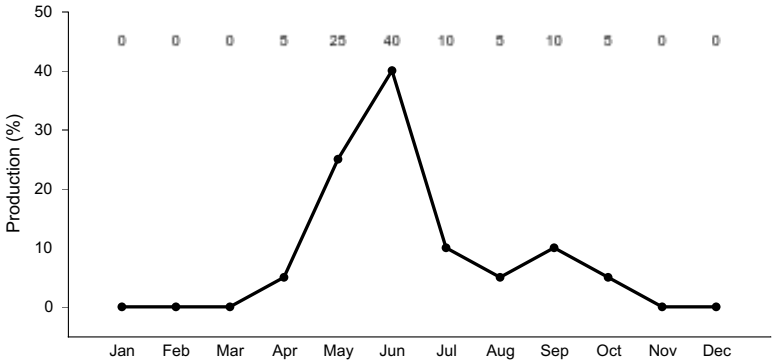


Figure 10. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 6.2
Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Figure 11. Sagebrush has expanded in this community with rhizomatous wheatgrass and Sandberg bluegrass.

Historically, this plant community evolved under grazing and a low fire frequency. Currently, it is found under moderate, season-long grazing by livestock and will be exacerbated by prolonged drought conditions. In addition, the fire regime for this site has been modified and extended periods without fire is now common. This plant community is still dominated by cool-season grasses, while short warm-season grasses and miscellaneous forbs account for the balance of the understory. Wyoming big sagebrush is now a conspicuous part of the overall production and accounts for the majority of the over story. The dominant grasses include Bluebunch wheatgrass, rhizomatous wheatgrasses, and Needleandthread. Grasses and grass-like species of secondary importance include Prairie junegrass, Blue grama, Sandberg bluegrass, and Threadleaf sedge. Forbs commonly found in this plant community include Scarlet globemallow, Fringed sagewort, and Spiny phlox. Wyoming big sagebrush can make up to 25 percent of the annual production. The over story of sagebrush and understory of grasses and forbs provide a

diverse plant community. When compared to the Reference Community 1.1, Wyoming big sagebrush, Blue grama, and Threadleaf sedge have increased. Plains prickly pear cactus will also have invaded, but occurs only in small patches. Indian ricegrass has decreased and may occur in only trace amounts under the sagebrush canopy or within the patches of prickly pear. In addition, the amount of Winterfat may or may not have changed depending on the season of use. The total annual production (air-dry weight) of this state is about 375 pounds per acre, but it can range from about 275 lbs./acre in unfavorable years to about 550 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resilient, but is subject to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing, lack of management or use causing decadence and decrease in vigor of the cover present or natural/man-made disturbance. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- Montana wheatgrass (*Elymus albicans*), grass
- Cusick's bluegrass (*Poa cusickii*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- spiny phlox (*Phlox hoodii*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- milkvetch (*Astragalus*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Inadequate livestock water quantity, quality, and distribution

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	185	224	336
Shrub/Vine	112	168	224
Forb	11	28	56
Total	**308**	**420**	**616**

Table 9. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0%
Grass/grasslike basal cover	0%
Forb basal cover	0%
Non-vascular plants	0%
Biological crusts	5-15%
Litter	10-25%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-5%

Bedrock	0%
Water	0%
Bare ground	20-35%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-10%	0-20%	0-15%
>0.15 <= 0.3	–	10-25%	10-50%	0-5%
>0.3 <= 0.6	–	0-5%	0-5%	0-5%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

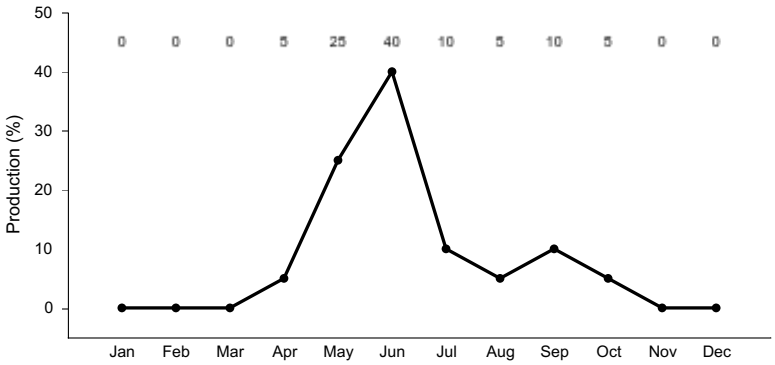


Figure 13. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 6.3
Bluebunch Wheatgrass/Perennial Grasses

Figure 14. Reference community is in tact with a few shifts, however sagebrush has been lost from this community.

This plant community is evolving with the hydrologic shift caused by the loss of the shrub component. Remnant sagebrush skeletons will help to hold a minor amount of moisture, but the site holds a reduced potential and vulnerability due to the loss of the structure component of the canopy. Currently, it is found under moderate,

season-long grazing by livestock and will be exacerbated by prolonged drought conditions. In addition, the fire regime for this site has been modified. This site appears to respond with an exaggerated shift in production from wet, normal and dry seasons and thus the fire threat will vary drastically from one production cycle to the next. This plant community is still dominated by cool-season grasses, while short warm-season grasses and miscellaneous forbs account for the balance of the understory. Under continued drought or intense grazing, this community is at-risk, shifting to a sod-forming, warm-season dominated grass community. Wyoming big sagebrush is relic in small depressions on the landscape, or may be replaced with rabbitbrush species or broom snakeweed, but has little to no production and is not included as a component of the over story. The dominant grasses include bluebunch wheatgrass, rhizomatous wheatgrasses, and needleandthread. Grasses and grass-like species of secondary importance include prairie junegrass, Sandberg bluegrass, and threadleaf sedge. Forbs commonly found in this plant community include scarlet globemallow, milkvetches, and spiny phlox. This site can still provide a diverse plant community, but lacks the structure for cover and wildlife habitat. When compared to the Reference Community 1.1, Wyoming big sagebrush is absent, while Sandburg bluegrass and threadleaf sedge have increased. Plains pricklypear cactus will also have invaded. Indian ricegrass has decreased and may occur in only trace amounts within the patches of Plains pricklypear. Season of use and treatment type may have limited or removed winterfat from this site. The total annual production (air-dry weight) of this state is about __ pounds per acre, but it can range from about __ lbs./acre in unfavorable years to about __ lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning, but has been altered or affected by the loss of snow catch by the sagebrush and ability to slow water movement over the surface; however, the biotic community is intact.

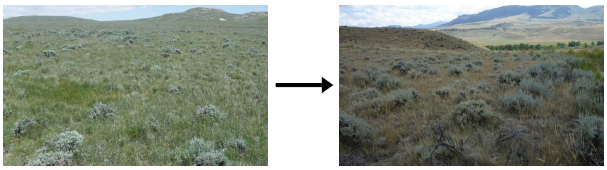
Dominant plant species

- Montana wheatgrass (*Elymus albicans*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- needle and thread (*Hesperostipa comata*), grass
- yellow salsify (*Tragopogon dubius*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- milkvetch (*Astragalus*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Classic gully erosion
- Aggregate instability
- Drifted Snow
- Plant productivity and health
- Plant structure and composition
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Pathway P1.1-1.2
Community 6.1 to 6.2

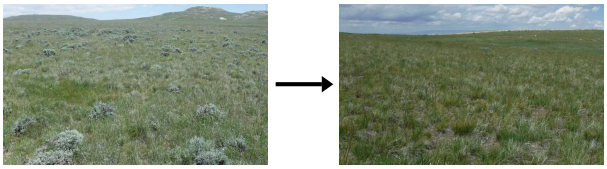


Bluebunch Wheatgrass/Needleandthread/ Sagebrush

Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Moderate, continuous season-long grazing will convert the plant community to the Rhizomatous/Perennial Grass/Big Sagebrush Plant Community. Prolonged drought will exacerbate this transition. The stressers reduce the bunchgrasses such as Bluebunch Wheatgrass, Needleandthread, Indian ricegrass; allowing the solitary growth and sod-formers to increase in dominance in the community.

Pathway CP1.1-1.3
Community 6.1 to 6.3

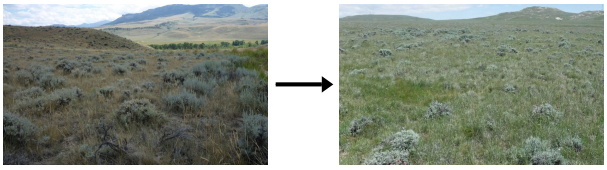


Bluebunch Wheatgrass/Needleandthread/ Sagebrush

Bluebunch Wheatgrass/Perennial Grasses

Extensive Brush Management or Fire with Drought, creates a shift in the hydrology of the site preventing the re-establishment of Wyoming big sagebrush on the site without extensive management changes. This transition has been seen to occur with sites that were treated with chemicals aerially in the late 1960's, and in areas where wildfires burned hot or were fired with a period of extended drought inhibiting the seed bank or preventing the establishment of seedlings into the area.

Pathway P1.2-1.1
Community 6.2 to 6.1



Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Bluebunch Wheatgrass/Needleandthread/ Sagebrush

Prescribed grazing or possibly long-term prescribed grazing, will allow recovery of this plant community to the Reference community. The probability of this occurring is high especially if rotational grazing along with short deferred grazing is implemented as part of prescribed method of use. In addition, the removal of fire suppression will allow a somewhat natural fire regime to reoccur to more easily transition between this plant community and the reference community. A prescribed fire treatment can be useful to hasten this transition, if desired and if invasive species risk is low. Other brush management techniques, such as mechanical or chemical are alterntives.

Conservation practices

Prescribed Grazing

Pathway CP1.2-1.3
Community 6.2 to 6.3

Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Bluebunch Wheatgrass/Perennial Grasses

Extensive Brush Management or Fire with Drought, creates a shift in the hydrology of the site preventing the re-establishment of Wyoming big sagebrush on the site without extensive management changes. This transition has been seen to occur with sites that were treated with chemicals aerially in the late 1960's, and in areas where wildfires burned hot or were fired with a period of extended drought inhibiting the seed bank or preventing the establishment of seedlings into the area.

Community 7

Community 8

Community 9

State 10
Sagebrush/Bare Ground

If continued pressure or disturbance occurs on the vulnerable community within the reference state (State 1), it can be forced into the Sagebrush/*Bare Ground* State. This state name is somewhat misleading in the perception considering that bare ground may only increase slightly and in many cases there is no change or a light decrease in cover by sagebrush. Over time, drought or grazing pressures on this state will eventually drive the sagebrush/shrub canopy out or decrease the health and vigor of the plant to a non-sustainable level. The herbaceous plant production may remain only slightly decreased, but the thriving species usually occur under the canopy of Wyoming Big sagebrush or similar shrub species (rabbitbrush) and within the protection of pricklypear cactus.

Characteristics and indicators. The prominent cover of Wyoming big sagebrush and significant lichen cover or bare ground is the key indicator for this State and Community Phase. The loss of key herbaceous species is significant, although remnant populations will reside within the sagebrush crown or cactus clumps.

Resilience management. Brush management, followed by prescribed grazing, may return this plant community to a similar or near Reference Plant Community. If prescribed fire is used as a means to reduce or remove the shrubs, sufficient fine fuels will need to be present. This may require deferment from grazing prior to treatment. Post management is critical to ensure success. This can range from two or more years of rest to partial growing season deferment, depending on the condition of the understory at the time of treatment and the growing conditions following treatment. In the case of an intense wildfire that occurs when desirable plants are not completely dormant, the length of time required to reach a community within the Reference State may be increased and seeding of natives is recommended.

Community 10.1
Wyoming Big Sagebrush / Bare Ground Plant Community

This plant community is the result of frequent and severe grazing and protection from fire. Sagebrush dominates this plant community, as the annual production of sagebrush ranges from 10 to 25% or greater. Wyoming big sagebrush is a significant component of the plant community and the preferred cool season grasses have been greatly reduced. The dominant grasses are prairie junegrass, Sandberg bluegrass, and threadleaf sedge. Cactus and sageworts often invade. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. As compared with the reference state and inclusive community, the annual production may show a decline, but initially the shrub production compensates for some of the decline in the herbaceous production. The open interspaces leave this site vulnerable to weedy annual species such as Cheatgrass to occupy the site if a seed source is available. If these species gain a foothold, they push the state across a threshold into an invaded or annual grass state. The total annual production (air-dry weight) of this state is about __ pounds per acre, but it can range from about __ lbs./acre in unfavorable years to about __ lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand becomes more decadent. These areas may actually be more resistant to fire as less fine fuels are available and the bare ground between the sagebrush plants is increased. 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 reference communities. 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
- prairie Junegrass (*Koeleria macrantha*), grass
- threadleaf sedge (*Carex filifolia*), grass
- spiny phlox (*Phlox hoodii*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- plains pricklypear (*Opuntia polyacantha*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Classic gully erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

Community 11

Community 12

Community 13

State 14
Sod-former

Threadleaf sedge is a sod-forming species that exist as a component of the perennial vegetation naturally (in reference communities) in the Loamy Calcareous ecological site. The general tendency of threadleaf sedge is to increase under grazing pressure, becoming dominant. The root-mat created as threadleaf sedge increases slows water infiltration, increasing runoff and reducing the hydrologic function of this community.

Characteristics and indicators. Threadleaf sedge will be the major soil cover of this community with a deteriorating component of sagebrush and cactus. As sagebrush declines, pricklypear cactus tends to increase in composition in the community.

Resilience management. Threadleaf sedge is extremely resilient and resistant to degradation once established. This creates a stable community.

Community 14.1
Threadleaf Sedge/Wyoming Big Sagebrush

Figure 15. Threadleaf sedge and black sagebrush are the dominant canopy within this community.

This plant community is the result of frequent and severe year-long grazing, which has adversely affected the perennial grasses as well as impacted the shrub component. Other factors that can affect the shrubs include drought, heavy browsing, wildfires, and/or human brush control measures. A dense sod of threadleaf sedge dominates this state. Prickly pear cactus can become dense enough in patches so that livestock cannot graze forage growing within the cactus clumps. Wyoming big sagebrush has been reduced to small patches or in some cases removed. Rubber rabbitbrush may be the sole remaining shrub on the site. When compared to the Reference State, threadleaf sedge, have increased. Pricklypear cactus has invaded. All cool-season mid-grasses, forbs, and most shrubs have been greatly reduced. Production has been significantly decreased. The total annual production (air-dry weight) of this state is about __ pounds per acre, but it can range from about __ lbs./acre in unfavorable years to about __ lbs./acre in above average years.

Resilience management. This community is at risk of transition to a completely sod-bound community as explained above, as the sod 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 sod-formers, but it will eventually remove the shrub component from the plant community. The biotic integrity of this state is not functional and plant diversity is extremely low. The plant vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool-season grasses. This sod-bound plant community is very resistant to water infiltration. While this sod protects the site itself, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in areas of bare ground and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- threadleaf sedge (*Carex filifolia*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Community 14.2
Threadleaf Sedge/Cactus Plant Community

Figure 16. The sagebrush cover was removed in the 1960s with no recovery, but broom snakeweed and threadleaf sedge are strong in this community.

This plant community can occur fairly easily through drought, wildfire or continued pressure on the remaining shrubs. A dense sod of threadleaf sedge dominates this state. Prickly pear cactus can become dense enough in patches so that livestock cannot graze forage growing within the cactus clumps. Wyoming big sagebrush has been generally removed from the site with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but is the remaining shrub on the site. When compared to the Reference Community 1.1, threadleaf sedge has increased. Prickly pear cactus has invaded. All cool-season mid-grasses, forbs, and most shrubs have been greatly reduced or removed. Production has been significantly decreased. The total annual production (air-dry weight) of this state is about __ pounds per acre, but it can range from about __ lbs./acre in unfavorable years to about __ lbs./acre in above average years.

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

Dominant plant species

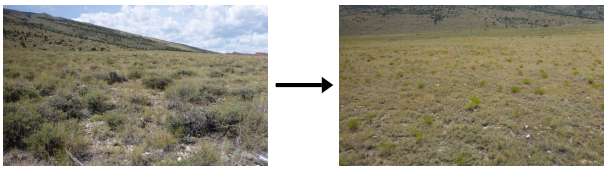
- threadleaf sedge (*Carex filifolia*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Pathway P3.1-3.2

Community 14.1 to 14.2



Threadleaf Sedge/Wyoming Big Sagebrush

Threadleaf Sedge/Cactus Plant Community

Frequent or Severe Grazing, Drought/Insect Damage, Fire/Wildfire – The Wyoming big sagebrush component of this community is the at risk species. Sagebrush will decrease under drought, and if grazing pressures persist through season or year-long patterns, becoming decadent and then dying. The sod dominated community reduces the ability for sagebrush to propagate, also leading to a recession of sagebrush. Although rare in occurrence, due to lack of fine fuels and canopy cover, fire will remove the shrub canopy as well. In some cases on the edge of the precipitation break, Rubber rabbitbrush will dominate a site as sagebrush diminishes. It is also noted that with periods of drought that have occurred in the past ten years, there is a noted decrease in the health and vigor of Blue grama and Threadleaf sedge. The dense root structure of the sod-former plants is reduced allowing other species to establish. The spring of 2014 has shown a flush of Sandberg bluegrass occupying Blue grama communities, and in some instances appear to be the dominant production for that community.

State 15
Invaded

Invasive plant species are a permanent concern with rangelands and management. Each year new species are discovered and will alter this section as they are. Currently within the Big Horn Basin there are several varieties of thistles, knapweeds, milkweeds, mustards and others that create a management issue for livestock and ecology. In areas where there has been a disturbance, natural or man-made, these species can gain a place in the landscape and are difficult to impossible to eradicate. Because of this it becomes a battle to maintain control with annual or prolonged management of the weed species, and preventing further shifts or changes to the native composition.

Characteristics and indicators. The presence of an invasive weed in a community warrants the transition to the Invaded State once it is at least 5 percent of the canopy cover or composition by weight in the community.

Resilience management. Treatment of many of the common invasive species is difficult and requires continual maintenance. Eradication, in many situations, has not been achieved. This leaves invaded communities open to further degradation, but resistant to improvement.

Community 15.1
Perennial Grasses/Invasive Species/Sagebrush

Figure 17. Cheatgrass is a significant factor of this community, however, the native population is persisting within the cheatgrass.

The Perennial Grasses/Invasive Species/Sagebrush community phase has maintained a representative sample of the perennial grasses and forbs that are typical of the site with the accompanying Wyoming big sagebrush

composition. The invasive species are present and hold a significant (10% or greater) composition of the landscape, and are prominent on the site (referring to a more wide scale composition, not one isolated patch in an isolated portion of the landscape). Production of the desired perennial species of this site is generally reduced but the total production is maintained or elevated due to the production potential of many of the annual or invasive species.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased. 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 more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated, this variability also applies to water flow patterns and pedestalling. Infiltration is reduced and runoff is increased due to loss of perennial vegetation and root density.

Community 15.2
Invasive Species/Sagebrush

This community phase is the at-risk community. As the native populations of perennial grasses and forbs become weakened, the site becomes invader driven, and irreversible. If environmental or management stressors or disturbances occur to remove the shrub component, the site crosses to community phase 4.3, Annual Grasses. Wyoming big sagebrush is able to compete and maintain a strong community under a heavy infestation level unless fire or disturbance of any nature weakens the plant. The canopy of the sagebrush serves as a protected niche in the system that can hold native grass species and help them to persist. But the system is low in resistance and even lower in resilience.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand becomes more decadent. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased. Plant diversity is poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that establishes on this site.

Community 15.3
Annual Grasses

Downy Brome, better known as Cheatgrass or *Bromus tectorum*, is able to green up and grow late into the fall taking advantage of the fall moisture. Seed lays dormant until conditions are positive, allowing growth before most native species. The plant's ability to grow quickly utilizes the minimal available resources before the native species can begin to break dormancy for the season. The ability for Cheatgrass to produce a large quantity of seed quickly, and in poor conditions, as well as the morphology of the seed allowing easy dispersal creates a wide spread seed bank that is unmanageable. These traits create a management challenge that has not been successfully met at this time. Once this species has a niche on a landscape it is resistant and resilient to all changes. There may be native species that will persist in small scattered populations and under certain climatic conditions can show their resiliency and respond to the available resources, but generally found unable to out-compete the annual invader.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. These areas are extremely prone to fire fueled by the high fine fuels load associated with the Cheatgrass litter. Plant diversity is poor. The plant vigor is diminished and replacement capabilities are non-existent due to the loss of cool-season grasses. Plant litter is noticeably more when compared to reference communities in response to the dense duff layer created by Cheatgrass. Soil erosion is generally reduced in response to the litter accumulation; however, the annual nature of this plant accentuates the water flow patterns and pedestalling. Infiltration is reduced and runoff is increased with the loss of perennial vegetation and root depth and density.

Pathway P4.1-4.2

Community 15.1 to 15.2

Frequent or Severe Grazing, Drought, Disturbances (mechancial) and Wildfire – Drought, wildfire, or other climatic stresses on the system can continue to stress the native species reducing their ability to maintain their footprint in the plant community. This continued stress or the complication with mechanical disturbances or, frequent or severe grazing or pressure from wildlife and livestock can reduce the natives to an unviable or unsustainable population and allow the invasive species to dominate the site. This is more typical in species such as knapweeds, Canada or Bull thistle, and specifically Cheatgrass (Downy brome).

Pathway CP4.1-4.3
Community 15.1 to 15.3

Fire or extended periods of drought can lead to the die back of sagebrush within this community. Mechanical or chemical removal of sagebrush will impact the native grasses and leave the community at threat of complete dominance of cheatgrass. Once cheatgrass forms a monoculture, the risk of fire is high and the ability for recovery is minimal

Pathway CP4.2-4.1
Community 15.2 to 15.1

With intensive weed control efforts and rest, native species have an opportunity to recover in this community. The prescription of a rest rotation with continued weed management can maintain a native community with the invasive species.

Conservation practices

Critical Area Planting
Prescribed Grazing
Heavy Use Area Protection
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management

Pathway CP4.2-4.3
Community 15.2 to 15.3

Fire or extended periods of drought can lead to the die back of sagebrush within this community. Mechanical or chemical removal of sagebrush will impact the native grasses and leave the community at threat of complete dominance of cheatgrass. Once cheatgrass forms a monoculture, the risk of fire is high and the ability for recovery is minimal

State 16
Disturbed

The Disturbed state could be drafted as a stand-alone box within the state and transition model diagram. No matter what state a site originally is ranked in, once the site is mechanically disturbed, or suffers a catastrophic or significant natural disaster that alters the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered.

Characteristics and indicators. To consider this as an alternate ecological site would not be unreasonable. In some cases (site by site consideration), a re-correlation of a location may be the best solution. But in many cases, the site has not been altered out of the current site, but the potential has shifted enough that it is no longer truly comparable to the reference community. So a dynamic state was captured to detail the altered communities that exist on the landscape.

Resilience management. The response to management varies with the specific form of disturbance, the stage or level of restoration attempted or the age of the community post disturbance. These communities are in a state of

flux and are sensitive to further disturbance.

Community 16.1
Disturbed Lands Plant Communities

The title Disturbed Lands is encompassing three broad classifications of these land types. Go-back fields are referring to sites that were once cultivated or have had minor surface disturbance, and have since been left to natural processes. Homestead and abandoned farming sites can be identified on the landscape (through photo-tone shifts in aerial photographs) and are generally a mix of natives that have moved into disturbed sites or a co-mingling of introduced species and natives. These sites are difficult to reclaim, generally due to the introduced species that persist on the landscape. And once reclaimed, do not tend to respond to the natural disturbance regimes in the same manner that a native, mechanically undisturbed site would respond. In a similar process, mined lands or lands affected by energy development including transmission corridors, transportation corridors and development sites provide a host of successional processes. Many times, these locations are re-exposed to disturbance frequently by mechanical means leaving annual weeds and primary successional species as the dominate canopy. Older, established sites or abandoned locations, have established communities similar to those expected on go-back fields and may be stable in nature. The last type of Disturbed lands is the “introduced grass plantings”. Although this could be considered reclaimed or restored, there are sites that were seeded to introduced or improved species, such as crested wheatgrass, smooth brome, or tall wheatgrass in a monoculture. These communities will transition or mature as the stand density declines with lack of management or inputs, the canopy opens and allows natives, if present, to begin to establish. Although each planting is highly variable on the exact composition that will be present, they appear to be stable and can be productive sites. The growth curve of this plant community will vary depending on the species that are selected for seeding. For a more accurate portrait of the growth curve for the seeded community, the species used and the climatic tendencies of the region must be considered. Rangeland Health Implications/Indicators: The plant community is variable and depending on the age of the stand and the stage of successional tendencies that the location is in will determine how stable (resilient/resistant) the community is. Plant diversity is generally strong, but is usually lacking in the structural groups that are desired on the site. Soil erosion is variable depending on the disturbance regime that is occurring on the site and again on the specific community that has established on a specific location. 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.

Community 16.2
Reclaimed Lands Plant Communities

Reclamation practices have shifted greatly over the last several decades. Crested wheatgrass was a species used frequently for reclamation throughout Wyoming and many of these communities persist today. Although there are areas where native species from neighboring sites are starting to slowly extend into the crested wheatgrass stands, many times, these stands remain as a monoculture until a disturbance occurs to open the canopy slightly to provide a more tolerable niche. Bozosky Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses have also been used in mixes to help compensate for the chemistry of these soils. Although the success of vegetative seedings are low in this LRU, due to the low precipitation and timing of precipitation events, there are limited areas along pipeline corridors, well sites or pad sites, and along transportation corridors where re-seeded sites have succeeded. As mentioned in the community phase above, as these seedings mature and the stands open, they can be characteristically similar to other disturbed sites. Where under the more current, and understood definition of reclaimed or restored, sites are planted to as close to a natural occurring plant community as possible. This excludes the use of non-native species and allows for a more similar ecological response than what is expected with non-native species. Again, these seedings 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 can be very similar. The growth curve of this plant community will vary depending on the species that are selected as the reclamation seed mix. For a more accurate portrait of the growth curve for the seeded community, the species used and the climatic tendencies of the region must be considered. Rangeland Health Implications/Indicators: Seeding mixtures will determine the plant community resistant to change and resilience to threat of invasive species and to erosion. Many of the stands established during seeding are diversity poor, but are better than the monocultures that were planned historically. Many seeded sites may be prone to fire as they mature as many of the cultivated seeds produce more biomass (possibly more litter) and thus may create more fine fuels to fuel 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 establishes on this site.

Pathway P5.1-5.2
Community 16.1 to 16.2

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing management – With the proper mechanical improvements and the follow-up through establishment and then maintenance, a disturbed site can be improved and managed. However, climatic limitations and soil chemistry limit the success of seeding treatments. Depending on the site location, invasive species are a risk to most sites within the Basin and create a low success potential for this process.

Conservation practices

Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)

Pathway P5.2-5.1
Community 16.2 to 16.1

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 will occur and then a shift in composition will occur. Since the site is altered from reference state in soils due to plowing, mining, or other similar disturbances, the plant community will not follow the same expected shifts of a native community and this will refer back to a community more reflective of a disturbed plant composition.

Pathway P4.1-4.2
Community 3 to 13

Frequent or Severe Grazing, Drought/Insect Damage, Fire/Wildfire – The Wyoming big sagebrush component of this community is the at risk species. Sagebrush will decrease under drought, and if grazing pressures persist through season or year-long patterns, becoming decadent and then dying. The sod dominated community reduces the ability for sagebrush to propagate, also leading to a recession of sagebrush. Although rare in occurrence, due to lack of fine fuels and canopy cover, fire will remove the shrub canopy as well. In some cases on the edge of the precipitation break, Rubber rabbitbrush will dominate a site as sagebrush diminishes. It is also noted that with periods of drought that have occurred in the past ten years, there is a noted decrease in the health and vigor of Blue grama and Threadleaf sedge. The dense root structure of the sod-former plants is reduced allowing other species to establish. The spring of 2014 has shown a flush of Sandberg bluegrass occupying Blue grama communities, and in some instances appear to be the dominant production for that community.

Pathway P5.1-5.2
Community 5 to 11

Frequent or Severe Grazing, Drought, Disturbances (mechancial) and Wildfire – Drought, wildfire, or other climatic stresses on the system can continue to stress the native species reducing their ability to maintain their footprint in the plant community. This continued stress or the complication with mechanical disturbances or, frequent or severe grazing or pressure from wildlife and livestock can reduce the natives to an unviable or unsustainable population and allow the invasive species to dominate the site. This is more typical in species such as knapweeds, Canada or Bull thistle, and specifically Cheatgrass (Downy brome).

Pathway P7.1-7.2
Community 8 to 9

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing management – With the proper mechanical improvements and the follow-up through establishment and then maintenance, a disturbed site can be improved and managed. However, climatic limitations and soil chemistry limit the success of seeding treatments. Depending on the site location, invasive species are a risk to most sites within the Basin and create a low success potential for this process.

Transition T1-2
State 6 to 10

Frequent and severe grazing plus no fire on these droughty soils, will convert the plant community to the Big Sagebrush/*Bare Ground* Plant Community. The probability of this occurring is high. This is especially evident on areas with historically higher precipitation and the sagebrush stand is not adversely impacted by drought or heavy browsing.

Constraints to recovery. The calcic layer in these soils limits water and nutrients, making recovery difficult on this site.

Pathway P1.1-1.2
Community 4 to 12

Moderate, continuous season-long grazing will convert the plant community to the Rhizomatous/Perennial Grass/Big Sagebrush Plant Community. Prolonged drought will exacerbate this transition. The stressers reduce the bunchgrasses such as Bluebunch Wheatgrass, Needleandthread, Indian ricegrass; allowing the solitary growth and sod-formers to increase in dominance in the community.

Transition T1-3
State 6 to 14

Frequent and severe grazing (yearlong grazing) plus wildfire or brush control, will convert the plant community to the Blue Grama Sod Plant Community. The probability of this occurring is high, especially if the sagebrush stand has been severely affected by drought or heavy use or has been removed altogether.

Constraints to recovery. The dense root system and altered hydrology presented by threadleaf sedge limits the ability for this community to recover to Reference.

Restoration pathway R2-1
State 10 to 6

Prescribed Grazing with rest will allow remnant grass species to begin to recover. Time is the biggest component that is needed for this recover, with cooperative climatic conditions. Seeding of native species will assist the process with brush control may be needed to make this transition happen.

Conservation practices

Brush Management
Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Heavy Use Area Protection
Upland Wildlife Habitat Management

Pathway P7.2-7.1
Community 9 to 8

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 will occur and then a shift in composition will occur. Since the site is altered from reference state in soils due to plowing, mining, or other similar disturbances, the plant community will not follow the same expected shifts of a native community and this will refer back to a community more reflective of a disturbed plant composition.

Pathway P1.2-1.1
Community 12 to 4

Prescribed grazing or possibly long-term prescribed grazing, will allow recovery of this plant community to the Reference community. The probability of this occurring is high especially if rotational grazing along with short deferred grazing is implemented as part of prescribed method of use. In addition, the removal of fire suppression will allow a somewhat natural fire regime to reoccur to more easily transition between this plant community and the reference community. A prescribed fire treatment can be useful to hasten this transition, if desired and if invasive species risk is low. Other brush management techniques, such as mechanical or chemical are alternatives.

Transition T2-4
State 10 to 15

Frequent or Severe Grazing, Wildfire, Disturbance - The chance of wildfire is reduced with the loss of the fuels from sagebrush to help carry across large areas, however, in favorable production years areas can produce enough fine fuels to carry a wildfire which in turn opens the canopy and provides a niche for annual invaders such as Cheatgrass and knapweeds to take hold. If the seed source is available, fire is a well-known avenue to provide the conditions for annuals to flourish, as well as general disturbance whether from herbivores or man-induced.

Constraints to recovery. Once the seed source gains a place in the community, it is extremely difficult to manage and may not be feasible or possible to completely remove the invaders.

Transition T3-4
State 14 to 15

Drought, Frequent or severe grazing, Disturbance – Drought as the only factor or drought with grazing intensity together can work to weaken the native species on this site to allow invasive species to establish. Threadleaf sedge has been seen to die back or die out with prolonged drought opening the canopy and the community’s vulnerability to invasive species. Disturbance by mechancial means or human activities that break the root masses or disturb the soil surface open this closed community to potential invasive species, especially when there is a readily available seed source for those invasive species.

Constraints to recovery. The lack of tools to eradicate invasive species is the major constraint to recovery of this community.

Restoration pathway R4-5
State 15 to 16

Integrated Pest Management, with Seeding the site to a native mixture - Success is not known to have occurred, and is rated to be low and highly variable for the rate of control of most species. Cheatgrass and knapweeds are two of the most invasive species for many of these sites but there are many others, for example, Halogeton, that can dominate these sites. It is a consensus that the site can be brought to an at-risk community within the reference state, but that it is not possible to reach the reference community condition once annuals have established on a site.

Conservation practices

Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Integrated Pest Management (IPM)

Transition T5-4
State 16 to 15

Frequent or Severe Grazing, Disturbance with a seed Source, or Drought - Any stressor that is applied with the inherent seed source puts this state at risk to transitioning into an Annual Grass or Invaded State.

Constraints to recovery. The lack of control tools to eradicate cheatgrass and other invasive species, limit the ability for recovery of this community.

Additional community tables

Table 11. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-Stature, Cool-Season Bunchgrass**			112–336	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	56–224	10–50
	needle and thread	HECO26	*Hesperostipa comata*	28–168	5–25
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–56	0–10
2	**Rhizomatous, Cool-Season Grasses**			0–84	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–28	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–28	0–5
	Montana wheatgrass	ELAL7	*Elymus albicans*	0–28	0–5
3	**Short-Stature, Cool-Season Grasses**			0–56	
	prairie Junegrass	KOMA	*Koeleria macrantha*	1–56	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	6–56	0–5
	squirreltail	ELEL5	*Elymus elymoides*	1–28	0–5
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–28	0–5
4	**Miscellaneous Grasses/Grass-likes**			0–28	
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–28	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
Forb					
5	**Perennial Forbs**			0–56	
	textile onion	ALTE	*Allium textile*	1–22	–
	sandwort	ARENA	*Arenaria*	0–22	–
	aster	ASTER	*Aster*	1–22	–
	milkvetch	ASTRA	*Astragalus*	1–22	–
	bastard toadflax	COMAN	*Comandra*	0–22	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	–
	larkspur	DELPH	*Delphinium*	0–22	–
	fleabane	ERIGE2	*Erigeron*	1–22	–
	desertparsley	LOMAT	*Lomatium*	1–22	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	1–22	–
	spiny phlox	PHHO	*Phlox hoodii*	1–22	–
	Nuttall's violet	VINU2	*Viola nuttallii*	0–22	–
Shrub/Vine					
6	**Dominant Shrubs**			56–168	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	56–168	10–15
	black sagebrush	ARNO4	*Artemisia nova*	0–56	0–10
7	**Miscellaneous Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5

Table 12. 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**			56–224	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	56–140	–
	needle and thread	HECO26	*Hesperostipa comata*	11–84	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–28	–
2	**Rhizomatous, Cool-Season Grasses**			28–84	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	11–56	–
	western wheatgrass	PASM	*Pascopyrum smithii*	11–56	–
	Montana wheatgrass	ELAL7	*Elymus albicans*	0–56	–
3	**Short-Stature, Cool-Season Grasses**			0–56	
	Sandberg bluegrass	POSE	*Poa secunda*	6–45	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	1–45	–
	squirreltail	ELEL5	*Elymus elymoides*	1–22	–
	muttongrass	POFE	*Poa fendleriana*	0–22	–
4	**Miscellaneous Grasses/ Grass-Likes**			0–28	
	Grass, perennial	2GP	*Grass, perennial*	0–22	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–22	–
	threadleaf sedge	CAFI	*Carex filifolia*	0–22	–
Forb					
5	**Perennial Forbs**			0–56	
	sandwort	ARENA	*Arenaria*	0–28	0–5
	milkvetch	ASTRA	*Astragalus*	0–28	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–28	0–5
	milkvetch	ASTRA	*Astragalus*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
6	**Annual Forbs**			0–28	
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	0–5
	northern tansymustard	DESO3	*Descurainia sophioides*	0–28	0–5
	Forb, annual	2FA	*Forb, annual*	0–28	0–5
Shrub/Vine					
7	**Dominant Shrubs**			56–224	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	56–224	10–30
	black sagebrush	ARNO4	*Artemisia nova*	0–56	0–10
8	**Secondary Shrubs**			0–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5

Animal community

1.1 - Bluebunch Wheatgrass/Needleandthread/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, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. 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 - Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush Plant Community: The combination of an overstory of sagebrush and an understory of grasses and forbs provide a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter, nesting, brood-rearing, and foraging habitat for sage grouse. Brewer's sparrows' nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20 to 30 percent cover range.

1.3 - Bluebunch Wheatgrass/Perennial Grasses Plant Community: The loss of the thermal and escape cover limit use, but is favored for grazers and mixed feeders such as bison, elk, and antelope. When found adjacent to sagebrush dominated states, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. 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 percent protein and 40 to 60 percent digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

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

3.2 - Threadleaf Sedge Sod/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 - Perennial 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 (Rhizomatous Wheatgrasses/Perennial Grasses/Sod formers/Wyoming Big Sagebrush) are to some extent enhanced for some species with the added forage provided by the invasive species. But as the invasive species increase, decreasing the desirable species, the wildlife species benefits are decreased as well.

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

4.3 - 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 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 under normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of

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

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

Plant Community Production Carrying Capacity*
Plant Community Description/Title: Lbs./Acre AUM/Acre
1.1 Bluebunch Wheatgrass/Needleandthread/Sagebrush 300-625 0.14
1.2 Rhizomatous Wheatgrasses/Perennial Grasses/Wyoming Big Sagebrush 275-550 0.10
1.3 Bluebunch Wheatgrass/Perennial Grasses ** **
2.1 Wyoming Big Sagebrush/*Bare Ground* ** **
3.1 Blue Grama/Threadleaf Sedge/Wyoming Big Sagebrush ** **
3.2 Blue Grama/Threadleaf Sedge Sod/Cactus ** **
4.1 Perennial Grasses/Invasive Species/Wyoming Big Sagebrush ** **
4.2 Invasive Species/Wyoming Big Sagebrush ** **
4.3 Annual Grasses ** **
5.1 Disturbed Lands ** **
5.2 Restored/Reclaimed Lands ** **

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

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

Distance to water, shrub density, and slope can affect carrying capacity (grazing capacity) within a management unit. Adjustments should be made for the area that is considered necessary for reduction of animal numbers. For example, 30 percent of a management unit may have 25 percent slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30 percent of the unit (i.e. 50 percent reduction on 30 percent of the management unit). Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of graze-able acres within a management unit. Adjustments should be made that incorporate these factors when calculating stocking rates.

Hydrological functions

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

Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Cryptogamic 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. This ecological site, however, can prove to have limitations when associated with Roadways and Trails in relation to erosion potential and functionality. The soils will be sticky or slick when wet and are more erosive than the Loamy range sites and so consideration needs to be given when crossing these areas with trails and roadways.

Wood products

No appreciable wood products are present on the site.

Other products

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

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

Inventory data references

Information presented in the original site description was derived from NRCS inventory data. Field observations from range-trained personnel also were 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.

Those involved in the development of the new concept for the Sandy ecological site include Tricia Hatle, Range Management Specialist, US Department of the Interior-Bureau of Land Management (USDI-BLM); Karen Hepp, Range Management Specialist, USDI-BLM; and Marji Patz, Ecological Site Specialist, NRCS.

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

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

Inventory Data References:
Ocular field estimations observed by trained personnel were completed at each site. Then sites were selected where a 100-feet tape was stretched, and the following sample procedures were completed by inventory staff. For full sampling protocol and guidelines with forms please refer to the Wyoming ESI Operating Procedures, compiled in 2012 for the Powell and Rock Springs Soil Survey Office, USDA-NRCS.
• Double Sampling Production Data (9.6 hoop used to estimate 10 points, clipped a minimum of three of these estimated points, with two 21-foot X 21-foot square extended shrub plots).
• Line Point Intercept (overstory 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 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 (Ten 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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Approval

Kirt Walstad, 3/04/2024

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	03/25/2020
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are normally not present. Some very minor rill development may occur in sparsely vegetated areas. Any rills present should be less than 1/2 inch deep, widely spaced (15 to 20 feet), and not connected. They should average < 4 feet in length. A slight increase in rill development may also be observed following large storm events or spring runoff periods, but should heal within the next year. Rill development may also increase where the site is adjacent to other sites that produce large amounts of runoff (i.e. steeper sites).

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2. **Presence of water flow patterns:** Barely observable but may be occurring on steeper slopes (10-25%). Any flow patterns present should be sinuous and wind around perennial plant bases. Generally short (<5 ft), < 1 foot wide, and spaced from 10 to 20 feet apart if present on steeper slopes. They should be stable with only minor evidence of deposition.

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3. **Number and height of erosional pedestals or terracettes:** Essentially non-existent, or rare if occurring. In that rare occurrence, plants may show very minor pedestalling where they are adjacent to water flow patterns, but there should be no exposed roots. A few minor terracettes may be present in similar situations on steeper slopes, however they should be stable and occur behind litter blocking water flow patterns.

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

should not be greater that 1 foot in size and should not be connected.

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

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to non-existent. No evidence of wind generated soil movement. Wind scoured (blowouts) and depositional areas are not present.

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7. **Amount of litter movement (describe size and distance expected to travel):** The majority of litter accumulates in place at the base of plant canopies. Slight movement of the finest material (< 1/8 inch) may move 1 to 2 feet in the direction of prevailing winds or downslope if being transported by water. Little accumulation is observed behind obstructions. Large woody debris from sagebrush will show no movement except for minimal debris damming after large rain or snowmelt events on slopes >9%.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Plant cover and litter is at 60% or greater of soil surface and maintains soil surface integrity. Soil stability class is anticipated to be 3.0 or greater on average. Ranging from 1 in interspaces and up to 6 under plant canopy.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil data is limited for this site. A-horizons vary in depth from 1 to 12 inches with OM of 1-2%.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of, on average, 75% grasses, 10% forbs, and 15% shrubs. This, with an evenly distributed canopy and litter, with deep healthy rooted native grasses enhancing infiltration, limits the runoff potential to little or no effect on this site.

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

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

    Dominant: Mid-stature cool season bunchgrasses

    Sub-dominant: perennial shrubs > cool season rhizomatous grasses

    Other: short stature bunchgrass and grass-likes > perennial forbs

    Additional: Community 1.1 = Perennial Cool-Season bunchgrasses > Shrubs > Rhizomatous Wheatgrasses>Perennial Forbs

Community 1.2 = Rhizomatous Wheatgrasses> Perennial Cool-Season bunchgrasses > Shrubs > Perennial Forbs

12b. F/S Groups not expected for the site: Annual Grass
12c. Number of F/S Groups: 6 groups
12d. Species number in Dominate and Sub-dominate F/S Groups: 8 species

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence can be observed and is typically associated with shrub component. It is common to find dead matter accumulated in bunchgrasses, but live plant matter quantity should exceed standing dead except for in times of severe drought. Sagebrush canopy will often have occasional dead branches, but it should not exceed 30% and shouldn't be found on most plants.

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14. **Average percent litter cover (%) and depth (in):** Litter ranges from 5 to 25% of total canopy with total litter including beneath the plant canopy can reach up to 70%. Herbaceous litter depth typically ranges from 3-10 mm, with woody littler varying between 4-6 cm. Woody litter can be up to a couple inches in diameter (4-6cm), but is sporadically distributed.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Community 1.1 =Total normal or average production is estimated at 525 lbs. with a low of 300 lbs. and ranging to 625 lbs.

    Community 1.2 =Total normal or average production is estimated at 375 lbs. with a low of 275 lbs. and ranging to 550 lbs.

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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:** Blue grama, Sandberg bluegrass, Threadleaf sedge, Threeawn, Fringed sagewort, Prickly pear cactus, Broom snakeweed and Rubber rabbitbrush; Alyssum, Blue mustard, Annual false crested wheatgrass, as well as other Annuals, and then Exotics and species found on the noxious weed list including but not limited to: Cheatgrass, Spotted knapweed, Bull thistle.

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17. **Perennial plant reproductive capability:** All species are capable of reproducing except in severe drought years. Thickspike and western wheatgrass will commonly reproduce by underground rhizomes and not by seed production.
