USDA Natural Resources Conservation Service

Ecological site EX043B23A172
Stony Upland (StU) Absaroka Lower Foothills

Last updated: 3/04/2024
Accessed: 05/15/2024

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 receives no additional water.
• Slope is < 20%
• Soils are:
o Non-saline, sodic, or saline-sodic
o Moderately deep to very deep (20-80+ in. (50-200+ cm)
o > 5% stone and boulder cover and < 20% cobble and gravel cover
o Skeletal (≥35% rock fragments) within 8-20 inches (20-50 cm) of mineral soil surface
o Textures range from fine sandy loam to clay loam in top 4 inches (10 cm) of mineral soil surface
o All subsurface horizons in the particle size control section have a weighted average of >18% but <35% clay. (The particle size control section is the segment of the profile from either the start of an argillic horizon for 50 cm or from 25-100 cm).

This concept is developed to capture those soils that have a surface cover of stones and boulders, as well as cobbles) with a strong cap of soil with few rock fragments that is stationed on a cobble and stony skeletal layer lower in the soil profile. These sites have excellent production between the surface fragments, but once degraded, the loss of the upper soil profile hinders recovery of this site.

Associated sites

EX043B23A175	**Skeletal (Sk) Absaroka Lower Foothills** Skeletal soils are found in more eroded surfaces or areas with less deposition where the entire profile is skeletal.
EX043B23A162	**Shallow Loamy (SwLy) Absaroka Lower Foothills** Shallow Loamy will occur on slopes near rock outcropping, where Steep Stony Upland will be found in deeper profiles below or above outcrops.
EX043B23A122	**Loamy (Ly) Absaroka Lower Foothills** Loamy is found in similar area where deposition has occurred without the influence of the rock. On landslides or erosional landforms, Loamy will be found in more concave segments of the slope where Stony Upland tends to be on convex or back slopes.

Similar sites

EX043B23B170	**Steep Stony Upland (SStU) Absaroka Upper Foothills** Steep Stony Upland is on higher sloping landforms and is generally occurring on side slopes.
EX043B23A109	**Cobbly Upland (CoU) Absaroka Lower Foothills** Cobbly Upland will occur on similar slopes, but is also found on gentle slopes and is comprised of cobbles and gravels with very few stones and boulders, where Steep Stony Upland is mainly stones and boulders but does have cobbles and gravels.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. wyomingensis* (2) *Artemisia frigida*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Leucopoa kingii*

Legacy ID

R043BX572WY

Physiographic features

The Stony Upland ecological site is found on gently rolling or undulating lands associated with landslides or glacial till or outwash areas. The slopes are nearly level or less than 20 percent.

Table 2. Representative physiographic features

Landforms	(1) Foothills > Eroded fan remnant (2) Foothills > Landslide (3) Foothills > Stream terrace
Runoff class	Negligible to high
Elevation	1,768–2,286 m
Slope	0–20%
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 15 and continues until about July 1. 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 25WNW and Wapiti 1NE are the representative weather stations for the Lower Foothill subset.. 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

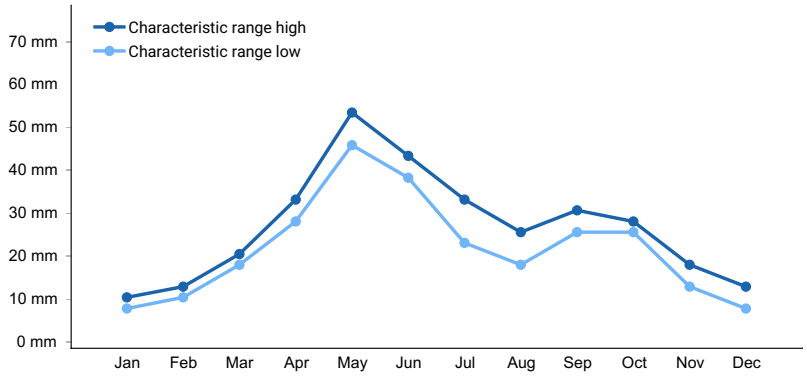


Figure 1. Monthly precipitation range

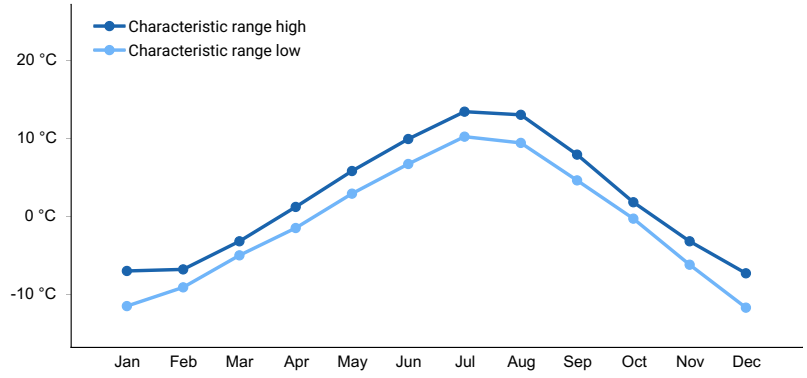


Figure 2. Monthly minimum temperature range

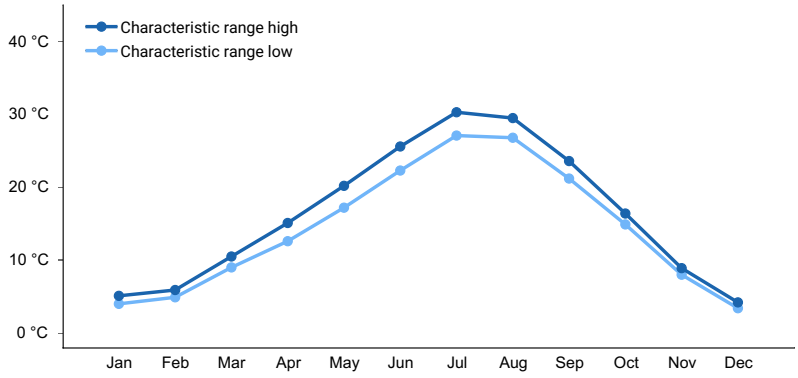


Figure 3. Monthly maximum temperature range

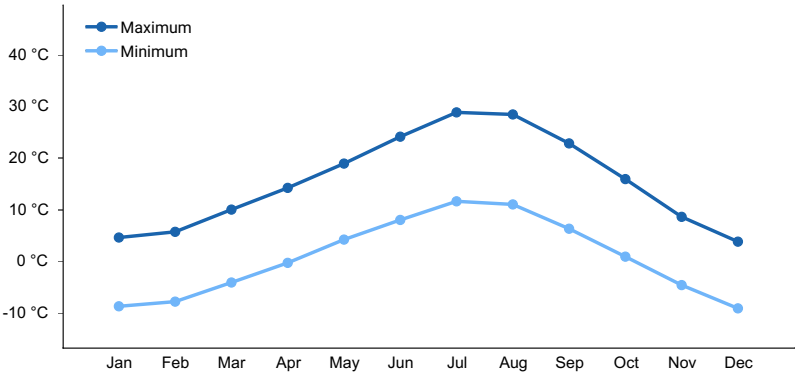


Figure 4. Monthly average minimum and maximum temperature

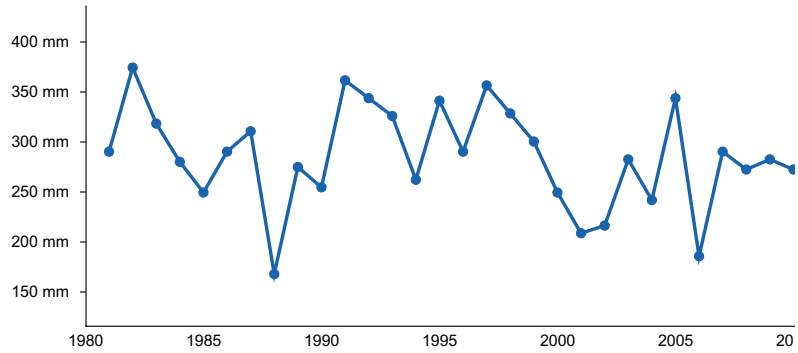


Figure 5. Annual precipitation pattern

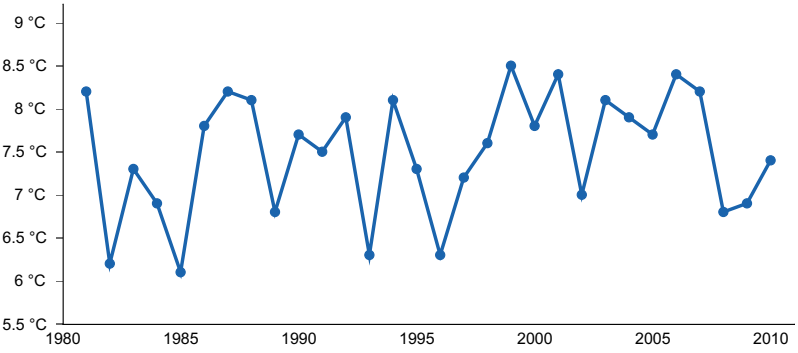


Figure 6. Annual average temperature pattern

Climate stations used

- (1) BUFFALO BILL DAM [USC00481175], Cody, WY
- (2) WAPITI 1NE [USC00489467], Cody, WY
- (3) CODY 21 SW [USC00481855], Cody, WY

- (4) THERMOPOLIS 25WNW [USC00488888], Thermopolis, WY
- (5) THERMOPOLIS [USC00488875], Thermopolis, 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). Generally, the soils will appear dry (droughty) compared to surrounding non-skeletal sites.

Soil features

The soils of this site are deep to moderately deep (greater than 20" to bedrock), moderately well to somewhat excessively well-drained & moderately slow to moderately rapid permeable. This site consists of a strong cap of soils with few rock fragments (less than 35%) with a skeletal fraction with bouldery to cobbly coarse fragments lower in the soil profile. The soil surface can be covered extensively with these coarse fragments, with at least 5% stones and boulders. The increased fragment cover impacts the plant cover, and plant density is reduced. The soil characteristics having most influential to the plant community are volume of coarse fragments in the profile that reduces the available moisture and the extensive cover of these coarse fragments, which can reduce the plant density.

Major Soil Series correlated to this site includes: Zillman

Figure 7. Hand excavated pit for the Stony Upland ecological site, showing the fine--loamy upper profile with a skeletal lower subsurface profile.

Table 4. Representative soil features

Parent material	(1) Alluvium–igneous, metamorphic and sedimentary rock (2) Slide deposits–igneous, metamorphic and sedimentary rock (3) Colluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Very stony, extremely bouldery, extremely stony loam (2) Silt loam (3) Clay loam (4) Sandy clay loam
Family particle size	(1) Fine-loamy (2) Loamy-skeletal (3) Fine-loamy over sandy or sandy-skeletal
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to moderately rapid
Soil depth	51 cm
Surface fragment cover <=3"	0–50%

Surface fragment cover >3"	5–35%
Available water capacity (0-101.6cm)	7.11–15.24 cm
Calcium carbonate equivalent (0-101.6cm)	0–14%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	6.8–8.4
Subsurface fragment volume <=3" (0-20.3cm)	0–20%
Subsurface fragment volume >3" (0-20.3cm)	0–15%

Ecological dynamics

The Stony Upland ecological site within the Absaroka Lower Foothills was originally correlated as a coarse upland range site. During the review of the coarse upland range site, communities were identified with a significant stone and boulder surface cover that had a fine-loamy surface soil (top 8 to 10 inches of the soil profile with less than 35 percent rock fragments) with a skeletal subsurface soil that was comprised of cobbles and stones. Although similar to the Coarse Upland range site, the community potential and system resilience are altered by the contrasting textural classes. The dominance of bluebunch wheatgrass, increased surface fragment cover and reduced production express the “shallow” acting characteristic of the site. Wyoming big sagebrush is generally restricted in cover due to limited available rooting soil surface. Minimal research can be found for this particular ecological site.

Potential vegetation on the Stony Upland ecological site, as with the Loamy ecological site, is dominated by mid-stature cool-season perennial grasses. Other significant vegetation includes Wyoming big sagebrush, fringed sagewort and a variety of forbs. The expected potential composition is 75 percent grasses, 10 percent forbs, and 15 percent woody plants. The composition and production will vary due to historic use and fluctuating precipitation.

As the Stony Upland ecological site deteriorates species such as threadleaf sedge, Sandberg bluegrass, and broom snakeweed will increase. Plains pricklypear and weedy annuals will invade. Cool-season grasses such as bluebunch wheatgrass, needle and thread, and Indian ricegrass will decrease in frequency and production.

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 (continuous season-long) periods of grazing, especially year-long grazing; resulting in a dense sod cover of threadleaf sedge.

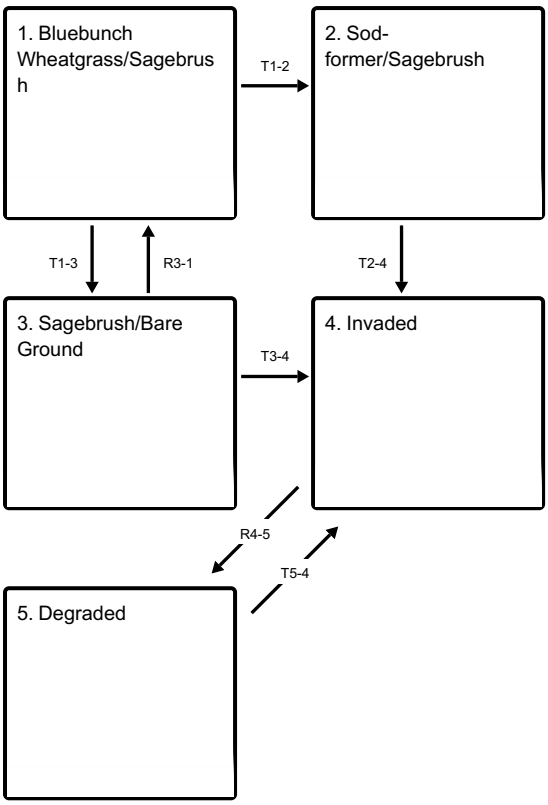
The reference plant community (description follows the plant community diagram) has been determined by study of relic rangeland sites, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical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

Ecosystem states



T1-2 - Frequent and severe grazing (yearlong grazing) or compaction from surface traffic, will weaken the mid-stature grasses and allow threadleaf sedge to increase.

T1-3 - Frequent and severe grazing as well as prolonged drought weakens the herbaceous cover reducing the community to a sagebrush dominated canopy.

T2-4 - Drought with or without hoof impact or mechanical soil impact to displace the sod opens the niche for invasive species to establish.

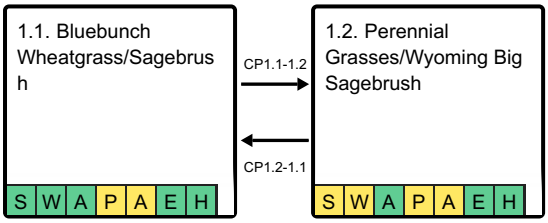
R3-1 - Brush management with seeding and long-term prescribed grazing with rest will allow this community to improve.

T3-4 - Disturbance to the soil surface provides the opportunity for invasive species to find their niche in a community.

R4-5 - Integrated weed management, seeding and grazing management will establish a community similar to Reference.

T5-4 - Any disturbance to or failure in reclaiming the community leaves this State at risk to invasion.

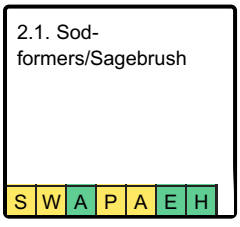
State 1 submodel, plant communities



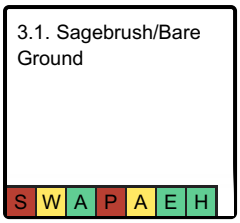
CP1.1-1.2 - Moderate, continuous season-long grazing, especially with drought, will reduce the key grasses moving this community to the Perennial Grasses/Sagebrush Community Phase.

CP1.2-1.1 - Prescribed grazing with deferment over time will allow the key bunchgrasses to increase in the community.

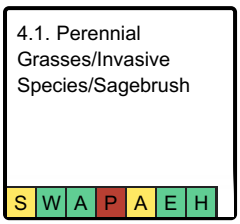
State 2 submodel, plant communities



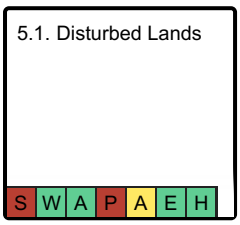
State 3 submodel, plant communities



State 4 submodel, plant communities



State 5 submodel, plant communities



State 1
Bluebunch Wheatgrass/Sagebrush

The Bluebunch Wheatgrass/Sagebrush State (State 1) is the reference community for the Stony Upland ecological site. The prominent cover is bluebunch wheatgrass, needle and thread, and other mid-stature cool-season bunchgrasses with perennial forbs and a mix of Wyoming big sagebrush and fringed sagewort make for a productive and stable site.

Characteristics and indicators. Bluebunch wheatgrass is the dominant herbaceous species on this site with Wyoming big sagebrush as the dominant woody cover. Pincushion or low growing forbs are also prominent in the community.

Resilience management. The hardiness of the vegetation that thrive within the Stony Upland ecological site create a plant community resistant to change. The community is drought tolerant and flexible to the variable climatic conditions. But once disturbed, the herbaceous component of this site is difficult to restore, reducing the resiliency of the community.

Community 1.1
Bluebunch Wheatgrass/Sagebrush

Figure 8. Although bordering on being steep, this community captures all the key species with a healthy sagebrush composition.

Figure 9. This community is steeper, and 2 year post-fire with little sagebrush regeneration. Herbaceous composition is dominantly bluebunch wheatgrass, needle and thread, and Indian ricegrass.

This plant community is the interpretive plant community for the Stony Upland ecological site and is considered to be the Reference Plant Community. This state evolved with grazing by large herbivores and infrequent periodic fires. This plant community can be found on areas that are properly managed with grazing and on areas receiving occasional short periods of rest. The potential vegetation is about 75% grasses or grass-like plants, 15% forbs, and 10% woody plants. This state is dominated by mid-stature cool-season grasses. The major grasses include bluebunch wheatgrass, needle and thread, Indian ricegrass, and Montana wheatgrass. Other grasses occurring in this state include prairie junegrass, Sandberg bluegrass and isolated occurrences of spike fescue. Wyoming big sagebrush is an element of this state, occurring in a mosaic pattern, and making up 5 to 15% of the annual production. Fringed sagewort is common in the community as are a variety of forbs. The total annual production (air-dry weight) of this state is about 600 lbs./acre, but it can range from about 450 lbs./acre in unfavorable years to about 800 lbs./acre in above average years.

Resilience management. This plant community is extremely stable and well adapted to the climatic conditions. The diversity in plant species is high across this community which allows for a high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- Indian ricegrass (*Achnatherum hymenoides*), grass
- tapertip hawksbeard (*Crepis acuminata*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- sulphur-flower buckwheat (*Eriogonum umbellatum*), other herbaceous

Dominant resource concerns

- Plant productivity and health
- 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	392	448	588
Shrub/Vine	84	168	224
Forb	28	56	84
Total	**504**	**672**	**896**

Table 6. Soil surface cover

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

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	5-10%	0-5%
>0.15 <= 0.3	–	5-10%	10-50%	0-5%
>0.3 <= 0.6	–	0-5%	0-5%	0-2%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

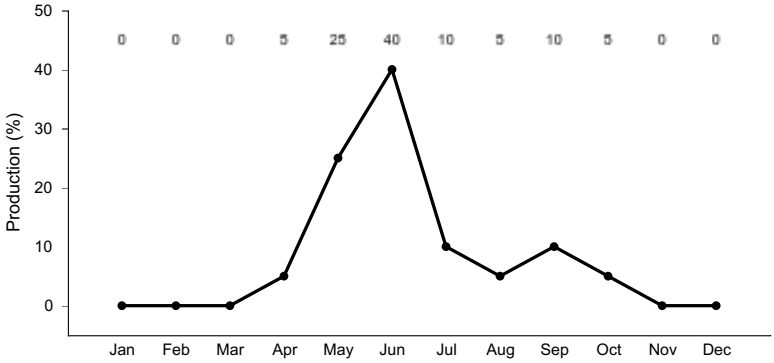


Figure 11. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Community 1.2
Perennial Grasses/Wyoming Big Sagebrush

Figure 12. Sagebrush has increased significantly in this community with threadleaf sedge and Juniper. Bluebunch wheatgrass is still prevalent.

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. This plant community is still dominated by cool-season grasses, while short-stature tillering grass-likes and miscellaneous forbs account for the balance of the understory. Wyoming big sagebrush is the larger part of the overall production and accounts for the majority of the upper canopy. Bluebunch wheatgrass and needle and thread is still present in the community although it is decreasing. Rhizomatous wheatgrasses, Sandberg bluegrass, and threadleaf sedge are increasing. Forbs commonly found in this plant community include rosy pussytoes, broom snakeweed, and spiny phlox. Wyoming big sagebrush can make up to 25 percent of the annual production. The upper canopy of sagebrush and lower canopy of grasses and forbs provide a diverse plant community. When compared to the Reference Community 1.1, the change in sagebrush accompanied by the increase of threadleaf sedge and plains pricklypear cactus are indicators of a transition. Indian ricegrass will only occur in trace amounts under the sagebrush canopy or within the patches of pricklypear. In addition, the amount of fringed sagewort has either maintained or increased in the community. The total annual production (air-dry weight) of this state is about 550 pounds per acre, but it can range from about 450 lbs./acre in unfavorable years to about 850 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: 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. 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 year-long or continuous season-long grazing or natural and man-made disturbances.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- spiny phlox (*Phlox hoodii*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous
- rosy pussytoes (*Antennaria rosea*), other herbaceous
- plains pricklypear (*Opuntia polyacantha*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Feed and forage imbalance
- 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	308	336	476
Shrub/Vine	168	224	392
Forb	28	56	84
Total	**504**	**616**	**952**

Table 9. Soil surface cover

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

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	10-30%	0-10%
>0.15 <= 0.3	–	5-20%	5-25%	0-5%
>0.3 <= 0.6	–	0-5%	0-5%	0-2%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

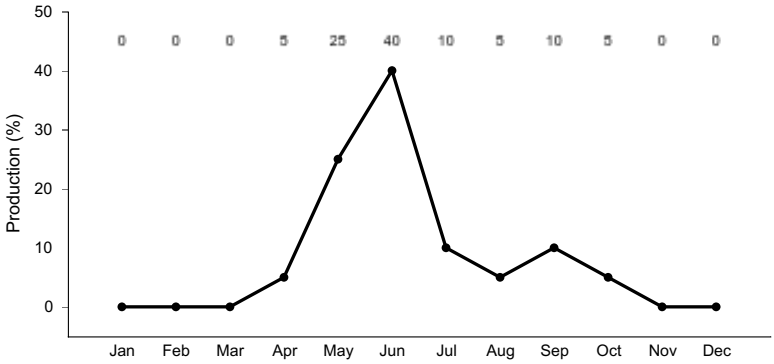


Figure 14. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

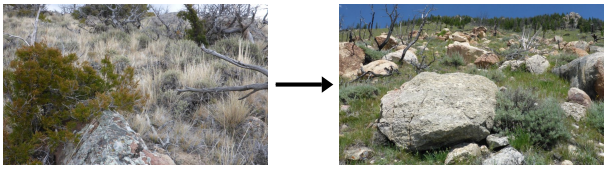
Pathway CP1.1-1.2
Community 1.1 to 1.2

Bluebunch Wheatgrass/Sagebrush

Perennial Grasses/Wyoming Big Sagebrush

Moderate, continuous season-long grazing will convert the plant community to the Perennial Grass/Sagebrush Community Phase. Prolonged drought will exacerbate this transition. The continuous use reduces the key mid-stature bunchgrasses such as bluebunch wheatgrass, needle and thread, and Indian ricegrass; allowing the short-stature bunchgrasses and sod-formers to increase in the community.

Pathway CP1.2-1.1
Community 1.2 to 1.1



Perennial Grasses/Wyoming Big Sagebrush

Bluebunch Wheatgrass/Sagebrush

Prescribed grazing or possibly long-term prescribed grazing, will allow recovery to the Reference Community Phase. Rotational grazing with deferment is implemented as part of the prescribed method of use. Prescribed fire or brush management may encourage rejuvination of sagebrush and will remove old standing growth of bluebunch wheatgrass and other bunchgrasses. Consideration of the risk of invasive species needs to be taken before using

prescribed fire on this community.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Upland Wildlife Habitat Management
Grazing management to improve wildlife habitat
Patch-burning to enhance wildlife habitat

State 2
Sod-former/Sagebrush

The Sod-former/Sagebrush ecological site is a low-stature community that has shifted from the cools-season bunchgrasses to tillering grass-likes (threadleaf sedge). Fringed sagewort and pricklypear cactus are common.

Characteristics and indicators. Wyoming big sagebrush is present in this Stat with an increase in fringed sagewort and rubber rabbitbrush. The sagebrush cover is dwarfed or droughty in appearance and generally has been reduced in vigor by the shift in hydrology of this community. Most other mid and short-stature cool-season bunchgrasses are limited to within the canopy of the sagebrush or within the protective cactus clumps.

Resilience management. The dense root map of threadleaf sedge makes this community extremely resistant to change, and resilient to disturbance. Although the establishment of threadleaf sedge is a slow process, it will recover with time. Removal of grazing or disturbance does not provide a shift in the herbaceous cover within this community. The overall health and vigor of both the herbaceous as well as woody cover will improve with the removal of the grazing pressure or disturbance from the community.

Community 2.1
Sod-formers/Sagebrush

Figure 15. Chemical application has removed sagebrush and historic use has created a threadleaf sedge dominated community phase.

This plant community is the result of frequent and severe (year-long or continuous season-long) grazing, which has adversely affected the perennial grasses as well as impacted the shrub component. Other factors that can affect this community include drought, shift in climate, wildlife browsing and alternative uses. A dense sod of threadleaf

sedge dominates this state. When compared to the Reference Communities, pricklypear cactus has increased as Wyoming big sagebrush is reduced or in some cases removed. Rubber rabbitbrush and fringed sagewort may persist in the community. All cool-season mid-stature grasses and forbs have been greatly reduced. Production has significantly decreased. Annual production values have not been provided for this community due to the lack of sufficient data to provide dependable values.

Resilience management. Rangeland Health Implications/Indicators: This community is 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 threadleaf sedge. Eventually, the shrub component can be removed from the plant community. The biotic integrity 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 slows water infiltration, and funnels water off-site, down-slope communities 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

- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- threadleaf sedge (*Carex filifolia*), grass
- needleleaf sedge (*Carex duriuscula*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Naturally available moisture use
- Sediment transported to surface water
- Plant productivity and health
- Plant structure and composition
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

State 3
Sagebrush/Bare Ground

The loss of most of the herbaceous understory in the Sagebrush/*Bare Ground* community phase leaves a barren and generally decadent (in appearance) stand of Wyoming big sagebrush, with rubber rabbitbrush in some areas. The cover of pincushion or low growing forbs is similar to reference or has increased with the loss of other herbaceous cover.

Characteristics and indicators. The dominance of sagebrush cover and the lack of most herbaceous cover is the indication of the Sagebrush/*Bare Ground* State. Remnant populations of perennial grasses will occur in the canopy of sagebrush or within the protective niche within cactus clumps.

Resilience management. The lack of native propagates and the limitations created by the rock soil cover restricts the ability of most native species to recover, lowering the resiliency of this State. This state is at-risk of transitioning to the Invaded State due to the lack of soil cover and competitive native species.

Community 3.1
Sagebrush/Bare Ground

The Sagebrush/*Bare Ground* Community Phase is the result of frequent and severe grazing and drought. Wyoming

big sagebrush dominates this plant community, with an absence of most perennial grasses. Forbs may be present, especially lower growing annual forbs. The remnant grasses commonly found in the sagebrush canopy or within the cactus are Montana wheatgrass, Sandberg bluegrass, and threadleaf sedge. Cactus often invades. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. As compared with the Reference State, the annual production declines with the loss of herbaceous cover. Shrub production may fluctuate slightly; however, the historic presumption of shrub increasing significantly has not been documented. Overall sagebrush cover maintains or may increase but the total number of plants is relatively stable. Changes in canopy size and shrub density will occur over a signficant period of time. The open interspaces leave this site vulnerable to weedy annual species such as cheatgrass to occupy the community if a seed source is available. If invasive species gain a foothold, they push the state across a threshold into the Invaded State. Annual production values have not been provided for this community due to the lack of sufficient data to provide dependable values.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand becomes more decadent. These areas hold a lower fire threat because of the lack of fine fuels and the increase of bare ground between sagebrush plants. 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
- prairie sagewort (*Artemisia frigida*), shrub
- Montana wheatgrass (*Elymus albicans*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- threadleaf sedge (*Carex filifolia*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- rosy pussytoes (*Antennaria rosea*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Aggregate instability
- Naturally available moisture use
- Sediment transported to surface water
- Plant productivity and health
- Plant structure and composition
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

State 4
Invaded

The Invaded State has a range of variability that is distinguished by its population of invasive or introduced (non-native) species that has successful established and become significant within the composition of the community. A significant component of this community initially is native species common to the Stony Upland ecological site.

Characteristics and indicators. The composition by weight of five percent or more of an invasive species is the factor tipping a community over the threshold into the Invaded State. The community can be relatively intact, having a representative composition of native species similar to the Reference State, but with a significant composition (minimum of five percent) cover of an invasive species or mix of invasive species. Cheatgrass is the most significant threat at this time; however, there are other aggressive non-native species that pose a concern on this ecological site. These species include field cottonrose, mustards, thistle, and kochia.

Resilience management. The competitive edge of most invasive species makes this site resistant to change and

resilient following disturbance. Cheatgrass has been seen to respond with a positive potential following disturbances (fire, mechanical).

Community 4.1
Perennial Grasses/Invasive Species/Sagebrush

The Perennial Grasses/Invasive Species/Sagebrush phase has maintained a representative sample of the perennial grasses and forbs that are typical of the site with Wyoming big sagebrush. The invasive species are present and hold a significant (five percent 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 is generally reduced but the total production is maintained or elevated due to the production potential of the invasive species.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to improvement, but will continue to degrade with no inputs. 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.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- cheatgrass (*Bromus tectorum*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- prairie sagewort (*Artemisia frigida*), other herbaceous
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous
- thistle (*Cirsium*), other herbaceous

Dominant resource concerns

- Aggregate instability
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

State 5
Degraded

The Degraded 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. The shift in potential and response to management makes it no longer similar to the reference community. The potential shifts are highly variable, so a dynamic state was captured to highlight the altered communities that exist on the landscape. The amount of surface stone and boulder cover limits the extent of disturbances that may occur. Alteration of the community may be extensive enough (removal of the stones and boulders), that site potential has shifted to a different ecological site or so slight that it may be difficult to identify.

Characteristics and indicators. The soil disturbance and mechanical or physical removal of the vegetative canopy is the key characteristic of the Disturbed State. The initial indicators are the primary successional species that

establish following a disturbance including kochia, six weeks fescue, and sunflowers. These initial colonizers will then be followed by any seeded species, or other species from within the locations seed bank.

Resilience management. The Disturbed State is highly variable and in a state of flux as the successional processes occur. Continued disturbance of these communities is a potential threat; and the communities are at-risk of transitioning to the Invaded State.

Community 5.1
Disturbed Lands

The title Disturbed Lands is encompassing two broad classifications of 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. The Stony Upland ecological site was not typically farmed, and was not directly influenced by homesteading or irrigation processes. The extent of this type is not known on the landscape. In a similar process, mined lands or lands affected by energy development including gravel or mineral excavation pits, transmission corridors, transportation corridors and oil and gas 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. Transportation corridors for recreation or development activities are the most common on the Stony Upland ecological site, but occurrences are limited and generally minor in size. The reclamation processes is limited due to the rock content of these communities. 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.

Resilience management. 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.

Dominant plant species

- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- sixweeks fescue (*Vulpia octoflora*), grass
- threadleaf sedge (*Carex filifolia*), grass
- burningbush (*Bassia scoparia*), other herbaceous
- tansymustard (*Descurainia*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous

Dominant resource concerns

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

Transition T1-2
State 1 to 2

Frequent and severe (year-long or continuous season-long) grazing or compaction from surface traffic, will convert the plant community to a threadleaf sedge sod. The impact of frequent or repeated defoliation during grazing, hoof impact, and lack of rest for recovery weakens and removes the key grass species in the community. As the mid-stature grasses decline, threadleaf sedge is able to increase and alter the hydrology of the site.

Constraints to recovery. The dense root mat formed by threadleaf sedge alters the hydrology, effectively removing moisture from the site, limiting the available resources for other native species. The dense sod also limits the available soil space for seedling establishment. Interpspaces between sod patches are prone to erosion and runoff (limited infiltration of moisture).

Transition T1-3
State 1 to 3

Frequent and severe grazing plus no fire will convert the plant community to the Sagebrush/*Bare Ground* Plant Community. This is especially evident on areas with historically higher precipitation and the sagebrush stand is not adversely impacted by drought or heavy browsing. Grazing impacts to the herbaceous cover repeatedly removes it from the community leaving a sagebrush dominated community. Drought, insect damage, and other natural disturbances can assist in this transition.

Constraints to recovery. The lack of a seed bank and the droughty nature of the soils limits seedling establishment and survival. The unpredictable and variable spring precipitation also limits success of recovery for the Stony Upland ecological site.

Transition T2-4
State 2 to 4

Drought, Frequent or severe grazing, Disturbance – Drought alone, or with grazing intensity, weakens and eventually removes Wyoming big sagebrush on the landscape. Once sagebrush has been removed from a community, it is extremely difficult and input heavy to re-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 mechanical 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 dense sod of threadleaf sedge will continue to impact the hydrology and competition for limited resources in this community limiting the potential for recovery. The lack of other key herbaceous species also is a constraint on this site. The inability, at this time, to eradicate cheatgrass does not allow for a complete recovery of an invaded community.

Restoration pathway R3-1
State 3 to 1

Brush management with prescribed grazing with periods of rest allows for this community to improve. Recovery is dependent on the remnant population of herbaceous species that are present, the current weather patterns, and timing.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Mulching
Prescribed Grazing

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

Transition T3-4
State 3 to 4

Drought, soil disturbances, or high-intensity grazing with a seed source present can open the soil surface and weaken the sod allowing invasive species to establish. Although not common, fire can provide the niche for cheatgrass to establish on this site.

Constraints to recovery. Once invasive species, especially cheatgrass, establish, it is costly and difficult (if even possible) to remove. The lack of the key grass species also limits recover of this site.

Restoration pathway R4-5
State 4 to 5

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 is one of the most invasive species for many ecological sites, although there are other challenges. With intensive weed control and inputs this community can resemble an at-risk community within the reference state, but it is not possible to reach the reference community condition once annuals have established.

Conservation practices

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

Transition T5-4
State 5 to 4

Frequent or Severe Grazing, Disturbance with a seed Source, or Drought - Any disturbance that occurs or stress that is placed on the herbaceous cover, weakens the canopy and allows for invasive species to establish if a seed source is present. This State is at high risk of transitioning to an Invaded State. The limited abilities to complete a seeding on rocky soil opens the community to invasion.

Constraints to recovery. The challenge of eradicating or reducing invasive species such as cheatgrass prevents recovery of most invaded communities without significant inputs for weed control, seeding with long-term grazing management.

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 Bunchgrasses**			56–392	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	56–336	10–30
	needle and thread	HECO26	*Hesperostipa comata*	0–84	0–15
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–28	0–5
	spike fescue	LEKI2	*Leucopoa kingii*	0–28	0–5
2	**Rhizomatous Cool-season Grasses**			0–112	
	Montana wheatgrass	ELAL7	*Elymus albicans*	6–56	2–10
	western wheatgrass	PASM	*Pascopyrum smithii*	0–56	0–10
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–28	0–5
3	**Short-stature Cool-season Bunchgrasses**			0–56	
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–28	0–5
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–28	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–28	0–5
4	**Miscellaneous Grasses**			0–28	
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–28	0–5
	needleleaf sedge	CADU6	*Carex duriuscula*	0–28	0–5
Forb					
5	**Perennial Forbs**			28–112	
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–28	0–5
	milkvetch	ASTRA	*Astragalus*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–28	0–5
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–28	0–5
	rosy pussytoes	ANRO2	*Antennaria rosea*	0–28	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
Shrub/Vine					
6	**Dominant Shrubs**			28–168	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	28–168	5–15
7	**Miscellaneous Shrubs**			0–84	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	Woods' rose	ROWO	*Rosa woodsii*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–28	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	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**			28–224	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	28–168	5–25
	needle and thread	HECO26	*Hesperostipa comata*	0–28	0–5
	spike fescue	LEKI2	*Leucopoa kingii*	0–28	0–5
2	**Rhizomatous Cool-season Grasses**			0–112	
	Montana wheatgrass	ELAL7	*Elymus albicans*	0–56	0–10
	western wheatgrass	PASM	*Pascopyrum smithii*	0–56	0–10
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–28	0–5
3	**Short-stature Cool-season Grasses**			28–112	
	Sandberg bluegrass	POSE	*Poa secunda*	28–84	5–15
	squirreltail	ELEL5	*Elymus elymoides*	0–56	0–10
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–28	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–28	0–5
4	**Miscellanous Grasses**			0–56	
	threadleaf sedge	CAFI	*Carex filifolia*	0–56	0–10
	needleleaf sedge	CADU6	*Carex duriuscula*	0–28	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–28	0–5
Forb					
5	**Perennial Forbs**			6–84	
	Forb, perennial	2FP	*Forb, perennial*	0–28	0–5
	milkvetch	ASTRA	*Astragalus*	0–28	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–28	0–5
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	0–5
	rosy pussytoes	ANRO2	*Antennaria rosea*	0–28	0–5
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–28	0–5
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	0–5
6	**Annual Forbs**			0–17	
	woolly plantain	PLPA2	*Plantago patagonica*	0–6	0–2
	flatspine stickseed	LAOC3	*Lappula occidentalis*	0–6	0–2
	western tansymustard	DEPI	*Descurainia pinnata*	0–6	0–2
	Forb, annual	2FA	*Forb, annual*	0–6	0–2
Shrub/Vine					
7	**Dominant Shrubs**			56–280	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	56–224	10–25
	prairie sagewort	ARFR4	*Artemisia frigida*	0–56	0–5
8	**Miscellaneous Shrubs**			0–112	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–84	0–10
	Woods' rose	ROWO	*Rosa woodsii*	0–56	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–56	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 - Bluebunch Wheatgrass/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 - 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 20-30% cover range.

2.1 - Threadleaf Sedge/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.

3.1 - Sagebrush/*Bare Ground* Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

4._ - Invaded State: 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 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.

5.1 - Disturbed Lands: 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 and Acres/AUM.

Plant Community Production Carrying Capacity*
Plant Community Description/Title: Lbs./Acre AUM/Acre Acres/AUM
1.1 Bluebunch Wheatgrass/Sagebrush 450-600-800 0.16 6.08
1.2 Perennial Grasses/Sagebrush 450-550-850 0.15 6.64
2.1 Threadleaf Sedge/Sagebrush ** **
3.1 Sagebrush/*Bare Ground* ** **

4._ Invaded ** **
5.1 Disturbed 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% of a management unit may have 25% slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30% of the unit (i.e. 50% reduction on 30% of the management unit). Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of graze-able acres within a management unit. Adjustments should be made that incorporate these factors when calculating stocking rates.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An 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

The Stony Upland ecological site provides hunting opportunities for upland game species. The wide varieties of plants which bloom from spring until fall have an aesthetic value that appeals to visitors. Outside of plants, the extent offers a variety of cultural resources to view on the landscape based on the location of many of these sites on higher ground on the benches and fans which also provides a rich source of geology for exploration. The Stony Upland ecological site has access limitations when associated with roadways and trails. The land surface is a sound base for travel and camping in relation to erosion potential, however the cover of stones and boulders limits the ease, comfort, and functionality for all these uses.

Wood products

No appreciable wood products are present on the site. Isolated areas of limber pine and Rocky Mountain juniper exist within the Stony Upland ecological site that may offer a limited extent of firewood timber.

Other products

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

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

Inventory data references

Information presented was derived from NRCS inventory data and historic range site descriptions. Field observations from range-trained personnel also were used. Those involved in the development of the new concept for the Stony Upland 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. 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 IV, and USDA NRCS Soil Surveys from various counties.

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.)

Other references

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

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

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

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

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

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

United States Department of Agriculture, Natural Resources Conservation Service. (electronic) National Water and Climate Center. Available online at http://www.wcc.nrcs.usda.gov/. Accessed November 2014.

United States Department of Agriculture, Natural Resources Conservation Service. 2009. Plant Guide: Cheatgrass. Prepared by Skinner et al., National Plant Data Center.

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health. Version 4. Technical Reference 1734-6. USDI-BLM.

Ricketts, M. J., R. S. Noggles, and B. Landgraf-Gibbons. 2004. Pryor Mountain Wild Horse Range Survey and Assessment. USDA-Natural Resources Conservation Service.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE .

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

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

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

United States Department of Agriculture, Natural Resources Conservation Service. 1997. National Range and Pasture Handbook. (http://www.glti.nrcs.usda.gov/technical/publications/nrph.html). Accessed October 2014.

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

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

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS), Soil Survey Staff. 2010. Keys to Soil Taxonomy, 11th Edition.

USDA/NRCS Soil survey manuals for various counties within MLRA 32X. Web soil survey is available online at: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Western Regional Climate Center. 2014. Electronic station metadata. Available online at: http://www.wrcc.dri.edu/summary/climsmwy.html.

Contributors

Dan Mattke, Resource Soil Scientist, NRCS Area Office

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.

Author(s)/participant(s)	Marji Patz

Contact for lead author	marji.patz@usda.gov; 307-271-3130
Date	04/23/2020
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rare to nonexistent. Some increase in rill development may occur on steeper slopes or on areas located below exposed bedrock or other water shedding areas where increased runoff may occur. Where rills are present, they should be fairly short (2-5 feet), <1 inch deep and somewhat widely spaced (4-8 feet). Rills may increase in length (3-6 feet) and decrease in spacing (3-6 feet)on slopes greater than 30 percent. A minor increase in rill development may be observed on all slopes following major thunderstorm or spring runoff events but should heal during the next growing season.

---

2. **Presence of water flow patterns:** Barely observable. Some very minor evidence of water flow patterns may be found around perennial plant bases. They show little evidence of current erosion. They are expected to be short (3-6 feet), stable, sinuous, and not connected. There may be very minor evidence of deposition. Evidence of water flow may increase somewhat with slope.

---

3. **Number and height of erosional pedestals or terracettes:** Perennial vegetation shows little evidence of erosional pedestalling (1 to 2% of individual plants). Plant roots are covered and litter remains in place around plant crowns. Terracettes should be absent or, if present, stable. A slight increase in both pedestal and terracette development may occur with increasing slope.

---

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 0-20%. Bare ground spaces should not be greater than 2 foot in diameter.

---

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

---

6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent. No evidence of wind generated soil movement is present. Wind caused blowouts and deposition are not present.

---

7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous and large woody litter not expected to move. Most litter resides in place with some redistribution downslope caused by water movement. The majority of litter accumulates at the base of plants. Some grass leaves and stems may accumulate in soil depressions adjacent to plants. Woody stems are not likely to move. However, some litter movement is expected (up to 6 feet) with increases in slopes >25% and/or increased runoff resulting from heavy thunderstorms.

---

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 3 (interspaces) to 6 (under plant canopy), but average values should be

4.0 or greater.

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil data is limited for this site. Soil OM of 2 to 5% is expected.

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of 50-80% grasses, 15% forbs, and 5-35% shrubs. Evenly distributed plant canopy (60-95%) and litter plus moderate infiltration rates result in minimal runoff. Basal cover is typically 5-15% for this site and does affect runoff on this site. Surface rock fragments of 5-20% provide stability to the site, but reduce infiltration

---

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None.

---

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 >> perennial forbs>>

    Other: tall-stature cool-season bunchgrasses = cool-season rhizomatous grasses = short-stature cool-season bunchgrasses

    Additional: Following a disturbance such as fire, drought, rodents or insects that remove woody vegetation, forbs and perennial grasses (herbaceous species) may dominate the community for a period of time. If a disturbance has not occurred for an extended period of time, woody species may continue to increase. These conditions would reflect a functional community phase within the reference state.

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** All age classes of perennial grasses should be present under average to above average growing conditions. There may be partial mortality on individual bunchgrasses and shrubs during drought periods, and complete mortality of individual plants during severe drought periods. Slight decadence in the principle shrubs could occur near the end of the fire cycle or during periods of extended drought, or insect infestations. In general, a mix of age classes should be expected with some dead and decadent plants present.

---

14. **Average percent litter cover (%) and depth (in):** Litter ranges from 5-30% of total canopy measurement with total litter (including beneath the plant canopy) from 30-50% expected. Herbaceous litter depth typically ranges from 5-15 mm. Woody litter can be up to a couple inches (4-6 cm).

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Average annual production is 600 lb/ac (673 kg/ha), and ranges from 450-800 lb/ac (504-897 kg/ha).

---

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:** Bare ground greater than 35% is the most common indicator of a threshold being crossed. Rhizomatous wheatgrasses, Sandberg bluegrass, juniper and big sagebrush are common increasers. Common dandelion, thistles, and annual weeds such as cheatgrass and mustards are common invasive species in disturbed sites.

---

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