USDA Natural Resources
Conservation Service

Ecological site EX043B23B123
Loamy Calcareous (LyCa) Absaroka Upper Foothills

Last updated: 3/04/2024
Accessed: 05/02/2024

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) 43B23B: Absaroka Upper 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 B is set for the higher elevations within the foothills, with 15 to 19 inches of precipitation. To verify or identify Subset B (the referenced subset for this ecological site), refer to the Wyoming LRU matrix key contained within the Ecological Site Key.

This particular LRU/Subset occurs along the eastern 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 then tracks east to the intersection of the Absaroka Range and the Owl Creek Range, 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: Typic Ustic
Temperature Regime: Frigid
Dominant Cover: Rangeland – Sagebrush Steppe (major species is Mountain Big Sagebrush)
Representative Value (RV) Effective Precipitation: 15-19 inches (381 – 483 mm)
RV Frost-Free Days: 37 - 80 days

Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):
2 Shrub & Herb Vegetation Class
2.B Temperate & Boreal Grassland & Shrubland Subclass
2.B.2 Temperate Grassland & Shrubland Formation
2.B.2.Na Western North American Grassland & Shrubland Division Division
M048 Central Rocky Mountain Montane-Foothill Grassland & Shrubland Macrogroup
G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group

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

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 percent or greater CCE’s at a depth of 7-20 inches.

Associated sites

EX043B23B122	**Loamy (Ly) Absaroka Upper 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.
EX043B23B121	**Limy Skeletal (LiSk) Absaroka Upper 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

EX043B23B121	**Limy Skeletal (LiSk) Absaroka Upper Foothills** See Above

EX043B23B120	**Limy Upland (LiU) Absaroka Upper 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.
EX043B23B162	**Shallow Loamy (SwLy) Absaroka Upper 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. vaseyana* (2) *Artemisia nova*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Elymus albicans*

Legacy ID

R043BX623WY

Physiographic features

This site occurs on nearly level to gently rolling land and on slopes generally less than 30 percent. Within the Upper Foothills this site is found to exist predominately on the gently sloping summits of erosional remnants or fan remnants that flow from the upper foothills into the lower foothills, but are found on several 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 > Fan remnant (2) Foothills > Stream terrace (3) Foothills > Erosion remnant
Runoff class	Negligible to high
Elevation	6,000–9,000 ft
Slope	0–30%
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 15 to 19 inches (381 – 483 mm). The normal precipitation pattern shows peaks in June tapering into September. This amounts to about 50% of the mean annual precipitation. Average snowfall is about 150 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Because of the varied topography, the wind will vary considerably for different parts of the area. The wind is usually much lighter at the lower elevations and in the valleys as compared with the higher terrain. The average winter wind velocity is 8.5 mph while the summer wind velocity averages 7.5 mph. Winds during storms and on ridges may exceed 45 mph.

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. High winds are generally blocked by high

mountains but occur in conjunction with thunderstorms, which are common in late summer. Growth of native cool-season plants begins about May 1 to May 15 and continues until about October 15.

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/. Historically, Crandall Creek was the representative weather stations within this subset. However, Sunshine 3NE, Tower Falls, and Yellowstone Pk Mammoth are the only available weather stations within a close proximity in location and characteristics for this 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)	17-57 days
Freeze-free period (characteristic range)	43-100 days
Precipitation total (characteristic range)	14-16 in
Frost-free period (actual range)	5-65 days
Freeze-free period (actual range)	22-108 days
Precipitation total (actual range)	14-16 in
Frost-free period (average)	36 days
Freeze-free period (average)	70 days
Precipitation total (average)	15 in

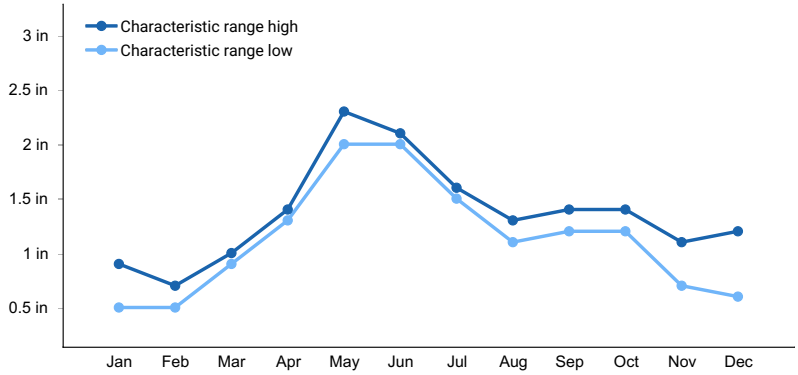


Figure 1. Monthly precipitation range

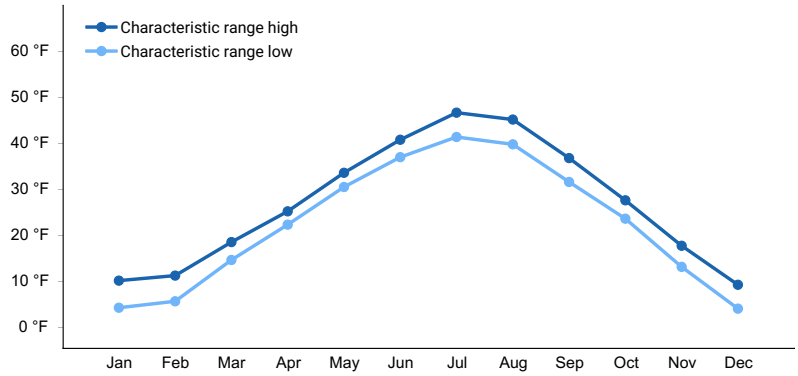


Figure 2. Monthly minimum temperature range

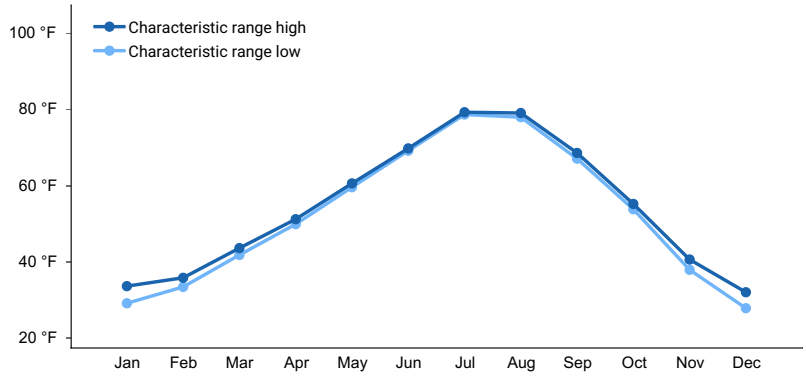


Figure 3. Monthly maximum temperature range

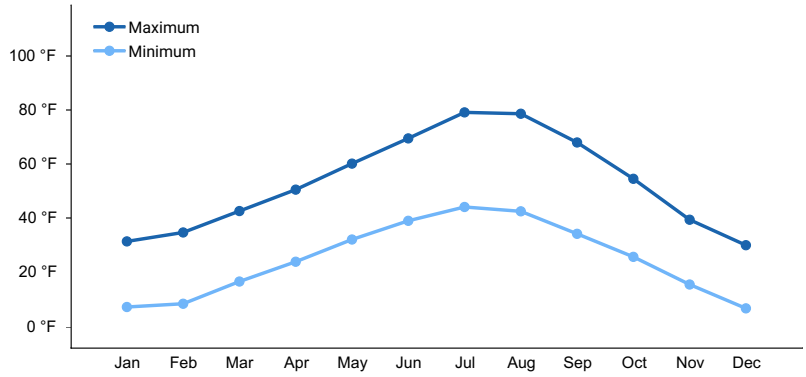


Figure 4. Monthly average minimum and maximum temperature

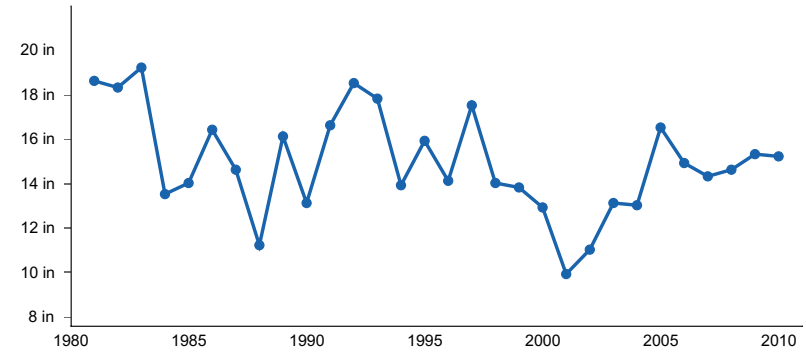


Figure 5. Annual precipitation pattern

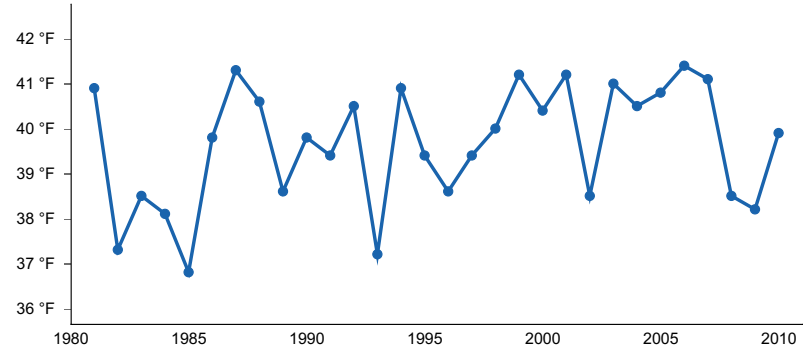


Figure 6. Annual average temperature pattern

Climate stations used

- (1) SUNSHINE 3NE [USC00488758], Meeteetse, WY
- (2) YELLOWSTONE PK MAMMOTH [USC00489905], Yellowstone National Park, WY
- (3) TOWER FALLS [USC00489025], Yellowstone National Park, 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 moderately slow to moderate permeability. The soil characteristic having the most influence on the plant community is available moisture and the potential to develop soluble salt near the surface. More data is needed to quantify these characteristics specifically for this site.

Major Soil Series correlated to this site include: Coyoteflats-like, Pachel-like.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–igneous, metamorphic and sedimentary rock (2) Colluvium–limestone and dolomite (3) Slide deposits–interbedded sedimentary rock
Surface texture	(1) Gravelly sandy clay loam (2) Fine sandy loam (3) Loam
Family particle size	(1) Fine-loamy
Drainage class	Somewhat poorly drained to well drained
Permeability class	Moderately slow to moderate
Soil depth	20 in
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–5%
Calcium carbonate equivalent (8-40in)	15–30%
Electrical conductivity (Depth not specified)	0–4 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0–12
Soil reaction (1:1 water) (Depth not specified)	6.8–8.4
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 was originally correlated as either a Loamy or Shallow Loamy range site. Review of the Loamy range site throughout the Big Horn Basin found that commonly the communities visited had calcareous characteristics. Historically, classification of the soils in the area did not recognize the calcareous tendencies. The calcareous communities are very similar to the Loamy and Shallow Loamy range sites, the community potential and system resilience are altered by the chemistry within the soil.

Historic correlations of these soils were made on production and plant cover. High productivity sites were correlated to Loamy, and to Shallow loamy when bluebunch wheatgrass was prominent with reduced production expressing a “shallow” acting characteristics. Mountain big sagebrush, although present on this site, is generally restricted in

vigor and production compared to a true Loamy 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 mountain big sagebrush, and a variety of forbs. The expected potential composition for this site is 75 percent grasses, 10 percent forbs, and 15 percent woody plants. The composition and production will vary due to historic use, fluctuating precipitation and fire frequency.

As this site deteriorates species such as mountain big sagebrush, rubber rabbitbrush, and bluegrasses will increase. Cool season grasses such as bluebunch wheatgrass, Columbia needlegrass, spike fescue, and Idaho fescue will decrease in frequency and production. As conditions deteriorate further, annuals such as cheatgrass will invade.

Mountain big sagebrush may become dominant in areas with absence of fire. Wildfires have been actively controlled, resulting in persistent, aged and decadent stands of sagebrush. Chemical control was used in place of fire throughout the 1960s, resulting in large areas where sagebrush has not recovered. Recently, prescribed burning has regained some popularity, but another popular treatment method is mowing or mulching of the sagebrush.

The big sagebrush component may not be as resilient once it has been removed or severely reduced, if a vigorous stand of grass exists and is maintained. The exception to this is where the herbaceous component is severely degraded at the time of treatment, growing conditions are unfavorable after treatment, and/or recovery of herbaceous species are inadequate due to poor grazing management. Regeneration of big sagebrush may also be suppressed if three-tip sagebrush and rubber rabbitbrush are established. This situation is more likely to develop in areas where fires have occurred in a relatively short cycle. Fringed sagewort and rubber rabbitbrush are strong resprouters and will out compete other shrubs where a site is disturbed. Any thinning project should be designed in a way to maintain the viability of the stand and to consider wildlife requirements.

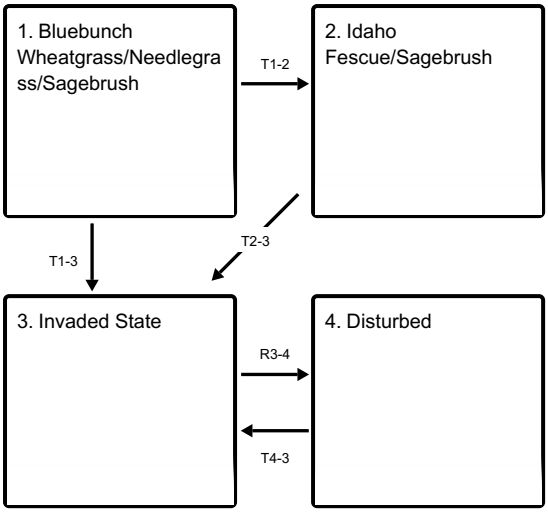
The reference plant community (description follows the plant community diagram) has been determined by study of relic rangeland sites, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical 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 with the change in fire frequency, drought, and other significant impacts to the herbaceous cover force this transition.

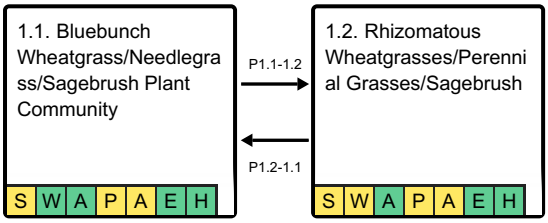
T1-3 - Fire, drought, and other major disturbances with a seed source present aid in this transition.

T2-3 - Continued frequent and severe use patterns, significant soil disturbance, drought, and other catastrophic events with a seed source present will transition this site to the Invaded State.

R3-4 - An integrated weed management plan with a native seeding and long-term prescribed grazing aids the transition of this site.

T4-3 - Lack of management, continued disturbance, failure of a reclamation process, or catastrophic events with seed source present will transition this community to the invaded state.

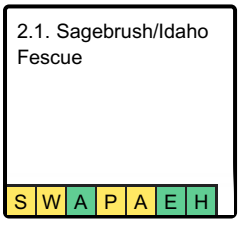
State 1 submodel, plant communities



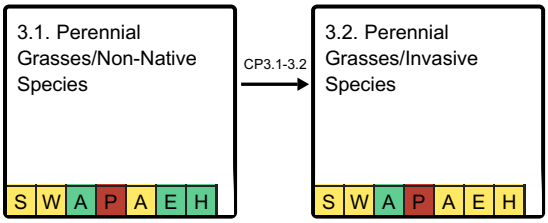
P1.1-1.2 - Moderate, continuous season-long grazing will convert the Reference Community Phase, and prolonged drought will exacerbate this transition.

P1.2-1.1 - Prescribed Grazing with rest and time will allow the tall-stature and desired grasses to regain vigor and sagebrush to recover.

State 2 submodel, plant communities

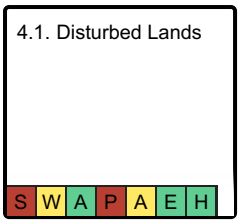


State 3 submodel, plant communities



CP3.1-3.2 - Severe and frequent grazing (continuous season-long) alone, or with drought, fire or other disturbance, will encourage invasive species when a seed source is present.

State 4 submodel, plant communities



State 1
Bluebunch Wheatgrass/Needlegrass/Sagebrush

State 1 is named the Bluebunch Wheatgrass/Needlegrass/Sagebrush State, in response to the dominance of mid to tall-stature cool-season bunchgrasses that are prominent in each community. Rhizomatous wheatgrasses and mid to short-stature cool-season bunchgrasses are secondary in these communities. Sagebrush is present, but is not the major cover class.

Characteristics and indicators. Bluebunch Wheatgrass/Needlegrass/Sagebrush State (State 1 - Reference) is characterized by the key species including: 15 percent or less composition by cover of mountain big sagebrush and black sagebrush, with bluebunch wheatgrass (less than 30 percent), rhizomatous wheatgrasses, and various other bunchgrasses. The modal concept for this site is in the fine-loamy (greater than 18 percent clays), however there are a few areas where the textures are coarser than this with similar plant characteristics (minor shifts). To cover this variance, the range of plant composition will capture this characteristic within the plant community tables.

Resilience management. This State is stable, even with moderate, continuous season-long grazing. The communities are tolerant of drought. But after time and extensive pressure or disturbance this community will begin to shift to a fescue driven community.

Community 1.1
Bluebunch Wheatgrass/Needlegrass/Sagebrush Plant Community

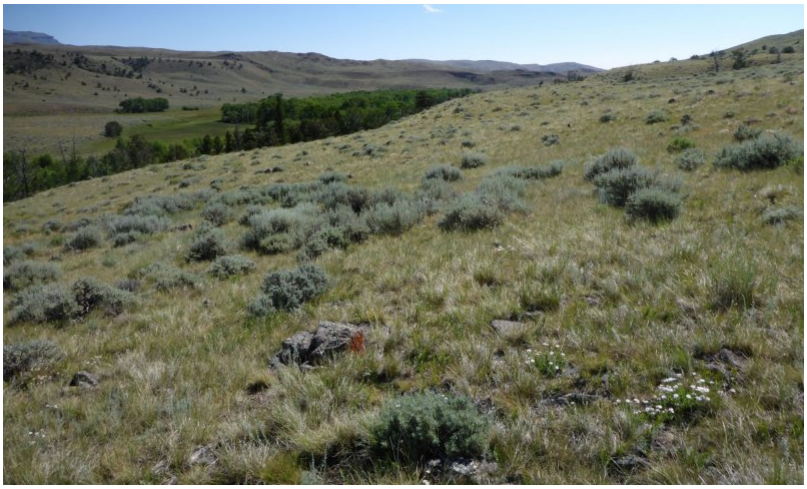


Figure 7. Bluebunch wheatgrass is prominent in this community with Columbia needlegrass, Montana wheatgrass and a combination of forbs.

The Bluebunch Wheatgrass/Needlegrass/Sagebrush Community Phase is the Reference community or interpretive plant community for the Loamy Calcareous ecological site. This state evolved with grazing by large herbivores and periodic fires. Potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving periods of rest. The cyclical nature of the fire regime in this community prevents big sagebrush from being the dominant landscape. Cool-season mid-stature grasses dominate the site. The major grasses include Columbia needlegrass, spike fescue, Idaho fescue, and bluebunch wheatgrass. Mountain big sagebrush is a conspicuous element of this site with black sage. The shrub cover occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Natural fire occurred in this community and prevented sagebrush from being the dominant landscape. A variety of forbs also occurs in this state and plant diversity is high (see Plant Composition Table). Annual production on this site ranges from 600 to 1000 pounds per acre depending on climatic conditions; with an average annual production of 800 pounds per acre.

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

Dominant plant species

- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- black sagebrush (*Artemisia nova*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Columbia needlegrass (*Achnatherum nelsonii*), grass
- spike fescue (*Leucopoa kingii*), grass
- silvery lupine (*Lupinus argenteus*), other herbaceous
- hawksbeard (*Crepis*), other herbaceous
- Indian paintbrush (*Castilleja*), other herbaceous

Dominant resource concerns

- Classic gully erosion
- Aggregate instability
- Plant structure and composition
- Inadequate livestock water quantity, quality, and distribution

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	525	650	725
Moss	50	100	200
Forb	25	50	75
Total	**600**	**800**	**1000**

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	5-15%
Litter	10-30%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	10-25%

Table 7. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-2%	0-5%	0-5%
>0.5 <= 1	–	0-5%	10-25%	0-5%
>1 <= 2	–	0-10%	25-50%	0-2%
>2 <= 4.5	–	0-5%	0-10%	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

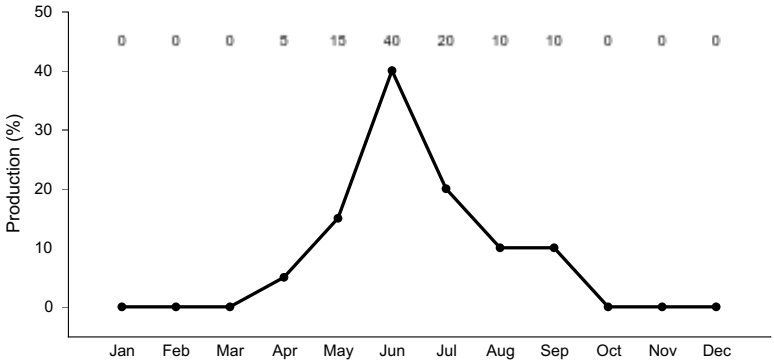


Figure 9. Plant community growth curve (percent production by month). WY0601, 15-19E all upland sites.

Community 1.2
Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Figure 10. Montana and western wheatgrass hold a large portion of this community with bluebunch wheatgrass, the shrubs are lacking in this community.

This plant community currently is found under heavy continuous season-long grazing by livestock and protection from fire. Mountain big sagebrush is a significant component of this plant community, although black sagebrush or rubber rabbitbrush may be as abundant. Cool-season grasses make up the majority of the understory, but some of the preferred bunchgrasses have been reduced or are absent. Dominant grasses include rhizomatous wheatgrasses, Lettermans needlegrass, bluegrasses, and of less frequency Columbia needlegrass, spikefescue, Idaho fescue and bluebunch wheatgrass. Grasses of secondary importance include prairie junegrass, slender wheatgrass, spike trisetum and native bromes. Forbs commonly found in this plant community include balsamroot, hawksbeard, paintbrush, groundsel, buckwheat, phlox, lupine, larkspur, sneezeweed, pussytoes, and American vetch. Mountain big sagebrush, black sagebrush, and rubber rabbitbrush can make up to 30% of the total annual

production. Annual production on this site ranges from 550 to 1100 pounds per acre depending on climatic conditions. The average annual production is 750 pounds per acre. When compared to the Reference Community Phase, mountain big sagebrush, rubber rabbitbrush, bluegrasses, Lettermans needlegrass, and rhizomatous wheatgrasses have increased.

Resilience management. 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 continuous season-long or year-long grazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement is not uncommon especially on steeper slopes. Incidence of pedestalling is minimal but normal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

Dominant plant species

- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- black sagebrush (*Artemisia nova*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Montana wheatgrass (*Elymus albicans*), grass
- Idaho fescue (*Festuca idahoensis*), grass
- pussytoes (*Antennaria*), other herbaceous
- silvery lupine (*Lupinus argenteus*), other herbaceous
- fleabane (*Erigeron*), other herbaceous

Dominant resource concerns

- Classic gully erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Wildfire hazard from biomass accumulation
- Inadequate livestock water quantity, quality, and distribution

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	425	500	700
Shrub/Vine	100	200	300
Forb	25	50	100
Total	**550**	**750**	**1100**

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	0-10%
Litter	10-30%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%

Bare ground	10-25%

Table 10. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-2%	0-10%	0-5%
>0.5 <= 1	–	5-10%	10-50%	0-10%
>1 <= 2	–	5-20%	5-25%	0-5%
>2 <= 4.5	–	0-5%	0-5%	1-2%
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

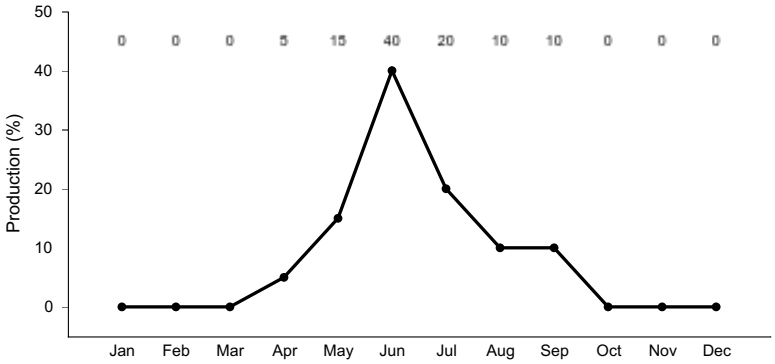
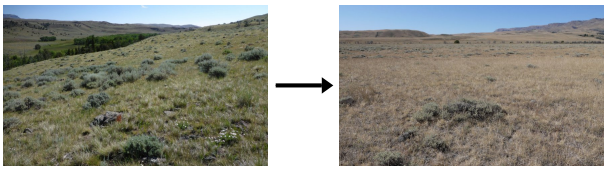


Figure 12. Plant community growth curve (percent production by month). WY0601, 15-19E all upland sites.

Pathway P1.1-1.2
Community 1.1 to 1.2

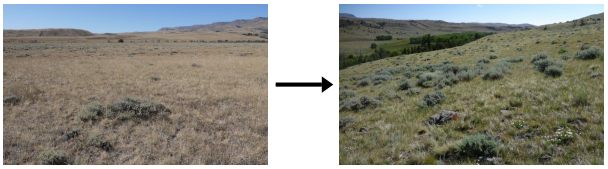


Bluebunch Wheatgrass/Needlegrass/Sagebrush Plant Community

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, Columbia Needlegrass and spike fescue; allowing the solitary growth and sod-formers to increase in dominance in the community.

Pathway P1.2-1.1
Community 1.2 to 1.1



Rhizomatous Wheatgrasses/Perennial Grasses/Sagebrush

Bluebunch Wheatgrass/Needlegrass/Sagebrush Plant Community

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.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Prescribed Grazing
Upland Wildlife Habitat Management

State 2
Idaho Fescue/Sagebrush

After significant pressure on the herbaceous understory and with the lack of fire to rejuvenate the woody component, this State has shifted to a mid and short-stature cool-season grasses with shrubs becoming a significant component of this state. Some of the preferred grasses have been reduced or are absent, and forbs (ground covering) have increased in the community. When compared to the Reference State, sagebrush, Idaho fescue, native bluegrasses, prairie junegrass, and rhizomatous wheatgrasses have increased. Most of the preferred grasses have been reduced and some are absent.

Characteristics and indicators. Dominant grasses include Idaho fescue, spike fescue, bluebunch wheatgrass, and rhizomatous wheatgrasses. Grasses of secondary importance include slender wheatgrass, spike trisetum, prairie junegrass, and bluegrasses. Columbia needlegrass, spike fescue, and bluebunch wheatgrass are significantly reduced or absent. Forbs commonly found in this plant community include lupine, phlox, agoseris, pussytoes, Indian paintbrush, and asters. Fringed sagewort, mountain big sagebrush, and juniper can make up to 25% of the total annual production. Black sagebrush and rubber rabbitbrush are common in the community.

Resilience management. This State is resistant to change without a major disturbance or inputs to start the change. But it is also at risk of degrading further and is susceptible to invasion due to the decreased herbaceous cover and increased woody structure.

Community 2.1
Sagebrush/Idaho Fescue

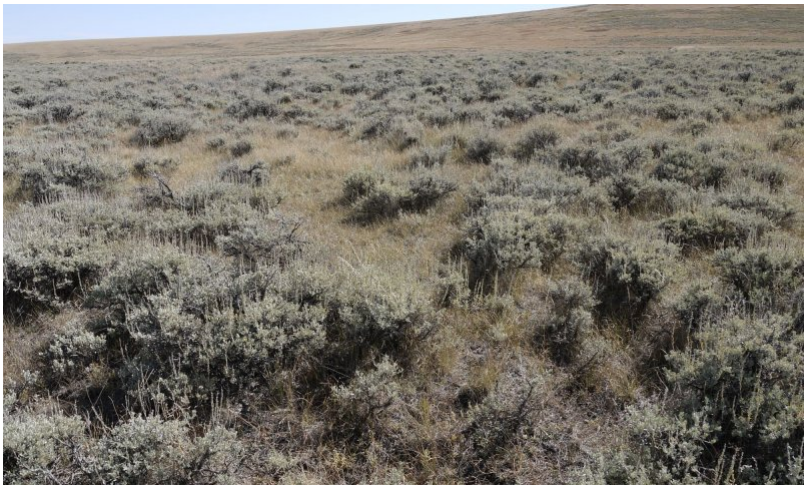


Figure 13. Mountain big sagebrush and Idaho fescue have become the dominant cover in this community.

Historically, this plant community evolved under grazing by large ungulates and a low fire frequency. Currently, it

occurs under moderate, season-long grazing by livestock and is exacerbated by prolonged drought conditions. In addition, the fire regime for this site has been modified and extended periods without fire is now common. Shrubs are significant components of this plant community. Cool-season grasses make up the majority of the understory with the balance made up of miscellaneous forbs. Dominant grasses include Idaho fescue, spike fescue, and bluebunch wheatgrass. Grasses of secondary importance include bluegrasses , prairie junegrass, Montana wheatgrass, and of less frequency Columbia needlegrass, and letterman's needlegrass. Forbs commonly found in this plant community include hawksbeard, groundsel, indian paintbrush, asters, pussytoes, phlox, and penstemons. Shrubs such as mountain big and black sagebrushes, rubber rabbitbrush, fringed sagewort, and juniper can make up to 25% of the total annual production. When compared to the Reference Community Phase, mountain big and black sagebrush, rubber rabbitnbrush, fringed sagewort, bluegrasses, and rhizomatous wheatgrasses have increased. Production of specific species such as Columbia needlegrass and spike fescue has been reduced. The total annual production (air-dry weight) of this state is about 700 pounds per acre, but it can range from about 550 lbs./acre in unfavorable years to about 900 lbs./acre in above average years.

Resilience management. 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 continuous season-long or year-long grazing. The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement is not uncommon especially on steeper slopes. Incidence of pedestalling is minimal but normal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- black sagebrush (*Artemisia nova*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- Idaho fescue (*Festuca idahoensis*), grass
- spike fescue (*Leucopoa kingii*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- silvery lupine (*Lupinus argenteus*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- prairie sagewort (*Artemisia frigida*), other herbaceous

Dominant resource concerns

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

Table 11. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	425	450	525
Shrub/Vine	100	200	300
Forb	25	50	75
Total	**550**	**700**	**900**

State 3
Invaded State

This plant community evolved under frequent and severe heavy grazing and the mountain big sagebrush shrub component has been reduced or possibly removed by heavy browsing, wildfire or human means. Non-native and weedy species are the most dominant plants and occupy any open bare ground area. Fringed sagewort and rubber rabbitbrush may or may not be present. However, it is common for these shrubs to occur as both are strong

resprouters and may quickly re-establish the site after a disturbance.

Characteristics and indicators. The major indication of entering this State is the abundant or significant presence of an introduced species, whether invasive or just an invader. To meet the terms of abundant or significant, the presence has to account for greater than or equal to ten percent cover of the community. Compared to Reference, non-native invaders such as smooth brome, timothy and kentucky bluegrass as well as weedy annual species are widespread and the major cool-season mid-grasses are absent or severely decreased. Mountain big sagebrush has also been impacted. Weedy annuals may include cheatgrass, Canada thistle, Russian thistle, and a variety of mustards. The interspaces between plants have expanded leaving the amount of bare ground more prevalent and more soil surface exposed to erosive elements.

Resilience management. This plant community is relatively stable and resistant to overgrazing. Annuals and non-native species are effectively competing against the establishment of native perennial cool-season grasses. Plant diversity is greatly altered and the herbaceous component is not intact. Recruitment of the major perennial grasses is not occurring and the replacement potential is absent. The biotic integrity is missing. The soils are unstable and not protected from excessive erosion. Rill channels and maybe even gullies may be present on site and adjacent areas are impacted by excessive runoff. Water flow patterns and pedestalling are obvious. The watershed is not functioning.

Community 3.1
Perennial Grasses/Non-Native Species

Figure 15. This community looks very similar to Community 2.1 with Idaho fescue, however, there is an undertone of Kentucky bluegrass in this community.

The Perennial Grasses/Non-Native Species Community Phase has maintained a representative sample of the perennial grasses and forbs that are typical of the site with a mixed shrub community. Non-native or invader species have established in the community and are a significant component in the community (10 percent or greater by foliar cover or 5 percent or greater by weight), and are prominent (referring to a more wide scale composition, not one isolated patch in an isolated portion of the landscape). The most common species to establish are smooth brome, Kentucky bluegrass, and dandelion. Timothy is found in areas where there is snow catch or within sagebrush cover. Other species that will increase are ballheaded sandwort, field chickweed, common yarrow, and Rocky Mountain juniper. Production of the desired perennial species is generally reduced but the total production is maintained or elevated due to the production potential of the non-native 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. 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 non-native 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

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- Montana wheatgrass (*Elymus albicans*), grass
- common dandelion (*Taraxacum officinale*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous
- field chickweed (*Cerastium arvense*), other herbaceous
- ballhead sandwort (*Arenaria congesta*), other herbaceous

Dominant resource concerns

- Classic gully erosion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Community 3.2
Perennial Grasses/Invasive Species

The Perennial Grasses/Invasive Species Community Phase has maintained a fractured sample of the perennial grasses and forbs that are typical of the site with invasive species. This plant community evolved under frequent and severe grazing. The shrub component has been impacted and possibly removed by heavy browsing, wildfire or human means. Weedy annuals and bluegrasses are the most dominant plants. Invasive species, most commonly cheatgrass, hold a significant (10 percent or greater) composition of the landscape, and are prominent (referring to a more wide scale composition, not isolated patches on the landscape). Fringed sagewort and rubber rabbitbrush may be more abundant than other shrubs, as they are strong resprouters and may quickly re-establish the site after a disturbance. The interspaces between plants have expanded leaving the amount of bare ground more prevalent and more soil surface exposed to erosive elements. With the decrease or loss of most desirable mid-stature cool-season grasses, bluegrass will persist on the site (bluegrass includes natives: Sandberg, mutton, Canby, and big; as well as introduced species: Kentucky). Smooth brome, dandelion, and other introduced species will increase if present on the site. Other noxious weeds such as Canada thistle may invade the site if a seed source is available. 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 continued herbivory. Annuals and bluegrasses are effectively competing against the establishment of native, perennial cool-season grasses. Plant diversity is greatly altered and the herbaceous component is not intact. Recruitment of the major perennial grasses is not occurring and the replacement potential is absent. The biotic integrity is diminished. The state is unstable and is not protected from excessive erosion. Rill channels and maybe even gullies may be present on site and adjacent areas are impacted by excessive runoff. Water flow patterns and pedestalling are obvious. The watershed is not functioning.

Dominant plant species

- Rocky Mountain juniper (*Juniperus scopulorum*), tree
- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- cheatgrass (*Bromus tectorum*), grass

- sixweeks fescue (*Vulpia octoflora*), grass
- smooth brome (*Bromus inermis*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- common dandelion (*Taraxacum officinale*), other herbaceous
- thistle (*Cirsium*), other herbaceous
- pussytoes (*Antennaria*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous

Dominant resource concerns

- Classic gully erosion
- Aggregate instability
- Naturally available moisture use
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Pathway CP3.1-3.2
Community 3.1 to 3.2

Frequent and Severe Grazing will convert this plant community to a Perennial Grasses/Invasive Species Community Phase. Drought or a fire (man-made or wild) are drivers that will encourage this transition as well, if a seed source is present. If fringed sagewort and common yarrow are present more than likely it will persist in varying degrees as it is difficult to control.

State 4
Disturbed

Catastrophic natural events, including fresh land slides, fire followed by extreme climatic events, or areas that are heavily impacted by recreational vehicles, trails, roadways, or other land disturbances have reduced or removed most native perennial vegetation and left a highly disturbed land. These points of disturbance can be large scale, encompassing several ecological sites. However, many times they are isolated in nature, especially on steeper slopes. 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, hydrologic, or chemical), the site potential is altered. Mechanical disturbances and reclamation practices using non-native species could qualify some stages of this state to be considered as a land use shift. The result is the shift in potential and response in management so that it is 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.

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 Russian thistle, 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 this community is a potential threat; and the community is at high risk of transitioning to the Invaded State.

Community 4.1
Disturbed Lands

The title Disturbed Lands is encompassing two broad classifications of these land types. Go-back fields or tilled

areas form Type one. The slope and rock cover of the Steep Stony Upland ecological site does not lend well for this type of disturbance. However, 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. A subset of Type one are those areas that were or currently are being impacted by recreation - camp sites, trails, parking areas, roadways. The varying stages of healing once abandoned, or the state of disturbance at each location leave a variable community. 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. The plant community is variable and depending on the slope extent, 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 and functional groups that are desired on the site. Soil erosion is variable depending on the slope extent and the disturbance regime that is occurring on the site and will vary with the specific community that has established on a specific location. Site-specific evaluation is needed to determine the water flow and pedestalling as well as infiltration and runoff potential and associated risks for each community.

Dominant resource concerns

- Sheet and rill erosion
- Classic gully erosion
- Compaction
- Aggregate instability
- Naturally available moisture use
- Sediment transported to surface water
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter
- Inadequate livestock water quantity, quality, and distribution

Transition T1-2
State 1 to 2

Heavy, continuous, season-long grazing plus no fires or altered fire frequency will convert the plant community to the Sagebrush/Idaho Fescue State. This is especially evident on areas where drought or heavy browsing has adversely impact the shrub stand. The impacts required to force this transition are significant, and this does not happen in a short time period.

Constraints to recovery. The loss of sagebrush in some of these communities and the lack of necessary seed bank and recovery time are limiting factors for this State to recover. Slope and erosional risks are also slows or inhibits recovery.

Transition T1-3
State 1 to 3

Fire, wild or prescribed, with no change in grazing management and seed source present allows for a rapid transition to the Invaded State. Drought or other catastrophic events will aid in this transition.

Constraints to recovery. The lack of effective treatment to eradicate or significantly control invasive species long term or to remove non-native species without impact to the native community limit the recovery of this State.

Transition T2-3
State 2 to 3

Drought, soil disturbances, or high-intensity grazing with a seed source present can open the soil surface and weaken the sod allowing non-native and invasive species to establish. Fire is a primary means of provide the niche for cheatgrass to establish on this site. Continued stress on a community, even and aggressive non-native dominant community is prone to drought and grazing pressure allowing invasive species to establish.

Constraints to recovery. The nature of non-native (introduced) as well as invasive species, especially cheatgrass, once they are established, they are prolific reproducers and are hardy plants, making it costly and difficult (if even possible) to remove. The lack of key grass species also limits recovery of this site.

Restoration pathway R3-4
State 3 to 4

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 of these 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 there is a significant composition of non-native and invasive species that have established on a site.

Conservation practices

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

Transition T4-3
State 4 to 3

Lack of management resulting in continued disturbance, catastrophic events, or failure in the restoration process are major causes for a disturbed or altered landscape to transition to an invaded state.

Constraints to recovery. The change in the soils and potentially the hydrology of the site as well as the presence of invasive species limit the recovery potential of this community. Soil limitations due to chemistry in the soil will limit the success and types of treatment that are available to improve this community.

Additional community tables

Table 12. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall-stature Cool-season Grasses**			200–450	
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	50–250	5–25
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	0–100	0–10
	mountain brome	BRMA4	*Bromus marginatus*	0–50	0–5

	slender wheatgrass	ELTR7	*Elymus trachycaulus*	0–50	0–5
2	**Mid-stature Cool-season Bunchgrasses**			100–350	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	50–300	5–30
	spike fescue	LEKI2	*Leucopoa kingii*	0–100	0–10
	Idaho fescue	FEID	*Festuca idahoensis*	0–75	0–5
3	**Rhizomatous Cool-Season Grasses**			50–100	
	Montana wheatgrass	ELAL7	*Elymus albicans*	15–50	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	15–50	–
4	**Short-stature Cool-season Grasses**			0–100	
	Sandberg bluegrass	POSE	*Poa secunda*	0–50	0–5
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–50	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–50	0–5
	spike trisetum	TRSP2	*Trisetum spicatum*	0–50	0–5
5	**Miscellaneous Grasses/Grass-Likes**			0–50	
	threadleaf sedge	CAFI	*Carex filifolia*	0–50	0–5
	needleleaf sedge	CADU6	*Carex duriuscula*	0–50	0–5
	onespike danthonia	DAUN	*Danthonia unispicata*	0–50	0–5
	Grass, perennial	2GP	*Grass, perennial*	0–50	0–5
Forb					
6	**Perennial Forbs**			25–75	
	Indian paintbrush	CASTI2	*Castilleja*	0–50	0–5
	silvery lupine	LUAR3	*Lupinus argenteus*	0–50	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–50	0–5
	agoseris	AGOSE	*Agoseris*	0–50	0–5
	pussytoes	ANTEN	*Antennaria*	0–50	0–5
	milkvetch	ASTRA	*Astragalus*	0–50	0–5
	balsamroot	BALSA	*Balsamorhiza*	0–50	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–50	0–5
	phlox	PHLOX	*Phlox*	0–50	0–5
	lousewort	PEDIC	*Pedicularis*	0–50	0–5
	beardtongue	PENST	*Penstemon*	0–50	0–5
	American vetch	VIAM	*Vicia americana*	0–50	0–5
Shrub/Vine					
7	**Dominant Shrubs**			50–150	
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	50–150	5–10
	black sagebrush	ARNO4	*Artemisia nova*	0–50	0–5
8	**Miscellaneous Shrubs**			0–50	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–50	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–50	0–5
	Shrub, other	2S	*Shrub, other*	0–50	0–5

Table 13. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					

1	**Tall-stature Cool-season Grasses**			50–300	
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	50–200	5–20
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	0–100	0–10
	mountain brome	BRMA4	*Bromus marginatus*	0–100	0–10
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	0–50	0–5
2	**Mid-Stature Cool-Season Bunchgrasses**			50–250	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	50–200	5–20
	Idaho fescue	FEID	*Festuca idahoensis*	0–100	0–10
	spike fescue	LEKI2	*Leucopoa kingii*	0–50	0–10
3	**Rhizomatous Cool-Season Grasses**			100–300	
	Montana wheatgrass	ELAL7	*Elymus albicans*	50–200	5–20
	western wheatgrass	PASM	*Pascopyrum smithii*	50–100	5–10
4	**Short-Stature Cool-Season Grasses**			75–200	
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–100	0–10
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–50	0–5
	spike trisetum	TRSP2	*Trisetum spicatum*	0–50	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–50	0–5
5	**Miscellaneous Grasses/Grass-Likes**			20–100	
	Grass, perennial	2GP	*Grass, perennial*	0–50	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–50	0–5
	needleleaf sedge	CADU6	*Carex duriuscula*	0–50	0–5
	onespike danthonia	DAUN	*Danthonia unispicata*	0–50	0–5
Forb					
6	**Perennial Forbs**			0–100	
	Indian paintbrush	CASTI2	*Castilleja*	0–50	0–5
	silvery lupine	LUAR3	*Lupinus argenteus*	0–50	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–50	0–5
	common yarrow	ACMI2	*Achillea millefolium*	0–50	0–5
	agoseris	AGOSE	*Agoseris*	0–50	0–5
	pussytoes	ANTEN	*Antennaria*	0–50	0–5
	milkvetch	ASTRA	*Astragalus*	0–50	0–5
	balsamroot	BALSA	*Balsamorhiza*	0–50	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–50	0–5
	phlox	PHLOX	*Phlox*	0–50	0–5
	beardtongue	PENST	*Penstemon*	0–50	0–5
	American vetch	VIAM	*Vicia americana*	0–50	0–5
	field chickweed	CEAR4	*Cerastium arvense*	0–50	0–5
7	**Annual Forbs**			0–50	
	woolly plantain	PLPA2	*Plantago patagonica*	0–25	0–5
	tansymustard	DESCU	*Descurainia*	0–25	0–5
	Forb, annual	2FA	*Forb, annual*	0–25	0–5
Shrub/Vine					
8	**Dominant Shrubs**			50–250	

	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	50–200	5–20
	black sagebrush	ARNO4	*Artemisia nova*	0–50	0–5
9	**Miscellaneous Shrubs**			0–100	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–50	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–50	0–5
	Shrub, other	2S	*Shrub, other*	0–50	0–5

Animal community

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: The combination of an overstory of big sagebrush and an understory of grasses and forbs provides a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer, elk, 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. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous Hawks, and golden eagles.

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 - Idaho Fescue/Sagebrush Plant Community: The combination of an overstory of sagebrush and an understory of grasses and forbs provides a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer, elk, 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. Other birds that would frequent this plant community include western meadowlark, lark bunting, sage thrasher, horned larks, red-tail and ferruginous Hawks, and golden eagles.

3._ - Invaded State: The combination of sagebrush and the added diversity of invasive grasses and/or forbs provide an extended plant community for wildlife. But as the invasive species increase, decreasing the desirable species, the wildlife species benefits are decreased as well. Early spring and fall green up of cheatgrass provides foraging opportunities for many of our grazers and mixed feeders.

4._-Disturbed State: 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/Sagebrush 600-1000 0.22
1.2 Perennial Grasses/Sagebrush 550-1100 0.21
2.1 Idaho Fescue/Sagebrush ** **
3.1 Invaded Plant Community ** **
4.1 Disturbed Plant Community ** **

* - 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 was derived, in part, from NRCS inventory data. Field observations from range-trained personnel also were used. Those involved in the development of the new concept for the Loamy Calcerous 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.

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, Ray Gullion, Blaise Allen
Contact for lead author	blaise.allen@usda.gov
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 less than 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).

---

2. **Presence of water flow patterns:** Barely observable but may be occurring on steeper slopes (10-25 percent). Any flow patterns present should be sinuous and wind around perennial plant bases. Generally short (less than 5 feet), less than 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.

---

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.

---

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 percent 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.

---

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 non-existent. No evidence of wind generated soil movement. Wind scoured (blowouts) and depositional areas are not present.

---

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 (less than 1/8 inch) may move 1 to 2 feet in the direction of prevailing winds or down slope 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 snow melt events on slopes greater than 9 percent.

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 percent 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 1.0 in interspaces and up to 6.0 under plant canopy.

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 percent.

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.

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.

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: 7 species

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 percent and shouldn't be found on most plants.

14. **Average percent litter cover (%) and depth (in):** Litter ranges from 5 to 25 percent of total canopy with total litter

including beneath the plant canopy can reach up to 70 percent. 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 (4-6 cm), but is sporadically distributed.

---

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 800 lbs. with a low of 600 lbs. and ranging to 1000 lbs.

    Community 1.2 =Total normal or average production is estimated at 750 lbs. with a low of 550 lbs. and ranging to 1100 lbs.

---

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:** Sandberg bluegrass, threadleaf sedge, fringed sagewort, pricklypear cactus, broom snakeweed and rubber rabbitbrush; mustards as well as other annuals, and then exotics and species found on the noxious weed list including but not limited to: cheatgrass, spotted knapweed, and bull thistle.

---

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