

## **Ecological site EX043B23C104 Clayey (Cy) Absaroka Subalpine Zone**

Last updated: 10/04/2019  
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### **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

Major Land Resource Unit (MLRA) 43B: 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](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053624#handbook).

### **LRU notes**

Land Resource Unit (LRU) 43B23C: Absaroka Subalpine Zone

Based on the shifts in geology, precipitation patterns and other climatic factors, as well as elevation 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 C is the high elevation zone noted for dense timber interspersed with open parks and longer persisting snowpack (within timberline). Precipitation can range from 18 to 20 plus inches and is more noted for the duration of snow cover and shorter growing season. To verify or identify Subset C (the referenced subset for this ecological site), refer to the Wyoming LRU matrix key contained within the Ecological Site Key.

This LRU/Subset occurs on the eastern divide of the Absaroka Range. This LRU starts north of Clark, WY and runs to the Thermopolis, WY area. Once the Absaroka Range merges with the Owl Creek and Wind River Ranges, the climatic patterns and elevational changes shifts the plant community and creates a break in the LRU/Subset.

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: Cryic

Dominant Cover: Rangeland – Sagebrush Steppe (major species is Mountain Big Sagebrush)

Representative Value (RV) Effective Precipitation: 20+ inches (508 mm)

RV Frost-Free Days: 31-65 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

M048 Central Rocky Mountain Montane-Foothill Grassland & Shrubland Macro-group

G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group

Ecoregions (EPA):

Level I: 6 North Western Forested Mountains

Level II: 6.2 Western Cordillera

Level III: 6.2.10 Middle Rockies

Level IV: 6.2.17ao – Absaroka Volcanic Subalpine Zone

6.2.17i – Absaroka – Gallatin Volcanic Mountains

## Ecological site concept

- Site receives no additional water.
- Slope is <20%
- Soils are:
  - o Textures range from loamy sand to very fine sandy loam in top 4" (10 cm) of mineral soil surface
  - o Clay content is  $\geq 35\%$  in top 4" (10 cm) of mineral soil surface
  - o All subsurface horizons in the particle size control section have a weighted average of  $\geq 35\%$  clay. (The particle size control section is the segment of the profile from either the start of an argillic horizon for 50 cm's or from 25-100 cm's).
  - o Moderately deep to very deep (20-80+ in. (50-200+ cm)
  - o <3% stone and boulder cover and 20% or less cobble and gravel cover
  - o Not skeletal (<35% rock fragments) within 20" (50 cm) of mineral soil surface
  - o None to Slightly effervescent throughout top 20" (50 cm) of mineral soil surface
  - o Non-saline, sodic, or saline-sodic

The Clayey ecological site concept is based on minimal (none to slight) influence from salts, carbonates, gypsum or other chemistry within the top 20 inches (50 cm) of the mineral soil surface. The main soil characteristic is a moderately deep to very deep soil that is fine textured with greater than or equal to 35% clay throughout the soil profile; the dominant soil textural classes are loamy sand to sandy loam in the subsurface.

The clayey site can be found occurring in a complex mosaic pattern where the geology is controlled by inter-bedded sandstone and shale. Locations controlled by primarily shale bedrock have pockets of dense clay and loamy sites intermixed with the clayey ecological site. Dense clay and clayey vary by the abrupt changes for dense clay, and the consistent clay layer for the clayey site.

## Associated sites

R043BY122WY	<b>Loamy High Mountains</b>
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## Similar sites

R043BY210WY	<b>Dense Clay Foothills and Mountains West</b> Dense Clay (DC) 15-19W has lower production.
R043BY110WY	<b>Dense Clay High Mountains</b> Dense Clay (DC) 20+ has lower production, and a shift in the shrub component.

**Table 1. Dominant plant species**

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> ssp. <i>vaseyana</i>
Herbaceous	(1) <i>Festuca idahoensis</i> (2) <i>Achnatherum nelsonii</i>

## Legacy ID

R043BX704WY

## Physiographic features

This site can be found in a lowland or upland position, on flat to moderately sloping land.

**Table 2. Representative physiographic features**

Landforms	(1) Mountain range > Alluvial fan (2) Mountain range > Ridge (3) Mountain range > Hill
Runoff class	Low to very high
Elevation	6,500–12,000 ft
Slope	0–60%
Aspect	Aspect is not a significant factor

## Climatic features

Annual precipitation and modeled relative effective annual precipitation range from 18 to 35 inches (457 – 889 mm). The normal precipitation pattern is evenly distributed through the year and averages over 20 inches. Annual snowfall averages 150 to 200 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. Prevailing winds are from the southwest, and strong winds are less frequent than over other areas of Wyoming. Occasional storms, however, can bring brief periods of high winds with gusts exceeding 50 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 June 1, but can be as late as July 15, and continues until the beginning of September.

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at <http://www.wcc.nrcs.usda.gov/>. Climate station representative of this precipitation zone include: “Cooke City 2W” and “Tower Falls”. 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)	1-2 days
Freeze-free period (characteristic range)	23-47 days
Precipitation total (characteristic range)	18-23 in
Frost-free period (actual range)	1-2 days

Freeze-free period (actual range)	17-53 days
Precipitation total (actual range)	17-24 in
Frost-free period (average)	2 days
Freeze-free period (average)	35 days
Precipitation total (average)	21 in

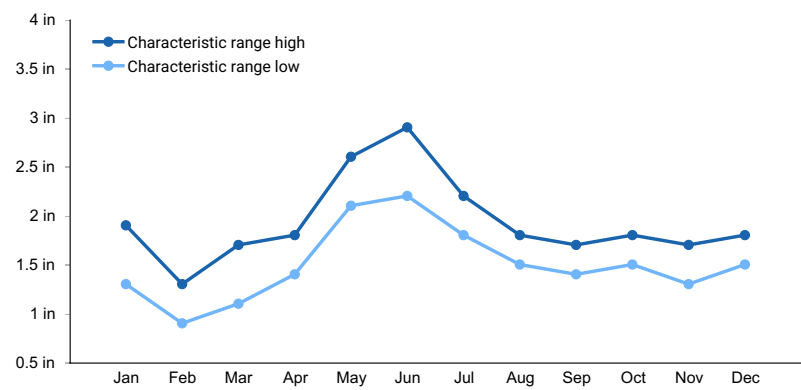


Figure 1. Monthly precipitation range

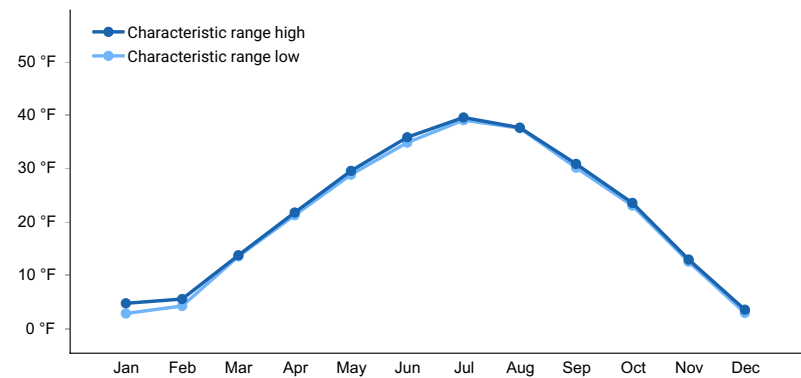


Figure 2. Monthly minimum temperature range

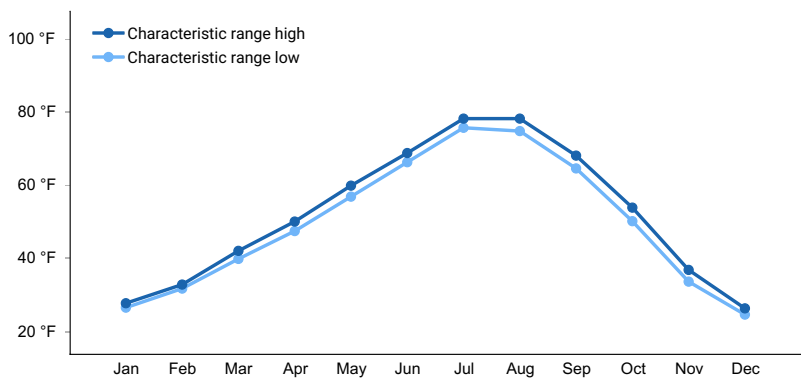
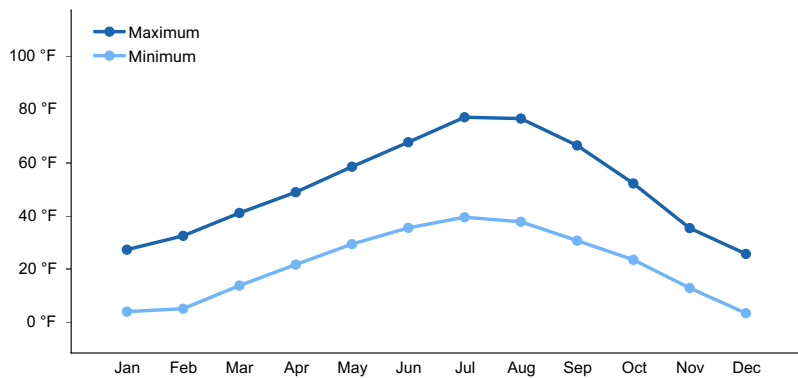
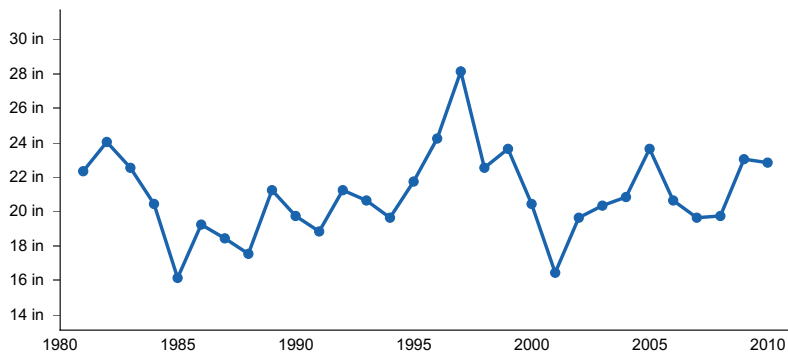


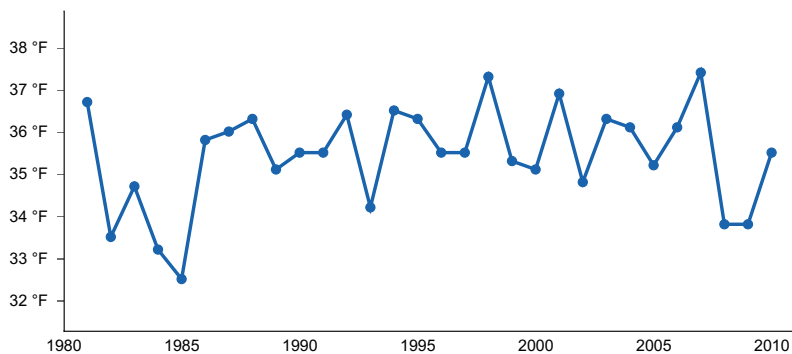
Figure 3. Monthly maximum temperature range



**Figure 4. Monthly average minimum and maximum temperature**



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) COOKE CITY 2 W [USC00241995], Gardiner, MT
- (2) 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" to bedrock), well to poorly drained soils formed in alluvium. These soils have slow to very slow permeability. The topsoil, except for thin ineffectual layers, will be heavy clays and/or soils that develop large cracks when dry and are very sticky when wet. These soils are not high in salinity and/or alkalinity.

**Table 4. Representative soil features**

Parent material	(1) Residuum–shale (2) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Clay loam (2) Clay (3) Sandy clay loam (4) Silty clay
Family particle size	(1) Fine
Drainage class	Well drained
Permeability class	Moderate to very slow
Soil depth	20–60 in
Surface fragment cover <=3"	0–5%
Available water capacity (0-40in)	2.8–6 in
Calcium carbonate equivalent (0-40in)	5–15%
Electrical conductivity (0-40in)	4–16 mmhos/cm
Sodium adsorption ratio (0-40in)	0–10
Soil reaction (1:1 water) (0-40in)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	0–15%

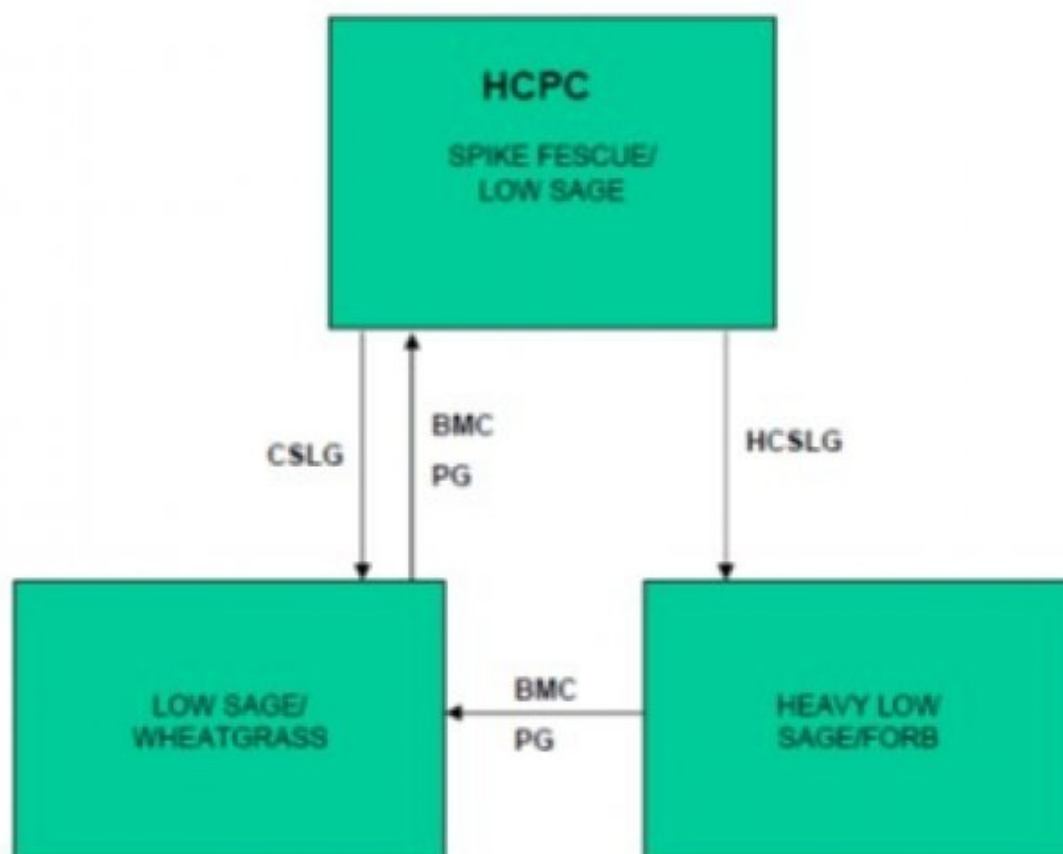
## Ecological dynamics

As this site deteriorates from improper grazing management, rhizomatous wheatgrass, bottlebrush squirreltail, low sagebrush, and green rabbitbrush will increase. Idaho fescue and spike fescue will decrease in frequency and production.

The Historic Climax Plant Community (description follows the plant community diagram) has been determined by study of rangeland relic areas, 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 Diagram that illustrates the common plant communities (states) that can occur on the site and the transitions between these communities. The ecological processes will be discussed in more detail in the plant community narratives following the diagram.

## State and transition model



BMA – Brush Management (all methods)  
 BMC – Brush Management (chemical)  
 BMF – Brush Management (fire)  
 BMM – Brush Management (mechanical)  
 CSP – Chemical Seedbed Preparation  
 CSLG – Continuous Season-long Grazing  
 DR – Drainage  
 CSG – Continuous Spring Grazing  
 HB – Heavy Browse  
 HCSLG – Heavy Continuous Season-long Grazing  
 HI – Heavy Inundation  
 LPG – Long-term Prescribed Grazing  
 MT – Mechanical Treatment (chiseling, ripping, pitting)

NF – No Fire  
 NS – Natural Succession  
 NWC – Noxious Weed Control  
 NWI – Noxious Weed Invasion  
 NU – Noxious  
 P&C – Plow & Crop (including hay)  
 PG – Prescribed Grazing  
 RPT – Re-plant Trees  
 RS – Re-seed  
 SGD – Severe Ground Disturbance  
 SHC – Severe Hoof Compaction  
 WD – Wildlife Damage (Beaver)  
 WF – Wildfire

## **Spike Fescue/Low Sage Plant Community (HCPC)**

### **Community 1.1**

#### **Spike Fescue/Low Sage Plant Community (HCPC)**

The interpretive plant community for this site is the Historic Climax Plant Community. This state evolved with grazing by large herbivores and is suited for grazing by domestic livestock. Potential vegetation is estimated at 65% grasses or grass-like plants, 15% forbs and 20% woody plants. The major grasses include thickspike wheatgrass, Idaho fescue, and spike fescue. Other grasses and grass-like plants may include Indian ricegrass, Columbia and Letterman needlegrass, prairie junegrass, sun sedge, mutton, big, Canby, Cusick, and Sandberg bluegrass, mountain and noddling brome, slender wheatgrass, and oniongrass. Low sagebrush is the major woody plant. Other woody plants that may occur include green rabbitbrush. A typical plant composition for this state consists of thickspike wheatgrass 20-30%, Idaho fescue 10-20%, spike fescue 10-20%, other grasses and grass-like plants 10-20%, perennial forbs 5-15%, low sagebrush 5-10%, and 5-15% other woody species. Ground cover, by ocular estimate, varies from 65-70%. The total annual production (air-dry weight) of this state is about 1500 pounds per acre, but it can range from about 1200 lbs./acre in unfavorable years to about 1800 lbs./acre in above average years. The following is the growth curve of this plant community expected during a normal year: Growth curve number: WY0101 Growth curve name: 20+M, UPLAND SITES Growth curve description: ALL UPLAND SITES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC 0 0 0 0 5 30 40 20 5 0 0 0 (Monthly percentages of total annual growth) This state is extremely stable and well adapted to the Central Rocky Mountains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:

- Continuous Season-long Grazing will convert this plant community to the Low Sage/Wheatgrass State.
- Heavy Continuous Season-long Grazing will convert this plant community to the Heavy Low Sage/Forb State.

## **State 2**

### **Low Sage/Wheatgrass Plant Community**

#### **Community 2.1**

##### **Low Sage/Wheatgrass Plant Community**

This plant community is the result of continuous season-long grazing. Low sage increases along with rhizomatous wheatgrasses. There is a substantial amount of bare ground. Phlox is a common forb on this site. The total annual production (air-dry weight) of this state is about 1000 pounds per acre, but it can range from about 500 lbs./acre in unfavorable years to about 1500 lbs./acre in above average years. The following is the growth curve of this plant community expected during a normal year: Growth curve number: WY0101 Growth curve name: 20+M, UPLAND SITES Growth curve description: ALL UPLAND SITES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC 0 0 0 0 5 30 40 20 5 0 0 0 (Monthly percentages of total annual growth) The soil is not protected and erosion will increase if management is not changed. The biotic integrity may be reduced due to low vegetative production and plant diversity. The watershed is functioning at risk. Transitional pathways leading to other plant communities are as follows:

- Chemical Brush Management and Prescribed Grazing will result in a plant community very similar to the Historic Climax Plant Community (Spike Fescue/Low Sage State).

## **State 3**

### **Heavy Low Sage/Forb Plant Community**

#### **Community 3.1**

##### **Heavy Low Sage/Forb Plant Community**

This plant community is the result of long-term, improper grazing. Low sagebrush dominates with annual production often exceeding 30-60%. There is mostly bare ground between sagebrush plants with an understory of mostly forbs limited to the protected areas under shrubs. The major grasses include Sandberg bluegrass and rhizomatous wheatgrass. The total annual production (air-dry weight) of this state is about 500 pounds per acre, but it can range from about 300 lbs./acre in unfavorable years to about 800 lbs./acre in above average years. The following is the growth curve of this plant community expected during a normal year: Growth curve number: WY0101 Growth curve name: 20+M, UPLAND SITES Growth curve description: ALL UPLAND SITES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC 0 0 0 0 5 30 40 20 5 0 0 0 (Monthly percentages of total annual growth) Soil erosion is



accelerated because of increased bare ground. The biotic community has been compromised, but is relatively stable. The watershed is functioning, but is at risk of further degradation. Water flow patterns and pedestals are obvious. Infiltration is reduced and runoff is increased. Transitional pathways leading to other plant communities are as follows: • Chemical Brush Management followed by Prescribed Grazing will convert this plant community to the Low Sage/Wheatgrass State.

## Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
<b>Grass/Grasslike</b>					
1				300–450	
	thickspike wheatgrass	ELLAL	<i>Elymus lanceolatus ssp. lanceolatus</i>	300–450	–
2				150–300	
	Idaho fescue	FEID	<i>Festuca idahoensis</i>	150–300	–
3				150–300	
	spike fescue	LEKI2	<i>Leucopoa kingii</i>	150–300	–
4				150–300	
	Grass, perennial	2GP	<i>Grass, perennial</i>	0–75	–
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	0–75	–
	Letterman's needlegrass	ACLE9	<i>Achnatherum lettermanii</i>	0–75	–
	Columbia needlegrass	ACNE9	<i>Achnatherum nelsonii</i>	0–75	–
	western needlegrass	ACOC3	<i>Achnatherum occidentale</i>	0–75	–
	Richardson's needlegrass	ACRI8	<i>Achnatherum richardsonii</i>	0–75	–
	mountain brome	BRMA4	<i>Bromus marginatus</i>	0–75	–
	Porter brome	BRPO2	<i>Bromus porteri</i>	0–75	–
	sun sedge	CAINH2	<i>Carex inops ssp. heliophila</i>	0–75	–
	squirreldtail	ELELE	<i>Elymus elymoides ssp. elymoides</i>	0–75	–
	blue wildrye	ELGL	<i>Elymus glaucus</i>	0–75	–
	slender wheatgrass	ELTR7	<i>Elymus trachycaulus</i>	0–75	–
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	0–75	–
	oniongrass	MEBU	<i>Melica bulbosa</i>	0–75	–
	Cusick's bluegrass	POCU3	<i>Poa cusickii</i>	0–75	–
	muttongrass	POFE	<i>Poa fendleriana</i>	0–75	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	0–75	–
7				75–225	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	75–225	–
<b>Forb</b>					
5				75–225	
	Forb, perennial	2FP	<i>Forb, perennial</i>	0–75	–
	common yarrow	ACMI2	<i>Achillea millefolium</i>	0–75	–
	onion	ALLIU	<i>Allium</i>	0–75	–
	pussytoes	ANTEN	<i>Antennaria</i>	0–75	–
	milkvetch	ASTRA	<i>Astragalus</i>	0–75	–

	hawksbeard	CREPI	<i>Crepis</i>	0–75	–
	fleabane	ERIGE2	<i>Erigeron</i>	0–75	–
	buckwheat	ERIOG	<i>Eriogonum</i>	0–75	–
	common sneezeweed	HEAU	<i>Helenium autumnale</i>	0–75	–
	little sunflower	HEPU3	<i>Helianthus pumilus</i>	0–75	–
	desertparsley	LOMAT	<i>Lomatium</i>	0–75	–
	bluebells	MERTE	<i>Mertensia</i>	0–75	–
	locoweed	OXYTR	<i>Oxytropis</i>	0–75	–
	ragwort	PACKE	<i>Packera</i>	0–75	–
	phlox	PHLOX	<i>Phlox</i>	0–75	–
	western coneflower	RUOC2	<i>Rudbeckia occidentalis</i>	0–75	–
	ragwort	SENEC	<i>Senecio</i>	0–75	–
	aster	SYMPH4	<i>Symphyotrichum</i>	0–75	–
	American vetch	VIAM	<i>Vicia americana</i>	0–75	–
	mule-ears	WYAM	<i>Wyethia amplexicaulis</i>	0–75	–
<b>Shrub/Vine</b>					
6				75–150	
	little sagebrush	ARAR8	<i>Artemisia arbuscula</i>	75–150	–
8				0–75	
	Shrub, deciduous	2SD	<i>Shrub, deciduous</i>	0–75	–
	Shrub, evergreen	2SE	<i>Shrub, evergreen</i>	0–75	–
	Tree, deciduous	2TD	<i>Tree, deciduous</i>	0–75	–
	Tree, evergreen	2TE	<i>Tree, evergreen</i>	0–75	–

## Animal community

### Animal Community – Wildlife Interpretations

Spike Fescue/Low Sage Plant Community (HCPC): Suitable thermal and escape cover for mule deer and elk may be limited due to the low height and density of woody plants. Birds that would frequent this plant community include horned larks and golden eagles.

Low Sage/Wheatgrass Plant Community: This plant community has a low level of diversity. Due to the dominance of grasses, feed for browsing animals is limited.

Heavy Low Sage/Forb Plant Community: This plant community may be beneficial for the same wildlife that would use the Historic Climax Plant Community. However, the plant community composition is less diverse, and thus, less apt to meet the seasonal needs of these animals. Areas of bare ground may provide lek locations for sage grouse at lower elevations.

### 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.

Plant Community Production Carrying Capacity\*  
(lb./ac) (AUM/ac)  
Spike Fesuce/Low Sage (HCPC) 1200-1800 0.5  
Low Sage/Wheatgrass 500-1500 0.3  
Heavy Low Sage/Forb 300-800 0.15

\* - Continuous, season-long grazing by cattle under average growing conditions.

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.

## **Hydrological functions**

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group D. Infiltration is very slow. Runoff potential for this site is high to very high depending on ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. 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 limited hunting opportunities.

## **Wood products**

No appreciable wood products are present on the site.

## **Inventory data references**

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range trained personnel were also used. Those involved in developing this site include: Bill Christensen, Range Management Specialist, NRCS; Karen Clause, Range Management Specialist, NRCS; and Everet Bainter, Range Management 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 3, and USDA NRCS Soil Surveys from various counties.

Information presented here has been derived from NRCS inventory data, Field observations from range trained personnel, and the existing range site descriptions. Those involved in developing the Loamy range site include: Karen Clause, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist.

Those involved in the development of the new concept for Loamy and Loamy Calcareous Ecological site include: Ray Gullion, Area Range Management Specialist, NRCS; Jim Wolf, Resource Manager, USDI-BLM; Jack Mononi, Range Management Specialist, USDI-BLM; Daniel Wood, MLRA Soil Survey Leader, NRCS; Jane Karinen, Soil Data Quality Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS.

### **Inventory Data References:**

Ocular field estimations observed by trained personnel were completed at each site. Then sites were selected where a 100-foot tape was stretched, and the following sample procedures were completed by inventory staff. For full sampling protocol and guidelines with forms please refer to the Wyoming ESI Operating Procedures, compiled in 2012 for the Powell and Rock Springs Soil Survey Office, USDA-NRCS.

- Double Sampling Production Data (4.8 square foot hoop used to estimate 10 points, clipped a minimum of 2 of

these estimated points, with two 21-foot X 21-foot square extended shrub plots).

- Line Point Intercept (over story and understory captured with soil cover). Height of herbaceous and woody cover is collected every three feet along established transect.)
- Continuous Line Intercept (Woody Canopy Cover, with minimum gap of 0.2 of a foot for all woody species and succulents. Intercept height collected at each measurement.),
- Gap Intercept (Basal Gap measured with a minimum gap requirement of 0.7 foot.),
- Sample Point (10 – 1-meter square point photographs taken at set distances on transect. Red 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.

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## Approval

Scott Woodall, 10/04/2019

## Rangeland health reference sheet

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

Author(s)/participant(s)	K. Clause, E. Bainter
Contact for lead author	karen.clause@wy.usda.gov or 307-367-2257
Date	03/16/2007
Approved by	E. Bainter
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:** Rare to nonexistent. Where present, short and widely spaced.

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2. **Presence of water flow patterns:** Barely observable.

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3. **Number and height of erosional pedestals or terracettes:** Rare to nonexistent.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 0-15%.

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5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.
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6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent.
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7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous and large woody litter not expected to move.
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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 3 (interspaces) to 6 (under plant canopy), but average values should be 4.5 or greater.
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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil data is limited for this site. Soil OM of 6-16% is expected.
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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of 65-80% grasses, 15% forbs, and 5-20% shrubs. Evenly distributed plant canopy (60-90%) and litter, despite slow infiltration rates, results in minimal runoff. Basal cover is typically greater than 10% for this site and does affect runoff on this site.
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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None.
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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**
- Dominant: Mid-size, cool season bunchgrasses>
- Sub-dominant: cool season rhizomatous grasses>>
- Other: perennial forbs>perennial shrubsshort, cool season bunchgrasses
- Additional:
- 
13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence, typically associated with shrub component.
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14. **Average percent litter cover (%) and depth ( in):** Litter ranges from 5-35% of total canopy measurement with total litter (including beneath the plant canopy) from 50-85% expected. Herbaceous litter depth typically ranges from 5-15mm. Woody litter can be up to a couple inches (4-6 cm).
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** English: 1200-1800 lb/ac (1500 lb/ac average); Metric 1344-2016 kg/ha (1680 kg/ha average).
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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Bare ground greater than 25% is the most common indicator of a threshold being crossed. Sandberg bluegrass, buckwheat, yarrow, and phlox are common increasers. Kentucky bluegrass, common dandelion, thistles, and annual weeds are common invasive species in disturbed sites.
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17. **Perennial plant reproductive capability:** All species are capable of reproducing, except in extreme drought years.
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