USDA Natural Resources
Conservation Service

Ecological site EX043B23C110
Dense Clay (DC) Absaroka Subalpine Zone

Last updated: 10/04/2019
Accessed: 05/18/2024

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

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.

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 <30%
• Soils are:
o Textures range from fine sandy clay loam to clay in top 4” (10 cm) of mineral soil surface
o Clay content is < 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 ≥ 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 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

Site drafted from historic range site: R043BY110WY. Based heavy clay soils that develop large cracks at the surface when dry. Site has a thin cap of coarser soils on the surface. This community is dominated by low sagebrush and generally lacks Wyoming big sagebrush.

Associated sites

R043BY122WY	**Loamy High Mountains** Loamy

Similar sites

R043BY210WY	**Dense Clay Foothills and Mountains West** R043BY210WY – Dense Clay (DC) 15-19W has lower production.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia arbuscula*
Herbaceous	(1) *Elymus lanceolatus ssp. lanceolatus* (2) *Leucopoa kingii*

Legacy ID

R043BX710WY

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 > Mountain slope
Runoff class	Negligible to very high
Elevation	1,981–3,658 m
Slope	0–60%

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)	457-584 mm
Frost-free period (actual range)	1-2 days
Freeze-free period (actual range)	17-53 days
Precipitation total (actual range)	432-610 mm
Frost-free period (average)	2 days
Freeze-free period (average)	35 days
Precipitation total (average)	533 mm

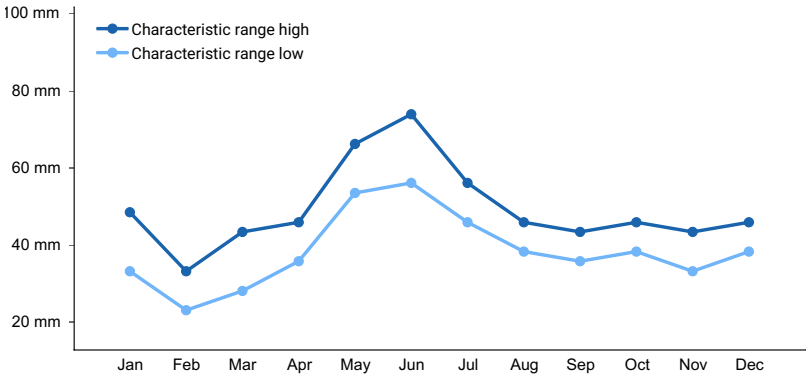


Figure 1. Monthly precipitation range

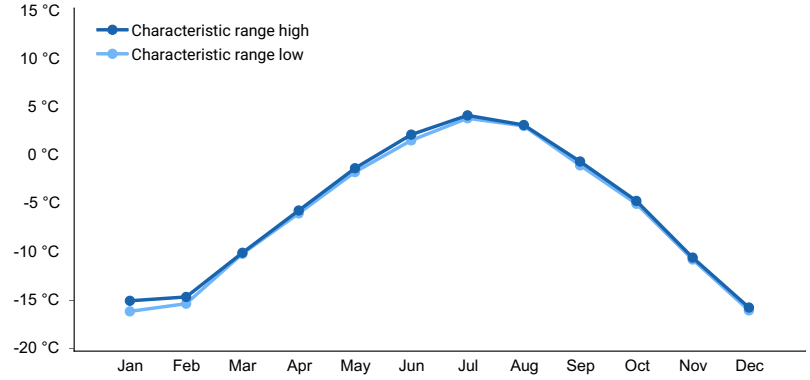


Figure 2. Monthly minimum temperature range

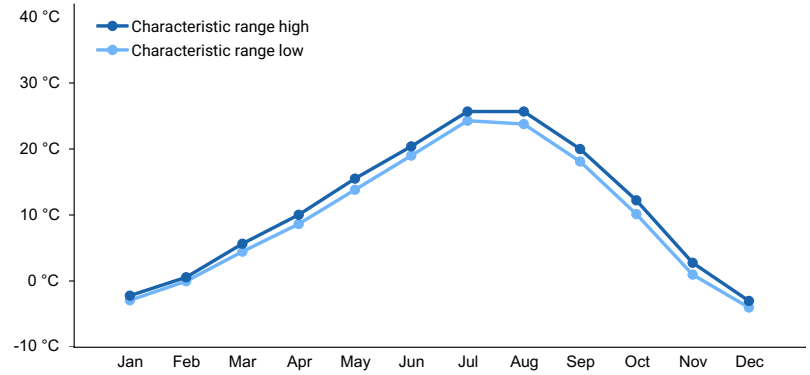


Figure 3. Monthly maximum temperature range

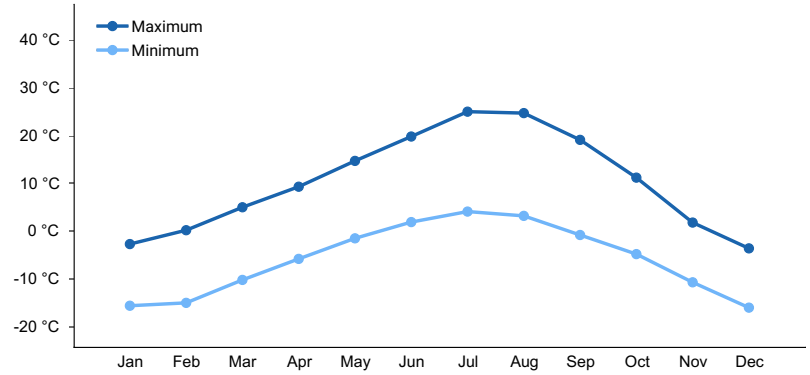


Figure 4. Monthly average minimum and maximum temperature

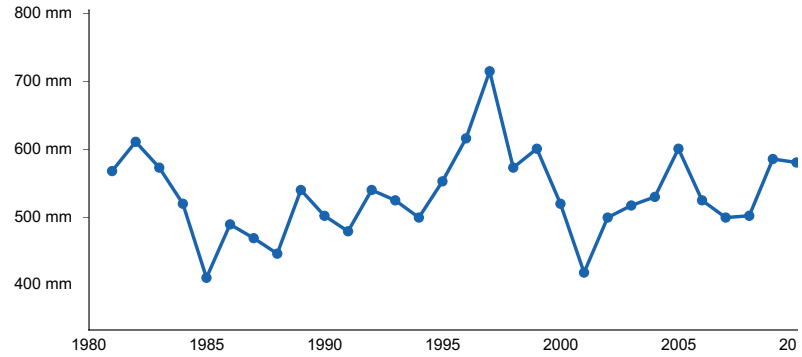


Figure 5. Annual precipitation pattern

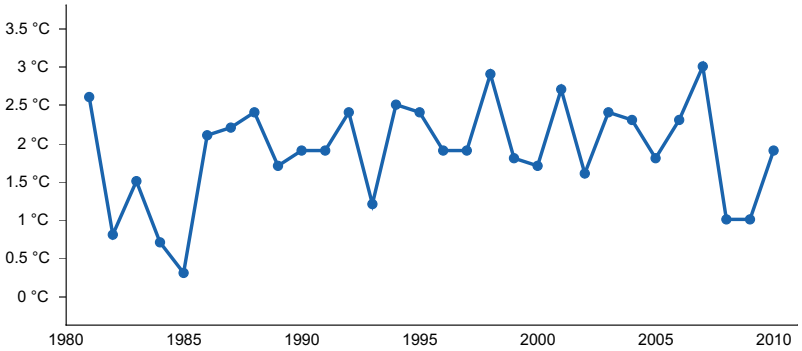


Figure 6. Annual average temperature pattern

Climate stations used

- (1) 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) Lacustrine deposits–igneous, metamorphic and sedimentary rock
Surface texture	(1) Clay loam (2) Clay (3) Silty clay loam (4) Silty clay
Family particle size	(1) Fine
Drainage class	Well drained
Permeability class	Very rapid to slow

Soil depth	51–152 cm
Surface fragment cover <=3"	0–5%
Available water capacity (0-101.6cm)	7.11–15.24 cm
Calcium carbonate equivalent (0-101.6cm)	5–15%
Electrical conductivity (0-101.6cm)	4–16 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–10
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	0–15%

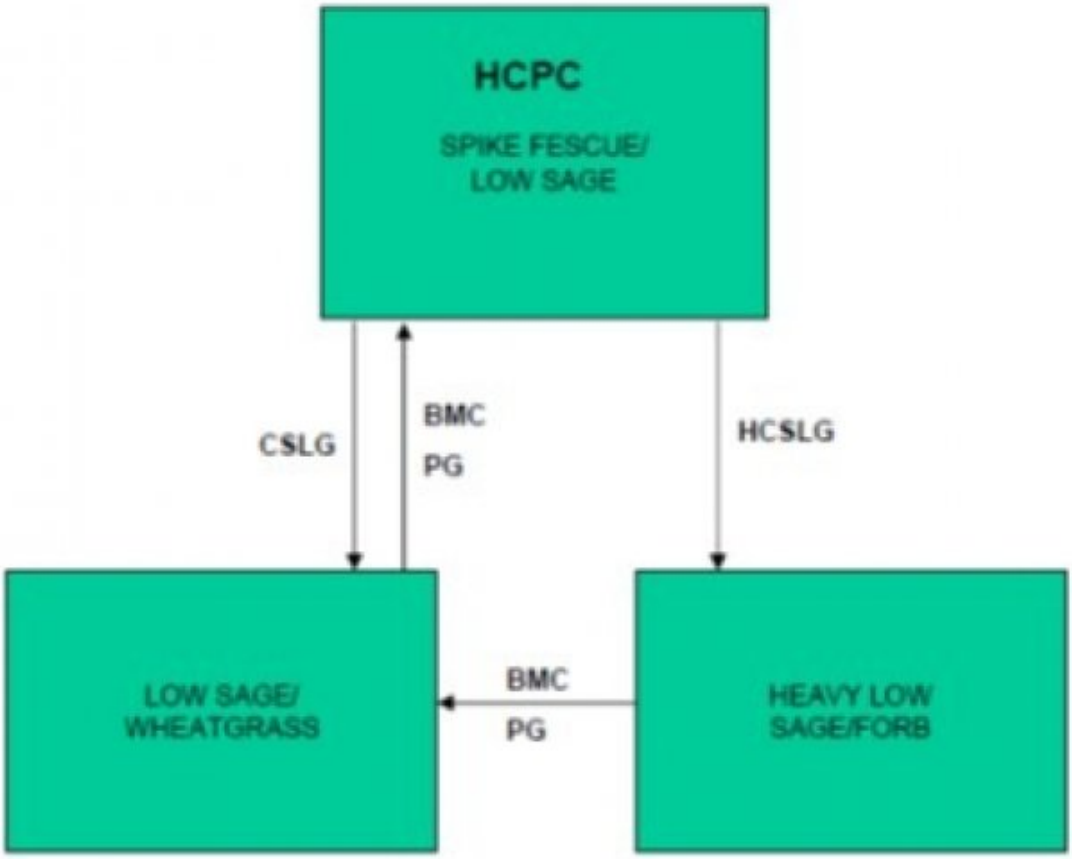
Ecological dynamics

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 – Nonuse
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

State 1

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 nodding 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.

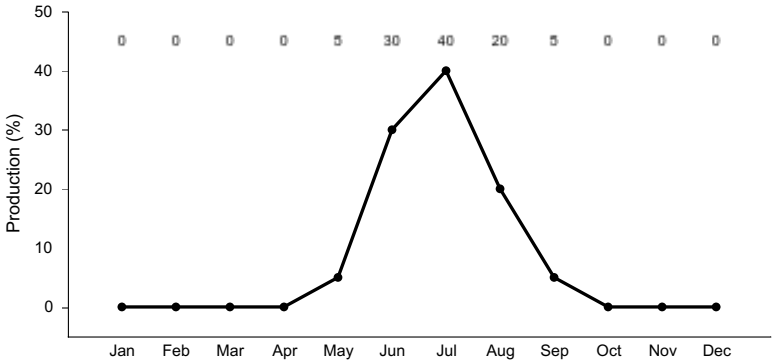


Figure 8. Plant community growth curve (percent production by month). WY0101, 20+ upland sites.

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).

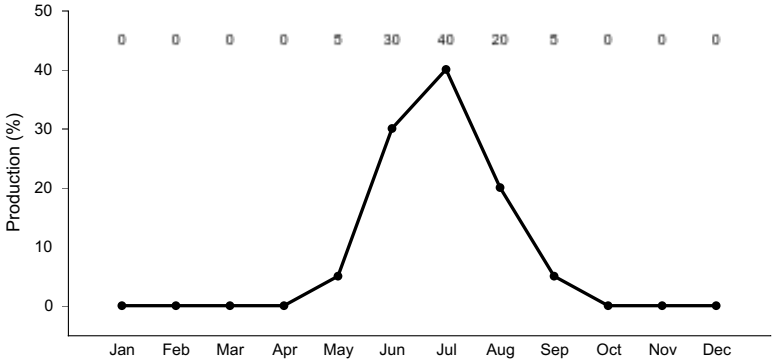


Figure 9. Plant community growth curve (percent production by month). WY0101, 20+ upland sites.

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.

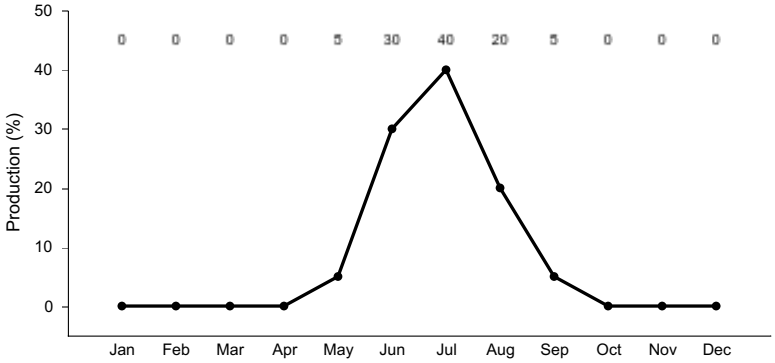


Figure 10. Plant community growth curve (percent production by month). WY0101, 20+ upland sites.

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				336–504	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	336–504	–
2				168–336	

	Idaho fescue	FEID	*Festuca idahoensis*	168–336	–
3				168–336	
	spike fescue	LEKI2	*Leucopoa kingii*	168–336	–
4				168–336	
	Grass, perennial	2GP	*Grass, perennial*	0–84	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–84	–
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	0–84	–
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	0–84	–
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–84	–
	Richardson's needlegrass	ACRI8	*Achnatherum richardsonii*	0–84	–
	mountain brome	BRMA4	*Bromus marginatus*	0–84	–
	Porter brome	BRPO2	*Bromus porteri*	0–84	–
	sun sedge	CAINH2	*Carex inops ssp. heliophila*	0–84	–
	squirreltail	ELELE	*Elymus elymoides ssp. elymoides*	0–84	–
	blue wildrye	ELGL	*Elymus glaucus*	0–84	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	0–84	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–84	–
	oniongrass	MEBU	*Melica bulbosa*	0–84	–
	Cusick's bluegrass	POCU3	*Poa cusickii*	0–84	–
	muttongrass	POFE	*Poa fendleriana*	0–84	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–84	–
7				84–252	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	84–252	–
Forb					
5				84–252	
	Forb, perennial	2FP	*Forb, perennial*	0–84	–
	common yarrow	ACMI2	*Achillea millefolium*	0–84	–
	onion	ALLIU	*Allium*	0–84	–
	pussytoes	ANTEN	*Antennaria*	0–84	–
	milkvetch	ASTRA	*Astragalus*	0–84	–
	hawksbeard	CREPI	*Crepis*	0–84	–
	fleabane	ERIGE2	*Erigeron*	0–84	–
	buckwheat	ERIOG	*Eriogonum*	0–84	–
	common sneezeweed	HEAU	*Helenium autumnale*	0–84	–
	little sunflower	HEPU3	*Helianthus pumilus*	0–84	–
	desertparsley	LOMAT	*Lomatium*	0–84	–
	bluebells	MERTE	*Mertensia*	0–84	–
	locoweed	OXYTR	*Oxytropis*	0–84	–
	ragwort	PACKE	*Packera*	0–84	–
	phlox	PHLOX	*Phlox*	0–84	–
	western coneflower	RUOC2	*Rudbeckia occidentalis*	0–84	–
	ragwort	SENEC	*Senecio*	0–84	–
	aster	SYMPH4	*Symphyotrichum*	0–84	–

	aster		*Symphyotrichum*	0–84	
	American vetch	VIAM	*Vicia americana*	0–84	–
	mule-ears	WYAM	*Wyethia amplexicaulis*	0–84	–
Shrub/Vine					
6				84–168	
	little sagebrush	ARAR8	*Artemisia arbuscula*	84–168	–
8				0–84	
	Shrub, deciduous	2SD	*Shrub, deciduous*	0–84	–
	Shrub, evergreen	2SE	*Shrub, evergreen*	0–84	–
	Tree, deciduous	2TD	*Tree, deciduous*	0–84	–
	Tree, evergreen	2TE	*Tree, evergreen*	0–84	–

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: Chris Krassin, 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.

Bestelmeyer, B., J. R. Brown, K. M. Havstad, B. Alexander, G. Chavez, 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.

NRCS. 2014. (electronic) National Water and Climate Center. Available online at http://www.wcc.nrcs.usda.gov/

NRCS. 2014. (electronic) Field Office Technical Guide. Available online at http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=WY NRCS. 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. (http://soils.usda.gov/technical/fieldbook/)

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. Pg.192-196.

USDA, NRCS. 1997. National Range and Pasture Handbook. (http://www.glti.nrcs.usda.gov/technical/publications/nrph.html)

Trlica, M. J. 1999. Grass growth and response to grazing. Colorado State University. Cooperative Extension. Range. 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, Baton Rouge, LA 70874-4490 USA.

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

USDA/NRCS Soil survey manuals for appropriate counties within MLRA 43B.

Western Regional Climate Center. (2014) (electronic) Station Metadata. Available online at: http://www.wrcc.dri.edu/summary/climsmwy.html.

Contributors

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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.

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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.

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

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

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

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent.

7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous and large woody litter not expected to move.

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 cool season rhizomatous grasses

    Sub-dominant: perennial forbs

    Other: perennial shrubs short, cool season bunchgrasses

    Additional:

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

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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.
