

Ecological site EX044B01A031

Limy Droughty (LyDr)

10-14" PZ Frigid

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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): 044B–Central Rocky Mountain Valleys

Major Land Resource Area (MLRA) 44B, Central Rocky Mountain Valleys, is nearly 3.7 million acres of southwest Montana and borders two MLRAs: 43B Central Rocky Mountains and Foothills and 46 Northern and Central Rocky Mountain Foothills. The major watersheds of this MLRA are those of the Missouri and Yellowstone Rivers and their associated headwaters such as the Beaverhead, Big Hole, Jefferson, Ruby, Madison, Gallatin, and Shields Rivers. These waters allow for extensive irrigation for crop production in an area that would generally only be compatible with rangeland and grazing. The Missouri River and its headwaters are behind several reservoirs that supply irrigation water, hydroelectric power, and municipal water. Limited portions of the MLRA are west of the Continental Divide along the Clark Fork River. The primary land use of this MLRA is production agriculture (grazing, small grain production, and hay), but there is some limited mining. Urban development is high with large expanses of rangeland converted to subdivisions for a rapidly growing population. The MLRA consists of one Land Resource Unit (LRU) and seven climate based LRU subsets. These subsets are based on a combination of Relative Effective Annual Precipitation (REAP) and frost free days. Each subset expresses a distinct set of plants that differentiate it from other LRU subsets. Annual precipitation ranges from a low of 9 inches to a high near 24 inches. The driest areas tend to be in the valley bottoms of southwest Montana in the rain shadow of the mountains. The wettest portions tend to be near the edge of the MLRA at the border with MLRA 43B. Frost free days also vary widely from less than 30 days in the Big Hole Valley to around 110 days in the warm valleys along the Yellowstone and Missouri Rivers. The plant communities of the MRLA are highly variable, but the dominant community is a cool-season grass and shrub-steppe community. Warm-season grasses have an extremely limited extent in this MLRA. Most subspecies of big sagebrush are present, to some degree, across the MLRA.

LRU notes

MLRA 44B has one LRU that covers the entire MLRA. The LRU has been broken into seven climate subsets based on a combination of Relative Effective Annual Precipitation (REAP) and frost free days. Each combination of REAP and frost free days results in a common plant community that is shared across the subset. Each subset is giving a letter designation of A through F for sites that do not receive additional water and Y for sites that receive additional water. LRU 01 Subset A has a REAP of nine to 14 inches (228.6-355.6mm) with a frost free days range of 70 to 110 days. This combination of REAP and frost free days results in a nearly treeless sagebrush steppe landscape. The soil moisture regime is Ustic, dry that borders on Aridic and has a Frigid soil temperature regime.

Classification relationships

Mueggler and Stewart. 1980. Grassland and Shrubland habitat types of Western Montana 1. *Stipa comata*/Bouteloua gracilis h.t. 2. *Agropyron spicatum*/Bouteloua gracilis h.t. Montana Natural Heritage Program Vegetation Classification 1. *Stipa comata* - Bouteloua gracilis Herbaceous Vegetation (STICOM – BOUGRA) Needle and thread/Blue grama Natural Heritage Conservation Rank-G5 / S5 Edition / Author- 99-11-16 / S.V. Cooper, EPA Ecoregions of Montana, Second Edition: Level I: Northwestern Forested Mountains Level II: Western Cordillera Level III: Middle Rockies & Northern Great Plains Level IV: Paradise Valley Townsend Basin Dry Intermontane Sagebrush Valleys Shield-Smith Valleys National Hierarchical Framework of Ecological Units: Domain: Dry Division: M330 – Temperate Steppe Division – Mountain Provinces Province: M332 –Middle Rocky Mountain Steppe – Coniferous Forest – Alpine Meadow Section: M332D – Belt Mountains Section M332E – Beaverhead Mountains Section Subsection: M332Ej – Southwest Montana Intermontane Basins and Valleys M332Dk – Central Montana Broad Valleys

Ecological site concept

The Limy Droughty ecological site is an upland site formed from colluvium, alluvium, or slope alluvium and is on slopes less than 60 percent. The site does not receive additional moisture from a water table or flooding. It is moderately deep to very deep and has no root-

restrictive layers within 20 inches (50cm). The surface of the site has less than five percent stone and is skeletal, with 35 percent or more rock fragments in the 10 to 20-inch depth. Soil surface texture ranges from sandy loam to clay loam in surface mineral 4 inches. The site does not have a saline or saline-sodic influence and is strongly or violently effervescent within four inches of the mineral surface. Calcium carbonates may increase with depth.

Associated sites

EX044B01A030	Limy (Ly) 10-14" PZ Frigid Limy ecological site occupies the same general landscape as the Limy Droughty.
EX044B01A036	Droughty (Dr) 10-14" PZ Frigid Shallow to Gravel, Limy tends to occupy the landscape position above the Limy Droughty site.

Similar sites

EX044B01A036	Droughty (Dr) 10-14" PZ Frigid The Droughty ecological site has a similar core plant community but differs in that it is not strongly or violently effervescent in the surface 4" of soil.
EX044B01A030	Limy (Ly) 10-14" PZ Frigid The Limy ecological site differs by being not skeletal within 20". Plant community is nearly identical with the exception of producing lower amounts of bluebunch wheatgrass.
EX044B01A137	Shallow to Gravel Limy (SwGrLy) 10-14" PZ Frigid The Shallow to Gravel, Limy ecological site shares a similar reference plant community however site differs in that the soil is sandy skeletal within 10-20" of soil surface and produces less above ground biomass

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Chrysothamnus viscidiflorus</i> (2) <i>Artemisia tridentata ssp. wyomingensis</i>
Herbaceous	(1) <i>Pseudoroegneria spicata</i> (2) <i>Hesperostipa comata</i>

Legacy ID

R044BA031MT

Physiographic features

This ecological site occurs on slopes ranging from nearly level to 60 percent; however, the representative slope is 4 to 10 percent. It is an area of dissected mountain valleys. The parent material is tertiary valley fill, alluvium, and slope alluvium of mixed geology.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Terrace (2) Intermontane basin > Fan remnant (3) Intermontane basin > Alluvial fan
Ponding frequency	None
Elevation	1,370 – 1,830 m
Slope	0 – 10 %
Water table depth	250 cm
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Ponding frequency	Not specified
Elevation	Not specified
Slope	0 – 60 %
Water table depth	Not specified

Climatic features

The Central Rocky Mountain Valleys MLRA has a continental climate. Fifty to sixty percent of the annual long-term average precipitation falls between May and August. Average precipitation for LRU A is 12 inches (305mm), and the frost-free period averages 78 days. Precipitation is highest in May and June.

Table 4 Representative climatic features

Frost-free period (characteristic range)	70-110 days
Freeze-free period (characteristic range)	110-140 days
Precipitation total (characteristic range)	230-360 mm
Frost-free period (actual range)	70-110 days
Freeze-free period (actual range)	110-140 days

Precipitation total (actual range)	230-360 mm
Frost-free period (average)	80 days
Freeze-free period (average)	130 days
Precipitation total (average)	310 mm

- (1) HELENA RGNL AP [USW00024144], Helena, MT
- (2) GARDINER [USC00243378], Gardiner, MT
- (3) DILLON AP [USW00024138], Dillon, MT
- (4) DEER LODGE 3 W [USC00242275], Deer Lodge, MT
- (5) TRIDENT [USC00248363], Three Forks, MT
- (6) BOULDER [USC00241008], Boulder, MT
- (7) DILLION U OF MONTANA WESTERN [USC00242409], Dillon, MT
- (8) ENNIS [USC00242793], Ennis, MT
- (9) TWIN BRIDGES [USC00248430], Sheridan, MT
- (10) TOWNSEND [USC00248324], Townsend, MT

Influencing water features

There are no water features influencing this site.

Wetland description

This site is not associated with wetlands.

Soil features

These soils are moderately deep to very deep, moderately to moderately rapid permeability, and well drained. These soils are formed from alluvium, colluvium, and slope alluvium. The soil is loamy-skeletal (rock fragments account for more than 35 percent of the volume in the 10 to 20-inch layer). This skeletal material decreases the water-holding capacity of the site. Typically, soil surface textures consist of loam, sandy loam, and loamy sand textures. Soils are also typically gravelly, very gravelly, very stony, or cobbly. Common soil series are Crago and Bronec. These soils may exist across multiple ecological sites due to natural variations in slope, texture, rock fragments, and pH. An onsite soil pit and the most current ecological site key are required to classify an ecological site.

Table 5. Representative soil features

Parent material	(1) Alluvium – igneous, metamorphic and sedimentary rock (2) Slope alluvium – igneous, metamorphic and sedimentary rock
Surface texture	(1) Gravelly loam (2) Sandy loam (3) Loamy sand
Family particle size	(1) Loamy

Drainage class	Moderately well drained to well drained
Permeability class	Moderately slow to moderately rapid
Soil depth	50 cm
Surface fragment cover <=3"	0 – 20 %
Surface fragment cover >3"	0 – 10 %
Available water capacity (0-101.6cm)	4.83 – 14.73 cm
Calcium carbonate equivalent (0-101.6cm)	20 %
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	0 – 10
Soil reaction (1:1 water) (0-101.6cm)	7.9 – 8.4
Subsurface fragment volume <=3" (25.4-50.8cm)	40 – 60 %
Subsurface fragment volume >3" (25.4-50.8cm)	20 – 60 %

Ecological dynamics

The Limy Droughty ecological site reference plant community is dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) and needle and thread (*Hesperostipa comata*). Subdominant species trend toward winterfat (*Krascheninnikovia lanata*) and Indian ricegrass (*Achnatherum hymenoides*). This potential is suggested by investigations showing a predominance of perennial grasses on near-pristine range sites (Ross et al., 1973). In the reference plant community, shrubs are a minor vegetative component.

The Limy Droughty ecological site occurs across a relatively large landscape; slight variations within the plant community occur due to elevation, frost-free days, and relative effective annual precipitation. Bluebunch wheatgrass, for example, occupies all known combinations of elevation and climate; however, under a drier moisture regime, it often shares dominance with needle and thread. These warmer, drier sites also tend to exhibit higher populations of warm-season shortgrasses such as blue grama and sand dropseed, especially when soil surface textures trend toward sandy loams. Conversely, colder, wetter sites within this Land Resource Unit often exhibit slight increases in Wyoming big sagebrush production, while bluebunch wheatgrass production also increases. Cold, dry rainshadow locations near the bases of the mountains express black sagebrush (*Artemisia nova*) as a dominant shrub.

Historical records indicate that, prior to the introduction of livestock (cattle and sheep) during the late 1800s, elk and bison grazed this ecological site. Because of the nomadic nature and herd structure of bison, grazed areas received periodic, high-intensity, short-duration grazing pressure. Livestock forage was noted as being minimal in areas recently grazed by bison (Lesica and Cooper 1997). Meriwether Lewis documented that he was met by 60 Shoshone warriors on horseback in August 1805, and the Corps of Discovery was later supplied with horses by the same band of Shoshone. This suggests that the areas near the modern-day Montana towns of Twin Bridges, Dillon, Grant, and Dell were grazed by an untold number of horses for nearly 50 years prior to the large introduction of cattle and sheep. The gold boom of the 1860s brought the first herds of livestock overland from Texas, and homesteaders began settling the area. During this time, cattle were the primary domestic grazers in the area. In the 1890s, sheep production increased by more than 400 percent and dominated the livestock industry until the 1930s. Since then, cattle production has dominated the region's livestock industry (Wyckoff and Hansen 2001).

Natural fire was a frequent ecological driver of this ecological site; however, due to the relatively low plant density and fire-resistant nature of the plants (saltbush and greasewood), stand replacement was rare. The reference community with a high amount of herbaceous growth as a result of favorable growing conditions has the highest susceptibility to extreme fire. A herbaceous invaded community that contains high amounts of exotic annual grasses can greatly increase the risk of fire frequency and intensity, resulting in the potential removal of native species.

Some of the major invasive species that can occur on this site include (but are not limited to) spotted knapweed (*Centaurea stoebe*), leafy spurge (*Euphorbia esula*), cheatgrass (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), dandelion (*Taraxicum spp.*), and Kentucky bluegrass (*Poa pratensis*). Invasive weeds have a high impact on this ecological site, and cheatgrass poses the highest risk of invasion.

Plant Communities and Transitions

A state and transition model for this ecological site is depicted below. Thorough descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field data, field observations, and interpretations by experts. It is likely to change as knowledge increases.

The plant communities within the same ecological site will differ across the MLRA due to the naturally occurring variability in weather, soils, and aspect. The biological processes on this site are complex; therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are intended to cover the core species and the known range of conditions and responses.

Both percent species composition by weight and percent canopy cover are referenced in this document. Canopy cover drives the transitions between communities and states because of the influence of shade, the interception of rainfall, and the competition for available water. Species composition by dry weight remains an important descriptor of the herbaceous community and of the community as a whole. Woody species are included in the species composition for the site. Calculating the similarity index requires species composition by dry weight.

Although there is considerable qualitative experience supporting the pathways and transitions within the State and Transition Model (STM), no quantitative information exists that specifically identifies threshold parameters between grassland types and invaded types in this ecological site. For information on STMs, see the following citations: Bestelmeyer et al. (2003), Bestelmeyer et al. (2004), Bestelmeyer and Brown (2005), and Stringham et al. (2003).

State and transition model

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	Cool Season Bunchgrasses			504-799	
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	448-757	–
	needle and thread	HECO26	<i>Hesperostipa comata</i>	168-532	–
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	25-80	–
	green needlegrass	NAVI4	<i>Nassella viridula</i>	25-50	–

	sand dropseed	SPCR	<i>Sporobolus cryptandrus</i>	0-50	-
2	Shortgrasses/Rhizomatous Grasses/Grasslikes			67-105	
	plains reedgrass	CAMO	<i>Calamagrostis montanensis</i>	17-53	-
	thickspike wheatgrass	ELLA3	<i>Elymus lanceolatus</i>	34-53	-
	western wheatgrass	PASM	<i>Pascopyrum smithii</i>	34-53	-
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	34-53	-
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	17-50	-
	needleleaf sedge	CADU6	<i>Carex duriuscula</i>	17-50	-
	threadleaf sedge	CAFI	<i>Carex filifolia</i>	17-50	-
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	34-50	-
	Grass, perennial	2GP	<i>Grass, perennial</i>	17-26	-
Forb					
3	Forbs			47-71	
	Forb, perennial	2FP	<i>Forb, perennial</i>	11-36	-
	fleabane	ERIGE2	<i>Erigeron</i>	24-35	-
	buckwheat	ERIOG	<i>Eriogonum</i>	24-35	-
	hairy false goldenaster	HEVI4	<i>Heterotheca villosa</i>	24-35	-
	desertparsley	LOMAT	<i>Lomatium</i>	24-35	-
	beardtongue	PENST	<i>Penstemon</i>	24-35	-
	spiny phlox	PHHO	<i>Phlox hoodii</i>	24-35	-
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	24-35	-
	American vetch	VIAM	<i>Vicia americana</i>	24-35	-
	ballhead sandwort	ARCO5	<i>Arenaria congesta</i>	17-28	-
	milkvetch	ASTRA	<i>Astragalus</i>	11-27	-
	Forb, annual	2FA	<i>Forb, annual</i>	0-11	-
Shrub/Vine					
4	Shrubs			54-85	
	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata ssp. wyomingensis</i>	27-43	-
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	0-43	-
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	17-43	-
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	24-43	-
	broom snakeweed	GUSA2	<i>Gutierrezia sarothrae</i>	0-27	-
	Gardner's saltbush	ATGA	<i>Atriplex gardneri</i>	11-27	-
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	0-27	-
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	0-27	-
	black sagebrush	ARNO4	<i>Artemisia nova</i>	11-27	-
	plains pricklypear	OPPO	<i>Opuntia polyacantha</i>	0-11	-

Table 7. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	Cool Season Bunchgrasses			472-757	
	needle and thread	HECO26	<i>Hesperostipa comata</i>	420-684	-
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	56-616	-
	green needlegrass	NAVI4	<i>Nassella viridula</i>	24-76	-
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	47-76	-

2	Shortgrasses/Rhizomatous grasses/Grasslike			63-101	
	thickspike wheatgrass	ELLA3	<i>Elymus lanceolatus</i>	31-56	-
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	31-50	-
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	31-50	-
	plains reedgrass	CAMO	<i>Calamagrostis montanensis</i>	31-50	-
	needleleaf sedge	CADU6	<i>Carex duriuscula</i>	31-50	-
	Grass, perennial	2GP	<i>Grass, perennial</i>	20-39	-
	threadleaf sedge	CAFI	<i>Carex filifolia</i>	20-34	-
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	0-26	-
	sand dropseed	SPCR	<i>Sporobolus cryptandrus</i>	0-26	-
Forb					
3	Forbs			31-50	
	Forb, perennial	2FP	<i>Forb, perennial</i>	16-26	-
	ballhead sandwort	ARCO5	<i>Arenaria congesta</i>	11-25	-
	milkvetch	ASTRA	<i>Astragalus</i>	11-25	-
	fleabane	ERIGE2	<i>Erigeron</i>	16-25	-
	buckwheat	ERIOG	<i>Eriogonum</i>	16-25	-
	hairy false goldenaster	HEVI4	<i>Heterotheca villosa</i>	16-25	-
	desertparsley	LOMAT	<i>Lomatium</i>	16-25	-
	beardtongue	PENST	<i>Penstemon</i>	16-25	-
	spiny phlox	PHHO	<i>Phlox hoodii</i>	16-25	-
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	16-25	-
	American vetch	VIAM	<i>Vicia americana</i>	16-25	-
	Forb, annual	2FA	<i>Forb, annual</i>	0-11	-
Shrub/Vine					
4	Shrubs			63-101	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	31-50	-
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	31-50	-
	broom snakeweed	GUSA2	<i>Gutierrezia sarothrae</i>	11-50	-
	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata ssp. wyomingensis</i>	31-50	-
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	22-45	-
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	0-45	-
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	0-28	-
	black sagebrush	ARNO4	<i>Artemisia nova</i>	0-28	-
	Gardner's saltbush	ATGA	<i>Atriplex gardneri</i>	11-25	-
	plains pricklypear	OPPO	<i>Opuntia polyacantha</i>	0-11	-

Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 9. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 10. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 11. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 12. Community 5.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Animal community

The Limy Droughty ecological site provides a variety of wildlife habitats for an array of species. Prior to the settlement of this area, large herds of antelope, elk, and bison roamed. Though the bison have been replaced, mostly with domesticated livestock, elk and antelope still frequently utilize this largely intact landscape for winter habitat in areas adjacent to forests. The relatively high grass component of the Reference Community provides excellent nesting cover for multiple neotropical migratory birds that select for open grasslands, such as the long-billed curlew and McCown's longspur. Greater sage grouse may be present on sites with suitable habitat, typically requiring a minimum of 15 percent sagebrush canopy cover (Wallestad 1975). The Bluebunch Wheatgrass Community (1.1) is likely to have minimal sage grouse presence given its low sagebrush canopy cover. However, the potentially diverse forb component of the Bunchgrass State may provide important early-season (spring) foraging habitat for the greater sage-grouse. Other communities on the site with sufficient sagebrush cover may harbor sage grouse populations, specifically Community 2.1 (the Needle and Thread Community), where big sagebrush populations are under a reduced fire regime. Also, as sagebrush canopy cover increases under Altered States 2.1 and 2.2 and, to a limited extent, under Degraded State 3.1, pygmy rabbit, Brewer's sparrow, and mule deer use may also increase. Managed livestock grazing is suitable on this site due to the potential to produce an abundance of high-quality forage. This is often a preferred site for grazing by livestock, and animals tend to congregate in these areas. To maintain the productivity of the Limy site, grazing on adjoining sites with less production must be managed carefully to be sure utilization on this site is not excessive. Management objectives should include maintenance or improvement of the native plant community. Careful management of the timing and duration of grazing is important. Shorter grazing periods and adequate deferment during the growing season are recommended for plant maintenance, health, and recovery. According to McLean et al., early-season defoliation of bluebunch wheatgrass can result in high mortality and reduced vigor in plants. They also suggest, based on prior studies, that regrowth is necessary before dormancy to reduce bluebunch injury. Since needle and thread normally matures earlier than bluebunch wheatgrass and produces a sharp awn, this species is usually avoided after seed set. Changing the grazing season of use will help utilize needle and thread more efficiently while preventing overuse of bluebunch wheatgrass. The grazing season has a greater impact on winterfat than the intensity of grazing. Late winter or early spring grazing is detrimental. However, early winter grazing may actually be beneficial (Blaisdell 1984). Continual non-prescribed grazing of this site will be detrimental, will alter the plant composition and production over time, and will result in the transition to the Altered Bunchgrass State. The transition to other states will depend on the duration of poorly managed grazing as well as other circumstances such as weather conditions and fire frequency. The Altered State can degrade further to the Degraded Shortgrass State or the Invaded State. Management should focus on grazing management strategies that will prevent further degradation, such as seasonal grazing deferment or winter grazing where feasible. Communities within this state are still stable and healthy under proper management. Forage quantity and/or quality may be substantially decreased from the Bunchgrass State. Grazing is possible in the Invaded State. Invasive species are generally less palatable than native grasses. Forage production is typically greatly reduced in this state. Due to the aggressive nature of invasive species, sites in the Invaded State face an increased risk of further degradation by invasive-dominant communities. Grazing has to be carefully managed to avoid further soil loss and degradation and possible livestock health issues. Prescriptive grazing can be used to manage invasive species. In some instances, carefully targeted grazing (sometimes in combination with other treatments) can reduce or maintain the species composition of invasive species. Grazing may be possible in a degraded state, but it is generally not economically or environmentally sustainable.

Hydrological functions

The hydrologic cycle functions best in the Bunchgrass State (1) with good infiltration and deep percolation of rainfall; however, the cycle degrades as the vegetation community declines. Rapid rainfall infiltration, high soil organic matter, good soil structure, and good porosity accompany a high bunchgrass canopy cover of around 80 percent. High ground cover reduces raindrop impact on the soil surface, which keeps erosion and sedimentation transport low. Water leaving the site will have a minimal sediment load, which allows for high water quality in associated streams. High rates of infiltration will allow water to move below the rooting zone during periods of heavy rainfall. The Bluebunch Wheatgrass Community (1.1) should have no rills or gullies present, and drainage ways should be vegetated and stable. Water flow patterns, if present, will be barely observable. Plant pedestals are essentially nonexistent. Plant litter remains in place and is not moved by wind or water. Improper grazing management results in a community shift to the Mixed Bunchgrass Community (1.2). This plant community has a similar canopy cover, but the bare ground will be less than 15 percent. Therefore, the hydrologic cycle is functioning at a level similar to the water cycle in the Bluebunch Wheatgrass Community (1.1). Compared to the Bluebunch Wheatgrass Community (1.1), infiltration rates are slightly reduced and surface runoff is slightly higher. In the Shortgrass Community (2.2), Degraded Shortgrass State (3), and the Invaded State (4), canopy and ground cover are greatly reduced compared to the Bunchgrass State (1), which impedes the hydrologic cycle. Infiltration will decrease and runoff will increase due to reduced ground cover, the presence of shallow-rooted species, rainfall splash, soil capping, reduced organic matter, and poor structure. Sparse ground cover and decreased infiltration can combine to increase the frequency and severity of flooding within a watershed. Soil erosion is accelerated, the quality of surface runoff is poor, and sedimentation increases.

Recreational uses

This site provides some limited recreational opportunities for hiking, horseback riding, big game and upland bird hunting. The forbs have flowers that appeal to photographers. This site provides valuable open space.

Wood products

This site is not suitable for wood products.

Inventory data references

Information presented was derived from the site's Range Site Description (Limy Droughty 9 –14" P.Z., Northern Rocky Mountain Valleys, South, East of Continental Divide), NRCS clipping data, literature, field observations, and personal contacts with range-trained personnel (i.e., used professional opinion of agency specialists, observations of land managers, and outside scientists).

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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)	Grant Petersen
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Date	11/02/2015
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. Number and extent of rills: Rills are not present in the reference condition on slopes less than 20%. Slopes greater than 20% rills may exist but will be limited and less than 1 foot.

2. Presence of water flow patterns: Water flow patterns are rare in the reference condition. If present, they are most likely to occur on steeper slopes (20%) and are inconspicuous, disconnected, and very short in length.

3. Number and height of erosional pedestals or terracettes: No pedestals or terracettes present.

4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):
Less than 25%

5. Number of gullies and erosion associated with gullies: No gullies present.

6. Extent of wind scoured, blowouts and/or depositional areas: None

7. Amount of litter movement (describe size and distance expected to travel): Movement of fine herbaceous litter may occur within less than a foot from where it originated.

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values): Soil Surface Stable with Stability Ratings of 4-6 (both under canopy and bare). Biotic crusts and or root mats may be present.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil Structure at the surface is typically medium fine granular to weak subangular blocky. A Horizon should be 2-4 inches thick with color, when wet, typically ranging in Value of 4 or less and Chroma of 3 or less. Local geology may affect color in which it is important to reference the Official Series Description (OSD) for characteristic range.
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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Evenly distributed across the site, bunchgrasses improve infiltration while rhizomatous grass protects the surface from runoff forces. The Limy Droughty ecological site is well drained and has a high infiltration rate. An even distribution of mid stature grasses, ~70-75% of site production, cool season rhizomatous grasses 10% of site production along with a mix of shortgrass 5-15%, forbs and shrubs (1-10%).
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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):** Not present.
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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-statured, cool season, perennial bunchgrasses
- Sub-dominant: Shortgrasses ? rhizomatous grasses > shrubs = perennial forbs
- Other:
- Additional:
-
13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Little evidence of mortality on any species.
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14. **Average percent litter cover (%) and depth (in):** Litter cover varies from approximately 30 to 40%; comprised of primarily herbaceous litter. Most litter is irregularly distributed on the soil surface and is not at a measurable depth.
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Average annual production is 850. Low: 600 High 950 lbs per acre. Production varies based on effective precipitation and natural variability of soil properties for this ecological site.
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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:** Non-native invasive species on this ecological site include: Dandelion (*Taraxicum spp*), Cheatgrass (*Bromus techtorum*), Field brome (*Bromus arvensis*), Spotted

knapweed (*Centaurea stoebe*), Yellow toadflax (*Linaria vulgaris*), Leafy Spurge (*Euphorbia esula*). Native species with the ability to indicate degradation however species presence alone does not imply degradation: Sandberg bluegrass (*Poa secunda*), Big sagebrush (*Artemisia tridentata*), Spineless horsebrush (*Tetradymia canescens*), Broom snakeweed (*Gutierrezia sarothrae*), Rubber rabbitbrush (*Ericameria nauseosa*), Yellow rabbitbrush (*Chrysothamnus viscidiflorus*), Rocky Mountain Juniper (*Juniperus scopulorum*), Douglas fir (*Pseudotsuga menziesii*), Ponderosa pine (*Pinus ponderosa*)

17. **Perennial plant reproductive capability:** In the reference condition, all plants are vigorous enough for reproduction either by seed or rhizomes in order to balance natural mortality with species recruitment. Density of plants indicates that plants reproduce at level sufficient to fill available resource.
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