Ecological site EX044B01C036
Droughty (Dr) 15-19" PZ
Frigid
North

Last updated: 3/03/2025
Accessed: 07/10/2026

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. This MLRA borders two other MLRAs: 43B, Central Rocky Mountains and Foothills, and 46, Northern and Central Rocky Mountain Foothills. The major watersheds of this MLRA are the Missouri and Yellowstone Rivers and their associated headwaters, such as the Beaverhead, Big Hole, Jefferson, Ruby, Madison, Gallatin, and Shields Rivers. Limited portions of the MLRA are west of the Continental Divide along the Clark Fork River. These waters allow for extensive irrigation for crop production in an area that is generally only compatible with rangeland and grazing. The Missouri River and its headwaters are behind several reservoirs used for irrigation water, hydroelectric power, and municipal water. The primary land use of this MLRA is production agriculture (grazing, small grain production, and hay) with limited mining. Urban development is high, with large expanses of rangeland being converted to subdivisions for a rapidly growing population. MLRA 44B consists of one Land Resource Unit (LRU) and 7 Climate-based LRU subsets. Annual precipitation ranges from a low of 9 inches to a high of 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 edges of the MLRA, where it borders MLRA 43B. Frost-free periods also vary greatly, with less than 30 days in the Big Hole Valley to approximately 110 days in the warm valleys along the Yellowstone and Missouri Rivers. MLRA 44B’s plant communities are highly variable but are dominated by a cool-season grass and shrub-steppe community on the rangeland and a mixed coniferous forest in the mountains. Warm-season grasses occupy an extremely limited extent and number of species in this MLRA. Most subspecies of big sagebrush are present, to some extent, across the MLRA.

LRU notes

LRU 01 Subset C Central Concept: • Moisture Regime: Ustic • Temperature Regime: Frigid • Dominant Cover: rangeland (mixed grassland and sagebrush steppe) • Representative Value (RV) of range of Effective Precipitation: 15 to 19 inches • Representative Value (RV) of range of Frost Free Days: 75 to 105days This LRU subset exists in northern portion of MLRA 44B particularly in Meagher, Powell, Broadwater, Lewis and Clark, Granite, and Deer Lodge Counties.

Classification relationships

Mueggler and Stewart. 1980. Grassland and Shrubland habitat types of Western Montana 1. Artemisia tridentata/Agropyron spicatum h.t. 2. Agropyron spicatum/Agropyron smithii h.t. 3. Artemisia tridentata/Festuca scabrella h.t. 4. Agropyron spicatum/Bouteloua gracilis h.t. 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 Level I: Great Plains Level II: West-Central Semi-Arid Prairies Level III: Northwestern Great Plains Level IV: Shield-Smith Valleys Non-calcareous Foothill Grassland

Ecological site concept

• Site does not receive any additional water • Site is less than 15 percent slope • Soils are o Generally not saline or saline-sodic o Moderately deep, deep, or very deep o Typically less than 5 percent stone and boulder cover (15 percent max) o Soil surface texture ranges from loam to clay loam in surface mineral 4 inches o Skeletal (greater than 35 percent rock fragments) at 10-20 inch soil control section o Not strongly or violently effervescent within surface mineral 4 inches • Parent material is alluvium and colluvium

Associated sites

EX044B01B032	**Loamy 15-19" PZ Frigid** EX044B01C032 The Loamy ecological site often occupies similar landscape position and has a similar plant community.
EX044B01B040	**Loamy Steep 15-19" PZ Frigid** EX044B01C040 The Loamy Steep ecological site often occupies nearby landscape positions. Sites share similar plant communities.

Similar sites

EX044B01B032	**Loamy 15-19" PZ Frigid** EX044B01C032 The Loamy ecological site often occupies similar landscape position and has a similar plant community.
EX044B01B040	**Loamy Steep 15-19" PZ Frigid** EX044B01C040 The Loamy Steep ecological site often occupies nearby landscape positions. Sites share similar plant communities.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. wyomingensis* (2) *Tetradymia canescens*
Herbaceous	(1) *Festuca campestris* (2) *Pseudoroegneria spicata*

Legacy ID

R044BC036MT

Physiographic features

This ecological site occurs on alluvial fans, valley floors, fan remnants, and eroded fan remnants. The Droughty ecological site may exist on slopes ranging from one (1) to 15 percent, but the core concept slopes of this site are four (4) to 10 percent.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Alluvial fan (2) Intermontane basin > Valley floor (3) Intermontane basin > Fan remnant (4) Intermontane basin > Eroded fan remnant

Runoff class	Negligible to low
Flooding frequency	None
Ponding frequency	None
Elevation	1,220 – 1,800 m
Slope	0 – 20 %
Water table depth	120 cm
Aspect	Aspect is not a significant factor

Climatic features

The Central Rocky Mountain Valleys MLRA has a continental climate. 50 to 60 percent of the annual long-term average total precipitation falls between May and August with the highest in May and June. Most of the precipitation in the winter is snow on frozen ground. Average precipitation for LRU 01 Subset C is 15 inches, and the frost-free period averages 75 to 105 days.

Table 3 Representative climatic features

Frost-free period (characteristic range)	80-110 days
Freeze-free period (characteristic range)	110-140 days
Precipitation total (characteristic range)	360-430 mm
Frost-free period (actual range)	80-110 days
Freeze-free period (actual range)	110-140 days
Precipitation total (actual range)	330-510 mm
Frost-free period (average)	90 days
Freeze-free period (average)	120 days
Precipitation total (average)	380 mm

- (1) WILSALL 8 ENE [USC00249023], Wilsall, MT
- (2) ANACONDA [USC00240199], Anaconda, MT
- (3) AUSTIN 1 W [USC00240375], Helena, MT
- (4) PHILIPSBURG RS [USC00246472], Philipsburg, MT
- (5) LENNEP 5 SW [USC00244954], White Sulphur Springs, MT
- (6) BOZEMAN MONTANA ST U [USC00241044], Bozeman, MT

Influencing water features

No water features are associated with this site.

Wetland description

Site is not associated with wetlands.

Soil features

These soils are moderately deep to very deep, have moderately slow to moderately rapid permeability, and are well drained. These soils are formed from alluvium and residuum. Typically, soil surface textures consist of loam, silt loam, and clay loam textures. Clay content will be less than 32 percent in the top four (4) inches of soil surface. Soils may have a gravelly surface, but this may vary based on landscape position and associated parent material. The soil will have greater than 35 percent rock fragments in the 10 to 20 inch soil control section. The common soil series in this ecological site is primarily Shawmut. This soil 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 4. Representative soil features

Parent material	(1) Alluvium – igneous, metamorphic and sedimentary rock (2) Residuum – igneous, metamorphic and sedimentary rock
Surface texture	(1) Loam (2) Silt loam (3) Clay loam
Family particle size	(1) Loamy-skeletal (2) Clayey-skeletal
Drainage class	Moderately well drained to well drained
Permeability class	Slow to moderately rapid
Soil depth	50 – 150 cm
Surface fragment cover <=3"	10 – 20 %
Surface fragment cover >3"	0 – 20 %

Available water capacity (0-101.6cm)	7.11 – 12.19 cm
Calcium carbonate equivalent (0-101.6cm)	0 – 20 %
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	0 – 10
Soil reaction (1:1 water) (0-101.6cm)	6.3 – 7.8
Subsurface fragment volume <=3" (25.4-50.8cm)	40 – 60 %
Subsurface fragment volume >3" (25.4-50.8cm)	0 – 40 %

Table 5. Representative soil features (actual values)

Drainage class	Moderately well drained to well drained
Permeability class	Slow to moderately rapid
Soil depth	50 – 250 cm
Surface fragment cover <=3"	0 – 30 %
Surface fragment cover >3"	0 – 20 %
Available water capacity (0-101.6cm)	5.08 – 12.7 cm

Calcium carbonate equivalent (0-101.6cm)	0 – 20 %
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0 – 10
Soil reaction (1:1 water) (0-101.6cm)	6.3 – 10
Subsurface fragment volume <=3" (25.4-50.8cm)	20 – 80 %
Subsurface fragment volume >3" (25.4-50.8cm)	0 – 80 %

Ecological dynamics

The reference plant community is dominated by bluebunch wheatgrass (Pseudoroegneria spicata) and rough fescue (Festuca campestris). Subdominant species may include green needlegrass (Nassella viridula), Idaho fescue (Festuca idahoensis), needle and thread (Hesperostipa comata), Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), and winterfat (Krascheninnikovia lanata). This potential is suggested by investigations showing a predominance of perennial grasses on near-pristine range sites (Ross et al., 1973).

The Droughty ecological site in LRU 01 Subset C occurs across a relatively small landscape, though slight variations within the plant community may occur due to elevation, frost-free days, and relative effective annual precipitation.

A shift to the dominance of shrubs may occur in response to improper grazing management, drought, or where big sagebrush occurs due to a lack of fire. Shrub encroachment by a variety of species, including broom snakeweed (Gutierrezia sarothrae), prairie sagewort (Artemisia frigida), Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), antelope bitterbrush (Purshia tridentata), yellow rabbitbrush (Chrysothamnus viscidiflorus), and plains prickly pear (Opuntia polyacantha) occurs within this site as the mid-stature bunchgrasses decrease, Shrub dominance and grass loss are associated with soil erosion and, ultimately, thinning of the native soil surface. Subsequent loss of soil could lead to a Degraded State. All states could also lead to the Invaded State when there is a lack of weed prevention and control measures.

Historical records indicate that, prior to the introduction of livestock (cattle and sheep) during the late 1800s, elk and bison grazed this ecological site. Grazed areas received periodic high intensity, short duration grazing pressure due to bison's nomadic nature and herd structure. Forage for livestock was noted as minimal in areas recently grazed by bison (Lesica and Cooper 1997). The gold boom in 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, Montana sheep production began to increase (by more than 400 percent) and dominated the livestock industry until the 1930s. Since the 1930s, cattle production has dominated the livestock industry in the region (Wyckoff and Hansen 2001).

Natural fire was a major ecological driver of this entire ecological site. Fire tended to restrict tree and sagebrush growth to small patches and promote an herbaceous plant community. The natural fire return interval was highly variable, ranging up to 100 years; however, it was likely shorter than 35 years (Arno and Gruell 1983). Since 1910, there has been a significant increase in the suppression of fire in sagebrush and trees.

Due to the relatively high rock fragment content of the soils on this site, the potential for conversion to farmland is low. Forage crop production may exist on this ecological site, however the acreage and extent is extremely limited.

Lesser spikemoss (Selaginella densa), in general, is a minor component of the reference plant community of the Droughty ecological site. The conditions that created large cover classes of clubmoss on this site point to a history of continuous (yearlong) or moderate spring grazing use (Sturm 1954). In some situations, the site could be old crop fields that have reverted back to rangeland. In this case, spikemoss is helping reduce erosion and increase site stability, especially where livestock use is restricted (such as in CRP). While lesser spikemoss provides soil stability on sites where it exists, anecdotal evidence suggests that it competes for the limited water resources in the upper soil profile, which restricts the amount of water available to plants. However, a study from Canada in a similar climate on similar soils indicates that the correlation between reduced plant-available water and spikemoss cover is negligible (Colberg and Romo 2003). Despite the lack of quantitative evidence, the relationship between decreased plant production and decreased soil moisture may simply be due to competition for space. Dense patches of spikemoss also inhibit seed contact with the soil, reducing seedling recruitment.

The following are some of the major invasive species that can occur on this site: spotted knapweed (Centaurea stoebe), leafy spurge (Euphorbia esula), sulphur cinquefoil (Potentilla recta), cheatgrass (Bromus tectorum), field brome (Bromus arevensis), yellow toadflax (Linaria vulgaris), and dandelion (Taraxicum spp.). Invasive weeds are beginning to have a high impact on this ecological site due to primarily human impacts from mismanaged grazing and urban development.

Plant Communities and Transitions

A state and transition model (STM) for this Droughty 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.

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	**Mid-Statured bunchgrasses**			925-1289	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	841-1149	35-65
	rough fescue	FECA4	*Festuca campestris*	168-308	15-20
	green needlegrass	NAVI4	*Nassella viridula*	84-196	7-15
	needle and thread	HECO26	*Hesperostipa comata*	135-168	10-15
	basin wildrye	LECI4	*Leymus cinereus*	0-56	0-2
2	**Shortgrasses/sedges**			168-269	
	prairie Junegrass	KOMA	*Koeleria macrantha*	45-90	3-5
	Sandberg bluegrass	POSE	*Poa secunda*	45-90	3-5
	Idaho fescue	FEID	*Festuca idahoensis*	56-90	3-5
	needleleaf sedge	CADU6	*Carex duriuscula*	11-56	1-3
	blue grama	BOGR2	*Bouteloua gracilis*	22-45	1-2
	threadleaf sedge	CAFI	*Carex filifolia*	0-39	0-1
3	**Rhizomatous grasses**			101-213	
	western wheatgrass	PASM	*Pascopyrum smithii*	56-135	2-5
	thickspike wheatgrass	ELLA3	*Elymus lanceolatus*	56-135	2-5

	plains reedgrass	CAMO	*Calamagrostis montanensis*	0-56	0-2
Forb					
4	**Forbs**			84-135	
	purple prairie clover	DAPU5	*Dalea purpurea*	45-90	1-2
	American vetch	VIAM	*Vicia americana*	22-84	1-2
	dotted blazing star	LIPU	*Liatris punctata*	45-84	1-2
	spiny phlox	PHHO	*Phlox hoodii*	0-56	0-1
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	22-56	1
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	22-45	1
	bastard toadflax	COUM	*Comandra umbellata*	0-45	0-1
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	0-45	0-1
	common yarrow	ACMI2	*Achillea millefolium*	22-45	1
	slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	22-45	1
	little larkspur	DEBI	*Delphinium bicolor*	0-22	1
	fleabane	ERIGE2	*Erigeron*	11-22	0-1
	buckwheat	ERIOG	*Eriogonum*	11-22	0-1
	cinquefoil	POTEN	*Potentilla*	0-22	0-1
	onion	ALLIU	*Allium*	0-22	0-1
	milkvetch	ASTRA	*Astragalus*	0-22	0-1
	desertparsley	LOMAT	*Lomatium*	0-21	0-1
Shrub/Vine					
5	**Shrubs**			101-196	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	67-196	10-20
	spineless horsebrush	TECA2	*Tetradymia canescens*	0-67	0-3
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	11-56	0-3
	common snowberry	SYAL	*Symphoricarpos albus*	11-45	0-5
	Woods' rose	ROWO	*Rosa woodsii*	11-45	0-2
6	**Subshrubs**			22-56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	22-56	1-5
	slender buckwheat	ERMI4	*Eriogonum microthecum*	0-22	0-1
	white sagebrush	ARLU	*Artemisia ludoviciana*	0-22	0-1
	prairie sagewort	ARFR4	*Artemisia frigida*	0-22	0-1
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0-11	0-1

Table 7. Community 1.2 plant community composition

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

Table 8. Community 2.1 plant community composition

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

Table 9. Community 2.2 plant community composition

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

Table 10. Community 3.1 plant community composition

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

Table 11. Community 4.1 plant community composition

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

Table 12. Community 5.1 plant community composition

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

Animal community

The Droughty ecological site provides a variety of wildlife habitat 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 habitat. 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 Mid-Statured Bunchgrass Community is likely to have this minimum sagebrush cover for sage grouse presence given its low to moderate sagebrush canopy cover. Also, the potentially diverse forage component of the Reference 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, where big sagebrush populations increased under a reduced fire regime. Also, as sagebrush canopy cover increases under Altered States 2.1 and 2.2 and, to a limited extent, in Degraded State 3.1, pygmy rabbit, Brewer's sparrow, pronghorn antelope, 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 Loamy site, grazing on adjacent sites with lower productivity must be carefully managed to ensure that 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 injury to bluebunch. Since needle and thread normally matures earlier than bluebunch wheatgrass and rough fescue 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 and rough fescue. The grazing season has a greater impact on winterfat than grazing intensity. 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 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 is subject to further degradation to the Degraded State or 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 Reference 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. 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 Reference State 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 high bunchgrass canopy cover. 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 Mid-Statured Bunchgrass Community 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. 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 Mid-Statured Bunchgrass Community. Compared to the Mid-Statured Bunchgrass Community, infiltration rates are slightly reduced and surface runoff is slightly higher. In the Needle and Thread/Shortgrass Community, the Degraded State, and the Invaded State, canopy and ground cover are greatly reduced compared to the Reference State, 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. The hydrology of the Conifer Encroached State is highly variable, but studies suggest that an increased tree canopy affects the interception of rainfall and reduces available soil moisture for herbaceous vegetation. This can negatively affect infiltration and increase runoff.

Recreational uses

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

Wood products

This site does not produce forest products.

Inventory data references

Information presented was derived from the site's Range Site Description (Droughty,15-19 inch 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).

References

. (Date accessed). **Fire Effects Information System**. http://www.fs.fed.us/database/feis/.

. 2021 (Date accessed). **USDA PLANTS Database**. http://plants.usda.gov.

Arno, S.F. and G.E. Gruell. 1982. Fire History at the Forest-Grassland Ecotone in Southwestern Montana. Journal of Range Management 36:332–336.

Barrett, H. 2007. Western Juniper Management: A Field Guide.

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

Bestelmeyer, B. and J. Brown. 2005. State-and-Transition Models 101: A Fresh look at vegetation change.

Blaisdell, J.P. 1958. Seasonal development and yield of native plants on the Upper Snake River Plains and their relation to certain climate factors.

Blaisdell, J.P. and R.C. Holmgren. 1984. Managing Intermountain Rangelands--Salt-Desert Shrub Ranges. General Tech Report INT-163. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 52.

Bunting, S.C., B.M. Kilgore, and C.L. Bushey. 1987. Guidelines for Prescribe burning sagebrush-grass rangelands in the Northern Great Basin. General Technical Report INT-231. USDA Forest Service Intermountain Research Station, Ogden, UT. 33.

Colberg, T.J. and J.T. Romo. 2003. Clubmoss effects on plant water status and standing crop. Journal of Range Management 56:489–495.

Daubenmire, R. 1970. Steppe vegetation of Washington.

DiTomaso, J.M. 2000. Invasive weeds in Rangelands: Species, Impacts, and Management. Weed Science 48:255–265.

Dormaar, J.F., B.W. Adams, and W.D. Willms. 1997. Impacts of rotational grazing on mixed prairie soils and vegetation. Journal of Range Management 50:647–651.

Hobbs, J.R. and S.E. Humphries. 1995. An integrated approach to the ecology and management of plant invasions. Conservation Biology 9:761–770.

Kuchler, A.W. 1964. Potential natural vegetation of the conterminous United States.

Lacey, J.R., C.B. Marlow, and J.R. Lane. 1989. Influence of Spotted knapweed (Centaurea maculosa) on surface runoff and sediment yield.. Weed Technology 3:627–630.

Lesica, P. and S.V. Cooper. 1997. Presettlement vegetation of Southern Beaverhead County, MT.

Manske, L.L. 1980. Habitat, phenology, and growth of selected sandhills range plants.

Masters, R. and R. Sheley. 2001. Principles and practices for managing rangeland invasive plants. Journal of Range Management 38:21–26.

McCalla, G.R., W.H. Blackburn, and L.B. Merrill. 1984. Effects of Livestock Grazing on Infiltration Rates of the Edwards Plateau of Texas. Journal of Range Management 37:265–269.

McLean, A. and S. Wikeem. 1985. Influence of season and intensity of defoliation on bluebunch wheatgrass survival and vigor in southern British Columbia. Journal of Range Management 38:21–26.

Miller, R.F., T.J. Svejcar, and J.A. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53:574–585.

Moulton, G.E. and T.W. Dunlay. 1988. The Journals of the Lewis and Clark Expedition. Pages in University of Nebraska Press.

Mueggler, W.F. and W.L. Stewart. 1980. Grassland and Shrubland Habitat Types of Western Montana.

Pelant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting Indicators of Rangeland Health.

Pellant, M. and L. Reichert. 1984. Management and Rehabilitation of a burned winterfat community in Southwestern Idaho. Proceedings--Symposium on the biology of Atriplex and related Chenopods. 1983 May 2-6; Provo UT General Technical Report INT-172.. USDA Forest Service Intermountain Forest and Range Experiment Station. 281–285.

Pitt, M.D. and B.M. Wikeem. 1990. Phenological patterns and adaptations in an Artemisia/Agropyron plant community. Journal of Range Management 43:350–357.

Pokorny, M.L., R. Sheley, C.A. Zabinski, R. Engel, T.J. Svejcar, and J.J. Borkowski. 2005. Plant Functional Group Diversity as a Mechanism for Invasion Resistance.

Wambolt, C. and G. Payne. 1986. An 18-Year Comparison of Control Methods for Wyoming Big Sagebrush in Southwestern Montana. Journal of Range Management 39:314–319.

West, N.E. 1994. Effects of Fire on Salt-Desert shrub rangelands. Proceedings--Ecology and Management of Annual Rangelands: 1992 May 18-22. Boise ID General Technical Report INT-GTR-313.. USDA Forest Service Intermountain Research Station. 71–74.

Whitford, W.G., E.F. Aldon, D.W. Freckman, Y. Steinberger, and L.W. Parker. 1989. Effects of Organic Amendments on Soil Biota on a Degraded Rangeland. Journal of Range Management 41:56–60.

Wilson, A.M., G.A. Harris, and D.H. Gates. 1966. Cumulative Effects of Clipping on Yield of Bluebunch wheatgrass. Journal of Range Management 19:90–91.

Contributors

Petersen
Synergy, Ricketts, Gibbons

Approval

Grant Petersen, 3/03/2025

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)	G. Petersen K. Walstad N. Rife R. Caquelin
Contact for lead author	grant.petersen@usda.gov
Date	03/01/2020
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.**

2. **Presence of water flow patterns:** **Water flow patterns are rare in the reference condition.**

3. **Number and height of erosional pedestals or terracettes:** **Pedestals are not evident in the reference condition.**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is less than 15 percent.

---

5. **Number of gullies and erosion associated with gullies:** Gullies are not present in the reference condition.

---

6. **Extent of wind scoured, blowouts and/or depositional areas:** Wind scoured, or depositional areas are not evident in the reference condition.

---

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. Scurfpea species may tumble significant distances for seed dispersal.

---

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). Abiotic crusts and/or root mats may be present. The A horizon is 4-7 inches thick.

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil Structure at the surface is typically strong to medium fine granular. The A horizon should be 4-7 inches thick with color, when wet, typically ranging in Value of 3 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).

---

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 Droughty ecological site is well drained and has a moderate infiltration rate. An even distribution of mid stature bunchgrasses, cool season shortgrasses, cool season rhizomatous grasses, forbs, and shrubs

---

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** A compaction layer is not present in the Reference State.

---

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, primarily bluebunch wheatgrass, needle and thread, rough fescue, and green needlegrass

    Sub-dominant: perennial shortgrasses and grasslikes > rhizomatous grasses ? shrubs = forbs

    Other:

    Additional:

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Mortality in herbaceous species is not evident. Species with bunch growth forms may have some natural mortality in centers.

---

14. **Average percent litter cover (%) and depth (in):** Total litter cover ranges from 30 to 40 percent. Most litter is irregularly distributed on the soil surface and is not at a measurable depth.

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Average annual production is 1500. Low: 1200. High 1700 lbs per acre. Production varies based on effective precipitation and natural variability of soil properties for this ecological site.

---

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:** Potential invasive (including noxious) species (native and non-native). Invasive species on this ecological site include (but not limited to) annual brome spp., spotted knapweed, yellow toadflax, leafy spurge, ventenata, dandelion, crested wheatgrass, Kentucky bluegrass, etc. Native species such as Rocky Mountain juniper, ponderosa pine, broom snakeweed, rabbitbrush, blue grama, Sandberg’s bluegrass, etc. when their populations are significant enough to affect ecological function, indicate site condition departure.

---

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.
