

Ecological site R044AA136MT

Shallow Loamy (Swlo)

LRU 44A-A

Last updated: 2/05/2022
Accessed: 08/15/2026

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): 044A–Northern Rocky Mountain Valleys

For further information regarding MLRAs, refer to: <http://soils.usda.gov/survey/geography/mlra/index.html> Land Resource Unit (LRU) 44A-A: • Moisture Phase: xeric, dry - ustic, dry • Temperature Phase: frigid warm • Dominant Cover: rangeland • Representative Value (RV) Effective Precipitation: 10-14 inches • RV Frost Free Days: 90-120 days Site Concept: Site does not receive any additional water Soils are: • shallow (10-20" deep). • not strongly or violently effervescent in surface mineral 4". • not skeletal. Clay content is 32% in surface mineral 4". Typically soil texture is loam, clay loam, or silt loam in surface mineral 4".

Associated sites

R044AA001MT	Clayey (Cy) LRU 44A-A The Clayey site has soils with >32% clay content., whereas the Shallow Loamy site has <32% clay content.
R044AA032MT	Loamy (Lo) LRU 44A-A The Loamy site has deep to very deep soils, whereas the Shallow Loamy ecologic site has shallow soils.
R044AA162MT	Thin Loamy (Tlo) LRU 44A-A This site has deeper than soils and slopes that are >15% than the Shallow Loamy ecologic site which has shallow soils.
R044AA161MT	Thin Clayey (Tcy) LRU 44A-A The Thin Loamy site does not have a mollic epipedon present and has deep to very deep soils. The Shallow Loamy site has shallow soils.

Similar sites

R044AA036MT	Droughty (Dr) LRU 44A-A This site differs by having deeper soils (>20
-------------	---

R044AA162MT	Thin Loamy (Tlo) LRU 44A-A This site differs by having deeper soils (>20
R044AA032MT	Loamy (Lo) LRU 44A-A This site differs by having deeper soils (>20
R044AA038MT	Droughty Steep (Drstp) LRU 44A-A

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) <i>Pseudoroegneria spicata</i> (2) <i>Hesperostipa comata</i>

Physiographic features

The Shallow Loamy (SwLo) ecological site (R044AA136MT) is located within LRU “A” in MLRA “44A.” This ecological site occurs on nearly level to very steep hills and bedrock escarpments. The slope ranges from 0% to 70%. This site occurs on all exposures; effect of aspect can be significant in LRU assignment.

Table 2. Representative physiographic features

Landforms	(1) Escarpment (2) Hill
Elevation	550 – 1,520 m
Slope	10 – 70 %
Water table depth	110 cm
Aspect	E, S, W

Climatic features

The dissected Northern Rocky Mountain Valleys of MLRA 44A are considered to have a maritime climate. Precipitation is fairly evenly distributed throughout the year with less than about 35% of the annual precipitation occurring during the growing season in Montana. Rainfall occurs as high-intensity, convective thunderstorms in the spring and fall. Most of the precipitation in the winter is snow or rain on fully or partially frozen ground. Average precipitation for LRU-A is 12”, and the frost-free period averages 105 days.

See Climatic Data Sheet for more details (Section II of the Field Office Technical Guide: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=MT) or reference the following climatic Web site:

Table 3 Representative climatic features

Frost-free period (average)	120 days
Freeze-free period (average)	140 days
Precipitation total (average)	360 mm

Influencing water features

Soil features

Soil surface textures (2mm) of this site usually range from very fine sandy loam to clay loam. Soils are shallow, ranging from 10-20" deep before the presence of the bedrock, lithic, or paralithic root restrictive layer.

Table 4. Representative soil features

Surface texture	(1) Loam (2) Silt loam (3) Clay loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately slow to moderately rapid
Soil depth	30 – 50 cm
Available water capacity (0-101.6cm)	5.08 – 10.16 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 – 8.2

Ecological dynamics

The Shallow Loamy ecological site is characterized by the production and composition of plant species in the Reference Plant Community, which is defined by soils, precipitation, and temperature regime influencing the site. The presumed Reference Plant Community of this site is dominated by cool-season perennial bunchgrass species, primarily bluebunch wheatgrass (*Pseudoroegneria spicata*) with minor components of perennial forbs and Wyoming big sagebrush (*Artemisia tridentata*). LRU-A occurs in the valleys of western Montana, on rangelands with a xeric, dry or ustic, dry soil moisture phase, a frigid, warm soil temperature phase, 10-14" of effective precipitation, and between 90 and 120 consecutive frost-free days annually. This site is characterized by having medium-textured surface horizons and soils which are shallow and not skeletal.

The majority of precipitation comes early in the form of snow and spring rain. Summers are usually dry. The growing season is short and cool; primary growth typically occurs between May and July, and dominant plants are those that have adapted to these conditions.

In response to disastrous fires in 1910, new firefighting policies were established. Wildland fire suppression became an important driving factor in the ecology of western rangelands. Livestock grazing during the late 1800s and early 1900s often occurred at very heavy levels. Heavy grazing resulted in a severe reduction in fine fuels, which further reduced potential for natural fires. These two actions altered the natural fire interval.

Fire suppression, along with fine-fuels reduction, has interfered with the natural fire interval; many areas have not burned for over 100 years (Arno and Gruell 1986). Prior to 1900, the average natural fire return intervals were probably shorter than 35 years for this MLRA. Historic fire frequency may have ranged from 15 to 75 years. Trees and non-sprouting shrubs were restricted to small patches or widely spaced plants. Following fire on medium-textured soils, perennial bunchgrasses apparently recovered in a few years and were present to fuel subsequent fires, which suppressed woody species and kept them as a minor component of the community (Arno and Gruell 1983).

Historical records indicate, prior to the introduction of livestock (cattle and sheep) during the late 1800s, elk and bison grazed this ecological site. Evidence shows periodic use by bison, in large numbers and concentrations. Forage for livestock was noted as minimal in areas recently grazed by bison (Lesica and Cooper 1997).

Significant livestock grazing has occurred on most of this ecological site in western Montana for more than 100 years (beginning with the 1860's gold boom and subsequent settlement through 1900). Indian horse herds were present and numerous for several hundred years prior. The primary type of European livestock grazed in this region has historically transitioned between sheep and cattle with early grazing (pre-1890) dominated by the cattle industry. In the 1890's Montana sheep production began to dramatically increase (by over 400%) and dominated the cattle industry for approximately four decades. However, by the 1930's livestock production once again favored the cattle industry, which continues to dominate livestock grazing in the region today (Wyckoff and Hansen 2001). The Shallow Loamy ecological site is relatively accessible and many examples were subject to heavy and/or season-long grazing until 1970 or later. Most of the deeper sites within MLRA 44A were plowed and converted to annual crops or tame pasture between 1880 and 1960.

Invasive species are an important part of the ecology of MLRA 44A. Notable invasive species include spotted knapweed (*Centaurea stoebe*), leafy spurge (*Euphorbia esula*), sulphur cinquefoil (*Potentilla recta*), and cheatgrass (*Bromus tectorum*). Invasive species impact almost every site in MLRA 44A. Sites are either currently invaded or have been treated to kill invasives, which can reduce production and change composition of forbs and shrubs. Even where invasives are not present, the threat of invasion drives management of this site.

Anthropogenic influences on this ecological site include agriculture and urban/suburban development. Hay production has constituted the largest replacement of native vegetation with introduced cool-season annuals, perennial grass species, and legumes (e.g., alfalfa). This ecological site has also been converted to pastureland (introduced grass or legume species) or cropland because of its relatively level topography, favorable fertility, and water-holding capacity. Other agronomic practices include crop production: some of the common crops include wheat, barley, and oats. Cropland, pastureland, and hayland are intensively managed with annual or periodic cultivation, annual harvesting, and/or frequent use of herbicides, pesticides, and commercial fertilizers to increase production. Where irrigation water is available, this site may be irrigated, which further modifies soil properties and increases production potential. Both cropland and pastureland require ongoing weed control because of residual or transported weed seed.

Cropland has seldom been abandoned in western Montana; however, abandoned croplands can revert to "go back land". This change

occurs when converted land (previously plowed land) is abandoned or mismanaged (poor crop or haying management or improper grazing management). When a previously farmed site is left unmanaged, there is an increased risk of invasion by noxious, invasive, introduced, and/or less desirable plants, such as spotted knapweed, leafy spurge, and cheatgrass.

Plowing this site may result in changes to soil structure, soil microbes (microfauna), and soil chemistry that make it difficult or impossible to return to native conditions within a practical cost range or human time scale. A return to native bunchgrass communities on the Shallow Loamy site is more likely to be successful if soil chemistry, microorganisms, and structure are not heavily disturbed. Preservation of favorable soil microbes increases the likelihood of a return to reference (or near reference) conditions. The native component of the grassland may be lost when seeding non-natives. Even when natives had been successfully reseeded, the ecological processes defining the past states of the site can significantly change.

In the short term the site can be restored to resemble the Taller Bunchgrass State by seeding mixtures of commercially available native grasses. With proper management (prescribed grazing, weed control, or brush control) over time, this site can come close to the diversity and complexity of the Bluebunch Wheatgrass Community (1.1). Because of introduced forbs and grasses and the changes in soil properties, this site is not likely to return to near reference conditions without active restoration.

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

Rangeland Health Reference Worksheets have been posted for this site on the Montana NRCS Web site (www.mt.nrcs.usda.gov) in Section II of the eFOTG under (F) Ecological Site Descriptions (ESD).

Plant Communities and Transitional Pathways

A STM for the Shallow Loamy ecological site (44AA136MT) is depicted in Figure 1. Thorough descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, and interpretations by experts and is likely to change as knowledge increases.

Plant communities will differ across the MLRA because of 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. The species lists are not intended to cover every situation or the full range of conditions, species, and responses for the site.

Both percent species composition by weight and percent canopy cover are used in this ESD. Most observers find it easier to visualize or estimate percent canopy for woody species (trees and shrubs). Canopy cover drives the transitions between communities and states because of the influence of shade and interception of rainfall. 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 species composition for the site. Calculating similarity index requires use of species composition by dry weight.

This STM includes only native communities and states. Converted communities are described in the Ecological Dynamics section above.

State and transition model

Figure 3. 44AA136MT Shallow Loamy

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	Cool Season Bunchgrasses			549-785	
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	549-785	–
	needle and thread	HECO26	<i>Hesperostipa comata</i>	235-336	–
	green needlegrass	NAVI4	<i>Nassella viridula</i>	78-112	–
2	Shortgrasses/Rhizomatous Grasses/Grasslikes			78-112	
	Grass, perennial	2GP	<i>Grass, perennial</i>	39-56	–
	sedge	CAREX	<i>Carex</i>	39-56	–
	thickspike wheatgrass	ELLA3	<i>Elymus lanceolatus</i>	39-56	–

	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	39-56	–
	western wheatgrass	PASM	<i>Pascopyrum smithii</i>	39-56	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	39-56	–
Forb					
3	Forbs			78-112	
	Forb, annual	2FA	<i>Forb, annual</i>	39-56	–
	Forb, perennial	2FP	<i>Forb, perennial</i>	39-56	–
	common yarrow	ACMI2	<i>Achillea millefolium</i>	39-56	–
	rosy pussytoes	ANRO2	<i>Antennaria rosea</i>	39-56	–
	twin arnica	ARSO2	<i>Arnica sororia</i>	39-56	–
	milkvetch	ASTRA	<i>Astragalus</i>	39-56	–
	tiny trumpet	COLI2	<i>Collomia linearis</i>	39-56	–
	bastard toadflax	COUM	<i>Comandra umbellata</i>	39-56	–
	shaggy fleabane	ERPU2	<i>Erigeron pumilus</i>	39-56	–
	blanketflower	GAAR	<i>Gaillardia aristata</i>	39-56	–
	hairy false goldenaster	HEVI4	<i>Heterotheca villosa</i>	39-56	–
	nineleaf biscuitroot	LOTR2	<i>Lomatium triternatum</i>	39-56	–
	beardtongue	PENST	<i>Penstemon</i>	39-56	–
	phlox	PHLOX	<i>Phlox</i>	39-56	–
	woolly plantain	PLPA2	<i>Plantago patagonica</i>	39-56	–
	sticky cinquefoil	POGL9	<i>Potentilla glandulosa</i>	39-56	–
	slender cinquefoil	POGR9	<i>Potentilla gracilis</i>	39-56	–
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	39-56	–
	largeflower triteleia	TRGR7	<i>Triteleia grandiflora</i>	39-56	–
	ironweed	VERNO	<i>Vernonia</i>	39-56	–
	meadow deathcamas	ZIVE	<i>Zigadenus venenosus</i>	39-56	–
Shrub/Vine					
4	Shrubs			78-112	
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	39-56	–
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	39-56	–
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	39-56	–
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	39-56	–
	Woods' rose	ROWO	<i>Rosa woodsii</i>	39-56	–

Table 6. Community 1.2 plant community composition

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

Table 7. Community 1.3 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 (%)
-------	-------------	--------	-----------------	----------------------	------------------

Animal community

Livestock grazing is suitable on this site due to the potential to produce high quality forage. This site is preferred for grazing by livestock, and animals may congregate in these areas, however if slopes are > 15% and distance from water is too great, livestock grazing will be limited. Management objectives should include maintenance or improvement of rangeland health attributes of this ecological site. Careful management of timing, intensity and duration of grazing to minimize grazing re-growth and providing adequate rest is important. Shorter grazing periods and changing season of use during the growing season are recommended for plant maintenance, health and recovery. Continuous grazing with improper stocking rates throughout the growing season in pastures year after year will be detrimental, will alter the plant composition and production over time, and will result in a transition to the Mixed Bunchgrass Community (1.2) or the Shrubland Community (1.3) or potentially hasten a change to the Invaded State (4). Transition to other states will depend on how well the site is managed over time with grazing animals as well as other circumstances such as weather conditions over a period of time. The transition to the Mixed Bunchgrass Community (1.2) or the Shrubland Community (1.3) can be the result of long-term, continuous grazing and/or repeated critical growing season grazing (early season grazing during stem elongation). This transition can also occur due to a combination of overgrazing and drought. Repeated grazing during stem elongation (generally mid-April through mid-June), can have detrimental affects, especially on the taller key bunchgrass species. Repeated spring grazing and/or repeated and prolonged summer grazing depletes stored carbohydrates, resulting in poor vigor of key forage plants over time and eventual death of these cool-season grasses – this can lead to an increase in less desirable native species and/or noxious weeds. The Mixed Bunchgrass Community (1.2) and the Shrubland Community (1.3) can occur across the entire ecological site or can occur in a mosaic with higher and/or lower states. This is most notable in areas that attract additional grazing, such as water sources or salting locations. The Mixed Bunchgrass Community (1.2) or the Shrubland Community (1.3) is subject to further degradation to the Altered State (2), the Sparsely Vegetated State (3) or the Invaded State (4). Management should focus on grazing management strategies that will prevent further degradation. Forage quantity and/or quality may be substantially reduced compared to the Reference Plant Community. In the Altered State, forage production is substantially reduced compared to the Taller Bunchgrass State. Grazing is possible in the Sparsely Vegetated State and the Invaded State, but forage production is greatly reduced in both states. Grazing should be carefully managed to avoid soil loss and degradation of soil properties as well as to ensure adequate livestock health. Prescriptive grazing should be included in a conservation plan to maintain vigor of key native plant species while targeting the invasive species problem. In some instances, carefully targeted grazing (sometimes in combination with other treatments) can reduce or eliminate populations of invasive species. Distance to drinking water and slope can reduce grazing capacity within a management unit. Adjustments should only be made for the area that is considered necessary for reduction of animal numbers. For example 30% of a management unit may have 25% slopes and distances of > 1 mile from water; therefore the adjustment is only calculated for 30% of the unit (50% reduction on 30% of management unit). The table below is a general guide for ranches in Montana (Ricketts et al. 2004). Fencing, slope length, management, access, terrain and breeds are all factors that can increase or decrease the percent of grazable acres within a management unit. Adjustments should be made that incorporate pasture conditions when calculating stocking rates.

Hydrological functions

The water cycle functions best in the Taller Bunchgrass State (1) with good infiltration and deep percolation of rainfall. The water 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 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 drainageways should be vegetated and stable. Improper grazing management results in the transition to the Altered State (2). This state has reduced canopy cover, and increased bare ground. Therefore, infiltration is reduced and runoff increased due to reduced ground cover, rainfall splash, soil capping, reduced organic matter, and poor structure. In the Sparsely Vegetated State (3) and the Invaded State (4) canopy and ground cover are greatly reduced compared to the Taller Bunchgrass State (1), which impairs the water cycle. Infiltration will greatly decrease and runoff will increase because of reduced ground cover, rainfall splash, soil capping, reduced organic matter, and poor structure. Sparse ground cover and decreased infiltration can combine to increase frequency and severity of flooding within a watershed. Soil erosion is accelerated, quality of surface runoff is poor, and sedimentation increases.

Recreational uses

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

Wood products

None

Other products

None

Other information

None

Other references

Arno, S. F., and Gruell, G. E. 1983. Fire history at the forest-grassland ecotone in southwestern Montana. *Journal of Range Management* 36(3): 332-336.

Arno, S. F., and Gruell, G. E. 1986. Douglas-fir encroachment into mountain grasslands in southwestern Montana. *Journal of Range Management* 39(3): 272-275.

Bais, H. P., T. S. Walker, F. R. Stermitz, R. H. Hufbauer, and J. M. Vivanco. 2002. Enantiomeric-dependent phytotoxic and antimicrobial activity of ($\pm$)-catechin. A rhizosecreted racemic mixture from spotted knapweed. *Plant Physiology* 128: 1173-1179.

Belnap, J., and S. L. Phillips. 2001. Soil biota in an ungrazed grassland: response to annual grass (*Bromus tectorum*) invasion. *Ecological Applications* 11:1261-1275.

Belnap, J., S. L. Phillips, S. K. Sherrod, and A. Moldenke. 2005. Soil biota can change after exotic plant invasion: does this affect ecosystem processes? *Ecology* 86:3007-3017.

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.

Callaway, R. M., and J. M. Vivanco. 2007. Invasion of plants into native plant communities using the underground information superhighway. *Allelopathy Journal* 19:143-151.

DiTomaso, J. M. 2000. Invasive weeds in rangelands: Species, impacts, and management. *Weed Science* 48:255-265.

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.

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

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* 3:627-631.

Launchbaugh, K. L., R. J. Daines, and J. W. Walker. [Eds.] 2006. Targeted grazing: a natural approach to vegetation management and landscape enhancement. Centennial, CO, USA: American Sheep Industry Association (available online at www.cnr.uidaho.edu/rx-grazing/Handbook.htm)

Lesica, P., and Cooper, S. V. 1997. Presettlement vegetation of southern Beaverhead County, Montana. Unpublished report to the State Office, Bureau of Land Management, and Beaverhead-Deerlodge National Forest. Montana Natural Heritage Program, Helena, MT. 35 pp.

Lowe, P. N., W. K. Laurenroth, and I. C. Burke. 2003. Effects of nitrogen availability on competition between *Bromus tectorum* and *Bouteloua gracilis*. *Plant Ecology* 167:247-254.

- Mack, R. N., D. Simberloff, W. M. Lonsdale, H. Evans, M. Clout, and F. A. Bazzaz. 2000. Biotic invasions: causes, epidemiology, global consequences, bunchgrass ranges in southern Idaho. *Journal of Range Management* 24:407-410.
- Masters, R. A., and R. L. Sheley. 2001. Principles and practices for managing rangeland invasive plants. *Journal of Range Management* 54: 502-517.
- Norton, J. B., T. A. Monaco, J. M. Norton, D. A. Johnson, and T. A. Jones. 2004. Soil morphology and organic matter dynamics under cheatgrass and sagebrush-steppe plant communities. *Journal of Arid Environments* 57:445-466.
- NRCS. 2008. National Range and Pasture Handbook. Chapter 3, Section 1, Montana Supplement: Montana Rangeland Ecological Site Key – Version 8.2.
- NRCS. 2008. (electronic) Field Office Technical Guide. Available online at http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=MT
- NRCS. 2009. Plant Guide: Cheatgrass. Prepared by Skinner et al., National Plant Data Center.
- Ogle, S., W. Reiners, and K. Gerow. 2003. Impacts of exotic annual brome grasses (*Bromus* spp.) on ecosystem properties of northern mixed grass prairie. *Am. Midl. Nat* 149:46-58.
- Pellant, M. 1996. Cheatgrass: The invader of the West. Bureau of Land Management, Idaho State Office, 22 pp.
- 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.
- Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. *Bioscience* 50:53-65.
- Pokorny, M. L., R. L. Sheley, C. A. Zabinski, R. E. Engel, A. J. Svejcar, and J. J. Borkowski. 2005. Plant functional group diversity as a mechanism for invasion resistance. *Restoration Ecology* 13(3): 1-12.
- Ricketts, M. J., R. S. Noggles, and B. Landgraf-Gibbons. 2004. Pryor Mountain Wild Horse Range Survey and Assessment. USDA-Natural Resources Conservation Service.
- Ross, R. L., E. P. Murray, and J. G. Haigh. 1973. Soil and vegetation of near-pristine sites in Montana. USDA Soil Conservation Service, Bozeman, MT
- Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and W. D. Broderson. [Edss.] 2002. Field book for describing and sampling soils, Version 2.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE. (<http://soils.usda.gov/technical/fieldbook/>)
- Sheley, R. L., B. E. Olson, and C. Hoopes. 2005. Impacts of noxious weeds. Pulling together against weeds. Published by Montana's Statewide Noxious Weed Awareness and Education Program.
- 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. USDA, NRCS. 1997. National Range and Pasture Handbook. (<http://www.glti.nrcs.usda.gov/technical/publications/nrph.html>)
- 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.
- USDA/NRCS Soil survey manuals for appropriate counties within MLRA 44A.
- Walker, L. R. and S. D. Smith. 1997. Impacts of invasive plants on community and ecosystem properties. p. 69-86. In: J. O. Luken, and J. W. Thieret. [Eds.] *Assessment and management of plant invasions*. Springer, New York, N.Y.
- Whisenant, S. G. 1990. Changing fire frequencies on Idaho's Snake River Plains: ecological and management implications. In: McArthur, E. D., E. M. Romney, S. D. Smith, P. T. Tueller. [Eds.] *Proceedings of the symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management*. p. 4-10. USFS-INT-GTR-313.
- Williamson, M. H., and A. Fitter. 1996. The characteristics of invasive plant successful invaders. *Biological Conservation* 78:163-170.
- Wilson, A. M., G. A. Harris, and D. H. Gates. 1960. Cumulative effects of clipping on yield of bluebunch wheatgrass. *Journal of Range*

Wyckoff, W. and K. Hansen. 2001. Settlement, livestock grazing and environmental change in Southwest Montana, 1860-1990. Environmental History Review 15:45-71.

Young, J. A., and F. L. Allen. 1997. Cheatgrass and range science: 1930-1950. Journal of Range Management 50:530-535.

Young, J. A., and R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. Journal of Rangeland Management 31:283-289.

Approval

Kirt Walstad, 2/05/2022

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)	W. Lujan, N. Svendsen, J. Alexander, K. Walstad, J. Siddoway, M. Hansen
Contact for lead author	NRCS Missoula Area Office
Date	03/01/2010
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

- 1. Number and extent of rills:** Slopes on this site range from 0% to 70%. Rills should not occur in the Taller Bunchgrass State on slopes less than 15%. As slope increases so will the number and length of rills. Rills on steep slopes (>35%) should be <5 feet long.

- 2. Presence of water flow patterns:** Water flow patterns are generally not evident in the reference state especially on slopes <4%. Following occasional (5 – 30 % probability), heavy thunderstorms and winter thaw events, common short, sinuous, discontinuous flow patterns may be apparent on 8%-35% slopes. On steeper slopes (>35%) water flow patterns may become more evident and there may be areas which show accumulations of litter due to water movement.

3. Number and height of erosional pedestals or terracettes: Very slight to slight on slopes <8%. Occasionally pedestals up to 0.5 inches may be encountered. As slopes increase pedestals may become more numerous and prominent.

4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground): Bare ground is expected to be between 10-20% - bare areas tend to be inconspicuous and not connected.

5. Number of gullies and erosion associated with gullies: Gullies should not occur in the Taller Bunchgrass State. If there is evidence of past erosion that has created gullies, these areas should be stabilized and have no active erosion.

6. Extent of wind scoured, blowouts and/or depositional areas: Appearance or evidence of these erosional features on the landscape would not be present on this site.

7. Amount of litter movement (describe size and distance expected to travel): Litter will be evident across this site representing organic debris from the vegetation of the functional/structural groups and will not move. A severe convection storm or a significant thaw event could cause litter to move short distances, especially on slopes greater than 6%.

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values): Resistance to erosion will be high with soil stability values of 5 or 6; areas of bare soil on this site may have values between 3 and 5 if not under plant canopy.

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness): Structure is granular at the soil surface. Organic matter is about 1%. The surface horizon is 3 to 6 inches thick.

10. Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff: The reference plant community (1.1) is dominated by bluebunch wheatgrass which will maximize infiltration and minimize runoff throughout the site. With the increase of needleandthread in Plant community (1.2) infiltration may decrease and runoff may increase but overall this plant community will have only slight effects on infiltration and runoff.

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 would not be expected on this ecological site. A platy soil surface structure would indicate a departure from 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: Plant community 1.1 - Taller cool season bunchgrasses (bluebunch wheatgrass) >> mid-stature cool season bunchgrasses (needleandthread) > cool season rhizomatous grasses (western wheatgrass), shortgrasses (prairie junegrass) and grasslikes (sedges) =

perennial forbs = shrubs. Plant community 1.2 – bluebunch wheatgrass and needleandthread share dominance – the other functional/structural groups will remain the same in descending order.

Sub-dominant:

Other:

Additional:

13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence): Plant mortality for all functional groups will be low, but there will be some natural mortality of functional groups over time. Prolonged droughts and/or excessive rest may show increases in mortality and decadence for all plant groups.
-

14. Average percent litter cover (%) and depth (in): Note: the majority of the litter in the plant community in the Taller Bunchgrass State will be non-persistent.
-

15. Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production): 700 #/acre – 1000 #/acre for the reference community (1.1) with a RV of 850 #/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: Cheatgrass, knapweed spp., leafy spurge, sulphur cinquefoil, dalmatian toadflax, Japanese brome, broom snakeweed, fringed sagewort, salsify and dandelion.
-

17. Perennial plant reproductive capability: All native plants are capable of reproducing sexually and/or vegetatively.
-