USDA Natural Resources
Conservation Service

Ecological site R044AA001MT
Clayey (Cy) LRU 44A-A

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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): 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:
o not saline or saline-sodic.
o not coarse-granular clay.
o moderately deep, deep, or very deep with less than 15% stone and boulder cover.
o not skeletal within 20” of soil surface.
o not strongly or violently effervescent in surface mineral 4”.
Slope is < 15%.
Clay content is > 32% in surface mineral 4”.

Associated sites

R044AA136MT	**Shallow Loamy (Swlo) LRU 44A-A**
R044AA032MT	**Loamy (Lo) LRU 44A-A** The Loamy site has soils that are moderately deep to very deep, with clay content <32% in surface mineral 4” with Argillic horizon, if present, has < 35% clay of mineral soil (ribbon < 2” long), whereas the Clayey site has Soil with 32% to 45% clay within surface mineral 4”

Similar sites

R044AA032MT	**Loamy (Lo) LRU 44A-A** This site occupies the same landscape positions and differs mainly by soil texture and plant community.
R044AA161MT	**Thin Clayey (Tcy) LRU 44A-A** This site differs by being on slopes >15% and not having a mollic epipedon.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Pseudoroegneria spicata*

Physiographic features

The Clayey (Cy) ecological site (R044AA001MT) is located within LRU “A” in MLRA “44A”. This ecological site typically occurs on nearly level to strongly sloping alluvial fans, stream terraces, till planes, lake plains, or moraines. The slope ranges from 0 to 15%. This site occurs on all exposures; effect of aspect is not significant.

Table 2. Representative physiographic features

Landforms	(1) Lake plain (2) Alluvial fan (3) Terrace
Elevation	549–1,524 m
Slope	0–15%
Water table depth	107 cm
Aspect	Aspect is not a significant factor

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: http://www.wrcc.dri.edu/climsum.html.

Table 3. Representative climatic features

Frost-free period (average)	105 days
Freeze-free period (average)	125 days
Precipitation total (average)	305 mm

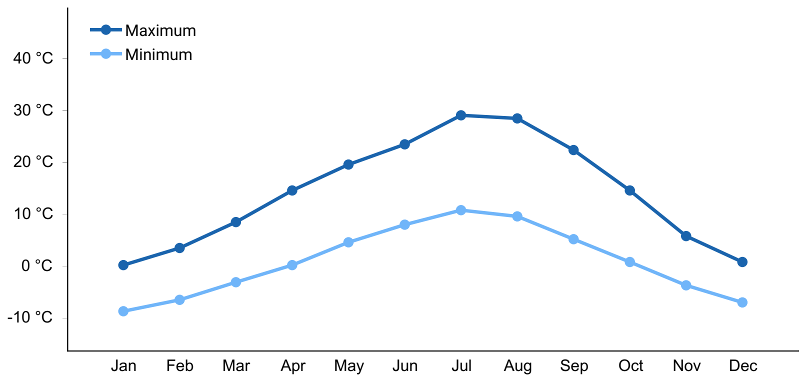


Figure 1. Monthly average minimum and maximum temperature

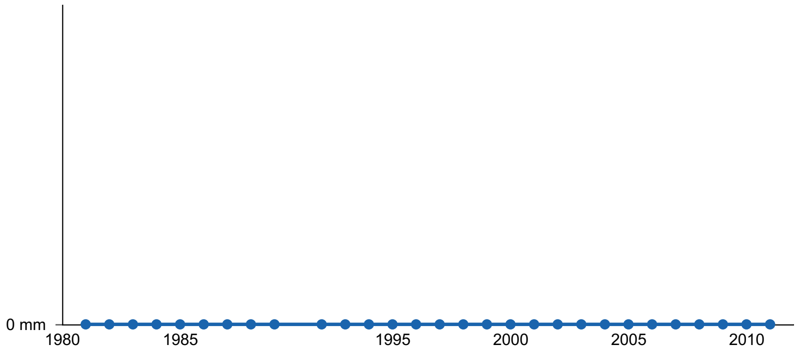


Figure 2. Annual precipitation pattern

Influencing water features

Soil features

These soils are typically very deep, well-drained soils that formed in lacustrine deposits. Surface textures (< 2mm) usually range from clay loam to clay; clay content is > 32%. Soil may contain gravel and/or cobbles but they will not exceed an average of 35% by volume in the 10-20” layer.

Table 4. Representative soil features

Surface texture	(1) Silty clay loam (2) Silty clay (3) Clay loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Moderately slow to moderately rapid
Soil depth	51 cm
Available water capacity (0-101.6cm)	10.16–17.78 cm
Calcium carbonate equivalent (0-101.6cm)	0–20%
Electrical conductivity (0-101.6cm)	0–1 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	6.3–8.2

Ecological dynamics

The Clayey ecological site is characterized by the production and composition of plant species in the Reference Community, which is defined by soils, precipitation, and the 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 shortgrasses, perennial forbs, and shrubs. 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 fine-textured surface horizons on soils more than 20” deep and slopes less than 15%.

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 1800's, 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 dramatically (by > 400%) and dominated the cattle industry for approximately four decades. By the 1930s, livestock production once again favored the cattle industry, which continues to dominate livestock grazing in the region today (Wyckoff and Hansen 2001). The Clayey 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*). Most sites in MLRA 44A are impacted by these invasives. 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 (with 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, those lands that are abandoned 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 Clayey 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 Community (or near Reference Community) 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 el al. 2003, Bestelmeyer et al. 2004, Bestelmeyer and Brown 2005, and Stringham et al. 2003.

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).

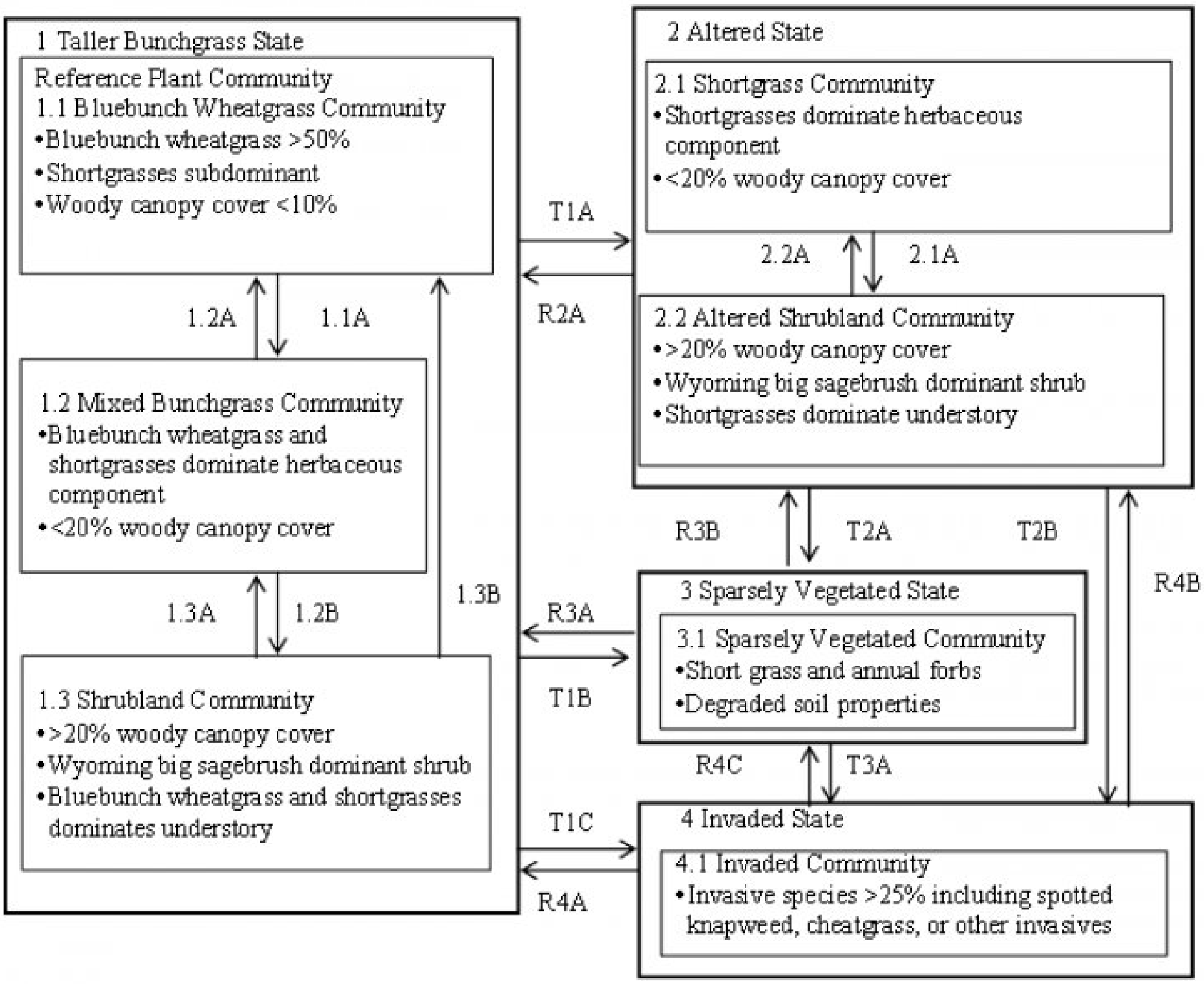
Plant Communities and Transitional Pathways
A STM for the Clayey ecological site (44AA001MT) is depicted in Figure 1. Thorough descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, and interpretations by experts and is likely to change as knowledge increases.

Plant communities 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



1.1A Lack of Fire, Improper Grazing Management
1.2A Fire, Proper Grazing Management
1.2B Lack of Fire, Improper Grazing Management
1.3A Fire, Proper Grazing Management
1.3B Fire, Proper Grazing Management
2.1A Overgrazing, Lack of Fire
2.2A Fire, Proper Grazing Management
T1A Overgrazing, Lack of Fire
T1B Overgrazing, Soil Erosion
T1C Introduction of Weedy Propagules

T2A Overgrazing, Soil Erosion
T2B Introduction of Weedy Propagules
T3A Introduction of Weedy Propagules
R2A Mechanical Brush Management, Range Seeding
R3A Proper Grazing Management, Range Seeding
R3B Range Seeding
R4A Weed Management, Range Seeding
R4B Weed Management, Woody Propagules Present
R4C Weed Management, Wood Propagules Not Present

Figure 4. 44AA001MT Clayey

State 1

Taller Bunchgrass State

This state is characterized by cool-season bunchgrasses and is represented by three communities that differ mainly in the percent composition of bluebunch wheatgrass and woody canopy cover (predominantly Wyoming big sagebrush). Forbs are a minor component in this state.

Community 1.1
Reference Plant Community - Bluebunch Wheatgrass Community

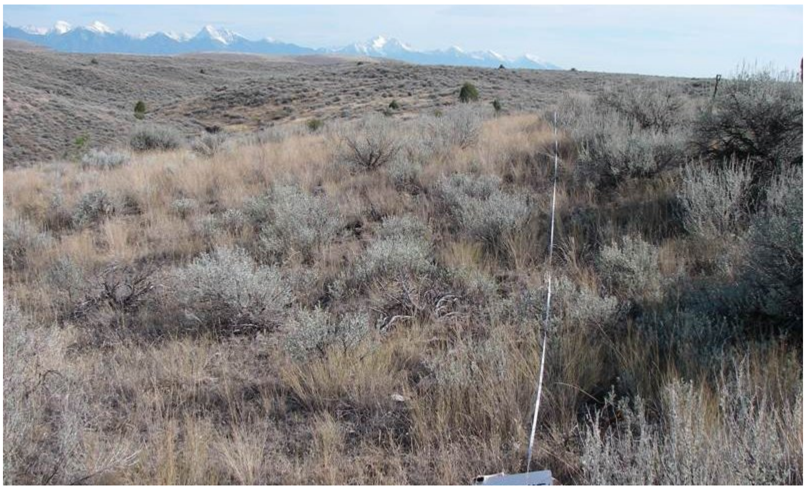


Figure 5. 44AA Clayey 1

The Taller Bunchgrass State (1) is dominated by bluebunch wheatgrass, a taller cool-season bunchgrass with minor components of shortgrasses, forbs, and shrubs. Bluebunch wheatgrass is typically the dominant species in the Bluebunch Wheatgrass Community (1.1). Many common forb species exist on this site, including western yarrow (*Achillea millefolium*). Shrub species, including Wyoming big sagebrush (*Artemisia tridentata*. ssp. wyomingensis) and fringed sage (*Artemisia frigida*), are present as a minor part of the community. The Taller Bunchgrass State (1) generally occurs on the Clayey site in areas where proper grazing management practices have been implemented over a long period of time. The Bluebunch Wheatgrass Community (1.1) can be maintained through the implementation of properly managed grazing that provides adequate growing-season deferment to allow establishment of taller-grass propagules and/or the recovery of vigor of stressed plants. The Bluebunch Wheatgrass Community (1.1) in general is resistant to change with proper grazing management, fire, or brush control and, near normal precipitation. However, bluebunch wheatgrass lacks resistance to grazing during the spring growing season. It may decline in vigor and production if grazed in the spring more than one year in three (Wilson et al. 1960). Under continued growing season pressure bluebunch wheatgrass will decrease in vigor. Shortgrasses and sagebrush will fill in the vegetation gaps. This change drives the community shift to the Mixed Bunchgrass Community (1.2). The Bluebunch Wheatgrass Community is moderately resilient to shrub invasion if properly managed. However, if continuous overgrazing does occur shrub canopy will increase and desirable understory will decrease. There will be a notable increase in more grazing tolerant plants such prairie junegrass (*Koeleria macrantha*), and Sandberg bluegrass (*Poa secunda*), will increase. When this occurs the Bluebunch Wheatgrass Community (1.1) will shift to a Mixed Bunchgrass Community (1.2). Once the site becomes dominated by shortgrasses it will transition to the Altered State (2). Periodic fire increases the resilience of the Bluebunch Wheatgrass Community (1.1) by reducing competition and canopy cover of woody species. Fire also removes decadent herbaceous material, particularly from taller bunchgrasses, which promotes increased vigor and seedling establishment. Timing and intensity of a fire are critical components that can have varying positive or negative effects on this plant community. Fire does increase risk of invasion from invasive species, most notably cheatgrass. At least two growing seasons of rest are recommended to allow for plants to recover after fire. Without fire and/or brush control, woody species on the site will increase and the site will shift to the Shrubland Community (1.3). This can occur with or without the degradation of the herbaceous community from bluebunch wheatgrass dominated to a community dominated by shortgrasses. If degradation of the herbaceous component does occur, the site will transition to the Altered State (2). Because the woody species that dominate in the Shrubland Community (1.3) are native species in the Taller Bunchgrass State (1), the shift to the Shrubland Community (1.3) is a linear process with shrubs starting to increase soon after fire or brush control ceases. Heavy continuous grazing will reduce plant cover, litter, and mulch. Bare ground will increase and expose the soil to erosion. Litter and mulch will move off-site as plant cover declines. When canopy cover decreases to below 50%, the surface horizon becomes less stable and erosion can occur. This will make it more difficult to reestablish bluebunch wheatgrass plants due to decreased soil fertility. When overgrazing continues, invasive weedy grass and forb species move into the plant community and the site transitions to the Altered State (2), Sparsely Vegetated State (3) or the Invaded State (4). Until the Bluebunch Wheatgrass Community (1.1) crosses the threshold into the Altered State (2.1), Sparsely Vegetated Community (3.1) or the Invaded State (4), this community can be managed back toward the Bluebunch Wheatgrass Community (1.1) using management practices including prescribed grazing, prescribed burning, and strategic weed control. It may take several years to achieve this state, depending upon the climate and the aggressiveness of the treatment. While the Bluebunch Wheatgrass Community (1.1) is resilient to degradation under proper management, the community remains at risk of invasion by aggressive non-native species because of the ability of spotted knapweed, leafy spurge, and cheatgrass to invade healthy rangelands and the widespread presence of propagules. Healthy plant communities are most resilient to invasives although many examples exist of well-managed areas that have been invaded by spotted knapweed. Invasives may impact this plant community even if the site does not yet have a critical population of invasives. Almost all reference sites had at least trace amounts of spotted knapweed and/or cheatgrass. It is believed that most sites with only trace amounts have been chemically treated for invasives at some point. These treatments would have impacted other broad-leafed species (forbs and shrubs). It is likely that this site had more potential for forb and shrub production than found on current reference sites. The natural fire regime would have favored an increase in forbs while maintaining shrubs as a very minor component. Plant basal cover is expected to be about 20-30%, and bare ground is expected to be < 10%. The soils of this site have high soil stability values. There should be no signs of current erosion occurring on the site. The following production figures do not represent the lowest or highest possible production for the reference community (1.1). For example, the high figure is not the most production that can occur in a wet year in the most mesic portion of the LRU. These values represent the range of variability for each species across the extent of the ecological site. Usually, values in the low production column represent production at the dry end of the LRU and those in the high production column represent production at the wet end of the LRU. Even the most stable communities exist within a range of dynamic equilibrium of species composition. The following table shows an example of species composition; the example is not the only mix of species possible in the Bluebunch Wheatgrass Community (1.1).

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	717	986	1255
Shrub/Vine	90	123	157
Forb	90	123	157
Total	**897**	**1232**	**1569**

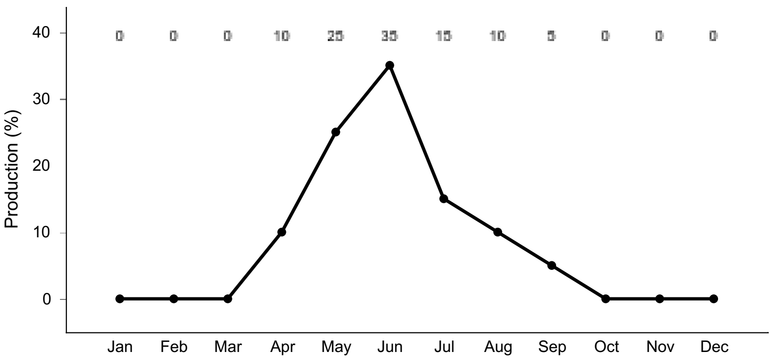


Figure 7. Plant community growth curve (percent production by month). MT0441, 44A - Uplands. Includes all upland sites in 44A.

Community 1.2
Mixed Bunchgrass Community

Bluebunch wheatgrass and shortgrasses share dominance of the understory in the Mixed Bunchgrass Community (1.2); Wyoming big sagebrush may have a moderate presence in the overstory. Wyoming big sagebrush increases in species composition when bluebunch wheatgrass decreases because of improper grazing management and lack of fire and brush control. Bluebunch wheatgrass will have lower relative production and lower total production than in the Bluebunch Wheatgrass Community (1.1). Other grass species that are more tolerant to grazing and likely to increase compared to the Reference Plant Community include Sandberg bluegrass, prairie junegrass, and western/thickspike wheatgrass (*Pascopyrum smithii*, *Elymus trachycaulus*). Some increaser forbs species include western yarrow (*Achillea millefolium*), hoods phlox (*Phlox hoodii*), scarlet globemallow (*Sphaeralcea coccinea*), hairy goldenaster (*Heterotheca villosa*), and pussytoes (Antennaria spp.). Fringed sagewort is a shrub that also increases under prolonged drought or heavy grazing. Heavy continuous grazing will reduce plant cover, litter, and mulch. Bare ground will increase and expose the soil to erosion. Litter and mulch will move off-site as plant cover declines. As long as the canopy cover remains greater than 50% and production of bluebunch wheatgrass is greater than 10% of total biomass production, the site can return to Bluebunch Wheatgrass Community (Pathway 1.2A). The Mixed Bunchgrass (1.2) and the Shrubland Community (1.3) are "At-Risk" Communities. The transition to the Altered State (2) can occur from any community within the Taller Bunchgrass State (1), it is not dependant on an increase of woody canopy cover, but on the decrease of bluebunch wheatgrass composition to < 10%. When overgrazing continues, increaser species such as sandberg and native forb species become more dominant and this triggers the transition from the Taller Bunchgrass State (1). Fire and/or brush control can be used to maintain the site in the Taller Bunchgrass State (1) as long as bluebunch wheatgrass production does not fall below 10%. Until the Mixed Bunchgrass Community (1.2) crosses the threshold into the Altered State (2.0), this community can be managed back toward the Bluebunch Wheatgrass Community (1.1) using management practices including prescribed grazing combined with prescribed burning and strategic brush control. It may take several years to make this shift, depending upon weather and aggressiveness of grazing management and brush treatment. Fire can be used to control smaller shrubs and trees. Chemical or mechanical treatment of larger shrubs and trees may be necessary in older stands. Without any form of brush control, woody species continue to increase in canopy cover. Once woody canopy exceeds approximately 20% and attains reproductive capability, a shift to the Shrubland Community (1.3) has occurred.

Community 1.3
Shrubland Community

The Shrubland Community (1.3) is characterized by greater than 20% woody canopy cover with bluebunch wheatgrass in the understory. Once woody canopy cover reaches 20%, the site will begin to take on the appearance of a shrubland. The dominant shrub species in this community is Wyoming big sagebrush. Other common shrub species include fringed sage, rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and Woods' rose (*Rosa woodsii*). Without fire, woody canopy cover increases and the Mixed Bunchgrass Community (1.2) shifts to the Shrubland Community (1.3). The Shrubland Community (1.3) differs from the Altered Shrubland Community (2.2) in the amount of degradation present in the understory. Under proper grazing management, the herbaceous component will be dominated by bluebunch wheatgrass. As long as bluebunch wheatgrass has not fallen below 10% species composition, the Shrubland Community (1.3) can be managed back to the Taller Bunchgrass Community (1.1) using prescribed grazing and strategic weed control. It may take several years to achieve this recovery, depending on growing conditions, vigor of remnant bluebunch wheatgrass plants, and the aggressiveness of the weed treatments. With improper grazing management, bluebunch wheatgrass will decline and less palatable grass species, such as prairie junegrass and Sandberg bluegrass and forb species will dominate understory and the site transitions to the Altered State (2).

Pathway 1.1A
Community 1.1 to 1.2

The Bluebunch Wheatgrass Community (1.1) requires fire and/or brush control to maintain woody species cover below 10%. This community will shift to the Mixed Bunchgrass Community (1.2) without fire or brush control. Native woody species canopy exceeding 10% indicates a transition to the Mixed Bunchgrass Community (1.2). The Bluebunch Wheatgrass Community (1.1) can be maintained through the implementation of brush management combined with properly managed grazing that provides adequate growing-season deferment to allow establishment of bluebunch wheatgrass propagules and/or the recovery of vigor of stressed plants. The driver for community shift 1.1A is improper grazing management in combination with lack of fire and/or brush control.

Pathway 1.2A
Community 1.2 to 1.1

The Mixed Bunchgrass Community (1.2) will return to the Bluebunch Wheatgrass Community (1.1) with brush control and proper grazing management that provides sufficient critical growing-season deferment in combination with proper grazing intensity. Favorable moisture conditions will facilitate or accelerate this transition. Reduction of the woody component will require inputs of fire and/or brush control. The driver for community pathway is proper grazing management in combination with fire and/or brush control.

Pathway 1.2B
Community 1.2 to 1.3

Shrubs make up a portion of the plant community in the Bluebunch Wheatgrass Community (1.1), hence woody propagules are present. Therefore, the Taller Bunchgrass State (1) is always at risk for shrub dominance and a shift to the Shrubland Community (1.3) in the absence of fire and brush management. The drivers for Community Shift 1.2B are overgrazing and lack of fire and/or brush control. The mean fire return interval in the Taller Bunchgrass State (1) is likely less than 35 years. Even with proper grazing and favorable climate conditions, lack of fire or brush control for 20 years will allow shrubs and trees to increase in canopy to reach the 20% threshold level. Improper grazing, prolonged drought, and a warming climate will provide a competitive advantage to shrubs, which will accelerate this process. The driver for this community shift is improper grazing management in combination with lack of fire and/or brush control.

Pathway 1.3B
Community 1.3 to 1.1

The Shrubland Community (1.3) can return to the Bluebunch Wheatgrass Community (1.1) after a fire as long as the understory is able to carry the fire and bluebunch wheatgrass crowns survive the fire and re-sprout and/or there is a sufficient seed for bluebunch wheatgrass to re-vegetate the area.

Pathway 1.3A
Community 1.3 to 1.2

The Shrubland Community (1.3) can return to the Mixed Bunchgrass Community (1.2) after a fire as long as the understory is able to carry the fire and bluebunch wheatgrass crowns survive the fire and re-sprout and/or there is a sufficient seed for bluebunch wheatgrass to re-vegetate the area.

State 2
Altered State

This state is characterized by having less than 10% bluebunch wheatgrass and less than 50% canopy cover. State 2 is represented by two communities that differ in the percent canopy cover of woody species. Production in this state is considerably lower than in the Taller Bunchgrass State (1). Some native plants tend to increase under prolonged drought and/or heavy grazing practices. A few of these species may include prairie junegrass, Sandberg bluegrass, western yarrow, scarlet globemallow, hairy goldenaster, and fringed sagewort.

Community 2.1
Shortgrass Community

The Shortgrass Community (2.1) is characterized by an herbaceous component dominated by shortgrasses with bluebunch wheatgrass being less than 10% of species composition by dry weight. This makes it difficult for bluebunch wheatgrass to increase with simply a change in grazing management alone. This community may or may not have a shrub component with canopy cover up to 20%. If a shrub component is present, it will most likely be dominated by Wyoming big sagebrush. The Shortgrass Community tends to occur if the forage component has been degraded but fire or brush control has kept the shrub community to less than 20% cover. This community is at risk of shifting to the Altered Shrubland Community (2.2) if without fire or other brush control. This shift can be accelerated when improper grazing management occurs. This most often happens when stocking rates are not adjusted to compensate for the decrease in forage production as shrub production increases. Canopy cover will likely be less than 50%. Wind and water erosion may erode soil from plant interspaces. Soil fertility is reduced, soil compaction is increased, and resistance to soil surface erosion is less than in the Taller Bunchgrass State (1).

Community 2.2
Altered Shrubland Community

The Altered Shrubland Community (2.2) is characterized by greater than 20% woody canopy cover with shortgrasses in the understory. This community has the appearance of shrub dominance with a degraded understory. The overstory is similar to the Shrubland Community (1.3) in the Taller Bunchgrass State (1). Wyoming big sagebrush typically dominates the shrub component but rabbitbrush and/or Woods' rose may share dominance. The understory in the community can be dominated by shortgrasses to an understory dominated by forbs and shortgrasses. Failure to adjust stocking rate as shrub cover increases results in further degradation of the herbaceous community causing an increase in bare ground between shrubs. This community can have a dense canopy of shrubs with sparse understory making it difficult to return to the Shortgrass Community or a community within the Taller Bunchgrass State, even if brush is removed. Reseeding and other cultural practices may be needed. When overgrazing continues, invasive grass and forb species move into the plant community and the site can transition to the Sparsely Vegetated State (3) or the Invaded State (4). Until the Altered Shrubland Community (2.2) crosses the threshold into the Sparsely Vegetated State (3) or the Invaded State (4) this community can be managed toward the Shortgrass Community (2.1) using prescribed grazing and strategic weed control.

Pathway 2.1A
Community 2.1 to 2.2

The Altered State (2) is always at risk for shrub dominance and a shift to the Altered Shrubland Community (2.2) in the absence of fire and brush management. The drivers for Community Shift 2.1A are overgrazing and lack of fire and/or brush control. The mean fire return interval in the Altered State (2) is likely less than 35 years. Even with proper grazing and favorable climate conditions, lack of fire or brush control for 20 years will allow shrubs and trees to increase in canopy to reach the 20% threshold level. Improper grazing, prolonged drought, and a warming climate will provide a competitive advantage to shrubs, which will accelerate this process. The driver for this community shift is improper grazing management in combination with lack of fire and/or brush control.

Pathway 2.2A
Community 2.2 to 2.1

The Altered Shrubland Community (2.2) can return to the Shortgrass Community (2.1) after a fire as long as the understory is able to carry the fire and shortgrass crowns survive the fire and re-sprout and/or there is a sufficient seed of shortgrasses to re-vegetate the area.

State 3
Sparsely Vegetated State

The single community described below characterizes this state.

Community 3.1
Sparsely Vegetated Community

Long-term grazing mismanagement with continuous growing-season pressure will reduce total productivity of the site and lead to an increase of bare ground. Once plant cover is reduced, the site is more susceptible to erosion. Soil erosion reduces soil fertility creating a reduction in plant production. This soil erosion or loss of soil fertility indicates the transition to the Sparsely Vegetated State (3). The decline may be exacerbated by extended rough conditions. Very sparse plant cover and soil surface erosion characterize this community. Canopy cover may be very sparse or clumped (canopy cover less than 25%). Weeds, annual species, or shortgrass species dominate the plant community. Perennial bunchgrass species (e.g., bluebunch wheatgrass) may exist, but only in patches. This community has crossed a threshold (T1B, T2A) compared to the Taller Bunchgrass State (1) and compared to the Altered State (2) due to the erosion of soil, loss of soil fertility, or degradation of soil properties. If further soil erosion occurs there will be a critical negative shift in the ecological processes of this site. The effects of soil erosion can alter the hydrology, soil chemistry, soil microorganisms, and soil physics to the point where intensive restoration is required to restore the site to another state or community. Simply changing grazing management cannot create sufficient change to restore the site within a reasonable time period. Restoration will require a considerable input of energy to move the site back to the Taller Bunchgrass State (1). This state has lost soil or vegetation attributes to the point that recovery to the Taller Bunchgrass State (1) will require reclamation efforts, i.e., soil rebuilding, intensive mechanical treatments, and/or reseeding. In this community phase there may be a significant amount of bare ground, and large gaps may occur between plants. The transition to this state could occur due to overgrazing (often due to failure to adjust stocking rates in response to declining forage production because of increased dominance of unpalatable invasive species), long-term lack of fire, warming climate, or extensive drought. Potential exists for soils to erode to the point that irreversible damage may occur. If herbaceous cover decreases to the point that soils are no longer stable, the shrub overstory may not prevent soil erosion. This plant community may be in a terminal state that will not return to the reference state because of degraded soil properties and loss of higher successional native plant species.

State 4
Invaded State

The single community described below characterizes this state.

Community 4.1
Invaded Community

The Invaded State (4) is characterized by > 25% of invasive species: spotted knapweed, leafy spurge, sulphur cinquefoil, and/or cheatgrass are the dominant invasive species in MLRA 44A. Introduced exotic plant species have been identified as one of the greatest threats to the integrity and productivity of native rangeland ecosystems and conservation of indigenous biodiversity (DiTomaso 2000 and Mack et al. 2000). In addition to environmental consequences, the damages caused and the costs incurred to control invasive plants are several billion dollars each year in the United States (Pimentel et al. 2000). Invasives are the driving factor throughout western Montana and they are a focal part of the ecology of MLRA 44A. Their ability to take over and dominate a site has become a big concern. Improper grazing management has contributed to the spread of these species. The potential for altered ecosystem structure and function is high in the Invaded State (4) and can occur in many ways. The increase in invasive species, especially noxious weeds, can lead to a reduction of the native bunchgrasses and an increase in the proportion of bare ground, which often results in reduced infiltration rates and increased surface runoff and erosion. Invasion by cheatgrass reduces above and below ground biomass (Ogle et al. 2003), increases plant litter, changes plant community canopy architecture (Belnap and Phillips 2001), reduces soil biota richness and abundance, reduces plant community richness (Belnap et al. 2005), increases wildfire frequency (Whisenant 1990), and potentially facilitates invasion by other noxious or invasive plants. Dense populations of invasive species can cause soil loss to increase because of lack of surface cover (Lacey et al. 1989). Early in the invasion process there is a lag phase where invasive plant populations remain small and localized before expanding exponentially (Hobbs and Humphries 1995). Based on research conducted in noxious weed-invaded plant communities in Montana, it is reasonable to estimate that 25% dry weight composition of invasive plant species is the point in the invasion process where spread and abundance is increasing exponentially and where a plant community has crossed a threshold (Masters and Sheley 2001). For aggressive invasive species, (i.e., spotted knapweed), this threshold could be < 10%. The site becomes “At Risk” as soon as the first individual plant of aggressive invasives reaches reproductive capacity. Once invasive species dominate the site, either in species composition by weight or in their impact on the community, the threshold has been crossed to the Invaded State (4). Once invasive species become established, they are very difficult to eradicate. Therefore, considerable effort should be placed in preventing plant communities from crossing a threshold to the Invaded State (4) through early detection and proper weed management. Preventing new invasions is by far the most cost-effective control strategy and typically places an emphasis on education. Control measures used on the noxious plant species impacting this ecological site include chemical, biological, and cultural control methods. The best success has been found with an integrated weed management strategy that incorporates one or several of these options along with education and prevention efforts (DiTomaso 2000). Production in the invaded community may vary greatly. A site dominated by spotted knapweed, where soil fertility and chemistry remain near potential, may have production near that of the reference community. A site with degraded soils and infestation of cheatgrass may produce only 10-20% as many pounds per acre of the reference community. Invasive plant species have effective reproductive strategies, long seed viability in the soil seed bank, and/or allelopathic properties (Williamson and Fitter 1996). Spotted knapweed has allelopathic properties whereby its roots exude catechin, which may limit the growth and establishment of other plant species (Callaway and Vivanco 2007; Bais et al. 2002), thus promoting its own success. An in-vitro experiment showed that other weeds like Dalmatian toadflax (*Linaria dalmatica*), kochia (Kochia scoparia), diffuse knapweed (*Centaurea diffusa*), and crops such as wheat (*Triticum aestivum*), showed mortality on the fourteenth day after addition of root exudates from spotted knapweed (Bais et al. 2002). This allelopathic property creates highly resilient communities. Cheatgrass has the ability to establish rapidly and attain community dominance following disturbances such as wildfire (Young and Evans 1978) or other disturbances that create bare soil. Cheatgrass is a successful invader because it has the ability to respond rapidly to increases in resource availability (Norton et al. 2004 and Lowe et al.

2003) as well as to compete for water (Pellant 1996). Cheatgrass was introduced into the United States in packing materials, ship ballast, and likely as a contaminant of crop seed. Cheatgrass was first found in the United States near Denver, Colorado, in the late 1800s. In the late 1800s and early 1900s, cheatgrass spread explosively in the ready-made seedbeds prepared by the trampling livestock hooves of overstocked rangelands. Cheatgrass has developed into a severe weed in several agricultural systems throughout North America, particularly western pastureland, rangeland, and winter wheat fields (NRCS 2009). Today, cheatgrass is found in most of the western states having reached its range of current distribution by 1930. In fact, a survey of 11 western states showed that cheatgrass was present on at least 60 million acres (Pellant 1996). After arriving in 1893 on the San Juan Islands in Washington, spotted knapweed had established in over 24 counties in three northwestern states by 1924, with several large infestations near Missoula, Montana (Sheley et al. 2005). By 1975, spotted knapweed had spread into most of the western counties of Montana, and today it is found in every county in Montana. Leafy spurge, a native to Eurasia, was sighted in Park County, Montana as early as 1925 and has since been found in every county in Montana. Overgrazing by livestock has contributed to the spread of leafy spurge (Sheley et al. 2005).

Transition T1A
State 1 to 2

The Taller Bunchgrass State (1) transitions to the Altered State (2) if bluebunch wheatgrass falls below 10% species composition. The trigger for this transition is the loss of taller bunchgrasses, which creates a shift in species composition towards lower productive species, especially prairie junegrass and Sandberg bluegrass. This transition can occur from any community within the Taller Bunchgrass State (1), it is not dependant on an increase of woody canopy cover, but on the decrease of bluebunch wheatgrass production. The driver for this transition is improper grazing management and/or long-term drought leading to a decrease in bluebunch wheatgrass composition to less than 10%.

Transition T1B
State 1 to 3

The Taller Bunchgrass State (1) transitions to the Sparsely Vegetated State (3) if plant canopy cover declines to < 25% and bluebunch wheatgrass decreases to below 10% by dry weight. The trigger for this transition is the loss of taller bunchgrasses, which creates open spots of bare soil. Soil erosion is accompanied by decreased soil fertility driving transitions to the Sparsely Vegetated State (3). There are several other key factors signaling the approach of transition T1B: increases in soil physical crusting, decreases in cover of cryptogamic crusts, decreases in soil surface aggregate stability, and/or evidence of erosion, including water flow patterns, development of plant pedestals, and litter movement. The driver for this transition is improper grazing management and/or long-term drought leading to a decrease in rough fescue composition to less than 10%.

Transition T1C
State 1 to 4

Regardless of grazing management, without some form of weed management (chemical, mechanical, or biological control), the Taller Bunchgrass State (1) can transition to the Invaded State (4) if aggressive invasive species, such as spotted knapweed and cheatgrass are introduced, even if the herbaceous component of the reference community is thriving. Healthy plant communities are most resilient to invasives. Long-term stress conditions for native species (e.g., overgrazing, drought, and fire) accelerate the process. If populations of invasive species reach critical levels, the site transitions to the Invaded State. The driver for this transition is the presence of aggressive invasive species.

Restoration pathway R2A
State 2 to 1

Restoration of the Altered State to the Taller Bunchgrass State (1) requires substantial energy input. The drivers for this restoration pathway are removal of woody species, restoration of native herbaceous species by reseeding bluebunch wheatgrass.

Transition T2A
State 2 to 3

Removal of shrubs without proper grazing management can lead to an increase in bare ground. This erosion of the fertile surface horizon can degrade to the Sparsely Vegetated State (3). The driver for this transition is brush management without proper grazing management.

Transition T2B
State 2 to 4

Removal of shrubs can lead to an increase in bare ground. If invasive species are present, bare ground offers opportunity for invasive species to fill open areas, leading to the Invaded State (4). The driver for this transition is brush management in presence of invasive species.

Restoration pathway R3A
State 3 to 1

The Sparsely Vegetated State (3) has lost soil or vegetation attributes to the point that recovery to the Taller Bunchgrass State (1) will require reclamation efforts such as soil rebuilding, intensive mechanical treatments, and/or revegetation. The drivers for this restoration pathway are reclamation efforts and proper grazing management. The trigger is restoration efforts.

Restoration pathway R3B
State 3 to 2

The Sparsely Vegetated State (3) has lost soil or vegetation attributes to the point that recovery to the Altered State (2) will require reclamation efforts such as soil rebuilding, intensive mechanical treatments, and/or reseeding in recommended areas only. If the reclamation efforts are performed without reseeding bluebunch wheatgrass, under unfavorable climatic conditions, or without proper grazing management, the site will return to the Altered State.

Transition T3A
State 3 to 4

Invasive species can occupy Sparsely Vegetated State (3) and drive it to the Invaded State (4). The Sparsely Vegetated State is at risk of this transition occurring if invasive propagules are present. The driver for this transition is the presence of critical population levels (> 25%) of invasive species. The trigger is the presence of propagules of invasive species.

Restoration pathway R4A
State 4 to 1

Restoration of the Invaded State (4) to the Taller Bunchgrass State (1) requires substantial energy input. The drivers for this restoration pathway are removal of invasive species, restoration of native bunchgrass species, ongoing management of invasives, and proper grazing management. Without maintenance, invasive species are likely to return (probably rapidly) because of the presence of propagules in the soil, increase in soil disturbance. The drivers for this reclamation pathway are treatments to reduce or remove invasive/noxious species in combination with favorable growing conditions. The trigger is invasive species control.

Restoration pathway R4B
State 4 to 2

Weed management without reseeding desirable taller bunchgrasses, favorable climatic conditions, or proper grazing management will lead to the Altered State (2).

Restoration pathway R4C
State 4 to 3

If invasive species are removed without sufficient remnant populations of reference community species (particularly rough fescue), a site in the Invaded State (4) is likely to return to the Sparsely Vegetated State (3) instead of the Taller Bunchgrass State (1). The driver for the reclamation pathway is weed management without reseeding. The trigger is invasive species control.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool Season Bunchgrasses**			628–1098	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	628–1098	–
	green needlegrass	NAVI4	*Nassella viridula*	45–78	–
2	**Shortgrasses/Rhizomatous Grasses/Grasslikes**			90–157	
	Grass, perennial	2GP	*Grass, perennial*	45–78	–
	sedge	CAREX	*Carex*	45–78	–
	thickspike wheatgrass	ELLA3	*Elymus lanceolatus*	45–78	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	45–78	–
	western wheatgrass	PASM	*Pascopyrum smithii*	45–78	–
	Sandberg bluegrass	POSE	*Poa secunda*	45–78	–
Forb					
3	**Forbs**			90–157	
	Forb, annual	2FA	*Forb, annual*	45–78	–
	Forb, perennial	2FP	*Forb, perennial*	45–78	–
	common yarrow	ACMI2	*Achillea millefolium*	45–78	–
	onion	ALLIU	*Allium*	45–78	–
	aster	ASTER	*Aster*	45–78	–
	milkvetch	ASTRA	*Astragalus*	45–78	–
	narrowleaf blue eyed Mary	COLI	*Collinsia linearis*	45–78	–
	bastard toadflax	COUM	*Comandra umbellata*	45–78	–
	tall annual willowherb	EPBR3	*Epilobium brachycarpum*	45–78	–
	fleabane	ERIGE2	*Erigeron*	45–78	–
	buckwheat	ERIOG	*Eriogonum*	45–78	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	45–78	–
	flax	LINUM	*Linum*	45–78	–
	desertparsley	LOMAT	*Lomatium*	45–78	–
	beardtongue	PENST	*Penstemon*	45–78	–
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	45–78	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	45–78	–
Shrub/Vine					
4	**Shrubs**			90–157	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	45–78	–
	prairie sagewort	ARFR4	*Artemisia frigida*	45–78	–
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	45–78	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	45–78	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	45–78	–
	Woods' rose	ROWO	*Rosa woodsii*	45–78	–

Animal community

Livestock grazing is suitable on this site due to the potential to produce high quality forage. This site may be preferred for grazing by livestock, and animals may congregate in these areas. 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) but infiltration is low on the Clayey Site. The water cycle degrades as the vegetation community declines. Soil organic matter and high total ground cover of around 95% 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. 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 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

Inventory data references

Information presented was derived from NRCS clipping data, literature, field observations (based on one sampled sites and observations from numerous others), 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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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.

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Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are unlikely to occur in the Taller Bunchgrass State.

2. **Presence of water flow patterns:** Water flow patterns are generally not evident in the reference state. Following occasional (5 – 30 % probability), heavy thunderstorms and winter thaw events, short, sinuous, discontinuous flow patterns may be apparent, but rare, on slopes ranging from 4 – 15%. Water flow patterns should not be evident on slopes lower than 4%.

3. **Number and height of erosional pedestals or terracettes:** None to very slight. Rarely pedestals up to 0.5 inches may be encountered.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground should not exceed 10% - 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 or 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%.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** 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.

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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 2%. The surface horizon is 3 to 6 inches thick.

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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 shortgrasses in Plant community (1.2) infiltration may slightly decrease and runoff may slightly increase but overall this plant community will have only minor affects on infiltration and runoff.

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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):** A compaction layer would not be common on this ecological site. Some discontinuous, weak platy soil surface structure may be 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: Plant community 1.1 - Taller cool season bunchgrasses (bluebunch wheatgrass) >>> cool season rhizomatous grasses (western wheatgrass), shortgrasses (prairie junegrass) and grasslikes (sedges) = perennial forbs = shrubs. Plant community 1.2 – bluebunch wheatgrass and shortgrass species share dominance – the other functional/structural groups will remain the same in descending order.

    Sub-dominant:

    Other:

    Additional:

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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.

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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.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-**

production): 800 #/acre – 1400 #/acre for the reference community (1.1) with a RV of 1100 #/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:** Cheatgrass, knapweed spp., leafy spurge, sulphur cinquefoil, dalmatian toadflax, Japanese brome, broom snakeweed, fringed sagewort, salsify and dandelion.

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