

Ecological site R058AY703MT Claypan 10-14

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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): 058A–Northern Rolling High Plains, Northern Part

MLRA 058A, Northern Rolling High Plains (Northern Part), is an expansive and agriculturally and ecologically significant area encompassing 26 counties in southeast Montana (99 percent) and northeast Wyoming (1 percent). It stretches approximately 290 miles from east to west and 220 miles from north to south and comprises approximately 42,350 square miles (26,875,928 acres). The area is within the Missouri Plateau, Unglaciaded, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been eroded. Slopes generally are gently rolling to steep, and wide belts of steeply sloping badlands border a few of the larger river valleys. In some areas flat-topped, steep-sided buttes rise sharply above the general level of the plains. Elevations generally range from 1,950 to 3,280 feet, increasing from east to west and from north to south.

Tertiary continental shale, siltstone, and sandstone of the Fort Union Formation underlie the eastern one-third to one-half of this area. Marine and continental sediments of the Cretaceous Montana Group underlie the rest of the MLRA, generally at the higher elevations. There are also younger Cretaceous sediments of the Livingston Group occurring between the higher elevation Montana Group sediments and the lower elevation Tertiary sediments. The dominant soil orders in MLRA 058A are Entisols and Inceptisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They range from shallow to very deep and are generally well drained and clayey or loamy.

The area primarily supports native prairie vegetation characterized by a variety of cool-season and warm-season graminoids, forbs, and shrubs. In the western portion of the area, cool-season grasses such as western wheatgrass and bluebunch wheatgrass are dominant but, in the eastern portion of the area, warm-season grasses such as little bluestem and sideoats grama become dominant. Wyoming big sagebrush, silver sagebrush, and fringed sagewort are common shrub species throughout the area. Forested areas occur in rough hilly areas and river breaks, particularly in areas with higher precipitation. Common tree species are ponderosa pine and Rocky Mountain juniper with scattered pockets of Douglas fir.

More than 75 percent of this MLRA is native rangeland utilized for livestock production and more than 50 percent of the MLRA consists of privately-owned ranches. Approximately 15 percent of the MLRA is used as cropland. Other land uses including forestland, urban development, water, and other uses combine for less than 10 percent of the total land use.

Classification relationships

NRCS Soil Geography Hierarchy

- Land Resource Region: Western Great Plains
- Major Land Resource Area (MLRA): 058A Northern Rolling High Plains, Northern Part

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)

- Domain: Dry

- Division: Temperate Steppe
- Province: Great Plains-Palouse Dry Steppe Province (331)
- Section: North Central Highlands (331K) and Powder River Basin (331G)

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)

- Class: Xeromorphic Woodland, Scrub and Herb Vegetation Class (3)
- Subclass: Cool Semi-Desert Scrub and Grassland Subclass (3.B)
- Formation: Cool Semi-Desert Scrub and Grassland Formation (3.B.1)
- Division: Cool Semi-Desert Scrub and Grassland Division (3.B.1.Ne)
- Macrogroup: Artemisia tridentata - Artemisia tripartita ssp. tripartita - Purshia tridentata Steppe and Shrubland Macrogroup (3.B.1.Ne.3)
- Group: Artemisia tridentata ssp. wyomingensis - Artemisia tridentata ssp. tridentata Steppe and Shrubland Group (3.B.1.Ne.3.a)

EPA Ecoregions

- Level 1: Great Plains (9)
- Level 2: West-Central Semi-Arid Prairies (9.3)
- Level 3: Northwestern Great Plains (9.3.3)
- Level 4: Montana Central Grasslands (43n), River Breaks (43c), and Pine Scoria Hills (43p)

Ecological site concept

This ecological site occurs on nearly level to gently sloping uplands, terraces, and fans at elevations ranging from 1,900 to 3,500 feet. Slopes range from 0 to 15 percent but are generally less than 8 percent. This site occurs on all aspects, although aspect is not a significant factor. This ecological site is typically associated with Loamy, Panspot, and Thin Claypan ecological sites. The distinguishing characteristic of this site is the presence of a dense, sodium-affected (natric) horizon between depths of 4 to 8 inches from the soil surface. The natric horizon exhibits columnar structure, is very hard and severely limits both root penetration and infiltration. Soil surface horizons (0 to 4 inches) are very fine sandy loam to silty clay loam, and the natric horizon is loam, clay, or clay loam.

Associated sites

R058AY708MT	Loamy 10-14 This site occupies similar landscapes to the Claypan ecological site. In the natric soils complex, the Loamy ecological site is typically found on the highest micro-topography; whereas, Claypan occupies lower positions.
R058AY721MT	Thin Claypan 10-14 This site occupies similar landscapes to the Claypan ecological site. In the natric soils complex, the Thin Claypan ecological site is typically found in mid-level micro-topography, higher than Panspot, but lower than the Claypan and the Loamy ecological sites.
R058AY712MT	Panspot 10-14 This site occupies similar landscapes to the Claypan ecological site. In the natric soils complex, the Panspot Dry Shrubland ecological site is found on the lowest micro-topography in the complex.

Similar sites

R058AY708MT	Loamy 10-14 This site differs from the Claypan ecological site in that the root restricting layer (evidenced by columnar structure) is either absent or greater than 8 inches below the soil surface. Surface horizon textures are typically loam, silt loam, very fine sandy loam or sandy clay loam and contain 32 percent clay or less.
R058AY701MT	Clayey 10-14 This site differs from the Claypan ecological site in that the root restricting layer (evidenced by columnar structure) is either absent or greater than 8 inches below the soil surface. Surface horizon textures range from clay loam to clay and contain greater than 32 percent clay.
R058AY721MT	Thin Claypan 10-14 This site differs from the Claypan ecological site in that the root restricting layer (evidenced by columnar structure) is between 1 and 4 inches below the soil surface. Deep rooted bunchgrasses are rare or absent.

R058AY712MT

Panspot 10-14

This site differs from the Claypan ecological site in that the root restricting layer (evidenced by columnar structure) is 1 inch or less from the surface. Commonly occurs in small depressions or pits on the landscape.

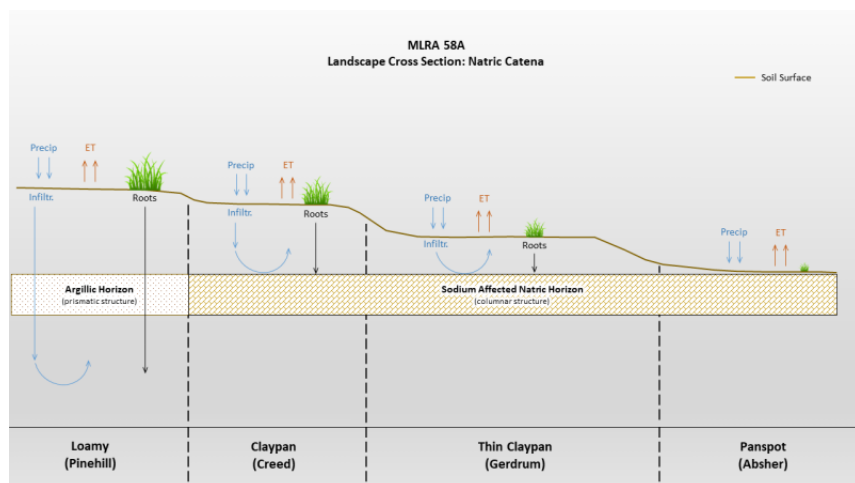


Figure 1. Associated and Similar Sites Diagram

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata ssp. wyomingensis</i>
Herbaceous	(1) <i>Pascopyrum smithii</i>

Physiographic features

This ecological site occurs on nearly level to gently sloping sedimentary plains, terraces, and fans. The slopes typically range from 0 to 15 percent but are generally less than 8 percent. This site occurs on all aspects. Aspect is not a significant factor.

Table 2. Representative physiographic features

Landforms	(1) Plain (2) Terrace (3) Terrace
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	1,900–3,500 ft
Slope	0–8%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified

Elevation	Not specified
Slope	0–15%

Climatic features

MLRA 058A is a semi-arid region and is considered to have a continental climate characterized by cold winters, hot summers, low humidity, light rainfall, and much sunshine. The climate is the result of the MLRA's location in the geographic center of North America. Temperatures can be extreme. The average annual temperature is 41 to 49 degrees Fahrenheit. Summer daytime temperatures are typically quite warm, generally averaging in the lower to mid 80 degree range for July and August. Summertime temperatures will typically reach 100 degrees or more at some point during the summer and can reach 90 degrees during any month between May and September. Conversely, winter temperatures can be cold, averaging in the lower teens or less for December and January. There will typically be several days of below zero temperatures each winter. It is not uncommon for temperatures to reach 30 to 40 degrees below zero, or even colder, most any winter.

During an average year, 70 to 75 percent of the annual precipitation falls between April and September, which are the primary growing season months. Most of the rainfall occurs as frontal storms early in the growing season during the months of May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rainfall occurs in autumn. Later summer precipitation is greater in the eastern portion of the MLRA, which effects plant community composition. Winter precipitation occurs as snow although snowfall is not heavy, averaging about 39 inches annually, and snow cover is typically 1 to 3 inches. Heavy snowfall occurs infrequently, usually late in the winter or early spring. The average annual precipitation ranges from 8 to 22 inches but is typically 10 to 17 inches throughout most of the area. This site is part of the lower precipitation subset ranging from 10 to 14 inches. Precipitation fluctuates widely from year to year and severe drought occurs 2 out of 10 years on average.

There are few natural barriers on the northern Great Plains and the winds move freely across the plains and account for rapid changes in temperature. Spring can be windy throughout the MLRA, with winds averaging over 10 mph about 15 percent of the time. Speeds of 50 mph or stronger can occasionally occur. During the winter months, the western half of the MLRA commonly experiences Chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The Chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain foothills and decrease eastward. In addition to producing damaging winds, prolonged Chinook episodes can result in drought or vegetation kills due to a reaction of plants to a "false spring" (Oard, 1993).

For local climate station information, refer to <https://wrcc.dri.edu/summary/Climsmemt.html>.

Table 4. Representative climatic features

Frost-free period (characteristic range)	85-150 days
Freeze-free period (characteristic range)	115-170 days
Precipitation total (characteristic range)	10-14 in
Frost-free period (average)	125 days
Freeze-free period (average)	145 days
Precipitation total (average)	13 in

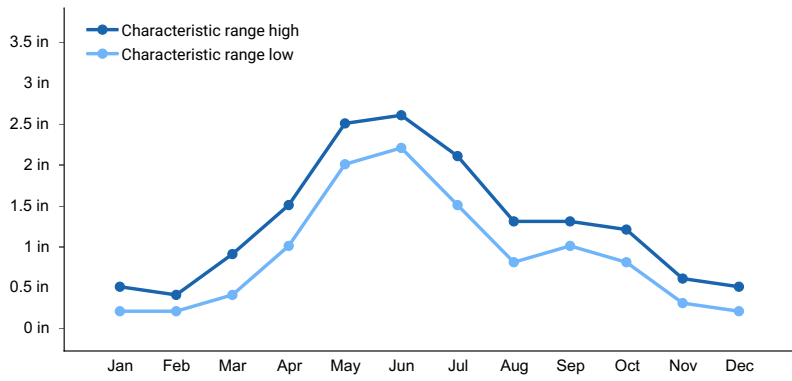


Figure 2. Monthly precipitation range

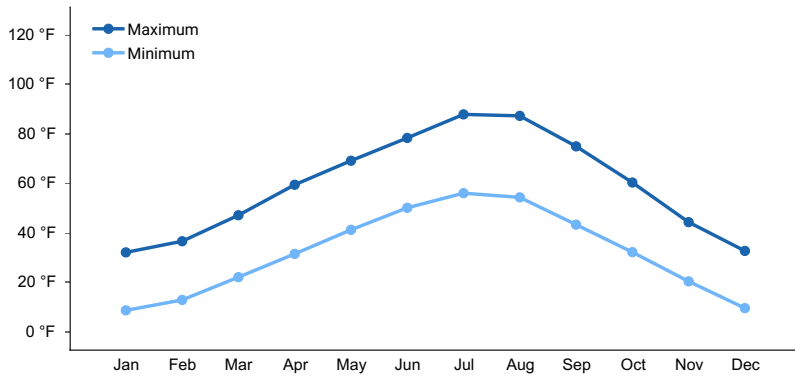


Figure 3. Monthly average minimum and maximum temperature

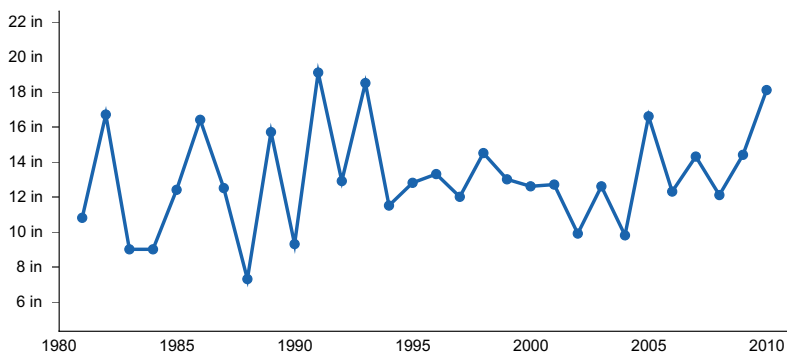


Figure 4. Annual precipitation pattern

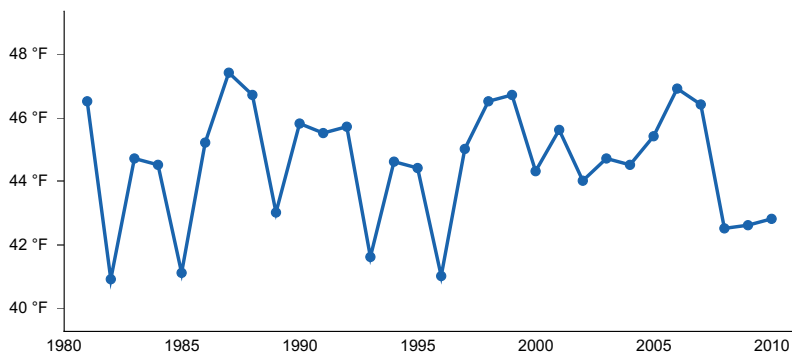


Figure 5. Annual average temperature pattern

Climate stations used

- (1) RAPELJE [USC00246862], Rapelje, MT
- (2) HYSHAM 25 SSE [USC00244364], Bighorn, MT
- (3) BRANDENBERG [USC00241084], Rosebud, MT

- (4) TERRY 21 NNW [USC00248169], Terry, MT
- (5) BLOOMFIELD 5 NNE [USC00240923], Bloomfield, MT
- (6) GLENDIVE [USC00243581], Glendive, MT
- (7) POWDERVILLE 8 NNE [USC00246691], Volborg, MT
- (8) JORDAN 23 ENE [USC00244530], Jordan, MT
- (9) FT PECK PWR PLT [USC00243176], Fort Peck, MT
- (10) CIRCLE [USC00241758], Circle, MT
- (11) BROCKWAY 3 WSW [USC00241169], Brockway, MT
- (12) MILES CITY F WILEY FLD [USW00024037], Miles City, MT
- (13) MIZPAH 4 NNW [USC00245754], Ismay, MT
- (14) SAND CREEK [USC00247342], Roy, MT
- (15) ROCK SPRINGS [USC00247136], Angela, MT
- (16) COHAGEN [USC00241875], Cohagen, MT

Influencing water features

This is an upland ecological site, but it has unique hydrology because infiltration is severely limited by the dense natric horizon 4 to 8 inches below the soil surface. Evapotranspiration exceeds precipitation on this site, and a state of moisture deficit persists for the majority of the year. In typical precipitation events, the upper 4 to 8 inches of the soil profile is filled to field capacity, then moisture amounts are quickly diminished by evapotranspiration. Abnormally wet years or very intense precipitation events can saturate the soil surface layer and cause very brief (less than 2 days) ponding and lateral flow via surface runoff into adjacent microlows. Lateral water movement is typically limited to a localized area due to the flat topography. Frequency and duration of saturation are not sufficient for the development of hydric soil features.

Wetland description

Not Applicable

Soil features

Soils for this ecological site are typically moderately deep to very deep (greater than 20 inches to bedrock), well drained, and derived from alluvium. A root restrictive layer referred to as a natric horizon occurs 4 to 8 inches below the soil surface. The natric horizon exhibits distinctive columnar structure and is dense, root-limiting, and affected by sodium salts. Surface horizon textures typically range from loam to silty clay and the underlying horizons typically and have loam, clay loam, silty clay loam, or sandy clay loam textures. The soil temperature regime is primarily frigid, with smaller areas of mesic temperature regime present. The soil moisture regime is aridic ustic. Figure 5 shows a typical soil profile for this ecological site.

Soil Series	Horizon	Depth	Texture	PH	SAR	CaCo3	Gypsum
Creed	A	0 - 5"	loam	6.1 – 8.4			
	E	5 - 6	sic	6.1 – 8.4			
	Btn	6 - 12	sicl	6.6 – 9.0	8 to 20		
	Btnk, Bky	12 - 28	sicl,	7.9 – 9.0	13 to 20	5 - 15	
	Byz	28 - 60	sicl,	7.9 – 9.0	13 to 25	5 - 10	1 to 5

Figure 6. Typical Soil Profile

Table 5. Representative soil features

Parent material	(1) Alluvium–sedimentary rock
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Surface texture	(1) Sandy clay loam (2) Silt loam (3) Loam (4) Clay loam (5) Silty clay loam
Drainage class	Well drained
Permeability class	Very slow to moderately slow
Depth to restrictive layer	4–8 in
Soil depth	20–72 in
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0–5%
Available water capacity (0-40in)	5.6–7.2 in
Electrical conductivity (0-40in)	0–16 mmhos/cm
Sodium adsorption ratio (6-40in)	8–25
Soil reaction (1:1 water) (0-40in)	6.1–9
Subsurface fragment volume <=3" (0-40in)	0–15%
Subsurface fragment volume >3" (0-40in)	0%

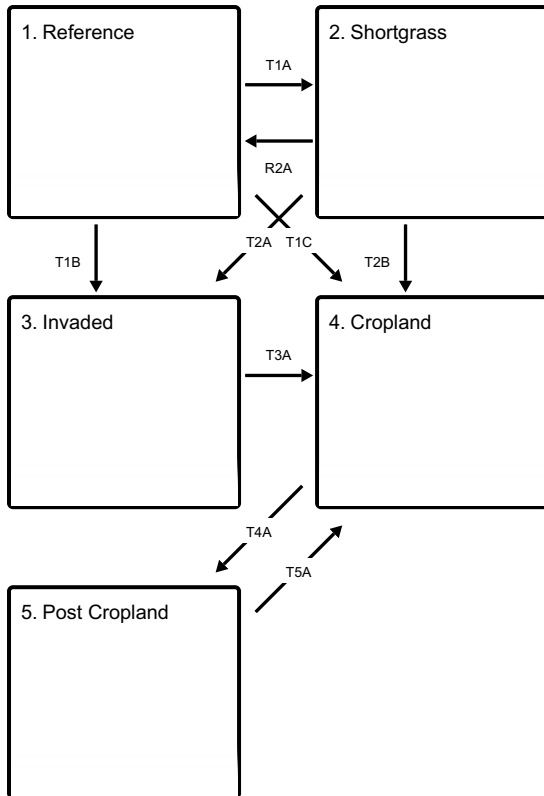
Ecological dynamics

Interpretations are primarily based on the Reference state, which is used as a reference in order to understand the original potential of the site. This ecological site developed under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. Changes may occur to the Reference state due to management actions such as improper grazing management, climatic conditions such as drought, and natural events such as multiple fires in close succession. The Reference state is dominated by shallower-rooted rhizomatous species, such as western wheatgrass or thickspike wheatgrass over deep-rooted bunchgrasses due to the root-restrictive natric horizon. Forb species are less common and occur in smaller amounts. Common shrubs and half-shrubs occurring on this site include species such as Wyoming big sagebrush, greasewood, Nuttall's saltbush, and winterfat. The Reference state is not necessarily the management goal, as other vegetative states may be considered desired plant communities as long as critical resource concerns are met.

In addition to the Reference state, other plant communities can occur on this site and are usually the result of historic management practices. Long term overgrazing on this ecological site results in a decrease of the more palatable grasses and forbs and in an increase of shortgrasses, less palatable forbs, and cacti. Half-shrubs and shrubs increase in the absence of prescribed fire and wildfire. More frequent fire intervals decreases the shrub component resulting in a site dominated by herbaceous species. There are various transitional stages which may occur on this ecological site.

State and transition model

Ecosystem states



T1A - Prolonged drought, improper grazing, or a combination of these factors

T1B - Introduction of non-native invasive species (annual bromes, crested wheatgrass, noxious weeds, etc.)

T1C - Conversion to cropland

R2A - Proper grazing management in combination with rangeland seeding, grazing land mechanical treatment, and timely moisture (management intensive and costly)

T2A - Introduction of non-native invasive species (annual bromes, crested wheatgrass, noxious weeds, etc.)

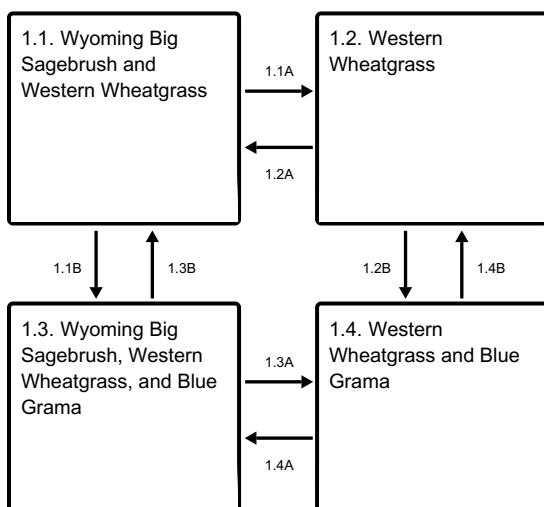
T2B - Conversion to cropland

T3A - Conversion to cropland

T4A - Cessation of annual cropping

T5A - Conversion to cropland

State 1 submodel, plant communities



1.1A - Prescribed fire and wildfire, mechanical and chemical treatments, and biological processes

1.1B - Drought, improper grazing management

1.2A - Approximately 30 years post-fire regrowth

1.2B - Drought, improper grazing management, multiple fires in close succession

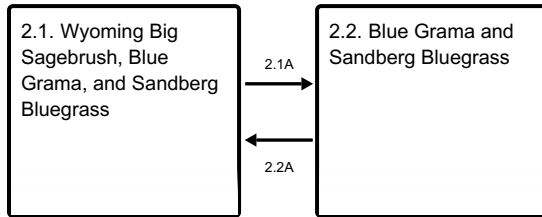
1.3B - Normal or above average precipitation, proper grazing management

1.3A - Prescribed fire and wildfire, mechanical and chemical treatments, and biological processes

1.4B - Normal or above average precip., proper grazing management

1.4A - Approximately 30 years post-fire regrowth

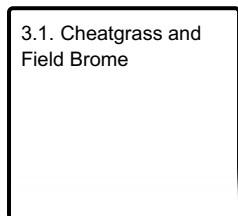
State 2 submodel, plant communities



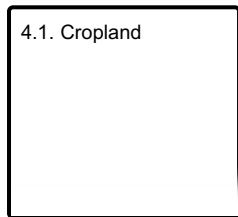
2.1A - Prescribed fire and wildfire, mechanical and chemical treatments, and biological processes

2.2A - Approximately 30 years post-fire regrowth

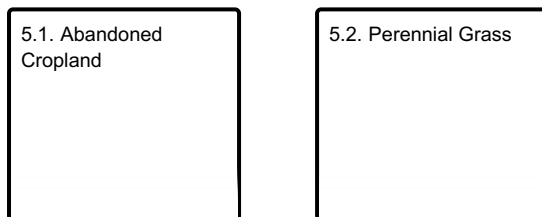
State 3 submodel, plant communities



State 4 submodel, plant communities



State 5 submodel, plant communities



State 1 Reference

The Reference state for this ecological site consists of four communities and evolved under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. The Reference state is the plant community in which interpretations are primarily based and is used as a reference in order to understand the original potential of the site.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- western wheatgrass (*Pascopyrum smithii*), grass
- blue grama (*Bouteloua gracilis*), grass

Community 1.1 Wyoming Big Sagebrush and Western Wheatgrass

This plant community is characterized by a mixed-grass community and Wyoming big sagebrush. The predominant species are shallower-rooted rhizomatous species such as western wheatgrass. Deeper-rooted bunchgrasses such as alkali sacaton and needle and thread are less common and occur at low to moderate cover. Shortgrasses such as blue grama and Sandberg bluegrass are present at low cover. Forbs such as purple prairie clover, white prairie clover, American vetch, scurfpea, and scarlet globemallow are less common and occur in smaller amounts. Wyoming big sagebrush occurs at approximately 5 to 15 percent canopy cover.

Community 1.2 Western Wheatgrass

This plant community is characterized by a reduction of Wyoming big sagebrush and a species composition shift to a rhizomatous wheatgrass community with western wheatgrass a predominant species. Bunchgrasses such as alkali sacaton and needle and thread occur at low to moderate cover. Shortgrasses such as blue grama, Sandberg bluegrass, and inland saltgrass occur at low cover. Forbs such as purple prairie clover, white prairie clover, American vetch, scurfpea, and scarlet globemallow are not common and occur in smaller amounts. Wyoming big sagebrush is absent to rare. This community occurs following sagebrush mortality due to wildfire, prescribed fire, mechanical and chemical treatments, or biological processes and may persist for 30 years or more thereafter (Watts and Wambolt, 1996; Wambolt et. al., 2001).

Community 1.3 Wyoming Big Sagebrush, Western Wheatgrass, and Blue Grama

This plant community is characterized by an increase in shortgrass species such as blue grama and Sandberg bluegrass and a decrease in mid-statured grasses such as western wheatgrass, needle and thread, and alkali sacaton. Prairie sagewort occurs at low to moderate cover and Wyoming big sagebrush occurs at 5 to 20 percent canopy cover. This plant community occurs when site conditions decline due to long-term drought or improper grazing management, and major sagebrush mortality has not occurred for at least 30 years prior.

Community 1.4 Western Wheatgrass and Blue Grama

This plant community is characterized by an increase in shortgrass species such as blue grama and Sandberg bluegrass and a decrease in mid-statured grasses such as western wheatgrass, needle and thread, and alkali sacaton. Prairie sagewort occurs at low to moderate cover and Wyoming big sagebrush is absent to rare. This plant community occurs when site conditions decline due to long-term drought or improper grazing management, and sagebrush mortality due to wildfire, prescribed fire, mechanical and chemical treatments, or biological processes has occurred on the site less than 30 years prior.

Pathway 1.1A Community 1.1 to 1.2

Community 1.1 will transition to community 1.2 through prescribed fire and wildfire, mechanical and chemical treatments, and biological processes. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway 1.1B Community 1.1 to 1.3

Drought, improper grazing management such as continuous season-long or year-long grazing, or a combination of these factors can shift community 1.1 to community 1.3. These factors favor an increase in blue grama and a decrease in cool-season mid-statured grasses (Coupland, 1961; Shay et al., 2001). Wyoming big sagebrush cover will be similar to community 1.1.

Pathway 1.2A Community 1.2 to 1.1

Approximately 30 years or more of natural vegetative regrowth will shift community 1.2 to community 1.1.

Approximately 30 years or more without major mortality permits Wyoming big sagebrush to recolonize the site.

Pathway 1.2B **Community 1.2 to 1.4**

Drought, improper grazing practices such as continuous season-long or year-long grazing, multiple fires in close succession, or a combination of these factors can shift community 1.2 to community 1.3. These factors favor an increase in blue grama and a decrease in cool-season mid-statured grasses (Coupland, 1961; Shay et al., 2001). Wyoming big sagebrush cover will be similar to community 1.2.

Pathway 1.3B **Community 1.3 to 1.1**

Approximately 30 years or more following mortality; normal or above-average precipitation and proper grazing management shifts community 1.3 to community 1.1.

Pathway 1.3A **Community 1.3 to 1.4**

Community 1.3 will transition to community 1.4 through prescribed fire and wildfire, mechanical and chemical treatments, and biological processes. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway 1.4B **Community 1.4 to 1.2**

Less than 30 years post-fire; normal or above-average precipitation and proper grazing management transitions the community 1.4 to community 1.2.

Pathway 1.4A **Community 1.4 to 1.3**

Approximately 30 years or more of natural vegetative regrowth will shift community 1.4 to community 1.3. Approximately 30 years or more without fire or similar mortality permits Wyoming big sagebrush to recolonize the site.

State 2 **Shortgrass**

The dynamics of the Shortgrass state are driven by long-term drought, improper grazing management such as continuous season-long or year-long grazing, or a combination of these factors. The Shortgrass state for this ecological site consists of two communities.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), shrub
- blue grama (*Bouteloua gracilis*), grass
- Sandberg bluegrass (*Poa secunda*), grass

Community 2.1 **Wyoming Big Sagebrush, Blue Grama, and Sandberg Bluegrass**

This plant community is characterized by a dominance of short-statured grasses such as blue grama and Sandberg bluegrass. Mid-statured grasses such as western wheatgrass, needle and thread, and alkali sacaton are rare or absent. Prairie sagewort is common and Wyoming big sagebrush canopy cover is 5 to 15 percent. This community results in a reduction of soil surface litter, soil organic matter, and infiltration and an increase of soil surface runoff. This plant community is capable of tolerating season-long, heavy grazing and therefore is highly resistant to change.

Community 2.2

Blue Grama and Sandberg Bluegrass

This plant community is characterized by a complete dominance of short-statured grasses such as blue grama and Sandberg bluegrass. Mid-statured grasses such as western wheatgrass, needle and thread, and alkali sacaton are rare or absent. Prairie sagewort is common and Wyoming big sagebrush is absent or rare. This plant community occurs when site conditions decline due to long-term drought or improper grazing management such as continuous season-long or year-long grazing, and sagebrush mortality due to wildfire, prescribed fire, mechanical and chemical treatments, or biological processes has occurred on the site less than 30 years prior.

Pathway 2.1A

Community 2.1 to 2.2

Community 2.1 will transition to community 2.2 through prescribed fire and wildfire, mechanical and chemical treatments, and biological processes. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway 2.2A

Community 2.2 to 2.1

It is estimated that approximately 30 years or more of natural vegetative regrowth could transition community 2.2 to community 2.1. It is possible that this transition could occur over time, however, the processes are not fully understood at this time. Therefore, this pathway is considered hypothetical until further investigation can be completed.

State 3

Invaded

The Invaded state occurs when invasive plant species invade native plant communities and displace the native species. The Invaded state consists of one community.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass
- field brome (*Bromus arvensis*), grass

Community 3.1

Cheatgrass and Field Brome

Observations suggest that native species diversity declines significantly when invasive or noxious species exceed approximately 30 percent of the plant community. Non-native, perennial, drought tolerant grasses such as crested wheatgrass, non-native, annual, invasive species such as cheatgrass and field brome, and noxious weed species can eventually dominate the seedbank of this site and displace native species. Reduced plant species diversity, simplified structural complexity, and altered ecological processes result in a state that is substantially departed from the Reference state. The dominance of annual, invasive grasses such as cheatgrass and field brome increases the fire cycle frequency.

State 4

Cropland

The Cropland state occurs when cultivation occurs to the land. The Cropland state consists of one community.

Community 4.1

Cropland

The land is cultivated and converted to crop production. Annual, cool-season cereal grains such as spring wheat, winter wheat, and barley are common crops which replace native plant communities.

State 5 Post Cropland

The Post Cropland state occurs when cultivated cropland is abandoned and allowed to either re-vegetate naturally or is seeded back to perennial species for livestock grazing or wildlife use. This state can transition back to the Cropland state if the site is returned to cultivation. No formal studies have been obtained regarding Wyoming big sagebrush recovery following cultivation and further investigation is needed to assess Wyoming big sagebrush recovery in the Post Cropland state. The Post Cropland state has two communities.

Community 5.1 Abandoned Cropland

In the absence of active management, the site can re-vegetate naturally and potentially return to a perennial grassland community over time. Shortly after cropland is abandoned, annual and biennial forbs and annual brome grasses invade the site. The site is highly susceptible to erosion due to the absence of perennial species. Eventually, these pioneering annual species are replaced by perennial forbs and perennial shortgrasses. Depending on the historical management of the site, mid-statured perennial grasses may also return; however, species composition will depend upon the seed bank. Invasion of the site by exotic species, such as crested wheatgrass and annual bromes, will depend upon the site's proximity to a seed source. Fifty or more years after cultivation, these sites may have species composition similar to communities in the Reference state. However, soil quality is consistently lower than conditions prior to cultivation and a shift to the Reference state is unlikely within a reasonable timeframe (Dormaar, J.F., and S. Smoliak. 1985).

Community 5.2 Perennial Grass

When the site is seeded to perennial forage species this community can persist for several decades. Introduced perennial grasses, in particular, may form monocultures that persist for 60 years or more (Samuel, M.J., and R.H. Hart. 1994). A mixture of native species may also be seeded to provide species composition and structural complexity similar to that of the Reference state. However, soil quality conditions have been substantially altered and will not return to pre-cultivation conditions within a reasonable timeframe.

Transition T1A State 1 to 2

Prolonged drought, improper grazing management such as continuous season-long or year-long grazing, or a combination of these factors weaken the resilience of the Reference state and drive its transition to the Shortgrass state. The Reference state transitions to the Shortgrass state when mid-statured graminoids become rare and shortgrasses such as blue grama, Sandberg bluegrass, and prairie Junegrass dominate the plant community.

Transition T1B State 1 to 3

The Reference state transitions to the Invaded state when non-native grasses or noxious weeds invade the plant community. Exotic plant species dominate the site in terms of cover and production and site resilience has been substantially reduced. In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered from the Reference state.

Transition T1C State 1 to 4

Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Reference state to the Cropland state.

Restoration pathway R2A

State 2 to 1

Blue grama can resist displacement by other species. A reduction in livestock grazing pressure alone may not be sufficient to reduce the cover of blue grama in the Shortgrass state and mechanical treatments may be necessary. Therefore, returning the Shortgrass state to the Reference state can require considerable cost, energy, and time.

Conservation practices

Prescribed Grazing

Transition T2A

State 2 to 3

The Shortgrass state transitions to the Invaded state when non-native grasses, noxious weeds, and other invasive plants invade the Shortgrass state. Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced.

Transition T2B

State 2 to 4

Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Shortgrass state to the Cropland state.

Transition T3A

State 3 to 4

The Invaded state will transition to the Cropland state when the site is placed under cultivation.

Transition T4A

State 4 to 5

The transition from the Cropland state to the Post Cropland state occurs with the cessation of cultivation. The site may also be seeded to perennial forage species, such as crested wheatgrass and alfalfa, or a mix of native species.

Transition T5A

State 5 to 4

Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Post Cropland state to the Cropland state.

Additional community tables

Inventory data references

Specific field data was not obtained for this provisional ecological site description. Existing field data were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities, states, and transitions. All community phases are considered provisional based on the sources identified in this ecological site description.

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	11/13/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

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

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

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

5. **Number of gullies and erosion associated with gullies:**

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

7. **Amount of litter movement (describe size and distance expected to travel):**

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution 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):**

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:

Sub-dominant:

Other:

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

14. **Average percent litter cover (%) and depth (in):**

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

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:

17. Perennial plant reproductive capability:
