USDA Natural Resources Conservation Service

Ecological site FX053A99X145
Panspot (Pn)

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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): 053A–Northern Dark Brown Glaciated Plains

The Northern Dark Brown Glaciated Plains, MLRA 53A, is a large, agriculturally and ecologically significant area. It consists of approximately 6.1 million acres and stretches 140 miles from east to west and 120 miles from north to south, encompassing portions of 8 counties in northeastern Montana and northwestern North Dakota. This region represents part of the southern edge of the Laurentide Ice Sheet during maximum glaciation. It is one of the driest and westernmost areas within the vast network of glacially derived prairie pothole landforms of the Northern Great Plains and falls roughly between the Missouri Coteau to the east and the Brown Glaciated Plains to the west. Elevation ranges from 1,800 feet (550 meters) to 3,300 feet (1,005 meters).

Soils are primarily Mollisols, but Inceptisols and Entisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). The bedrock is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur in glacial outwash channels and along major drainages, including portions of the Missouri, Poplar, and Big Muddy Rivers. Large eolian deposits of sand occur in the vicinity of the ancestral Missouri River channel east of Medicine Lake (Fullerton et al., 2004). The northwestern portion of the MLRA contains a large unglaciated area containing paleoterraces and large deposits of sand and gravel known as the Flaxville gravel.

Much of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton and Colton, 1986; Fullerton et al., 2004). Subsequent erosion from major stream and river systems has created numerous drainageways throughout much of the MLRA. The result is a geologically young landscape that is predominantly a dissected till plain interspersed with alluvial deposits and dominated by soils in the Mollisol and Inceptisol orders. Much of this area is typic ustic, making these soils very productive and generally well suited to production agriculture.

Dryland farming is the predominant land use, and approximately 50 percent of the land area is used for cultivated crops. Winter, spring, and durum varieties of wheat are the major crops, with over 48 million bushels produced annually (USDA-NASS, 2017). Areas of rangeland typically are on steep hillslopes along drainages. The rangeland is mostly native mixed-grass prairie similar to the Stipa-Agropyron, Stipa-Bouteloua-Agropyron, and Stipa-Bouteloua faciations (Coupland, 1950, 1961). Cool-season grasses dominate and include rhizomatous wheatgrasses, needle and thread, western porcupine grass, and green needlegrass. Woody species are generally rare; however, many of the steeper drainages support stands of trees and shrubs, such as green ash and chokecherry. Seasonally ponded, prairie pothole wetlands may occur throughout the MLRA, but the greatest concentrations are in the east and northeast where receding glaciers stagnated and formed disintegration moraines with hummocky topography and numerous areas of poorly drained soils.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 053A Northern Dark Brown Glaciated Plains

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: Glaciated Northern Grasslands Section 331L
• Subsection: Glaciated Northern Grasslands Subsection 331La
• Landtype association/Landtype phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Mesomorphic Shrub and Herb Vegetation Class (2)
• Subclass: Temperate and Boreal Grassland and Shrubland Subclass (2.B)
• Formation: Temperate Grassland and Shrubland Formation (2.B.2)
• Division: Central North American and Shrubland Division (2.B.2.Nb)
• Macrogroup: Hesperostipa comata - *Pascopyrum smithii* - Festuca hallii Grassland Macrogroup (2.B.2.Nb.2)
o Group: Hesperostipa comata - *Bouteloua gracilis* Dry Mixedgrass Prairie Group (2.B.2.Nb.2.b)

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: Glaciated Dark Brown Prairie (42i)
Glaciated Northern Grasslands (42j)

Ecological site concept

Panspot is an ecological site of limited extent site occurring on till plains, moraines, and fans in MLRA 53A. The distinguishing characteristic of this site is the presence of a dense, sodium-affected (natric) horizon at a depth of 1 inch or less from the soil surface. The natric horizon exhibits columnar structure, is very hard, and severely limits both root penetration and infiltration. Soils for this ecological site are typically moderately deep to very deep (more than 20 inches to bedrock), well drained, and derived from till or glaciofluvial deposits. Characteristic vegetation is blue grama (*Bouteloua gracilis*), prairie Junegrass (*Koeleria macrantha*), and western wheatgrass (*Pascopyrum smithii*).

Associated sites

FX053A99X165	**Thin Claypan (TCp)** The Thin Claypan ecological site is typically found in complex with this site and is found on micro-highs relative to the Panspot ecological site site.
FX053A99X006	**Claypan (Cp)** The Claypan ecological site is frequently found in complex with this site and is found on micro-highs relative to the Panspot ecological site.
FX053A99X032	**Loamy (Lo)** The Loamy ecological site is commonly found near this site and is on the highest slope positions relative to the Panspot ecological site.

Similar sites

FX053A99X006	**Claypan (Cp)** This site differs from the Panspot site in that the root-restricting layer (evidenced by columnar structure) is between 4 inches to 10 inches below the soil surface.
FX053A99X032	**Loamy (Lo)** This site differs from the Panspot site in that the root-restricting layer (evidenced by columnar structure) is either absent or more than 10 inches below the soil surface.
FX053A99X165	**Thin Claypan (TCp)** This site differs from the Panspot site in that the root-restricting layer (evidenced by columnar structure) is between 1 inch and 4 inches below the soil surface.

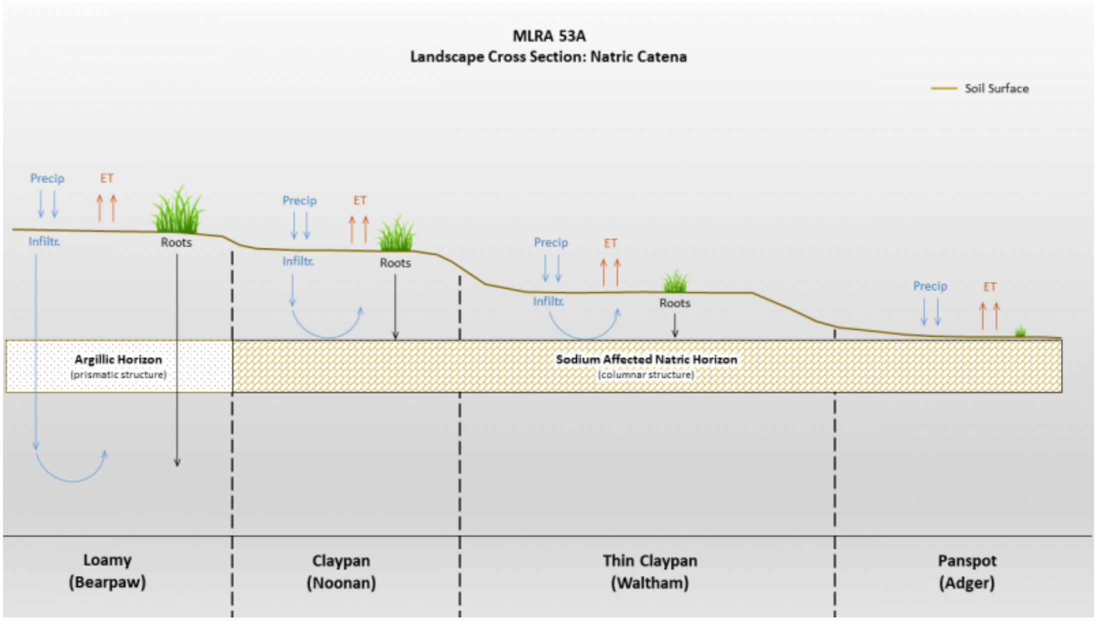


Figure 1. Diagram of similar and associated sites

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Bouteloua gracilis* (2) *Pascopyrum smithii*

Legacy ID

R053AY710MT

Physiographic features

This ecological site occurs on nearly level to gently sloping till plains, moraines, outwash fans, and alluvial fans. The slopes may range from 0 to 15 percent but are typically less than 8 percent.

Table 2. Representative physiographic features

Geomorphic position, flats	(1) Dip
Landforms	(1) Till plain > Moraine (2) Till plain > Outwash fan (3) Alluvial fan

Flooding frequency	None
Ponding frequency	None
Elevation	1,800–3,300 ft
Slope	0–8%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	0–15%

Climatic features

The Northern Dark Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Coupland, 1958; Richardson and Hanson, 1977; Heidel et al., 2000). The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Summer rainfall comes mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Approximately 80 percent of the annual precipitation occurs during the growing season. June is the wettest month, followed by July and May (Richardson and Hanson, 1977; Heidel et al., 2000). Average annual precipitation ranges from 11 inches (280 mm) near Richey, Montana, to 15 inches (380 mm) in the Little Muddy drainage near Williston, North Dakota, but precipitation varies greatly from year to year. On average, severe drought and very wet years occur with the same frequency, which is 1 out of 10 years (Coupland, 1958; Heidel et al., 2000). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). The frost-free period for this ecological site ranges from 90 to 130 days, and the freeze-free period ranges from 115 to 155 days.

Table 4. Representative climatic features

Frost-free period (characteristic range)	90-130 days
Freeze-free period (characteristic range)	115-155 days
Precipitation total (characteristic range)	11-15 in
Frost-free period (average)	110 days
Freeze-free period (average)	135 days

Precipitation total (average)	13 in

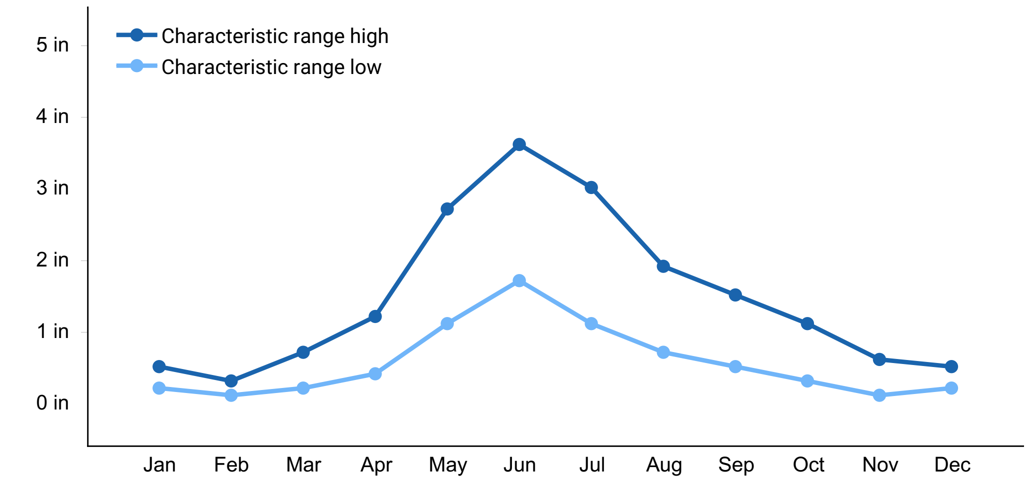


Figure 2. Monthly precipitation range

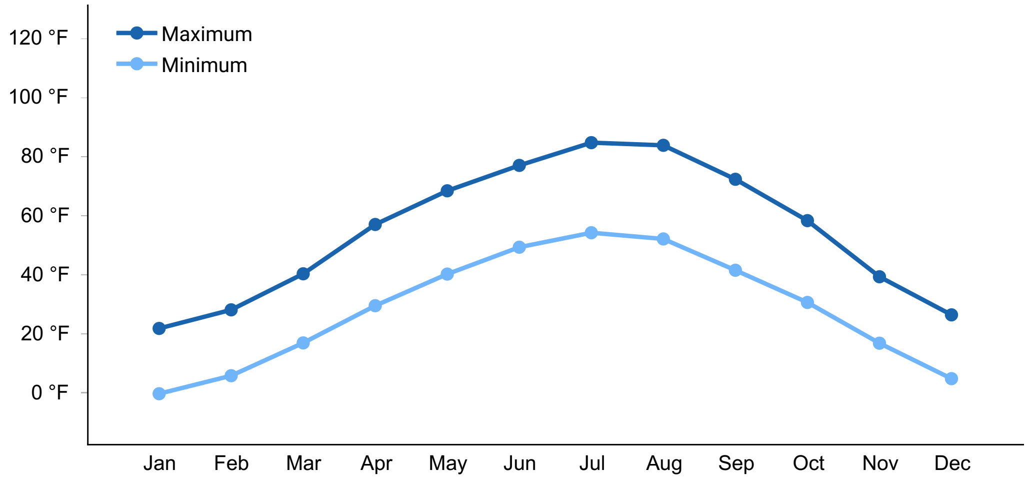


Figure 3. Monthly average minimum and maximum temperature

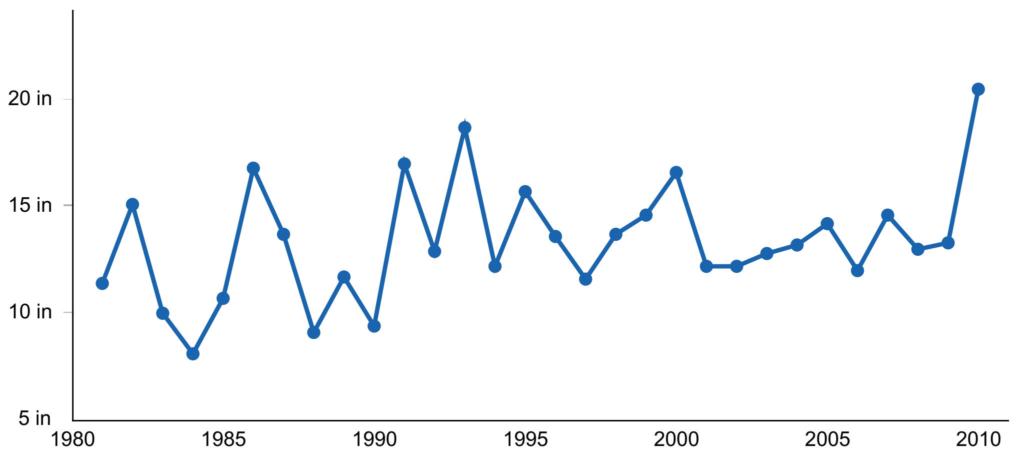


Figure 4. Annual precipitation pattern

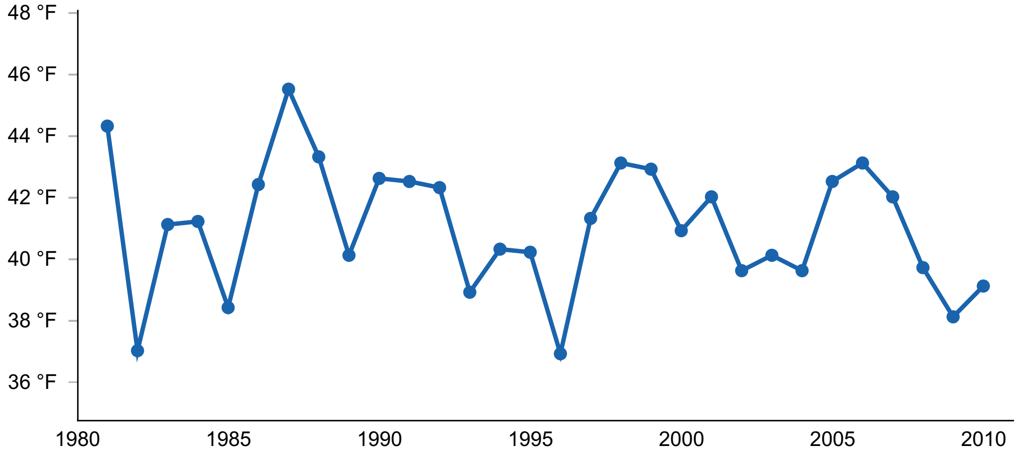


Figure 5. Annual average temperature pattern

Climate stations used

- (1) BREDETTE [USC00241088], Poplar, MT
- (2) CULBERTSON [USC00242122], Culbertson, MT
- (3) OPHEIM 10 N [USC00246236], Opheim, MT
- (4) OPHEIM 12 SSE [USC00246238], Opheim, MT
- (5) PLENTYWOOD [USC00246586], Plentywood, MT
- (6) SCOBEY 4 NW [USC00247425], Scobey, MT
- (7) SIDNEY [USC00247560], Sidney, MT
- (8) VIDA 6 NE [USC00248569], Vida, MT
- (9) WILLISTON SLOULIN INTL AP [USW00094014], Williston, ND

Influencing water features

This is an upland ecological site, but it has unique hydrology because infiltration is severely limited by the dense natric horizon within one-inch of 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, most of the moisture is lost through evapotranspiration before it can infiltrate. Abnormally wet years or very intense precipitation events can cause very brief (less than two days) ponding and lateral flow via surface runoff from adjacent micro-highs. 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.

Soil features

Soils for this ecological site are typically moderately deep to very deep (more than 20 inches to bedrock), well drained, and derived from clayey alluvium or glaciofluvial deposits. They have a typic ustic moisture regime, which means that the soils are moist in some or all parts for either 180 cumulative days or 90 consecutive days during the growing season but are dry in some or all parts for over 90 cumulative days, and a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface horizon textures found in this site are most frequently loam, but can range from fine sandy loam to silty clay loam, and typically contain between 15 to 30 percent clay. The underlying natric horizons typically contain 35 to 50 percent clay and have clay, clay loam, or silty clay loam textures. Depth to secondary carbonates and soluble sulfate salts is typically about 5 inches below the soil surface. Calcium carbonate equivalent is typically less than 5 percent in the upper 5 inches of soil. In the upper 20 inches, electrical conductivity is at some point more than 4 but less than 16 and the sodium absorption ratio is typically less than 15. Soil pH classes are moderately acid to slightly alkaline in the surface horizon and neutral to strongly alkaline in the subsurface horizons. Content of coarse fragments is less than 35 percent in the upper 20 inches of soil and is typically less than 15 percent.

Table 5. Representative soil features

Parent material	(1) Till–igneous, metamorphic and sedimentary rock (2) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Loam (2) Sandy loam (3) Silty clay loam
Drainage class	Well drained
Depth to restrictive layer	0–1 in
Soil depth	20–72 in
Electrical conductivity (0-20in)	2–8 mmhos/cm
Sodium adsorption ratio (0-20in)	0–15
Subsurface fragment volume <=3" (0-20in)	0–34%
Subsurface fragment volume >3" (0-20in)	0–34%

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The Panspot provisional ecological site in MLRA 53A consists of five states: the Historic Reference state (1), the Current Potential state (2), the Altered state (3), the Cropland state (4), and the Post Cropland state (5). Plant communities associated with this ecological site evolved under the combined influences of climate, grazing, and fire. Extreme climatic variability results in frequent droughts, which have the greatest influence on the relative contribution of species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). Due to the dominance of cool-season graminoids, annual production is highly dependent upon mid- to late-spring precipitation (Heitschmidt and Vermeire, 2005; Anderson, 2006).

The historic ecosystem experienced periodic lightning-caused fires with estimated fire return intervals of 6 to 25 years (Bragg, 1995). Historically, Native Americans also set periodic fires. The majority of lightning-caused fires occurred in July and August, whereas Native Americans typically set fires during spring and fall to correspond with the movement of bison (Higgins, 1986). The precise effects of the historic fire return interval are not definitive, but in general the mixed-grass ecosystem was resilient to fire. Potential effects are generally temporary and may include reduction of litter, fluctuations in production, and changes in species composition (Vermeire et al., 2011, 2014).

Native grazers also shaped these plant communities. American bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocapra americana), elk (Cervus canadensis), and deer (Odocoileus spp.) were also common. Additionally, small mammals such as prairie dogs (Cynomys spp.) and ground squirrels (Urocitellus spp.) influenced this plant community (Salo et al., 2004). Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus) also played an important role in the ecology of these communities (Lockwood, 2004). The mixed-grass ecosystem was resilient to grazing, although localized areas could experience shifts in species composition due to heavy grazing.

Following European settlement, fire was largely eliminated, domestic livestock replaced native ungulates as the primary grazers, and non-native species were introduced to the ecosystem. Aside from drought, livestock grazing is now the principle disturbance on the landscape.

Improper grazing of this site can result in a reduction in the cover of the perennial grasses and an increase in bare ground, cactus, and annual species. Improper grazing practices include any practices that do not allow sufficient opportunity for plants to physiologically recover from a grazing event or multiple grazing events within a given year and/or that do not provide adequate cover to prevent soil erosion over time. These practices may include, but are not limited to, overstocking, continuous grazing, and/or inadequate seasonal rotation moves over multiple years. Periods of extended drought (approximately 3 years or more) may have similar effects (Coupland, 1958, 1961). Further degradation of the site due to improper grazing can result in a community dominated by cactus and annual forbs.

Most, if not all, extant examples of this site have some degree of invasion by non-native species. Non-native grasses such as crested wheatgrass (*Agropyron cristatum*), and annual bromes (Bromus spp.) are the most common invasive species. These species are widespread throughout the Northern Great Plains and can invade relatively undisturbed grasslands (Heidinga and Wilson, 2002; Henderson and Naeth, 2005). In most cases native ecological function is relatively intact, but in some cases non-native grasses may at some point dominate the ecological dynamics of this site and result in an invaded state. However, on this ecological site, this phenomenon has not been sufficiently documented, the ecological mechanisms are unclear, and further investigation is needed.

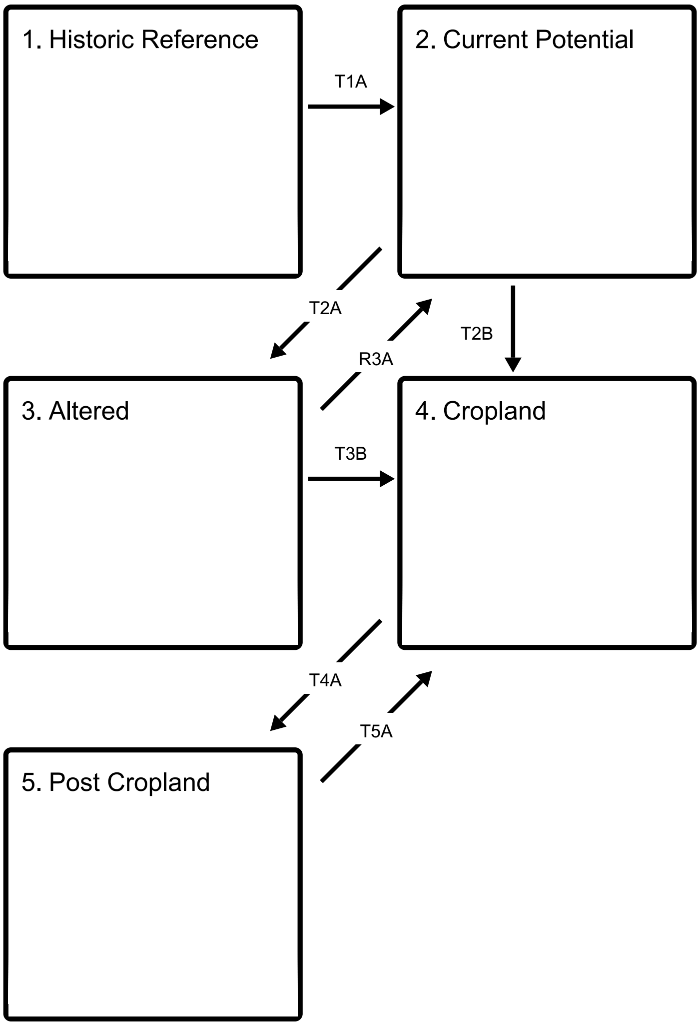
The effects of an altered fire regime are not completely understood at the time of this writing, but evidence suggests that long-term fire suppression can result in accumulations of litter and may contribute to increased abundance of non-native grasses (Vermeire et al., 2011; Whisenant, 1990).

Due to the presence of a sodium-affected natric horizon, this ecological site is not generally regarded as productive cropland. Regardless, some of it has been cultivated and planted to cereal grain crops, such as winter wheat, spring wheat, and barley. When taken out of production, this site is either allowed to revert back to perennial grassland or is seeded back to perennial grass. Such seedings may be comprised of introduced grasses and legumes or a mix of native species. Sites left to undergo natural plant succession after cultivation are unlikely to return to reference conditions in a reasonable amount of time due to the unfavorable physical and chemical soil properties. Natric chemical properties near the soil surface tend to cause these soils to crust following cultivation, therefore making it difficult for vegetation to reestablish naturally. Reestablishment of perennial vegetation may be more successful if the site is reseeded; however, studies have not been conducted on this site specifically. Stand vigor is expected to be limited and stand longevity is unknown at the time of this writing.

The state-and-transition model (STM) suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State and transition model

Ecosystem states



T1A - Introduction of non-native grass species, particularly annual bromes such as field brome and cheatgrass.

T2A - Prolonged drought, improper grazing management, or a combination of these factors

T2B - Conversion to cropland

R3A - Range seeding, grazing land mechanical treatment, timely moisture, proper grazing management (management intensive and costly)

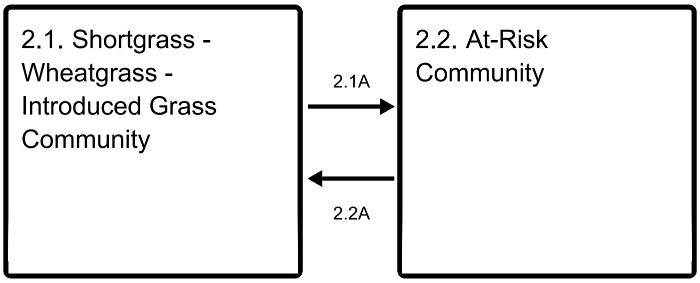
T3B - Conversion to cropland

T4A - Cessation of annual cropping

T5A - Conversion to cropland

State 1 submodel, plant communities

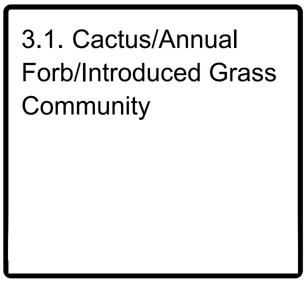
State 2 submodel, plant communities



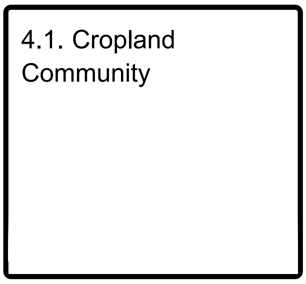
2.1A - Drought, improper grazing management

2.2A - Return to normal or above average precipitation, proper grazing management

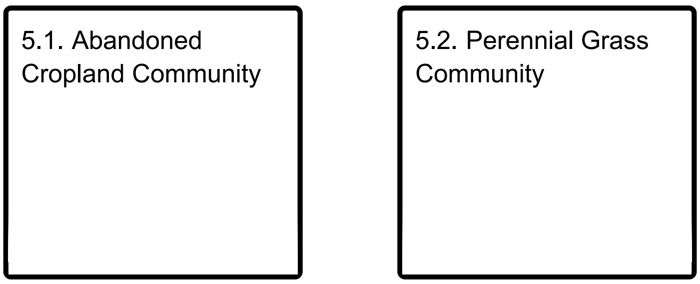
State 3 submodel, plant communities



State 4 submodel, plant communities



State 5 submodel, plant communities



State 1
Historic Reference

The Historic Reference state (1) contains one community phase characterized by shortgrasses and rhizomatous wheatgrasses. This state is considered extinct and is included here for historical reference purposes. It evolved under the combined influences of climate, grazing, and fire, with climatic variation having the greatest influence on cover and production. In general, this state was resilient to grazing; however, localized areas likely received heavy grazing, which may have resulted in shifts in the species composition. Fire dynamics are not well understood, but fire was most likely a minor influence on this site due to the sparse vegetation.

Community 1.1
Shortgrass - Rhizomatous Wheatgrass Community

The Shortgrass - Rhizomatous Wheatgrass Phase (1.1) was characterized by predominance of shortgrasses with a subdominant component of rhizomatous wheatgrasses. Shortgrasses comprised about 15 to 20 percent foliar cover and included prairie Junegrass (*Koeleria macrantha*) and blue grama (*Bouteloua gracilis*). Rhizomatous wheatgrasses comprised approximately 10 to 15 percent cover. Western wheatgrass (*Pascopyrum smithii*) was the predominant species, however thickspike wheatgrass (*Elymus lanceolatus*) also occurred, particularly in the northern extent of this site. Forbs comprised about 10 percent of the cover and cactus (Opuntia spp) cover was low.

State 2
Current Potential

The Current Potential state (2) contains two community phases characterized by shortgrasses and rhizomatous wheatgrasses. It evolved under the combined influences of climate, grazing, and fire, with climatic variation having the greatest influence on cover and production. This state differs from the historical reference state in that it is influenced by introduced plant species and has altered fire and grazing regimes. In general, this state is resilient to grazing although grazing can influence species composition in localized areas. Fire dynamics are not well understood, but fire is most likely a minor influence on this site due to the sparse vegetation.

Community 2.1
Shortgrass - Wheatgrass - Introduced Grass Community

The Shortgrass - Wheatgrass - Introduced Grass Phase (2.1) is predominantly native shortgrasses and mid-statured rhizomatous wheatgrasses, but has some degree of non-native grass establishment. Shortgrasses are dominantly blue grama and prairie Junegrass and comprise 15 to 20 percent foliar cover. Rhizomatous wheatgrasses comprise 10 to 15 percent cover and are mostly western wheatgrass, but thickspike wheatgrass may also occur, particularly in the northern extent of this site. Forbs comprised about 10 percent of the cover and cactus cover was low. Non-native species typically comprise 1 to 3 percent of the plant community and may include field brome (*Bromus arvensis*) and cheatgrass (*Bromus tectorum*).

Community 2.2
At-Risk Community

The At-Risk Community Phase (2.2) occurs when site conditions decline due to drought or improper grazing management. It is characterized by a predominance of shortgrasses. Mid-statured rhizomatous wheatgrasses are rare or absent. Grasses are in decline and have been substantially reduced in both cover and vigor. Annual forbs and cactus are increasing. The amount of bare ground also begins to increase, and the soil is exposed to increased solar heating.

Pathway 2.1A
Community 2.1 to 2.2

Drought, improper grazing management, or a combination of these factors can shift the Shortgrass - Wheatgrass - Introduced Grass Phase (2.1) to the At-Risk Community Phase (2.2). These factors favor an increase in shortgrasses such as blue grama and a decrease in midgrasses (Coupland, 1961).

Pathway 2.2A
Community 2.2 to 2.1

Normal or above-normal spring precipitation and proper grazing management transition the At-Risk Community Phase (2.2) back to the Shortgrass - Wheatgrass - Introduced Grass Phase (2.1).

State 3
Altered

The Altered state (3) consists of one community phase. The dynamics of this state are driven by long-term drought, improper grazing management, or a combination of these factors. Perennial grasses decrease with long-term improper grazing and bare ground increases. It is hypothesized that this results in increased heating of the soil by solar radiation, which exacerbates the already dry site conditions and creates a self-perpetuating condition of extreme drought. Under these conditions, it is very difficult for perennial species to persist or establish. This hypothesis has not been tested and requires further investigation. Non-native annual bromes may also persist in this state, but it is not known if they the site properties sufficiently to transition it to an Invaded State.

Community 3.1
Cactus/Annual Forb/Introduced Grass Community

The Cactus/Annual Forb/Introduced Grass Phase (3.1) occurs when site conditions decline due to long-term drought or improper grazing. Perennial grasses such as blue grama and rhizomatous wheatgrasses have been largely eliminated and replaced by cactus and annual forbs, such as woolly plantain (*Plantago patagonica*). Non-native annual bromes may also be common in some cases. The amount of bare ground is high, and the soil is exposed to solar heating.

State 4
Cropland

The Cropland state (4) occurs when land is put into cultivation. Major crops in MLRA 53A are small grains such as wheat.

Community 4.1
Cropland Community

Annual, cool-season cereal grains, such as spring wheat, winter wheat, and barley, are the most common crops.

State 5
Post Cropland

The Post Cropland state (5) occurs when cultivated cropland is abandoned and allowed to either revegetate naturally or is seeded back to perennial species for grazing or wildlife use. This state can transition back to the Cropland state (4) if the site is put back into cultivation.

Community 5.1
Abandoned Cropland Community

The Abandoned Cropland Community Phase (5.1) typically occurs when cropland is abandoned with no further management. It may also occur when cropland is abandoned and then seeded to perennial forage species and the reseeding fails. In the absence of active management, the site can revegetate naturally and, over time, potentially return to a perennial grassland community with shortgrasses such as blue grama. The chemical properties of the soil surface layers tend to cause crusting on this site following cultivation which may significantly slow down the revegetation process. The first species to establish after cropland is abandoned are typically annual and biennial forbs and annual brome grasses (Samuel and Hart, 1994). At this point, the site is extremely susceptible to erosion due to the absence of perennial species. Eventually, these pioneering annual species are replaced by perennial forbs and perennial shortgrasses, such as blue grama. 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 phases in the Contemporary Reference State (2). However, soil quality is consistently lower than under conditions prior to cultivation and a shift to the Contemporary Reference State (2) is unlikely within a reasonable time frame (Dormaar and Smoliak, 1985; Christian and Wilson, 1999).

Community 5.2
Perennial Grass Community

The Perennial Grass Community Phase (5.2) occurs when the site is seeded to perennial species for livestock forage or wildlife cover. The chemical soil properties of this site make it relatively difficult for perennial vegetation to reestablish but once established, it can persist for several decades. Seedings typically are comprised of introduced species such as intermediate wheatgrass (*Thinopyrum intermedium*) and alfalfa (*Medicago sativa*). Aggressive species such as crested wheatgrass tend to form monocultures which may persist for at least 60 years (Krzic et al., 2000; Henderson and Naeth, 2005) and can invade adjacent sites if conditions are favorable. A mixture of native species may also be seeded to provide species composition and structural complexity similar to those of the Contemporary Reference State (2). However, soil quality conditions have been substantially altered and will not return to pre-cultivation conditions within a reasonable time frame (Dormaar et al., 1990).

Transition T1A
State 1 to 2

Introduction of non-native grass species occurred in the early 20th century. The naturalization of these species in relatively undisturbed grasslands, coupled with changes in fire and grazing regimes, transitions the Reference state (1) to the Current Potential state (2).

Transition T2A
State 2 to 3

Prolonged drought, improper grazing practices, or a combination of these factors weaken the resilience of the Contemporary Reference State (2) and drive its transition to the Altered state (3). The Current Potential state (2) transitions to the Altered state (3) when perennial grasses become rare and contribute little to production. Cactus and annual forbs dominate the plant community.

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 Current Potential state (2) to the Cropland state (4).

Restoration pathway R3A
State 3 to 2

It is hypothesized that solar heating creates a self-perpetuating condition of extreme drought that suppresses establishment of perennial species, therefore a reduction in livestock grazing pressure alone may not be sufficient to restore the Altered state (3) to the Current Potential state (2). Intensive management treatments may be necessary (Hart et al., 1985), but it is not known how well this site responds to practices such as mechanical treatment of grazing land and range seeding. Therefore, returning the Altered State (3) to the Current Potential state (2) will likely require considerable energy and cost and may not be feasible within a reasonable amount of time.

Conservation practices

Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting

Transition T3B
State 3 to 4

Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Altered state (3) to the Cropland state (4).

Transition T4A
State 4 to 5

The transition from the Cropland state (4) to the Post Cropland state (5) occurs with the cessation of cultivation. The site may also be seeded to perennial forage species. Such seedings may be comprised of introduced grasses and legumes 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 (5) to the Cropland state (4).

Additional community tables

Inventory data references

Data for this provisional ecological site was obtained from one medium-intensity plot representing the Contemporary Reference State (2). This plot was used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for this state. Information for remaining states was obtained from professional experience and a review of the scientific literature. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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Contributors

Scott Brady
Stuart Veith

Approval

Kirt Walstad, 4/23/2025

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Bill Drummond, USDA-NRCS (retired)
Pete Weikle, USDA-NRCS

Peer Review
Kirt Walstad, USDA-NRCS
Mark Hayek, USDA-NRCS
Kami Kilwine, USDA-NRCS
Robert Mitchell, USDA-NRCS

Quality Control
Kirt Walstad, USDA-NRCS

Quality Assurance
Stacey Clark, USDA-NRCS

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	04/23/2025
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:**