Ecological site FX053A99X029
Limy Steep (LyStp)

Last updated: 11/22/2023
Accessed: 04/24/2024

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 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 Grassland and Shrubland Division (2.B.2.Nb)
• Macrogroup: Hesperostipa comata - Pascopyrum smithii - Festuca hallii Grassland Macrogroup (2.B.2.Nb.2)
• Group: Pascopyrum smithii - Hesperostipa comata - Schizachyrium scoparium Mixedgrass Prairie Group (2.B.2.Nb.2.c)
• Alliance: Schizachyrium scoparium Northwestern Great Plains Grassland Alliance
• Association: Schizachyrium scoparium - Muhlenbergia cuspidata Grassland

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

This provisional ecological site is common throughout MLRA 53A. Figure 2 illustrates the distribution of this ecological site based on current data. This map is approximate, is not intended to be definitive, and may be subject to change. Limy Steep is an extensive ecological site occurring on moderately steep to very steep landscapes, typically along the sides of drainages. This site is characterized by a relatively young, undeveloped soil profile, which is evidenced by increased calcium carbonate (lime) concentrations in the upper 5 inches. Soils typically have an ochric epipedon and are deeper than 20 inches to a restrictive layer. Characteristic vegetation is little bluestem (Schizachyrium scoparium), plains muhly (Muhlenbergia cuspidata), and needle and thread (Hesperostipa comata).

Associated sites

FX053A99X032	**Loamy (Lo)** This site occurs on gentler slopes (less than 15 percent) upslope from the Limy Steep ecological site. It is most commonly on summits where slopes are linear or concave. It may also occur on footslopes.
FX053A99X062	**Swale (Se)** This site is generally downslope from the Limy Steep ecological site in swales and drainageways and receives additional moisture from surface water run-in. Soils are typically more than 40 inches deep, are pachic, and have a higher available water-holding capacity.
FX053A99X030	**Limy (Ly)** This site occurs on gentler slopes (less than 15 percent) upslope from the Limy Steep ecological site. It is generally on shoulders or crests whereas the Limy Steep ecological site is on backslopes.
FX053A99X040	**Loamy Steep (LoStp)** This site occurs on moderate to steeply sloping hillslopes adjacent to the Limy Steep ecological site. It occurs in backslope positions with slopes of 15 percent or greater and most commonly occurs on north-facing slopes or slopes with a linear or concave shape.

Similar sites

FX053A99X030	**Limy (Ly)** This site differs from the Limy Steep ecological site in that slopes are less than 15 percent.
FX053A99X040	**Loamy Steep (LoStp)** This site differs from the Limy Steep ecological site in that the soils contain less than 5 percent calcium carbonate in the upper 5 inches (as evidenced by lack of effervescence).

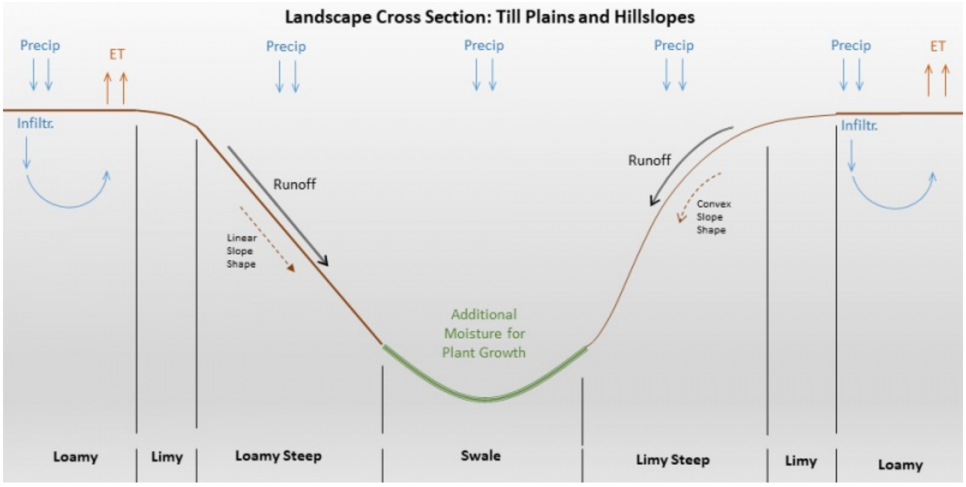


Figure 1. Diagram of similar and associated sites.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Muhlenbergia cuspidata*

Legacy ID

R053AY705MT

Physiographic features

The Limy Steep ecological site largely occurs where the till plain has been dissected by streams or rivers. It occurs on till plains, hillslopes, and bluffs where slopes are 15 percent or greater. Typical hillslope positions are backslopes and shoulders. The slope shape is typically convex. The site may occur on any aspect but is most common on south-facing slopes.

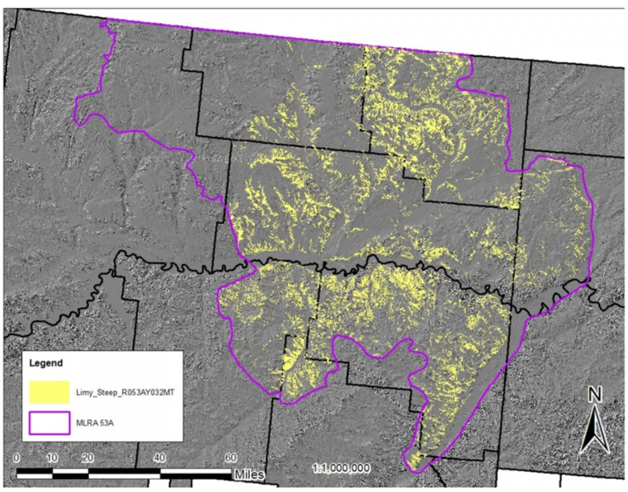


Figure 2. General distribution of the Limy Steep ecological site by map unit

extent.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Shoulder
Landforms	(1) Till plain > Hillslope (2) Till plain > Bluff
Flooding frequency	None
Ponding frequency	None
Elevation	1,800–3,300 ft
Slope	15–60%
Aspect	Aspect is not a significant factor

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 3. 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

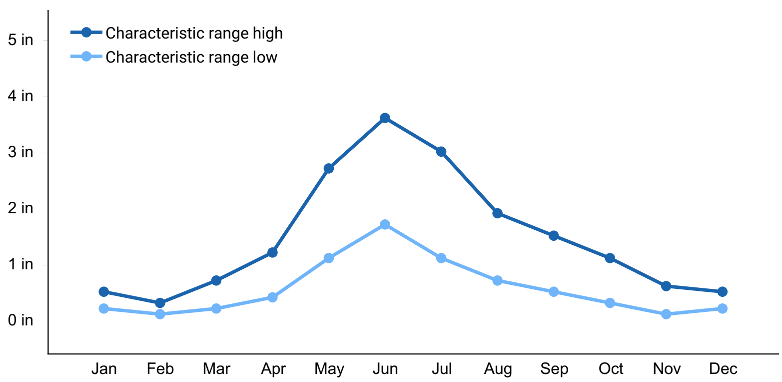


Figure 3. Monthly precipitation range

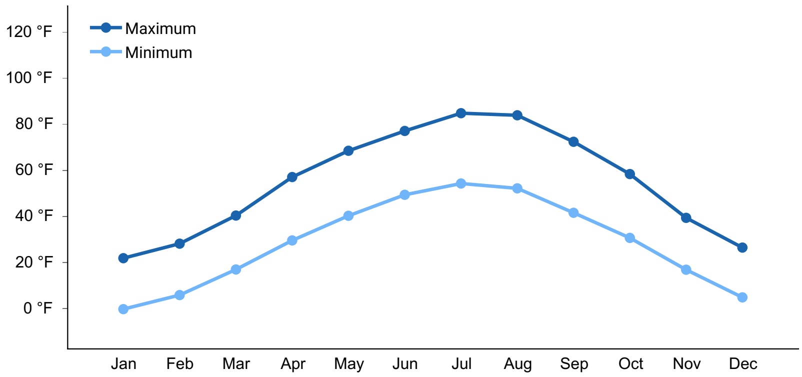


Figure 4. Monthly average minimum and maximum temperature

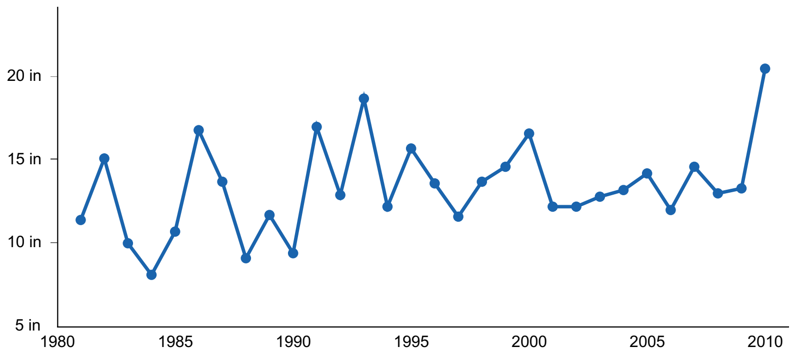


Figure 5. Annual precipitation pattern

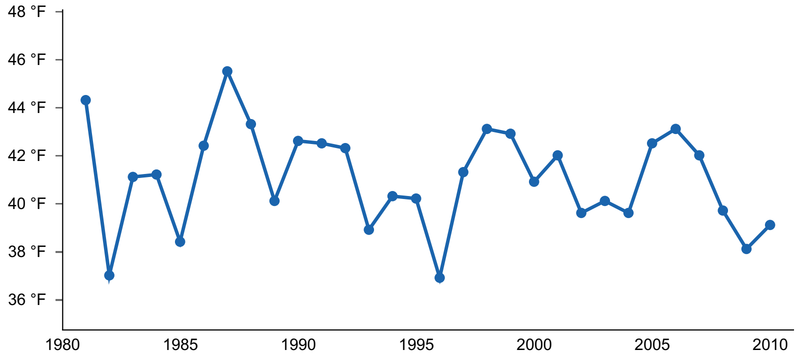


Figure 6. Annual average temperature pattern

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 and is not influenced by a water table or run-in from adjacent sites. Due to the semi-arid climate in which it occurs, the water budget is normally contained within the soil pedon. Soil moisture is recharged by spring rains, but it rarely exceeds field capacity in the upper 40 inches before being depleted by evapotranspiration. During intense precipitation events, precipitation rates frequently exceed infiltration rates and this site delivers moisture to downslope sites via surface runoff. Moisture loss through evapotranspiration exceeds precipitation for the majority of the growing season, and soil moisture is the primary limiting factor for plant production on this ecological site.

Soil features

The soil series that best represents the central concept of this ecological site is Zahill, but only when it occurs on slopes of 15 percent or greater. This soil is in the Calciustepts great group and is characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon and by an accumulation of calcium carbonate in the upper 5 inches. It is derived from till parent material, has mixed mineralogy, and is in the fine-loamy family, meaning that it contains between 18 and 35 percent clay in the particle-size control section. The soil moisture regime for all soils in this ecological site concept is typic ustic, 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. These soils have a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface horizons textures found in this site are typically loam or clay loam and contain 18 to 35 percent clay. The underlying horizons typically contain 18 to 35 percent clay and have loam or clay loam textures. Organic matter content in the surface horizon typically ranges from 1 to 2 percent, and moist colors vary from yellowish brown (10YR 5/4) to dark grayish brown (10YR 4/2). The upper 5 inches of soil contains 5 percent or more calcium carbonate equivalent and reacts strongly or violently with hydrochloric acid. Soil pH classes are slightly to moderately alkaline in the surface horizon and moderately to strongly alkaline in the subsurface horizons. The soil depth class for this site is typically deep or very deep (more than 40 inches to bedrock). Content of coarse fragments in the upper 20 inches of soil is less than 35 percent.

Table 4. Representative soil features

Parent material	(1) Till
Surface texture	(1) Loam (2) Clay loam
Drainage class	Well drained
Soil depth	40–72 in
Available water capacity (0-40in)	5.8–7.3 in
Calcium carbonate equivalent (0-5in)	5–15%
Electrical conductivity (0-20in)	0–3 mmhos/cm
Sodium adsorption ratio (0-20in)	0–12
Soil reaction (1:1 water) (0-40in)	7.4–9
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) (Figure 3), 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 Limy Steep provisional ecological site in MLRA 53A consists of four states: the Historic Reference State (1), the Contemporary Reference State (2), the Altered State (3), and the Invaded State (4). 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 mid-statured bunchgrasses and an increase in shortgrasses such as blue grama (Smoliak et al., 1972; Smoliak, 1974). 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) can reduce mid-statured, cool-season grasses and shift the species composition of this community to one dominated by blue grama (Coupland, 1958, 1961). Further degradation of the site due to improper grazing can result in a community dominated by shortgrasses such as blue grama and prairie Junegrass (Koeleria cristata).

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 bluegrasses (Poa spp.) are the most common invasive species. These species are widespread throughout the Northern Great Plains can invade relatively undisturbed grasslands (Heidinga and Wilson, 2002; Henderson and Naeth, 2005; Toledo et al., 2014). In most cases native ecological function is relatively intact, but in some cases non-native grasses will displace native species and dominate the ecological functions of the site.

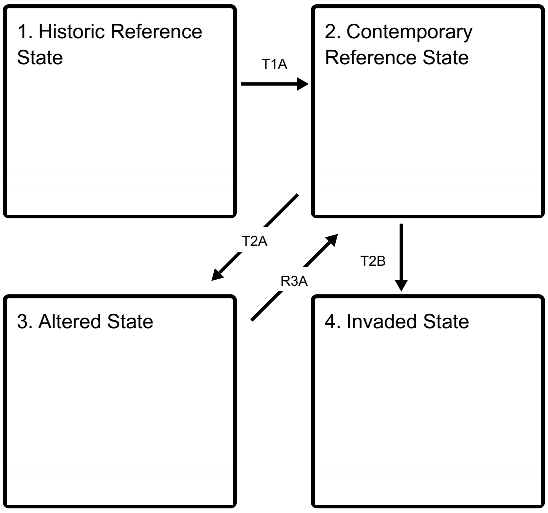
The effects of an altered fire regime are not completely understood at the time of this writing, but evidence suggests that long-term fire suppression can result in accumulations of litter and may contribute to increased abundance of non-native grasses (Murphy and Grant, 2005; Vermeire et al., 2011; Whisenant, 1990). Conversely, fire return intervals of less than 6 years, such as annual burning, can reduce productivity and shift species composition toward warm-season, short-statured grasses (Shay et al., 2001; Smith and McDermid, 2014).

Due to the steep slopes and the increased concentration of calcium carbonate near the soil surface, this ecological site is generally not suitable for cropland. In general, this site has not been converted to cropland and has remained in native vegetation.

The state-and-transition model (STM) (Figure 3) 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



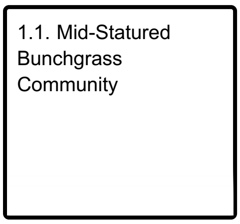
T1A - Introduction of non-native grass species, such as Kentucky bluegrass, smooth brome, and crested wheatgrass.

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

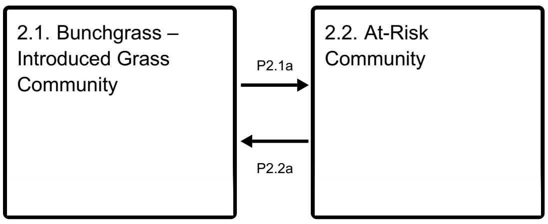
T2B - Displacement of native species by non-native invasive species (Crested Wheatgrass, Kentucky bluegrass, noxious weeds, etc.)

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

State 1 submodel, plant communities



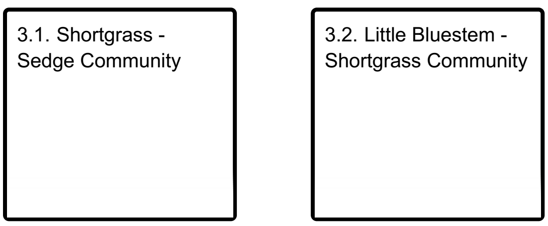
State 2 submodel, plant communities



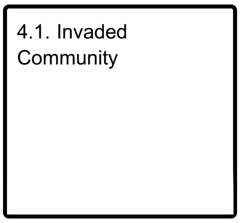
P2.1a - Drought, improper grazing management

P2.2a - Return to normal or above average precipitation, proper grazing management

State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Historic Reference State

The Historic Reference State (1) contains one community phase characterized by a predominance of mid-statured bunchgrasses. 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 resulted in the species composition shifting to short-statured species. Fire most likely resulted in a short-term shift in species composition to more warm-season grasses such as blue grama and fewer cool-season bunchgrasses.

Community 1.1
Mid-Statured Bunchgrass Community

The Mid-Statured Bunchgrass Community Phase (1.1) was characterized by a dominance of mid-statured bunchgrasses. The predominant bunchgrasses were little bluestem, plains muhly, and needle and thread. Sedges such as threadleaf sedge (*Carex filifolia*) were common, but less abundant than the bunchgrasses. The mat-forming, warm-season, perennial grass blue grama (*Bouteloua gracilis*) and prairie Junegrass (*Koeleria macrantha*) were the predominant shortgrasses (Coupland, 1950, 1961). Forbs comprised about 10 percent of the cover and shrubs about 1 to 5 percent.

State 2
Contemporary Reference State

The Contemporary Reference State (2) contains two community phases characterized by mid-statured bunchgrasses and sedges such as threadleaf sedge. 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 and fire, although these factors can influence species composition in localized areas

Community 2.1
Bunchgrass – Introduced Grass Community

The Bunchgrass – Introduced Grass Community Phase (2.1) is predominantly native mid-statured bunchgrasses but has some degree of non-native grass establishment. Mid-statured bunchgrasses are dominantly little bluestem, plains muhly, and needle and thread. Sideoats grama (*Bouteloua curtipendula*) may be present on some sites. Sedges, particularly threadleaf sedge, are common with low to moderate cover. Shortgrasses include blue grama and prairie Junegrass. Common forbs are spiny phlox (*Phlox hoodii*), Indian breadroot (Pediomelum spp.), and white milkwort (*Polygala alba*). Shrubs and subshrubs make up about 1 to 5 percent of the cover and include prairie sagewort (*Artemisia frigida*), creeping juniper (*Juniperus horizontalis*), and skunkbush sumac (*Rhus trilobata*). Non-native species typically comprise 1 to 3 percent of the plant community and may include crested wheatgrass and Kentucky bluegrass (*Poa pratensis*). The approximate species composition of this plant community is as follows: Percent composition by weight* Mid-Statured Bunchgrasses - 40-50% Little Bluestem - (20-30%) Needle and Thread - (10-20%) Plains Muhly - (5-10%) Sideoats Grama - 0-5% Sedges - 10-15% Shortgrasses - 10-15% Blue Grama -(5-10%) Prairie Junegrass - (0-5%) Other Native Grasses - 15% Perennial Forbs - 10% Shrubs/Subshrubs - 5% Non-native grasses - 1-3% Estimated Total Annual Production (lbs./ac)* Low - Insufficient Data Representative Value - 800 High - Insufficient Data *Estimated based on current data – subject to revision

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 nearly equal proportions of needle and thread and sedges, particularly threadleaf sedge. Shortgrasses such as blue grama and prairie Junegrass are increasing. More palatable, less grazing-tolerant bunchgrasses such as plains muhly are rare or absent. The response of little bluestem depends on the season of grazing. Little bluestem tends to decrease when grazed in early summer, but may increase in abundance in fall grazed pastures due to its low palatability in the fall. Prairie sagewort may also increase in this phase.

Pathway P2.1a
Community 2.1 to 2.2

Drought, improper grazing management, or a combination of these factors can shift the Bunchgrass – Introduced Grass Community 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 P2.2a
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 Bunchgrass – Introduced Grass Community Phase (2.1).

State 3
Altered State

The Altered State (3) consists of two community phases. The dynamics of this state are driven by long-term drought, improper grazing management, or a combination of these factors. Shortgrasses increase with long-term improper grazing at the expense of cool-season midgrasses (Coupland, 1961; Biondini and Manske, 1996). In particular, communities dominated by blue grama can alter soil properties, creating conditions that resist establishment of other grass species (Dormaar and Willms, 1990; Dormaar et al., 1994). Reductions in stocking rates can reduce shortgrass cover and increase the cover of cool-season midgrasses, although this recovery may take decades (Dormaar and Willms, 1990; Dormaar et al., 1994).

Community 3.1
Shortgrass - Sedge Community

The Shortgrass - Sedge Community Phase (3.1) occurs when site conditions decline due to long-term drought or improper grazing, particularly when grazing occurs in spring or early summer. Mid-statured grasses such as plains muhly and needle and thread have been largely eliminated. Short-statured species such as blue grama and prairie Junegrass dominate the plant community. Threadleaf sedge may persist due to its low stature and extensive root system; however, its vigor is declining due to grazing pressure. The subshrub prairie sagewort is common.

Community 3.2
Little Bluestem - Shortgrass Community

The Little Bluestem-Shortgrass Community Phase (3.2) may develop under certain conditions. When actively growing, little bluestem is regarded as desirable forage for livestock; however, livestock tend to avoid it when it is mature. As a result, pastures that are repeatedly grazed in late summer or fall may exhibit an increase in little bluestem. Repeated late summer to fall grazing combined with improper grazing management may result in this phase. The dynamics of this phase are not completely understood and require further investigation.

State 4
Invaded State

The Invaded State (4) occurs when invasive plant species invade adjacent native grassland communities and displace the native species. Data suggest that the diversity of native species declines significantly when invasive species exceed 30 percent of the plant community. Non-native perennial grasses, such as crested wheatgrass and Kentucky bluegrass, are the most widespread concerns. Crested wheatgrass has been planted on an estimated 20 million acres in the western U.S. since the 1930s (Holechek, 1981) and is the greatest concern on this ecological site. It is extremely drought tolerant, establishes readily on a variety of soil types, has high seedling vigor, and can dominate the seedbank of invaded grasslands (Rogler and Lorenz, 1983; Henderson and Naeth, 2005). Kentucky bluegrass is widespread throughout the Northern Great Plains (Toledo et al., 2014) and mainly affects the moister portions of this site. It is very competitive and displaces native species by forming dense root mats, altering nitrogen cycling, and having allelopathic effects on germination (DeKeyser et al., 2013). It may also alter soil surface hydrology and modify soil surface structure (Toledo et al., 2014). Plant communities dominated by Kentucky bluegrass have significantly less cover of native grass and forb species (Toledo et al., 2014; DeKeyser et al., 2009). Invasive grass species can invade relatively undisturbed grasslands, and it is not clear what triggers them to displace native species. In some cases, they have been found to substantially increase under long-term grazing exclusion (DeKeyser et al., 2009, 2013; Grant et al., 2009), but a consistent correlation to grazing management practices cannot be made at this time. Reduced plant species diversity, simplified structural complexity, and altered biologic processes result in a state that is substantially departed from both the Reference State (1) and the Contemporary Reference State (2). Noxious weeds such as leafy spurge and Canada thistle are not widespread in MLRA 53A, but they can be a concern in localized areas. These species are very aggressive perennials. They typically displace native species and dominate ecological function when they invade a site. In some cases, these species can be suppressed through intensive management (herbicide application, biological control, or intensive grazing management). Control efforts are unlikely to eliminate noxious weeds, but their density can be sufficiently suppressed so that species composition and structural complexity are similar to that of the Contemporary Reference State (2). However, cessation of control methods will most likely result in recolonization of the site by the noxious species.

Community 4.1
Invaded Community

Encroachment by introduced grasses, noxious weeds, and other invasive species is common. Rangeland health attributes have departed substantially from both the Reference State (1) and the Contemporary Reference State (2).

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 Contemporary Reference State (2).

Transition T2A
State 2 to 3

Prolonged drought, improper grazing management, or a combination of these factors weakens the resilience of the Contemporary Reference State (2) and drives its transition to the Altered State (3). The Contemporary Reference State (2) transitions to the Altered State (3) when mid-statured grasses become rare and contribute little to production. Shortgrasses such as blue grama and prairie Junegrass dominate the plant community.

Transition T2B
State 2 to 4

The Contemporary Reference State (2) transitions to the Invaded State (4) when aggressive perennial grasses or noxious weeds displace native species. The most common concerns are crested wheatgrass and introduced bluegrasses, which are widespread invasive species in the Northern Great Plains (Henderson and Naeth, 2005; Toledo et al., 2014). The precise triggers of this transition are not clear, but data suggest that exclusion of grazing and fire may be a contributing factor in some cases (DeKeyser et al., 2013). In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered.

Restoration pathway R3A

State 3 to 2

A reduction in livestock grazing pressure alone may not be sufficient to reduce the cover of shortgrasses in the Altered State (3) (Dormaar and Willms, 1990). Blue grama, in particular, can resist displacement by other species (Dormaar and Willms, 1990; Laycock, 1991; Dormaar et al., 1994; Lacey et al., 1995). Intensive management, such as reseeding and mechanical treatment, may be necessary (Hart et al., 1985), but these practices are labor intensive and costly. Therefore, returning the Altered State (3) to the Contemporary Reference State (2) may 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

Additional community tables

Inventory data references

Data for this provisional ecological site was very limited. Only one low-intensity plot could be confirmed as representative of this site. One medium-intensity plot was found, but it was used circumspectly because of uncertainties in soils and ecological site classification. A low-intensity plot from a similar site in MLRA 53B was used as a proxy reference. These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for the Contemporary Reference State (2). 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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Acknowledgments

A number of USDA-NRCS staff supported this project. Staff contributions are as follows:

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Quality Assurance
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Preceding Version: None. New concept that was formerly included in:
Lacey et al., 2005. Silty-Steep 10 to 14 inch p.z. R053AE058MT. Field Office Technical Guide Section II. U.S. Department of Agriculture, Natural Resources Conservation Service - Montana.

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	04/24/2024
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:**