Ecological site FX053A99X062
Swale (Se)

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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 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: *Pascopyrum smithii* - *Hesperostipa comata* - Schizachyrium scoparium Mixedgrass Prairie Group (2.B.2.Nb.2.c)
 Alliance: *Pascopyrum smithii* - Nassella viridula Northwestern Great Plains Grassland Alliance
 Association: *Pascopyrum smithii* - Nassella viridula Grassland

o Group: *Hesperostipa comata* - *Bouteloua gracilis* Dry Mixedgrass Prairie Group (2.B.2.Nb.2.c)
 Alliance: *Hesperostipa curtiseta* - *Elymus lanceolatus* Grassland Alliance
 Association: *Hesperostipa curtiseta* - *Elymus lanceolatus* 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. Many map units contain minor components with this ecological site; these minor components typically make up less than 10 percent of the map unit composition. The map in Figure 1 is approximate, is not intended to be definitive, and may be subject to change. Swale is an extensive ecological site occurring on swale micro-features within nearly level to gently sloping landscapes. The distinguishing characteristic of this site is that it receives additional moisture via surface runoff from adjacent sites. Soils for this ecological site are typically very deep (more than 60 inches) with a thick (16 inches or more) mollic epipedon. Characteristic vegetation is green needlegrass (Nassella viridula), rhizomatous wheatgrasses, and needlegrass (Hesperostipa spp).

Associated sites

FX053A99X032	**Loamy (Lo)** The Loamy ecological site is found on slopes of less than 15 percent on moraines and till plains upslope from and commonly surrounding the Swale Moist Grassland ecological site. The upper 4 inches of soil contains 18 to 35 percent clay.
FX053A99X040	**Loamy Steep (LoStp)** The Loamy Steep ecological site is found on slopes of 15 percent or greater upslope from the Swale ecological site. It occurs on hillslopes whereas Swale ecological site occurs on swale microfeatures where surface runoff is concentrated.

FX053A99X029	**Limy Steep (LyStp)** The Limy Steep ecological site is found on slopes of 15 percent or greater upslope from the Swale ecological site. It occurs on convex hillslopes whereas the Swale ecological site occurs on swale microfeatures where surface runoff is concentrated.
FX053A99X030	**Limy (Ly)** The Limy ecological site occurs upslope from the Swale ecological site. It is generally on shoulders or crests whereas Swale ecological site occurs on swale microfeatures where surface runoff is concentrated.

Similar sites

FX053A99X756	**Woody Draw (WD)** This site differs from the Swale ecological site in that it is dominated by woody species. It typically occurs in steep, V-shaped drainages whereas Swale occurs in broad U-shaped swales.
FX053A99X060	**Overflow (Ov)** This site differs from the Swale ecological site in that it is on flood plains rather than upland swales. It generally is on stream terraces adjacent to a losing stream reach and in some areas has a water table greater than 40 inches below the soil surface.

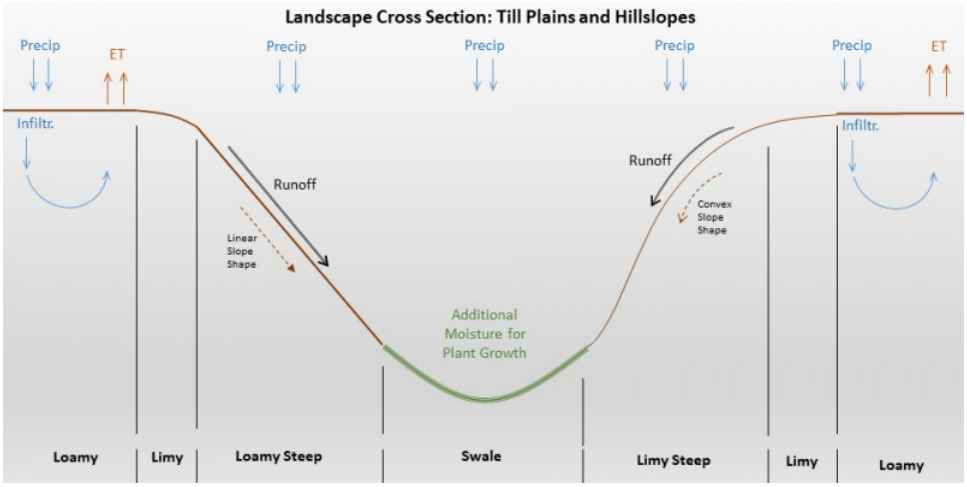


Figure 1. Similar and associated sites diagram.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Symphoricarpos occidentalis*
Herbaceous	(1) *Nassella viridula* (2) *Pascopyrum smithii*

Legacy ID

R053AY720MT

Physiographic features

Swale is an extensive ecological site occurring on a variety of landforms across MLRA 53A. It occurs on till plains, moraines, and outwash fans. Although present in the vast majority of soil map units, it is frequently associated with a minor component because it occurs on swale micro-features. A swale is defined as a shallow, open depression in unconsolidated materials that lacks a defined channel but can funnel overland or subsurface flow into a drainageway (USDA-NRCS, 2016).

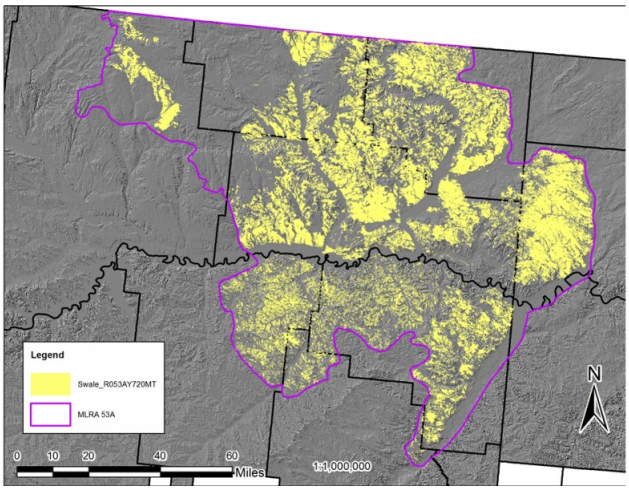


Figure 2. General distribution of the Swale ecological site by map unit extent.

Table 2. Representative physiographic features

Landforms	(1) Till plain > Moraine > Swale (2) Till plain > Hillslope > Swale
Flooding frequency	None
Ponding frequency	None
Elevation	1,800–3,300 ft
Slope	0–14%
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

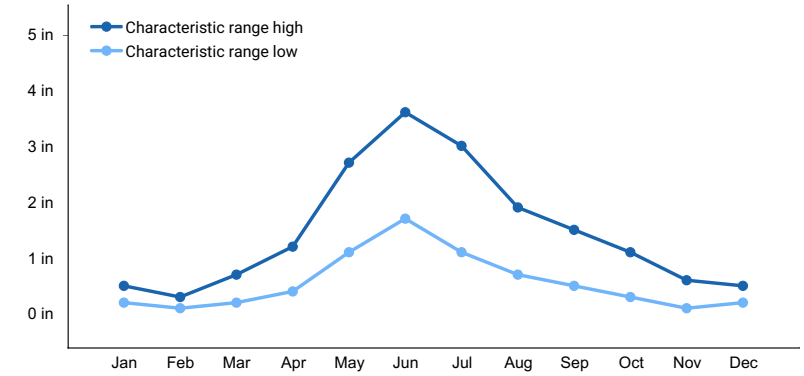


Figure 3. Monthly precipitation range

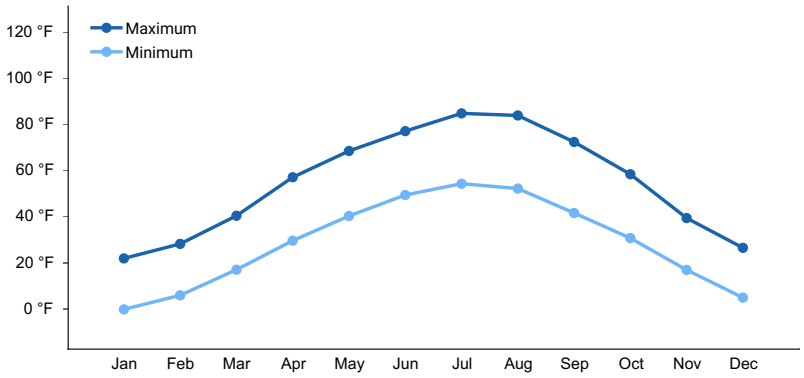


Figure 4. Monthly average minimum and maximum temperature

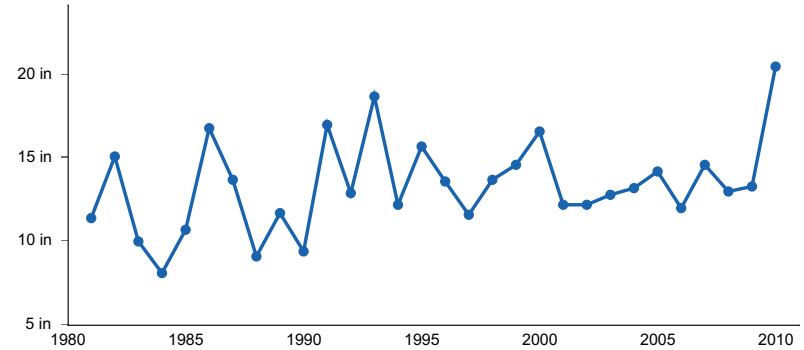


Figure 5. Annual precipitation pattern

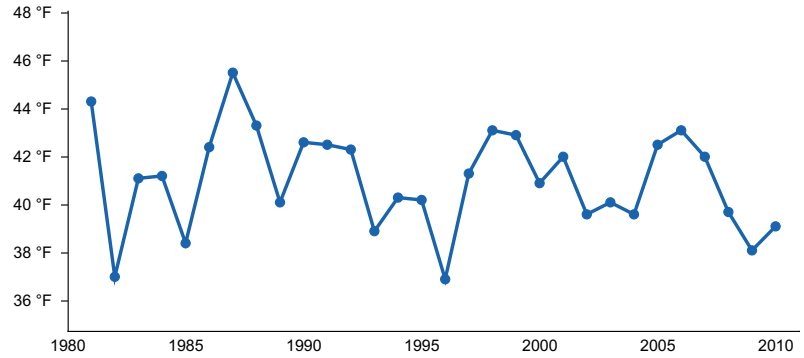


Figure 6. Annual average temperature pattern

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 that is not influenced by a water table but does receive 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. Moisture loss through evapotranspiration exceeds precipitation for the majority of the growing season, but this site receives enough moisture from runoff to remain moist much longer than adjacent sites. During intense precipitation events, precipitation rates frequently exceed infiltration rates and this site receives additional moisture from upslope sites via surface runoff. Typical precipitation events deliver enough moisture to fill the soil profile, but soil moisture rarely exceeds field capacity in the upper 40 inches before being depleted by evapotranspiration. Annual crops such as wheat are less efficient at removing soil moisture than native vegetation. As a result, areas that are predominantly in annual crops may have surplus soil moisture, particularly in fallow years. In addition, the Swale ecological site may be affected by saline seeps due to deep percolation and discharge from adjacent cropland.

Soil features

The soil series that best represent the central concept of this ecological site are Bowbells, Zeeland, and Grail, where they occur on swale micro-features. These soils are in the Argiustolls great group and are characterized by a mollic epipedon that is pachic, meaning it is at least 16 inches thick, and by an underlying argillic horizon where clay has accumulated through weathering. The Grail soil is also classified as vertic, meaning it exhibits shrink-swell properties. The Bowbells soil 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 Zeeland and Grail soils have smectitic mineralogy and are in the fine family, meaning they contain between 35 and 60 percent clay in the particle-size control section. The typical parent material for these soils is till or alluvium. 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 horizon textures in this site are typically loam or silty clay loam and contain 18 to 35 percent clay. The underlying horizons typically contain 25 to 40 percent clay and have loam or clay loam textures. Organic matter content in the surface horizon typically ranges from 3.5 to 5 percent, and moist colors vary from dark brown (10YR 3/3) to very dark brown (10YR 2/2). Calcium carbonate equivalent is typically less than 5 percent in the upper 5 inches of soil, and the depth to secondary carbonates is typically 15 inches or more below the soil surface. Soil pH classes are neutral to slightly alkaline in the surface horizon and neutral to moderately alkaline in the subsurface horizons. The soil depth class for this site is typically very deep (more than 60 inches). Content of coarse fragments in the upper 20 inches of soil is less than 35 percent

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Till
Surface texture	(1) Loam (2) Silty clay loam
Drainage class	Well drained
Soil depth	60–72 in
Available water capacity (0-40in)	6.7–7.8 in
Calcium carbonate equivalent (0-5in)	0–4%

Electrical conductivity (0-20in)	0–3 mmhos/cm
Sodium adsorption ratio (0-20in)	0–12
Soil reaction (1:1 water) (0-40in)	6.6–8.4
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 Swale provisional ecological site in MLRA 53A consists of five states: the Historic Reference State (1), the Contemporary Reference State (2), the Invaded 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 mid-statured grasses, particularly bunchgrasses such as green needlegrass (Smoliak et al., 1972; Smoliak, 1974). Rhizomatous wheatgrasses, particularly western wheatgrass (*Pascopyrum smithii*), appear to be relatively resistant to grazing on this site, presumably due to the increased moisture availability and their rhizomatous nature. 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 drought can also reduce cool-season, mid-statured grasses (Coupland, 1958, 1961). Further degradation of the site due to improper grazing can result in reduced vigor of rhizomatous wheatgrasses and an increase in unpalatable forbs such as white sagebrush, more commonly known as cudweed sagewort (*Artemisia ludoviciana*). Mid-statured bunchgrasses are eliminated or

nearly so. Short-statured species such as prairie Junegrass (Koeleria cristata) may increase under grazing pressure, but this site does not appear to cross a threshold into a shortgrass state.

Most, if not all, extant examples of this site have some degree of invasion by non-native species. Non-native grasses such as bluegrasses (Poa spp.) and smooth brome (*Bromus inermis*) are the most common invasive species. These species are widespread throughout the Northern Great Plains and can invade relatively undisturbed grasslands (DeKeyser et al., 2013; Grant et al., 2009; 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.

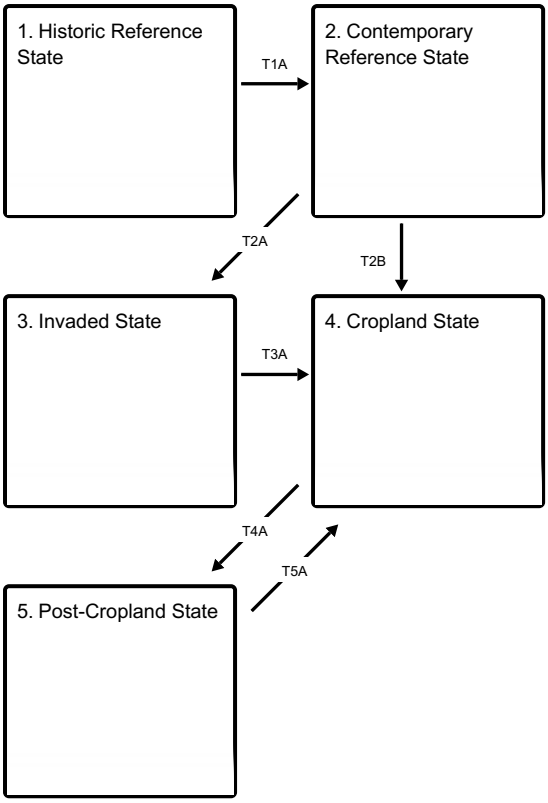
The effects of an altered fire regime are not completely understood at the time of this writing, but evidence suggests that long-term fire suppression can result in accumulations of litter and may contribute to increased abundance of non-native grasses (DeKeyser et al., 2013; Murphy and Grant, 2005; Vermeire et al., 2011). 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 productivity of the soils, this ecological site has the potential to be productive cropland. However, conversion to cropland depends on the steepness of the site. Side slopes greater than 8 percent are generally inaccessible to farm equipment. Regardless, many acres have been cultivated and planted to cereal grain crops, such as winter wheat, spring wheat, and barley. Due to the concentration of runoff, this site is very susceptible to erosion when farmed and soil loss is common. Unfarmed swales are also susceptible to deposition when surrounding areas are farmed, and deposition impairs the ecological function of the site. When taken out of production, this site is most commonly seeded back to perennial grass. Introduced species such as pubescent wheatgrass are most common, but native species may also be seeded. When this site is seeded with non-native species, it may persist as this cover type indefinitely. This site is unlikely to return to pre-cultivated conditions, even if seeded to native species, because reseeding projects commonly involve extensive earthmoving and soil disturbance. Sites left to undergo natural plant succession after cultivation will most likely continue to erode and, as a result, have drastically altered soil properties, hydrology, and vegetation. Such a site may stabilize over time and support perennial vegetation, but it is likely that non-native or invasive species will be common.

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

T2B - Conversion to cropland

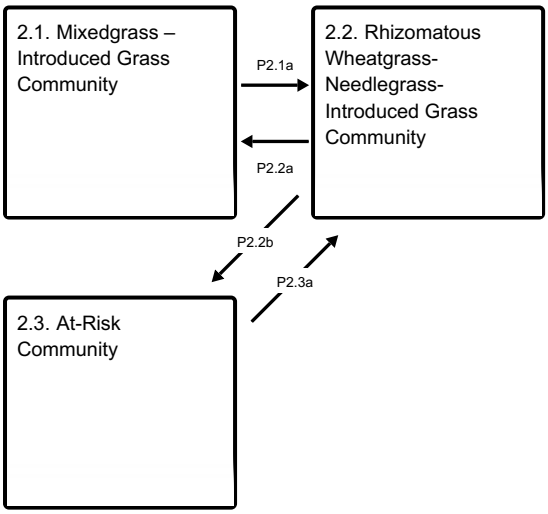
T3A - Conversion to cropland

T4A - Cessation of annual cropping

T5A - Conversion to cropland

State 1 submodel, plant communities

State 2 submodel, plant communities



P2.1a - Drought, improper grazing management

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

P2.2b - Prolonged drought, improper grazing management, or a combination of these factors.

P2.3a - Normal or above-normal spring moisture, proper grazing management.

State 3 submodel, plant communities

3.1. Invaded Community

State 4 submodel, plant communities

4.1. Cropland Community

State 5 submodel, plant communities

5.1. Abandoned Cropland Community

5.2. Perennial Grass Community

State 1
Historic Reference State

The Historic Reference State (1) contains one community phase characterized by mid-statured bunchgrasses 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 and fire, although these factors could influence species composition in localized areas.

Community 1.1
Mixedgrass Community

The Mixedgrass Community Phase (1.1) was characterized by green needlegrass and rhizomatous wheatgrasses. Other needlegrasses were also common: western porcupine grass (*Hesperostipa curtiseta*) occupied the cooler, moister portions of this site and needle and thread (*Hesperostipa comata*) the warmer, drier portions. The predominant rhizomatous wheatgrasses were western wheatgrass and thickspike wheatgrass (*Elymus lanceolatus*). Both species were present, but thickspike wheatgrass became more common in the northern extent of this site. The mat-forming, warm-season, perennial grass blue grama (*Bouteloua gracilis*) and prairie Junegrass were the predominant shortgrasses (Coupland, 1950, 1961). Forbs comprised about 15 percent of the cover and shrubs about 5 to 10 percent.

State 2
Contemporary Reference State

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

Community 2.1
Mixedgrass – Introduced Grass Community

The Mixedgrass – Introduced Grass Community Phase (2.1) is predominantly native mid-statured bunchgrasses and rhizomatous wheatgrasses, but has some degree of non-native grass establishment. Mid-statured bunchgrasses are dominantly green needlegrass but may also include other needlegrasses, such as western porcupine grass and needle and thread. Western porcupine grass is common in the cooler, moister portions of this site, but the site gradually transitions to needle and thread in the drier portions. Cool-season, rhizomatous wheatgrass such as western and thickspike wheatgrass are common, with thickspike wheatgrass being most common in the northern extent of this site. Short-statured grasses, such as blue grama and prairie Junegrass, are not abundant in this phase but are generally present at low cover. Common forbs are upright prairie coneflower (*Ratibida columnifera*), western yarrow (*Achillea millefolium*), and aster (Symphyotrichum spp.). Shrubs and subshrubs occur at about 5 to 10 percent cover and include western snowberry (*Symphoricarpos occidentalis*) and rose (Rosa spp). Non-native species typically comprise 1 to 3 percent of the plant community and may include Kentucky bluegrass (*Poa pratensis*) and smooth brome. The approximate species composition of this plant community is as follows: Percent composition by weight* Mid-Statured Bunchgrasses - 35-45% Green Needlegrass (30-40%) Other Needlegrasses (5-10%) Rhizomatous Wheatgrass - 25-35% Shortgrasses - 1-5% Blue Grama (5-10%) Prairie Junegrass (0-5%) Other Native Grasses - 5% Perennial Forbs 10% Shrubs/Subshrubs 10% Non-native grasses 1-3% Estimated Total Annual Production (lbs./ac)* Low - Insufficient data Representative Value - 2000 High - Insufficient data *Estimated based on current data – subject to revision

Community 2.2
Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community

The Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2) is characterized by nearly equal proportions of rhizomatous wheatgrasses and needlegrasses such as western porcupine grass and needle and thread. Green needlegrass has been significantly reduced and persists at low cover, typically making up less than 5 percent of species composition. Short-statured species such as prairie Junegrass may also increase in this phase. Unpalatable forbs, such as cudweed sagewort and common yarrow (*Achillea millefolium*), also increase in abundance. The species structure has begun to shift from dominantly bunchgrasses to dominantly rhizomatous grasses.

Community 2.3
At-Risk Community

The At-Risk Community Phase (2.3) occurs when site condition declines due to prolonged drought (approximately 3 years or more) or improper grazing management. Mid-statured bunchgrasses, particularly green needlegrass, have been eliminated or nearly so. The plant community is dominated by rhizomatous wheatgrasses, primarily western wheatgrass, but vigor is reduced and unpalatable forbs are common. Cover of shortgrasses such as prairie Junegrass may also increase. The decreased vigor of native species may make this phase more susceptible to invasion by non-native species such as introduced bluegrasses.

Pathway P2.1a
Community 2.1 to 2.2

Drought, improper grazing management, or a combination of these factors can shift the Mixedgrass – Introduced Grass Community Phase (2.1) to the Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2).

Pathway P2.2a
Community 2.2 to 2.1

Normal or above-normal spring precipitation and proper grazing management transitions the Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2) back to the Mixedgrass – Introduced Grass

Community Phase (2.1).

Conservation practices

Prescribed Grazing

Pathway P2.2b
Community 2.2 to 2.3

Prolonged drought, continued improper grazing practices, or a combination of these factors can shift the Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2) to the At-Risk Community Phase (2.3). The Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2) transitions to the At-Risk Community Phase (2.3) when mid-statured bunchgrasses become rare and contribute little to production. In addition, mid-statured rhizomatous grass cover and vigor are reduced.

Pathway P2.3a
Community 2.3 to 2.2

Normal or above-normal spring precipitation and proper grazing management transition the At-Risk Community Phase (2.3) back to the Rhizomatous Wheatgrass-Needlegrass-Introduced Grass Community Phase (2.2).

Conservation practices

Prescribed Grazing

State 3
Invaded State

The Invaded State (3) occurs when invasive plant species invade adjacent native grassland communities and displace the native species. Data suggest that native species diversity declines significantly when invasive species exceed 30 percent of the plant community. The most common concerns are non-native perennial grasses such as Kentucky bluegrass and smooth brome, which are widespread throughout the Northern Great Plains (Toledo et al., 2014). Kentucky bluegrass, in particular, 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, although 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 3.1
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).

State 4

Cropland State

The Cropland State (4) occurs when land is put into cultivation. Major crops in MLRA 53A are small grains such as wheat. The site is highly susceptible to erosion due to the lack of perennial species. Wheat/fallow rotations are also very inefficient at removing moisture from the soil in comparison to native vegetation. In some cases, the Swale ecological site may receive ground-water discharge from surrounding sites. In areas where soils or underlying parent materials have a high amount of soluble salts, a saline seep may develop.

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 State

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 seeded to perennial forage species and the reseeding fails. The Swale ecological site is susceptible to erosion that will likely result in downcutting and gullying. Over time, the site will most likely stabilize and revegetate to a perennial grassland community, but not before a significant amount of soil has been lost. Due to significant changes in soil structure, organic matter content, and possibly hydrology, the site is unlikely to return to the Contemporary Reference State (2) within a reasonable amount of time. Invasion of the site by exotic species, such as Kentucky bluegrass and smooth brome, will depend upon the site's proximity to a seed source.

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. Typically, extensive earthmoving is employed to grade and shape the site prior to seeding. Most frequently the site is seeded to introduced rhizomatous grasses, such as intermediate wheatgrass (*Thinopyrum intermedium*), which can persist for several decades. Some introduced species, such as smooth brome, are very aggressive, commonly form a monoculture, 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 that of the Contemporary Reference State (2). However, earthmoving has substantially altered soil properties and the site is unlikely return to pre-cultivation conditions within a reasonable time frame. After reseeding, the surrounding area commonly remains in cropland and the Swale ecological site is managed as a grassed waterway. Under these conditions, the site is subject to deposition from surrounding slopes and requires continual management to prevent sedimentation.

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

The Contemporary Reference State (2) transitions to the Invaded State (3) when aggressive perennial grasses or

noxious weeds displace native species. The most common concerns are introduced bluegrasses and smooth brome, which are widespread invasive species in the Northern Great Plains (Grant et al., 2009; 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.

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 Contemporary Reference State (2) to the Cropland State (4).

Transition T3A
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 Invaded 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 low-intensity plot and one medium-intensity plot representing the Contemporary Reference State (2). These plots were 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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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	10/12/2024
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:**