USDA Natural Resources Conservation Service

Ecological site FX052X02X062
Swale (Se) Moist Grassland

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Accessed: 05/21/2025

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.

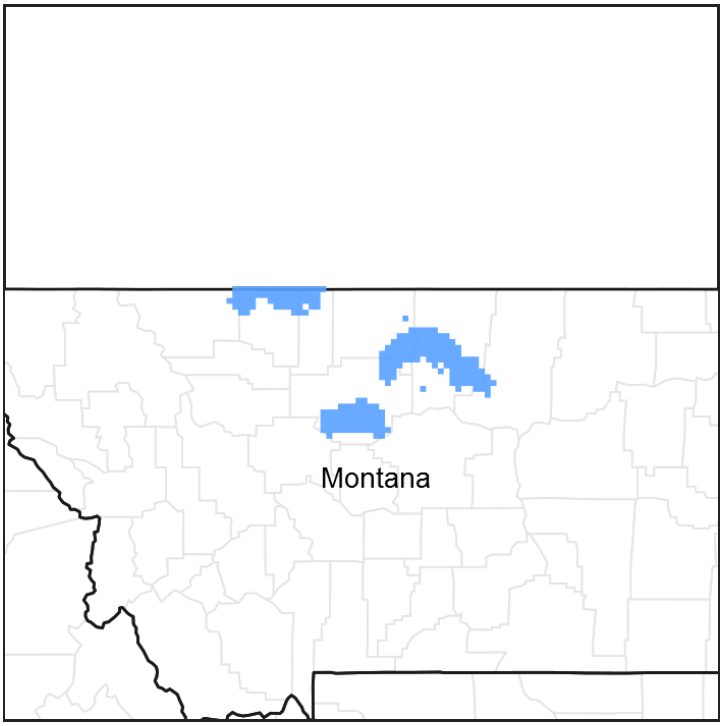

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 052X–Brown Glaciated Plains

The Brown Glaciated Plains, MLRA 52, is an expansive, agriculturally and ecologically significant area. It consists of approximately 14.5 million acres and stretches across 350

miles from east to west, encompassing portions of 15 counties in north-central Montana. This region represents the southwestern limit of the Laurentide Ice Sheet and is considered to be the driest and westernmost area within the vast network of glacially derived prairie pothole landforms of the northern Great Plains. Elevation ranges from 2,000 feet (610 meters) to 4,600 feet (1,400 meters).

Soils are primarily Mollisols, but Entisols, Inceptisols, Alfisols, and Vertisols 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, and in some areas glacially deformed bedrock occurs at or near the soil surface (Soller, 2001). Underlying sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007) is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton et al., 2004). The result is a geologically young landscape that is predominantly a level till plain interspersed with lake plains and dominated by soils in the Mollisol and Vertisol orders. These soils are very productive and generally are well suited to dryland farming. Much of this area is aridic ustic. Crop-fallow dryland wheat farming is the predominant land use. Areas of rangeland typically are on steep hillslopes along drainages.

The rangeland, much of which is native mixedgrass prairie, increases in abundance in the eastern half of the MLRA. The Wisconsin-age till in the north-central part of this area typically formed large disintegration moraines with steep slopes and numerous poorly drained potholes. A large portion of Wisconsin-age till occurring on the type of level terrain that would typically be optimal for farming has large amounts of less-suitable sodium-affected Natrustalfs. Significant portions of Blaine, Phillips, and Valley Counties were glaciated approximately 150,000 years ago during the Illinoisan age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The dry shrubland zone represents the northernmost extent of the big sagebrush (Artemisia tridentata) steppe on the Great Plains. As similar soils occur in both southern and northern portions of the MLRA, it is currently hypothesized that climate is the primary driving factor affecting big sagebrush distribution in this area. However, the precise factors are not fully understood at this time.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and adjacent southern Saskatchewan are home to the Northern Montana population of greater

sage-grouse (Centrocercus urophasianus), and large portions of this area are considered to be a Priority Area for Conservation (PAC) by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 2013). This population is unique among sage grouse populations in the fact that many individuals overwinter in the big sagebrush steppe (dry shrubland) in the southern portion of the MLRA and then migrate to the northern portion of the MLRA, which lacks big sagebrush (dry grassland), to live the rest of the year (Smith, 2013).

Areas of the till plain near the Bearpaw and Highwood Mountains as well as the Sweetgrass Hills and Rocky Mountain foothills are at higher elevations, receive higher amounts of precipitation, and have a typic ustic moisture regime. These areas have significantly more rangeland production than the drier aridic ustic portions of the MLRA and have enough moisture to produce crops annually rather than just bi-annually, as in the drier areas. Ecological sites in this higher precipitation area are classified as the Moist Grassland climatic zone.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
• Climate Zone: Moist Grassland

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: Northwestern Glaciated Plains 331D
• Subsection: Montana Glaciated Plains 331Dh
• 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, Meadow, and Shrubland Formation (2.B.2)
• Division: Great Plains 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 – Bouteloua spp. Mixedgrass Prairie Group (2.B.2.Nb.2.c)
o Alliance: *Pascopyrum smithii* – Nassella viridula Northwestern Great Plains Herbaceous Alliance
 Association: *Pascopyrum smithii* – Nassella viridula Herbaceous Vegetation
o Alliance: Prunus virginiana - Symphoricarpos occidentalis - Amelanchier alnifolia Great

Plains Shrubland Alliance
 Association: Symphoricarpos occidentalis Shrubland

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: North Central Brown Glaciated Plains (42o)
Glaciated Northern Grasslands (42j)
Cherry Patch Moraines (42m)
Milk River Pothole Upland (42n)

Ecological site concept

This provisional ecological site occurs in the Moist Grassland climatic zone of MLRA 52. Map units shown in Figure 1 contain minor components of this ecological site, typically less than 10 percent of the map unit composition. This map is approximate, is not intended to be definitive, and may be subject to change. Swale Moist Grassland is an extensive ecological site on till plains, moraines, and outwash fans in MLRA 52. Although present in the vast majority of soil map units, it is nearly always a minor component because it occurs on swale microfeatures. A swale is defined as a shallow, open depression in unconsolidated materials which lacks a defined channel but can funnel overland or subsurface flow into a drainageway (USDA-NRCS, 2016).

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) and derived from alluvium. This ecological site may occur on slopes of up to 15 percent but most commonly occurs on slopes of 8 percent or less. Soil textures in the upper 4 inches are typically loam, silt loam, or silty clay loam. In most areas, but not all, the soils are pachic. This site is more productive than surrounding sites due to the increased available moisture. Characteristic vegetation is green needlegrass (Nassella viridula), shortbristle needle and thread, also known as western porcupine grass (Hesperostipa curtiseta), and rhizomatous wheatgrasses. The principal shrubs on this site are silver sagebrush (Artemisia cana) and snowberry (Symphoricarpos spp.), either of which can be quite abundant in some areas.

Associated sites

FX052X02X032	**Loamy (Lo) Moist Grassland** The Loamy Moist Grassland 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.

FX052X02X040	**Loamy-Steep (Lostp) Moist Grassland** The Loamy Steep Moist Grassland ecological site is found on slopes of 15 percent or greater upslope from the Swale Moist Grassland ecological site. It occurs on hillslopes whereas Swale Moist Grassland ecological site occurs on swale microfeatures where surface runoff is concentrated.
FX052X02X029	**Limy-Steep (Lystp) Moist Grassland** The Limy Steep Moist Grassland ecological site is found on slopes of 15 percent or greater upslope from the Swale Moist Grassland ecological site. It occurs on convex hillslopes whereas Swale Moist Grassland ecological site occurs on swale microfeatures where surface runoff is concentrated.
FX052X02X030	**Limy (Ly) Moist Grassland** This site occurs upslope from the Swale Moist Grassland ecological site It is generally on shoulders or crests whereas Swale Moist Grassland ecological site occurs on swale microfeatures where surface runoff is concentrated.

Similar sites

FX052X99X060	**Overflow (Ov)** This site differs from Swale Moist Grassland 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.
FX052X02X756	**Woody Draw (Wd) Moist Grassland** This site differs from the Swale Moist Grassland ecological site in that it is dominated by facultative woody species. Shrubs dominate the site in terms of cover and production.
FX052X01X032	**Loamy (Lo) Dry Grassland** This site differs from the Swale Moist Grassland ecological site in that it is in higher topographical positions that do not receive additional moisture whereas the Swale Moist Grassland ecological site is in the bottoms of coulees or swales and receives additional moisture.

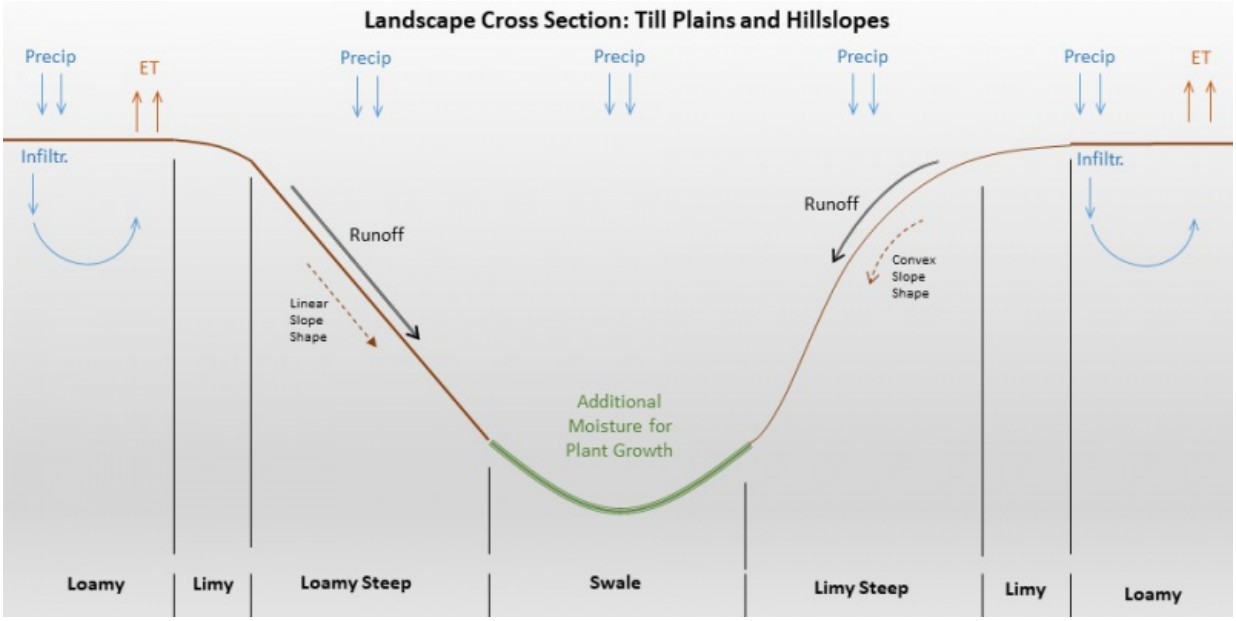

Figure 2. Figure 3. Similar and associated sites diagram. Figure 3 shows a landscape cross-section of till plains and hillslopes.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY754MT

Physiographic features

Swale Moist Grassland is a common ecological site occurring in the moist areas of MLRA 52. It is found on till plains, moraines, and outwash fans; primarily at higher elevations near the various mountain ranges and the Sweetgrass Hills. This site is extensive but typically occurs as a minor component of most map units. It is found on swale microfeatures that receive additional moisture via surface runoff from adjacent sites and is typically in complex with the Loamy ecological site and the Loamy Steep ecological site.

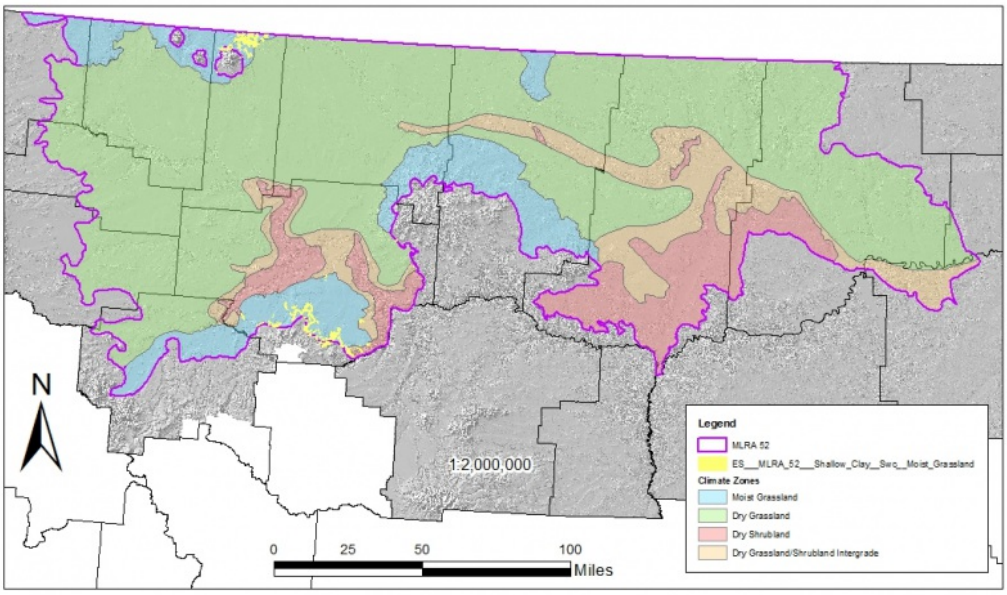

Figure 3. Figure 1. Map units containing Swale Moist Grassland ecological site as a minor component (<10% map unit composition).

Table 2. Representative physiographic features

Landforms	(1) Till plain > Moraine > Swale (2) Till plain > Outwash fan > Swale
Elevation	1,097–1,399 m
Slope	0–15%
Aspect	Aspect is not a significant factor

Climatic features

The Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Cooper et al., 2001). The average frost-free period for this ecological site is 110 days. 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. Severe drought occurs on average in 2 out of 10 years. Annual precipitation ranges from 13 to 17 inches, 70 to 80 percent of which occurs during the growing season (Cooper et al., 2001). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

During the winter months, the western half of MLRA 52 commonly experiences chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain foothills and decrease eastward. In addition to producing damaging winds, prolonged chinook episodes can result in drought or vegetation kills due

to a reaction of plants to a “false spring” (Oard, 1993).

Table 3. Representative climatic features

Frost-free period (average)	110 days
Freeze-free period (average)	135 days
Precipitation total (average)	381 mm

Climate stations used

- (1) GERALDINE [USC00243445], Geraldine, MT
- (2) GOLDBUTTE 7 N [USC00243617], Sunburst, MT

Influencing water features

This is a semi-arid, upland ecological site and the water budget is normally contained within the soil pedon. During intense precipitation events, precipitation rates frequently exceed infiltration rates and this site receives additional moisture from upslope sites via surface runoff. 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. Typical precipitation events deliver enough moisture to fill the soil profile, but the site is not generally considered a recharge site. When seeded to annual crops, this site may become a discharge site, especially if adjacent cropland is in a wheat and fallow rotation. In this case the Swale Moist Grassland ecological site may be affected by saline seeps due to deep percolation from adjacent cropland.

Soil features

The central concept for this ecological site is best represented by Bowbells, Gerber, and Zeeland soils that occur on swale microfeatures. The estimated extent of this ecological site in MLRA 52 is 45,000 acres. All three of these soils are in the Argiustolls great group and are characterized by a mollic epipedon and an underlying argillic horizon where clay has accumulated through weathering. The Bowbells and Zeeland soils have a mollic epipedon that is thick enough to be classified as pachic (greater than 16 inches). The Bowbells soil has mixed mineralogy and is in the fine-loamy particle-size family, meaning that it contains between 18 and 35 percent clay in the particle-size control section. The Zeeland and Gerber soils have smectitic mineralogy and are in the fine particle-size family, meaning they contain between 35 and 60 percent clay in the particle-size control section. The Gerber soil contains enough clay to exhibit shrink-swell characteristics. The typical parent materials for these soils are alluvium or till. 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 found in this site are most commonly loam, silt loam, or silty clay loam and typically contain between 25 to 45 percent clay. The underlying horizons typically contain 30 to 50 percent clay and have loam, clay loam, and clay textures. Organic matter content in the surface horizon typically ranges from 2 to 6 percent, and moist colors vary from dark brown (10YR 3/3) to very dark brown (10YR 2/2). The surface horizon of these soils does not typically react with hydrochloric acid. 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. In the upper 20 inches, electrical conductivity is less than 4, and the sodium absorption ratio is less than 13. Soil pH classes are neutral in the surface horizon and neutral to moderately alkaline in the subsurface horizons. The soil depth class for this is typically very deep (> 60 inches). Content of coarse fragments is less than 35 percent in the upper 20 inches of soil and is typically less than 15 percent.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Till
Surface texture	(1) Loam (2) Silt loam (3) Silty clay loam
Drainage class	Well drained
Soil depth	152–183 cm
Available water capacity (0-101.6cm)	16.26–18.54 cm
Calcium carbonate equivalent (0-12.7cm)	0–4%
Electrical conductivity (0-50.8cm)	0–3 mmhos/cm
Sodium adsorption ratio (0-50.8cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (0-50.8cm)	0–34%
Subsurface fragment volume >3" (0-50.8cm)	0–34%

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM) (Figure 2), 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 Moist Grassland provisional ecological site in MLRA 52 consists of four states: The Reference State (1), the Invaded State (2), the Cropland State (3), and the Post-Cropland 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).

Native grazers also shaped these plant communities. Bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocarpa 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 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). Generally, the mixedgrass ecosystem is resilient to fire and the primary effects of the historic fire return interval are reduction of litter and short-term fluctuations in production (Vermeire et al., 2011, 2014). However, studies have shown that shorter fire return intervals can have a negative effect, shifting species composition toward warm-season, short-statured grasses (Shay et al., 2001; Smith and McDermid, 2014). Conversely, long-term fire suppression in the 20th century removed periodic fire from the ecosystem altogether. Lack of periodic fires can result in an increase in litter accumulation and, in some cases, provide ideal conditions for seed germination and seedling establishment of non-native annual brome species, such as field brome (*Bromus arvensis*), better known as Japanese brome (Whisenant, 1990). These species have become naturalized in relatively undisturbed grasslands (Ogle et al., 2003; Harmoney, 2007) and can be present in any state within the scope of this ecological site. They typically do not have a significant ecological impact; however, their presence can reduce the production of cool-season perennial grasses in some cases (Haferkamp et al., 1997). Their abundance varies depending on precipitation and germination conditions.

Improper grazing of this site can result in a reduction in the cover of cool-season midgrasses, particularly bunchgrasses (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). Short-statured species such as prairie Junegrass (*Koeleria macrantha*) do not appear to be prevalent on this site, but they may increase under grazing pressure. 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. This site is quite resilient and has not been documented to cross a threshold into an altered native state; however, this site is highly susceptible to invasion by non-native species. Introduced bluegrasses (Poa spp.) are the most common invasive species, but smooth brome (*Bromus inermis*) can also be a concern in some areas. These species are widespread throughout the Northern Great Plains and appear able to invade any phase of the Reference State (1) (Toledo et al., 2014). Once established, they will displace native species and dominate the ecological functions of the site.

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. Reseeding projects commonly involve extensive earthmoving and soil disturbance, therefore the site is unlikely to return to the Reference State (1) even if seeded to native species. Sites seeded with non-native species may persist as this cover type indefinitely. 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 is it likely that non-native or invasive species will be common. Under ideal circumstances, it may take over 75 years for soil organic matter to return to its pre-disturbed state (Dormaar et al., 1994); it is likely to take much longer if soil erosion is significant.

The state-and-transition model (STM) diagram (Figure 2) 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

(Figure 2). 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 1: Reference State
The Reference State (1) contains three community phases. This state 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. Vegetation is characterized by mid-statured cool-season bunchgrasses, mid-statured cool-season rhizomatous grasses, and shrubs such as silver sagebrush. Lesser spike-moss, also known as dense clubmoss (*Selaginella densa*), may be common in some areas, yet completely absent in others. Its dynamics are not well understood, and its abundance appears to vary greatly from site to site without discernable reason.

Phase 1.1: Green Needlegrass-Western Porcupinegrass Community Phase
The Green Needlegrass-Western Porcupinegrass Community Phase (1.1) is characterized primarily by mid-statured cool-season bunchgrasses. The primary species are green needlegrass and western porcupinegrass. Needle and thread (*Hesperostipa comata*) is common on the drier portions of this site but decreases in abundance as mean annual precipitation increases. Rhizomatous wheatgrasses such as western wheatgrass and thickspike wheatgrass (*Elymus lanceolatus*) are common, typically comprising about 10 percent of the plant community. Both species may be present, but thickspike wheatgrass becomes more common in the northern extent of this site. Short-statured grasses, such as prairie Junegrass, are not abundant in this phase but are generally present at low cover. Common forbs are American vetch (*Vicia americana*), Indian breadroot (Pediomelum spp.), and upright prairie coneflower (*Ratibida columnifera*). Common shrubs are silver sagebrush and snowberry, which may comprise up to 10 percent of the canopy cover. Prairie rose (*Rosa arkansana*) is sometimes present at low cover. The approximate species composition of the reference plant community is as follows:

Percent composition by weight*
Green Needlegrass 35%
Western Porcupine Grass 10-25%
Rhizomatous Wheatgrass 10%
Needle and Thread 0-15%
Other Native Grasses 5%
Perennial Forbs 15%
Shrubs/Subshrubs 10%

Estimated Total Annual Production (lbs/ac)*
Low - Insufficient data
Representative Value - 2000
High - Insufficient data
* Estimated based on current data – subject to revision

Phase 1.2: Rhizomatous Wheatgrass-Western Porcupinegrass Community Phase
The Rhizomatous Wheatgrass-Western Porcupinegrass Community Phase (1.2) is characterized by nearly equal proportions of mid-statured rhizomatous wheatgrasses and western porcupinegrass. Green needlegrass has been significantly reduced and persists at low cover, typically 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.

Phase 1.3: At-Risk Community Phase
The At-Risk Community Phase (1.3) 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.

Community Phase Pathway 1.1a
Drought, improper grazing management, or a combination of these factors can shift the Green Needlegrass-Western Porcupinegrass Community Phase (1.1) to the Rhizomatous Wheatgrass-Western Porcupinegrass Community Phase (1.2).

Community Phase Pathway 1.2a
The Rhizomatous Wheatgrass-Western Porcupinegrass Community Phase (1.2) can return to the Green Needlegrass-Western Porcupinegrass Community Phase (1.1) with normal or above-normal spring precipitation and proper grazing management.

Community Phase Pathway 1.2b
Prolonged drought, continued improper grazing practices, or a combination of these factors can shift the Rhizomatous Wheatgrass-Porcupinegrass Community Phase (1.2) to the At-Risk Community Phase (1.3). The Rhizomatous Wheatgrass-Porcupinegrass Community Phase (1.2) transitions to the At-Risk Community Phase (1.3) when mid-statured bunchgrasses become rare and contribute little to production. In addition, mid-statured rhizomatous grass cover is reduced and vigor is lowered.

Community Phase Pathway 1.3a
Normal or above-normal spring precipitation and proper grazing management can return The At-Risk Community Phase (1.3) to the Rhizomatous Wheatgrass-Porcupinegrass Community Phase (1.2)

Transition T1A
The Reference State (1) transitions to the Invaded State (2) when aggressive perennial grasses or noxious weeds invade. The most common concerns are introduced bluegrasses and smooth brome, which are widespread invasive species in the northern Great Plains (Toledo et al., 2014). Decreased vigor of native species may be one factor that increases susceptibility to invasion. Studies have also shown that exclusion of grazing and fire favors invasive bluegrass species (Dekayser et al., 2013). In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered from the Reference State (1).

Transition T1B
Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Reference State (1) to the Cropland State (3).

State 2: Invaded State
The Invaded State (2) occurs when invasive plant species invade adjacent native grassland communities. Introduced bluegrasses, such as Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass (*Poa compressa*), are the most widespread concerns. Smooth brome is less widespread, but it can also become a concern on this site, particularly in wetter areas. Kentucky bluegrass, in particular, is widespread throughout the Northern Great Plains (Toledo et al., 2014). It is very competitive and displaces native species by forming dense root mats, altering nitrogen cycling, and creating allelopathic effects on germination (DeKeyser et al., 2013). Plant communities dominated by Kentucky bluegrass have significantly less cover of native grass and forb species (Toledo et al., 2014; Dekeyser et al., 2009). Effects on soil quality are still unknown at this time, but possible concerns are alteration of surface hydrology and modification of soil surface structure (Toledo et al., 2014). Invasive grass species appear to be capable of invading any phase of the Reference State, regardless of grazing management practices, and have been found to substantially increase under long-term grazing exclusion (DeKeyser et al., 2009, 2013; Grant et al., 2009). Reduced plant species diversity, simplified structural complexity, and altered biologic processes result in a state that is substantially departed from the Reference State (1).

Noxious weeds are not widespread in MLRA 52, but leafy spurge and Canada thistle have both have the potential to invade this site. 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 Reference State (1). However, cessation of control methods will most likely result in recolonization of the site by the noxious species.

Transition T2A
Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Invaded State (2) to the Cropland State (3).

State 3: Cropland State
The Cropland State (3) occurs when land is put into cultivation. Major crops in MLRA 52 include winter wheat, spring wheat, and barley. The Swale Moist Grassland ecological site is highly susceptible to erosion due to the lack of perennial species in this state. Wheat/fallow rotations are also very inefficient at removing moisture from the soil in comparison to native vegetation. In some cases, the Swale Moist Grassland 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.

Transition T3A
The transition from the Cropland State (3) to the Post-Cropland State (4) 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. This transition frequently involves extensive earthmoving, grading, and shaping of the site.

State 4: Post-Cropland State
The Post-Cropland State (4) occurs when cultivated cropland is abandoned and allowed to either re-vegetate naturally or is seeded back to perennial species for grazing or wildlife use. This state can transition back to the Cropland State (3) if the site is put back into cultivation.

Phase 4.1: Abandoned Cropland Community Phase
The Abandoned Cropland Community Phase (4.1) occurs in the absence of active management. The Swale Moist Grassland ecological site is susceptible to erosion that is likely to result in downcutting and gullying. Eventually, the site will probably stabilize and re-vegetate 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 Reference State within a reasonable amount of time. Invasion of the site by exotic species, such as Kentucky bluegrass and annual bromes, will depend upon the site’s proximity to a seed source.

Phase 4.2: Perennial Grass Community Phase
The Perennial Grass Community Phase (4.2) occurs when the site is seeded to perennial forage species. This community phase can persist for several decades, particularly when

seeded to introduced perennial grasses. 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 pubescent wheatgrass, to control erosion. Some introduced species, such as smooth brome, are very aggressive, frequently 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 Reference State (1). However, earthmoving has substantially altered soil properties and the site is unlikely return to pre-cultivation conditions within a reasonable timeframe. After reseeding, the surrounding area commonly remains in cropland and the Swale Moist Grassland 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 5A
The Post-Cropland State (4) transitions back to the Cropland State (3) when the site is converted to cropland.

State and transition model

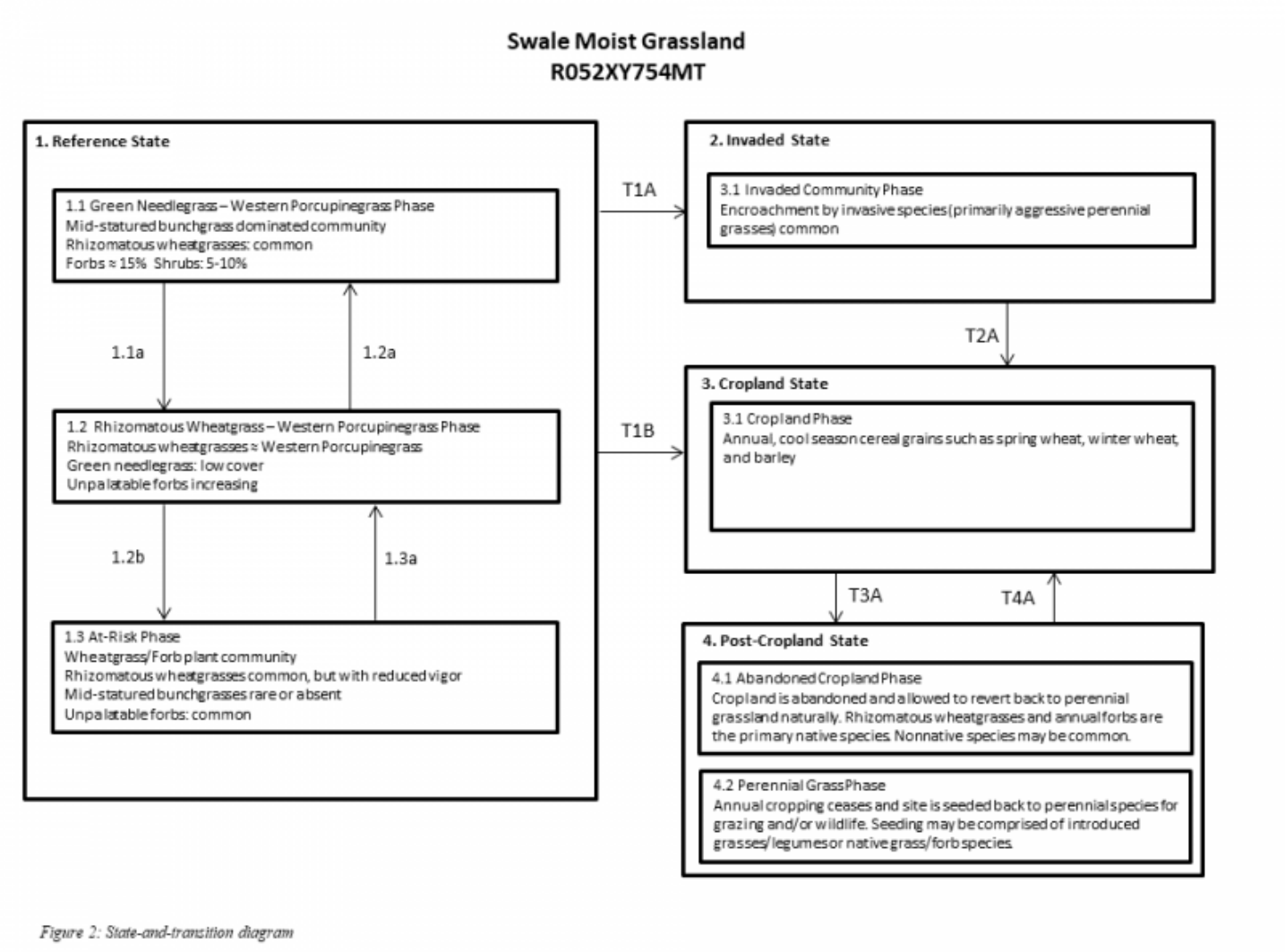

Figure 2: State-and-transition diagram

Swale Moist Grassland
R52XY754MT

Legend

- 1.1a drought, improper grazing management
- 1.2a normal or above-normal spring moisture, proper grazing management
- 1.2b prolonged drought, continued improper grazing, or a combination of these factors
- 1.3a normal or above-normal spring moisture, proper grazing management
- T1A introduction of non-native invasive species (primarily bluegrass species)
- T1B, T2A, T4A tillage or herbicide application and seeding of annual crops
- T3A cessation of annual cropping (frequently in conjunction with earthmoving)

Figure 3: State and Transition Diagram

Inventory data references

One medium-intensity plot and one low-intensity plot were available for this provisional ecological site. One low-intensity plot and one medium-intensity plot from MLRA 53A were referenced for comparision. These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the reference plant community. 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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Approval

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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	
Approved by	
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):**

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

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

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
