Natural Resources
Conservation Service

Ecological site FX052X02X032
Loamy (Lo) Moist Grassland

Last updated: 8/23/2019
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.

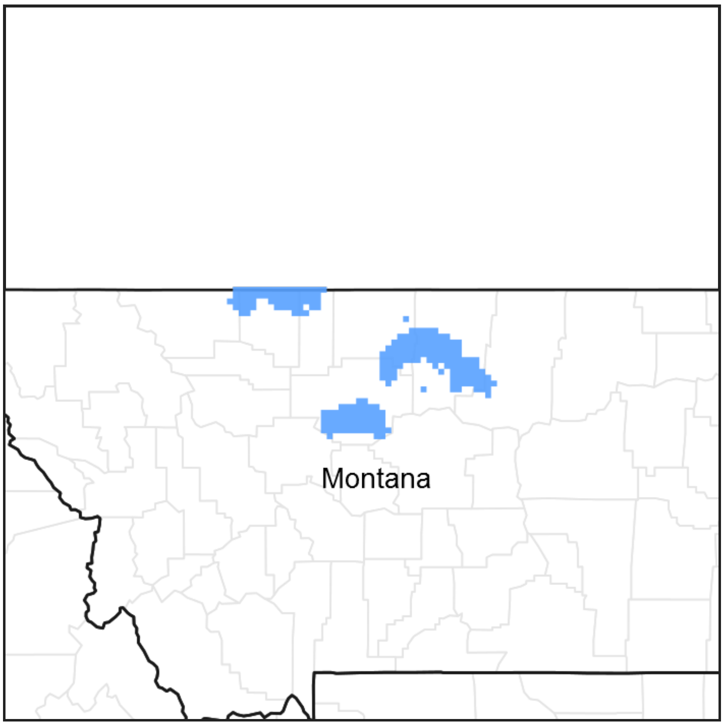

Figure 1. Mapped extent

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 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 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 climatic zone represents the northernmost extent of the big sagebrush (Artemisia tridentata) steppe on the Great Plains. Because 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 because 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)

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

o Group: *Hesperostipa comata* - *Bouteloua gracilis* Dry Mixedgrass Prairie Group (2.B.2.Nb.2.b)
 Alliance: Hesperostipa curtiseta - *Elymus lanceolatus* Grassland Alliance

Ecological site concept

This provisional ecological site occurs in the Moist Grassland climatic zone of MLRA 52. Figure 1 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. Loamy Moist Grassland is an extensive ecological site occurring on areas of the till plain near the various mountain ranges as well as the Sweetgrass Hills in MLRA 52. This ecological site occurs on till plains, moraines, hillslopes, outwash fans, and alluvial fans where slopes are less than 15 percent. This site is typically on linear or concave backslopes, footslopes, shoulders, or summits.

The distinguishing characteristics of this site are fine-loamy textures in the upper 4 inches of soil and a well-developed soil profile. Calcium carbonate (lime) concentration in the upper 5 inches of soil is less than 5 percent. Soils are typically moderately deep to very deep (more than 20 inches to bedrock) and are primarily derived from till or glaciofluvial materials. Soils have a mollic epipedon. Soil surface textures fall within the fine-loamy textural family and contain 18 to 35 percent clay. Characteristic vegetation is rhizomatous wheatgrass, shortbristle needle and thread, also known as western porcupinegrass (Hesperostipa curtiseta), and Green needlegrass (Nasella viridula).

Associated sites

FX052X02X030	**Limy (Ly) Moist Grassland** This site occurs adjacent to the Loamy Moist Grassland ecological site on similar landforms. It is generally on shoulders or crests with a convex slope whereas the Loamy ecological site is on summits or footslopes with linear or concave slope shapes.
FX052X02X040	**Loamy-Steep (Lostp) Moist Grassland** This site occurs on moderate to steeply sloping hillslopes adjacent to or downslope from the Loamy Moist Grassland ecological site. It occurs in backslope positions with slopes of 15 percent or greater and is most often found on north-facing slopes or slopes with a linear or concave slope shape.
FX052X02X029	**Limy-Steep (Lystp) Moist Grassland** This site occurs on moderate to steeply sloping hillslopes adjacent to or downslope from the Loamy Moist Grassland ecological site. It occurs in backslope positions with slopes of 15 percent or greater and is most often found on south-facing slopes or slopes with a convex slope shape.

FX052X02X062	**Swale (Se) Moist Grassland** This site is generally found downslope from the Loamy Moist Grassland ecological site in swales and drainageways and receives additional moisture from surface water run in. Soils are typically more than 40 inches deep, pachic, and have higher available water holding capacity.

Similar sites

FX052X02X030	**Limy (Ly) Moist Grassland** This site differs from Loamy Moist Grassland ecological site in that soils contain more than 5 percent calcium carbonate in the upper 5 inches (as evidenced by strong or violent effervescence).
FX052X02X040	**Loamy-Steep (Lostp) Moist Grassland** This site differs from Loamy Moist Grassland ecological site in that slopes are 15 percent or greater.
FX052X02X062	**Swale (Se) Moist Grassland** This site differs from Loamy Moist Grassland ecological site in that this site receives additional moisture from surface water run in. Plant community is far more productive and contains a higher proportion of forbs and shrubs.

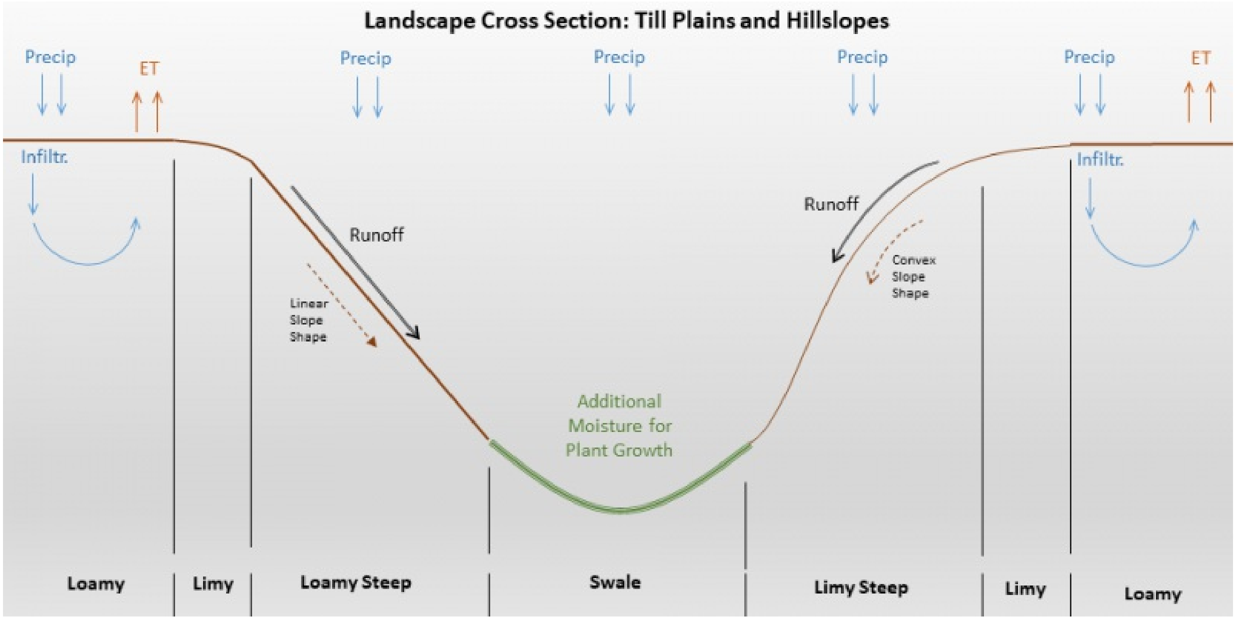

Figure 2. Figure 3. Similar and associated sites diagram. Figure 3 shows a landscape cross section of till plains and hillslopes for similar and associated sites.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY740MT

Physiographic features

Loamy Moist Grassland is an extensive ecological site occurring in the moist areas of MLRA 52. The majority of MLRA 52 is covered by a broad till plain, and this ecological site largely occurs at higher elevations near the various mountain ranges and the Sweetgrass Hills. It mostly occurs on moraines (ground, recessional or end) but can also occur on other landforms such as outwash fans or alluvial fans. This site is typically found on linear and concave slope positions where slopes are less than 15 percent.

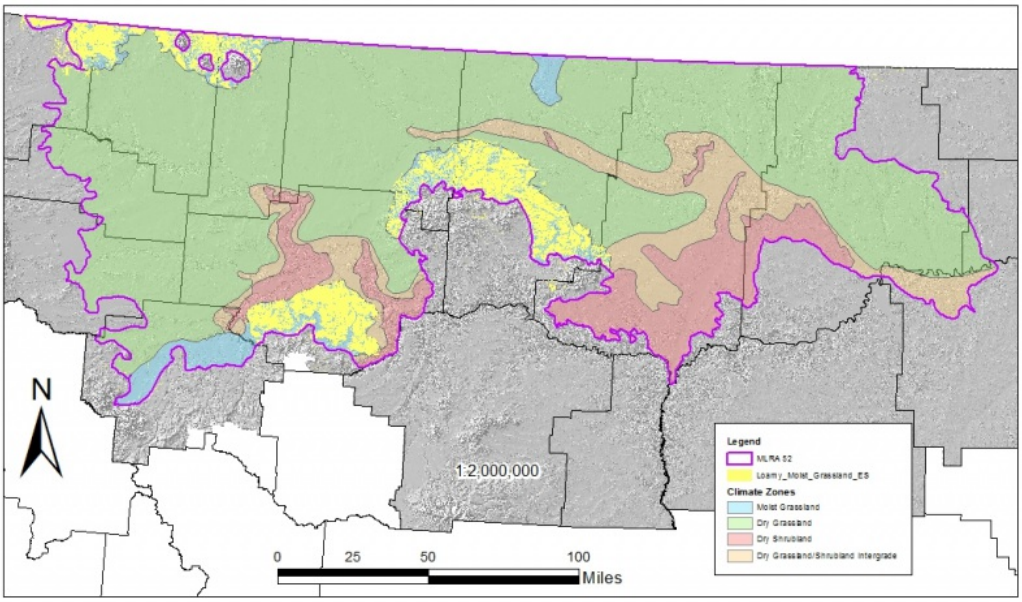

Figure 3. Figure 1. General distribution of the Loamy Moist Grassland ecological site by map unit extent.

Table 2. Representative physiographic features

Landforms	(1) Till plain > Moraine (2) Till plain > Hillslope (3) Till plain > Fan
Elevation	3,600–4,590 ft
Slope	0–14%
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)	15 in

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 delivers moisture to downslope sites via surface runoff. Moisture loss through evapotranspiration exceeds precipitation for the majority of the growing season. Soil moisture levels are greatest in May and June but rarely reach field capacity in the upper 40 inches. Soil moisture is the primary limiting factor for plant production on this ecological site.

Soil features

Soil series that best represent the central concept of this ecological site are Bearpaw and Williams. These soils are in the Argiustolls great group. They have a relatively dark mollic epipedon and an underlying argillic horizon where clay has accumulated through weathering. The Bearpaw soil is in the fine family, meaning that it can contain between 35 and 60 percent clay in the particle-size control section but is typically between 35 and 45 percent. The Williams soil is fine-loamy, meaning that it contains between 18 and 35 percent clay in the particle-size control section. Both soils have mixed minerology. The soil moisture regime for these and 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 typically loam, silty clay loam, or clay loam and contain 18 to 35 percent clay. Underlying horizons typically, but not always, have an argillic horizon that contains between 18 to 45 percent clay depending on the soil series. Soil textures in the underlying horizons are typically loam, clay loam, silty clay loam, or clay. Organic matter content in the surface horizon typically ranges from 2 to 5 percent, and moist colors vary from dark brown (10YR 3/3) to very dark brown (10YR 2/2). Depth to secondary carbonates is greater than 6 inches below the soil surface but is typically greater than 10 inches. The upper 5 inches of soil contains less than 5 percent calcium carbonate equivalent and does not react strongly or violently with hydrochloric acid. Soil pH classes are moderately acid to slightly alkaline in the surface horizon and neutral to strongly alkaline in the subsurface horizons. The soil depth class for this site can be moderately deep (between 20 to 40 inches to bedrock) where bedrock is present but is typically very deep (greater than 60 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 (2) Alluvium
Surface texture	(1) Loam (2) Silty clay loam (3) Clay loam
Drainage class	Well drained
Soil depth	20–72 in
Available water capacity (0-40in)	6.2–7.1 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)	5.6–9

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 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 Loamy Moist Grassland provisional ecological site in MLRA 52 Dry Grassland consists of five states: The Reference State (1), the Shortgrass 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).

Native grazers also shaped these plant communities. 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 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).

Improper grazing of this site can result in a reduction in the cover of the mid-statured bunchgrasses and an increase in blue grama (*Bouteloua gracilis*) (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 Sandberg bluegrass (Poa sandbergii). This site is also susceptible to invasion by non-native species. Non-native perennial grasses such as bluegrass (Poa spp.) and smooth brome (*Bromus inermis*) are the most common invasive species. 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.

Some of the highly productive Loamy Moist Grassland ecological site has been converted to annual cropland. The most common crops are cereal grain crops, such as winter wheat, spring wheat, and barley. When taken out of production, this site is either allowed to revert back to perennial grassland or is seeded back to perennial grass. Such seedings may be comprised of introduced grasses and legumes or a mix of native species. Sites left to undergo natural plant succession after cultivation can, over several decades, support native vegetation similar to the Reference State (1) (Christian and Wilson, 1999) although it may take over 75 years for soil organic matter to return to its pre-disturbed state (Dormaar and Willms, 1990). Sites seeded with non-native species may persist with this cover type indefinitely (Christian and Wilson, 1999). A mix of native species may also be seeded, however, a return to the Reference State (1) in a reasonable amount of time is unlikely.

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. 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 two community phases characterized by mid-statured bunchgrasses, and mid-statured rhizomatous wheatgrasses. 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.

Lesser spikemoss, also known as dense clubmoss (*Selaginella densa*) is frequently present and may constitute significant ground cover. Its dynamics are not well understood, however, and its abundance varies greatly from site to site without discernable reason.

Phase 1.1: Mixedgrass Community Phase

The Mixedgrass Community Phase (1.1) is characterized by mid-statured bunchgrasses and mid-statured rhizomatous wheatgrasses. Rhizomatous wheatgrasses include both western wheatgrass (*Pascopyrum smithii*) and thickspike wheatgrass (*Elymus lanceolatus*). Mid-statured bunchgrasses on this ecological site are diverse and variable. The predominant bunchgrass 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. Rough fescue (*Festuca campestris*) becomes common as mean annual precipitation increases, particularly on north aspects. In the northwest portions of this site, other fescue species such as Idaho fescue (*Festuca idahoensis*) may also occur. Bluebunch wheatgrass may occur on this site, but is typically limited to the southwest portions. The mat-forming, warm-season, perennial grass blue grama is the most common shortgrass in this phase, although prairie Junegrass (*Koeleria macrantha*) and Sandberg bluegrass may also be present. Common forbs are American vetch (*Vicia americana*), cutleaf anemone, or pasqueflower (*Pulsatilla patens* subsp. multifida), and upright prairie coneflower (*Ratibida columnifera*). Shrubs and subshrubs such as prairie sagewort (*Artemisia frigida*) and silver sagebrush (*Artemisia cana*) occur at about 5 percent cover. The approximate species composition of the reference plant community is as follows:

Percent composition by weight*
Rhizomatous Wheatgrass 30%

Mid-Statured Bunchgrasses 40%
Green Needlegrass (5-15%)
Western Porcupinegrass (5-20%)
Rough Fescue (0-25%)
Other Native Bunchgrasses (5-15%)

Blue Grama 5%
Other Native Grasses 10%
Perennial Forbs 10%
Shrubs/Subshrubs 5%

Estimated Total Annual Production (lbs/ac)*
Low - 1,000
Representative Value - 1,400
High - 1,800
* Estimated based on current data – subject to revision

Phase 1.2: At-Risk Community Phase
The At-Risk Community Phase (1.2) occurs when site conditions decline due to drought or improper grazing management. Multiple fires in close succession can also transition the site to this phase. It is characterized by nearly equal proportions of needlegrasses (Hesperostipa spp.) and shortgrasses. Rhizomatous wheatgrasses are in decline and have been substantially reduced in both cover and vigor. Palatable mid-statured bunchgrasses such as green needlegrass and rough fescue are rare or absent. Shortgrasses such as blue grama and prairie Junegrass are increasing. Prairie sagewort may also increase in this phase.

Community Phase Pathway 1.1a
Drought, improper grazing management, multiple fires in close succession, or a combination of these factors can shift the Mixedgrass Community Phase (1.1) to the At-Risk Community Phase (1.2). These factors favor an increase in shortgrasses such as blue grama and a decrease in midgrasses (Coupland, 1961).

Community Phase Pathway 1.2a
Normal or above-normal spring precipitation and proper grazing management transitions the At-Risk Community Phase (1.2) back to the Mixedgrass Community Phase (1.1).

Transition T1A
Prolonged drought, improper grazing practices, or a combination of these factors weaken the resilience of the Reference State (1) and drive its transition to the Shortgrass State (2). The Reference State (1) transitions to the Shortgrass State (2) when mid-statured grasses become rare and contribute little to production. Shortgrasses such as blue grama, prairie Junegrass, and Sandberg bluegrass dominate the plant community.

Transition T1B
The Reference State (1) transitions to the Invaded State (3) when aggressive perennial grasses or noxious weeds invade the Reference State (1). 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 (DeKeyser 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 T1C
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 (4).

State 2: Shortgrass State
The Shortgrass State (2) consists of one community phase. The dynamics of this state are driven by long-term drought, improper grazing management, or a combination of these

factors. Shortgrasses increase with long-term improper grazing at the expense of cool-season midgrasses (Coupland, 1961; Biondini and Manske, 1996; Derner and Whitman, 2009). Blue grama-dominated communities in particular, 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). Dense clubmoss cover varies from rare to abundant. Its dynamics are not well understood, however, and its abundance varies greatly from site to site without discernable reason. Therefore, it is not considered a reliable indicator of past grazing use (Montana State College, 1949).

Phase 2.1: Shortgrass Community Phase
The Shortgrass Community Phase (2.1), occurs when site conditions decline due to long-term drought or improper grazing. Mid-statured grasses such as green needlegrass, western porcupinegrass, and rhizomatous wheatgrasses have been largely eliminated. Short-statured species such as blue grama, prairie Junegrass, and Sandberg bluegrass dominate the plant community. The subshrub, prairie sagewort is common. Cover of perennial forbs may also increase.

Transition T2A
The Shortgrass State (2) transitions to the Invaded State (3) when aggressive perennial grasses or noxious weeds invade the Shortgrass State (2). 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 (DeKeyser 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 T2B
Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Shortgrass State (2) to the Cropland State (4).

Restoration Pathway R2A
A reduction in livestock grazing pressure alone may not be sufficient to reduce the cover of shortgrasses in the Shortgrass State (2) (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 Shortgrass State (2) to the Reference State (1) may require considerable energy and cost, and may not be feasible within a reasonable amount of time.

State 3: Invaded State

The Invaded State (3) 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 may also become a concern on this site, particularly on concave slope shapes. 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 (1), 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 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 T3A
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).

State 4: Cropland State
The Cropland State (4) occurs when land is put into cultivation. Major crops in MLRA 52 include winter wheat, spring wheat, and barley.

Transition T4A
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.

State 5: Post-Cropland State
The Post-Cropland State (5) 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 (4) if the site is put back into cultivation.

Phase 5.1: Abandoned Cropland Community Phase
In the absence of active management, the site can re-vegetate naturally and, over time, potentially return to a perennial grassland community with bunchgrasses and blue grama. Shortly after cropland is abandoned, annual and biennial forbs and annual brome grasses invade the site (Samuel and Hart, 1994). The site is extremely susceptible to erosion due to the absence of perennial species. Eventually, these pioneering annual species are replaced by perennial forbs and perennial shortgrasses such as blue grama. Depending on the historical management of the site, perennial bunchgrasses such as needle and thread may also return; however, species composition will depend upon the seed bank. Cover and production of cool-season rhizomatous wheatgrasses are low, even after several decades (Dormaar and Smoliak, 1985; Dormaar et al., 1994; Christian and Wilson, 1999). Invasion of the site by exotic species, such as Kentucky bluegrass, will depend upon the sites proximity to a seed source. Fifty or more years after cultivation, these sites may have species composition similar to phases in the Reference State (1). However, soil quality is consistently lower than conditions prior to cultivation (Dormaar and Smoliak, 1985; Christian and Wilson, 1999) and a shift to the Reference State (1) is unlikely within a reasonable timeframe.

Phase 5.2: Perennial Grass Community Phase
When the site is seeded to perennial forage species, particularly introduced perennial grasses, this community phase can persist for several decades. 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, soil quality conditions have been substantially altered and will not return to pre-cultivation conditions within a reasonable timeframe (Dormaar et al., 1994).

Transition 5A
The Post-Cropland State (5) transitions back to the Cropland State (4) when the site is converted to cropland.

State and transition model

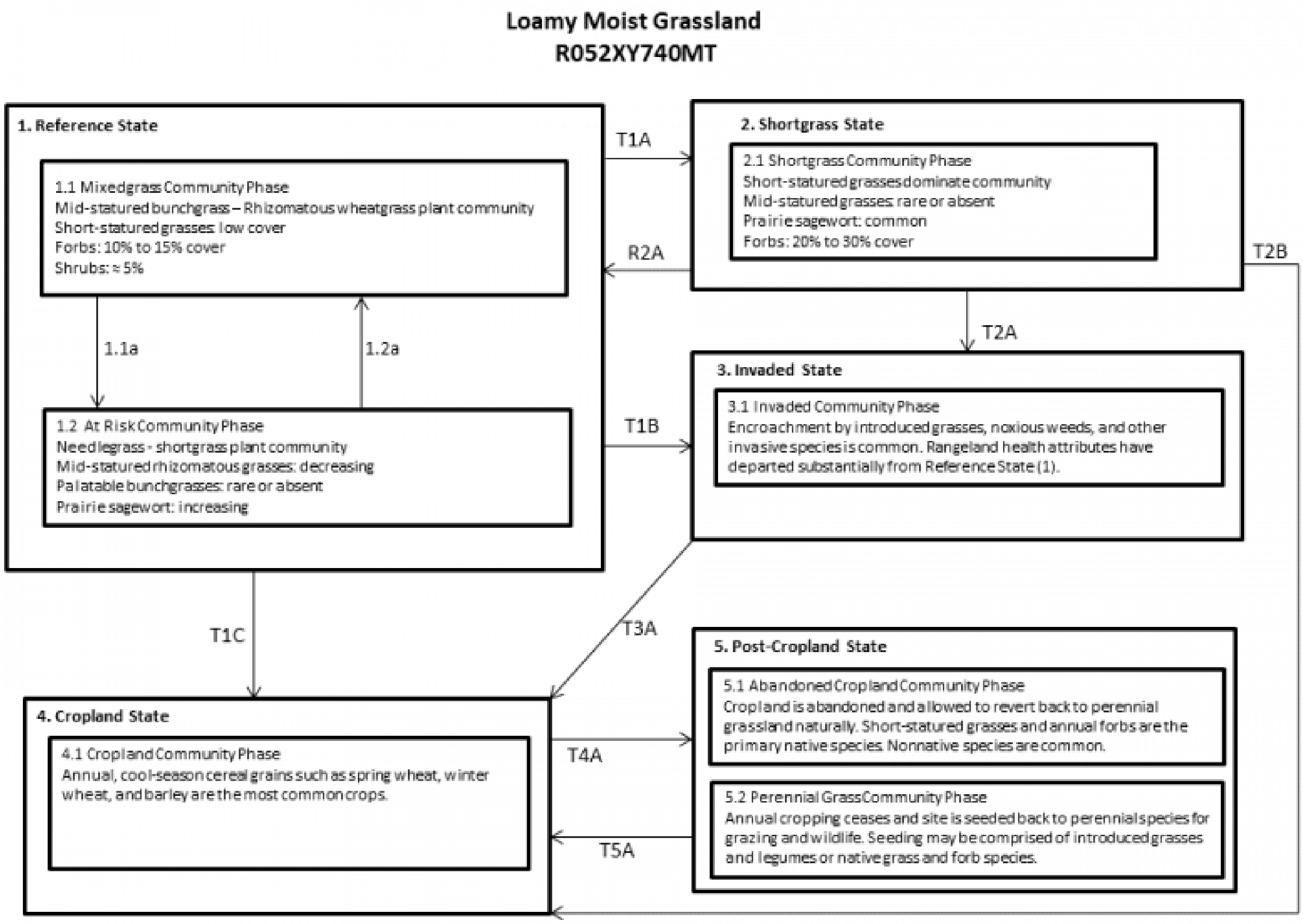

Figure 2. State and Transition Model Diagram.

Loamy Moist Grassland
R052XY740MT

Legend

1.1a - drought, improper grazing management, multiple fires in close succession
1.2a - normal or above average precipitation, proper grazing management
T1A - prolonged drought, improper grazing, or a combination of these factors
T1B - introduction of non-native invasive species (Kentucky bluegrass, noxious weeds, etc.)
T2A - introduction of weedy species; combined with drought and improper grazing management
R2A - range seeding, grazing land mechanical treatment, timely moisture, proper grazing management (management intensive and costly)
T1C, T2B, T3A, T5A - conversion to cropland
T4A - cessation of annual cropping

Figure 2. State and Transition Model Diagram (Continued).

Inventory data references

Three medium-intensity plots and two low-intensity plots were available for this provisional ecological site. Representative long-term data from the Aden and Twin River rangeland reference areas in Alberta, Canada were also used (Broadbent et al., 2013). Two low-intensity plots from the Loamy Steep Moist Grassland ecological site were referenced as a comparison. These data represented the Reference State (1) and the Invaded State (3). These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for their respective states. 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

Scott Brady, 8/23/2019

Acknowledgments

This provisional ecological site description could not have been completed without the contributions of Karen Newlon. She conducted an extensive literature review, which provided most of the background information for this project as well as many of the references. She also co-authored the Loamy and Thin Claypan Dry Grassland ecological sites previously prepared in MLRA 52.

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

Soil Concepts, Soils Information, and Field Descriptions
Charlie French, USDA-NRCS
Josh Sorlie, USDI-BLM

NASIS Reports, Data Dumps, and Soil Sorts
Bill Drummond, USDA-NRCS
Pete Weikle, USDA-NRCS

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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):**

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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):**

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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:**
