Ecological site FX052X01X094
Loamy Sodic (Losd)
Dry Grassland

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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): 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: Dry 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 Mixedgrass Prairie Group (2.B.2.Nb.2.c) • Alliance: No existing correlation • Association: No existing correlation 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) and Glaciated Northern Grasslands (42j)

Ecological site concept

This provisional ecological site occurs in the Dry 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. Onsite evaluations are necessary, particularly in boundary or intergrade areas where ecological sites from multiple climate zones may overlap. Loamy Sodic Dry Grassland is an ecological site of limited extent occurring on alluvial landscapes throughout MLRA 52. It occurs on alluvial fans, drainageways, and terraces where salts have accumulated. The distinguishing characteristic of this site is that soils contain less than 35 percent clay in the upper 4 inches and that saline, sodic, or saline-sodic conditions are evident in the upper 20 inches of soil. Soils for this ecological site are typically very deep (more than 60 inches) and derived from fine-loamy alluvium or outwash deposits. Soil textures in the upper 4 inches are typically loam, clay loam, silt loam, or silty clay loam. Soils typically have an ochric epipedon. Characteristic vegetation is western wheatgrass (Pascopyrum smithii) and inland saltgrass (Distichlis spicata). The principal sagebrush species on this site is silver sagebrush (Artemisia cana), which typically only occurs at low cover.

Associated sites

FX052X01X030	**Limy (Ly) Dry Grassland** Limy Dry Grassland is on similar landscapes, typically it is found on higher slope positions than Loamy Sodic Dry Grassland. It occurs in areas where lime has accumulated rather than salts.
FX052X01X012	**Dense Clay Sodic (Dcsd) Dry Grassland** Dense Clay Sodic Dry Grassland is on similar landscapes and slope positions as Loamy Sodic Dry Grassland. Typically it occurs in areas where clay content is greater than 35 percent.
FX052X01X032	**Loamy (Lo) Dry Grassland** Loamy Dry Grassland is on similar landscapes, typically it is found on higher slope positions than Loamy Sodic Dry Grassland. It occurs in areas where salts and lime have not accumulated.

Similar sites

FX052X03X094	**Loamy Sodic (Losd) Dry Shrubland** This site differs from Loamy Sodic Dry Grassland in that it has slightly warmer annual temperatures and can support Wyoming big sagebrush.
FX052X01X012	**Dense Clay Sodic (Dcsd) Dry Grassland** This site differs from Loamy Sodic Dry Grassland in that soils contain more than 35 percent clay in the upper 4 inches.
FX052X99X091	**Saline Overflow (Sov)** This site differs from Loamy Sodic Dry Grassland in that Saline Overflow is found on floodplains and receives enough additional moisture to significantly increase production, whereas the Loamy Sodic Dry Grassland site occurs in uplands or ephemeral drainageways and does not receive enough additional moisture to increase production.

FX052X01X032	**Loamy (Lo) Dry Grassland** This site differs from Loamy Sodic Dry Grassland in that soils do not exhibit saline, sodic, or saline-sodic conditions in the upper 20 inches of the profile. This is evidenced by the lack of sodium-tolerant species, such as Nutall's alkaligrass and inland saltgrass.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY094MT

Physiographic features

Loamy Sodic Dry Grassland is an ecological site of limited extent occurring on alluvial fans, drainageways, and terraces.

Figure 1. Figure 1. General distribution of the Loamy Sodic Dry Grassland ecological site by map unit extent

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Drainageway (3) Terrace
Elevation	610 – 1,180 m
Slope	0 – 10 %
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 120 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 ten years. Annual precipitation ranges from 10 to 14 inches, and 70 to 80 percent of this 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 the reaction of plants to a “false spring” (Oard, 1993).

Table 3 Representative climatic features

Frost-free period (average)	120 days
Freeze-free period (average)	140 days
Precipitation total (average)	310 mm

- (1) CARTER 14 W [USC00241525], Floweree, MT
- (2) CHESTER [USC00241692], Chester, MT
- (3) TIBER DAM [USC00248233], Chester, MT
- (4) HARLEM [USC00243929], Harlem, MT
- (5) MALTA 7 E [USC00245338], Malta, MT
- (6) TURNER 11N [USC00248415], Turner, MT
- (7) CONRAD [USC00241974], Conrad, MT
- (8) SHELBY [USC00247500], Shelby, MT
- (9) GLASGOW [USW00094008], Glasgow, MT
- (10) HAVRE CITY CO AP [USW00094012], Havre, MT

Influencing water features

This is a dry 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, rarely reaching field capacity levels in the upper 40 inches.

Soil features

The soil series that best represents the central concept for this ecological site is the Benz soil. The Loamy Sodic concept covers about 61,000 acres in MLRA 52. The Benz soil is in the Ustorthents great group. The particle-size family is fine-loamy, meaning that the soils contain between 18 and 35 percent clay in the particle-size control section. The minerology is mixed and the typical parent material for this series is alluvium. These and all soils in this concept are characterized by an accumulation of salts in the upper 20 inches and a surface horizon that lacks enough organic matter to have a mollic epipedon. The soil moisture regime for all soils in this ecological site concept is ustic bordering on aridic, 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, and 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 commonly loam, clay loam, silt loam, or silty clay loam. The upper 4 inches of soil contains less than 35 percent clay. The underlying horizons are typically comprised of stratified alluvial deposits. They are characterized by many thin layers of sediment deposited by past flood events. Subsurface horizon textures are clay loam, silt loam, or silty clay loam. Organic matter in the surface horizon typically ranges from 0.5 to 2 percent organic matter, and moist colors vary from light olive brown (2.5Y 5/3) to very dark grayish brown (2.5Y 3/2). Calcium carbonate equivalent is typically less than 15 percent throughout the soil profile. The upper 20 inches of soil contain accumulated salts, as evidenced by an electrical conductivity of 4 or more, a sodium absorption ratio of 13 or more, or both. Soil pH classes are slightly to strongly alkaline in the surface horizon and moderately to strongly alkaline in the subsurface horizons. The soil depth class for this site is typically very deep (greater than 60 inches). Coarse fragments are typically rare or absent in the upper 20 inches of soil.

Table 4. Representative soil features

Parent material	(1) Alluvium

Surface texture	(1) Loam (2) Clay loam (3) Silt loam (4) Silty clay loam
Drainage class	Well drained
Soil depth	150 – 180 cm
Available water capacity (0-101.6cm)	11.43 – 12.7 cm
Calcium carbonate equivalent (0-12.7cm)	0 – 10 %
Electrical conductivity (0-50.8cm)	0 – 20 mmhos/cm
Sodium adsorption ratio (0-50.8cm)	10 – 40
Soil reaction (1:1 water) (0-101.6cm)	7.4 – 10
Subsurface fragment volume <=3" (0-50.8cm)	0 – 10 %
Subsurface fragment volume >3" (0-50.8cm)	0 – 10 %

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 Sodic Dry Grassland provisional ecological site in MLRA 52 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. 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 historic ecosystem experienced relatively frequent 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). It is not known how significant fire was on the Loamy Sodic Dry Grassland ecological site. It is believed that the frequency and intensity of fire would be less than that of adjacent sites due to the sparse vegetative cover. Further investigation of fire dynamics is needed to better assess this. Nonnative annual bromes have become naturalized in relatively undisturbed grasslands (Ogle et al., 2003; Harmoney, 2007). They can be present in any state within the scope of this ecological site, but their abundance varies depending on precipitation and germination conditions. They typically are not abundant enough to have a significant ecological impact. However, in the Invaded State (3), they may be abundant enough to do so. Further study is required to assess this assumption.

Improper grazing of this site can result in a reduction in the cover of the mid-statured cool-season, rhizomatous wheatgrasses and an increase in shortgrasses (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 rhizomatous wheatgrasses, triggering an increase in shortgrasses, such as Sandberg bluegrass (Coupland, 1961; Clarke et al., 1947).

Further degradation of the site due to improper grazing, can result in a community dominated by shortgrasses such as Sandberg bluegrass. Cover and vigor of mid-statured rhizomatous grasses are severely reduced. Unpalatable forbs, such as curlycup gumweed (Grindelia squarrosa), are common. Invasive species dynamics are not well understood on this ecological site. Invasive species, such as annual bromes, smooth brome (Bromus inermis), and crested wheatgrass (Agropyron cristatum), have been documented on this site. Crested wheatgrass, in particular, is a highly drought tolerant and competitive cool-season, perennial bunchgrass (DeLuca and Lesica, 1996). It can invade relatively undisturbed grasslands, reducing cover and production of native cool-season midgrasses (Heidinga and Wilson, 2002; Henderson and Naeth, 2005). Invasive species dynamics have not been studied on this site and further investigation is needed to fully document ecological pathways and processes.

The Loamy Sodic Dry Grassland ecological site is not well suited to cropland. Regardless, many acres have been converted to cropland. Cereal grains, such as wheat and barley, are the most common crops. When taken out of production, the site is either allowed to revert back to perennial grassland or is seeded with introduced species. Sites left to undergo natural plant succession after cultivation can, over several decades, support cool-season rhizomatous wheatgrasses, although cover and production of these species are lower than in the Reference State (1). Those sites seeded with non-native species, may persist with this cover type indefinitely, particularly if salt-tolerant species such as RS wheatgrass (Elymus hoffmannii), also known as hybrid wheatgrass, are used. When reseeded to native species, it may take over 75 years for the soil on productive sites to return to the pre-disturbed state (Dormaar and Willms, 1990). The Loamy Sodic Dry Grassland ecological site may take longer due to the difficult growing conditions. Further investigation is needed to better evaluate this assumption.

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 State (1) 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. 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 rhizomatous grasses, sodium-tolerant rhizomatous grasses, and sodium-tolerant bunchgrasses.

Phase 1.1: Rhizomatous Wheatgrass-Inland Phase

The Rhizomatous Wheatgrass-Inland Saltgrass Phase (1.1) is typically dominated by western wheatgrass and inland saltgrass. Thickspike wheatgrass (Elymus lanceolatus) may also occur on this site, but is typically not abundant. Sodium-tolerant bunchgrasses, such as alkali sacaton (Sporobolus airoides) and Nutall’s alkaligrass (Puccinellia nuttalliana), are common and occur at low to moderate cover. Short-statured grasses, such as Sandberg bluegrass (Poa secunda) are not abundant in this phase, but they are generally present at low cover. Forbs are not common and generally comprise 5 percent cover or less. Species that may occur are common yarrow (Achillea millefolium), curlycup gumweed (Grindelia squarrosa), and various annuals. Shrubs and subshrubs are rare on this site, however, prairie sagewort (Artemisia frigida), also known as fringed sagewort, and Gardner’s saltbush (Atriplex gardneri) can occur at low cover. The approximate species composition of the Reference State (1) plant community is as follows:

Percent composition by weight*
Rhizomatous Wheatgrass 35%
Inland Saltgrass 25%
Sodium-tolerant bunchgrasses 5-10%
Sandberg bluegrass 5%
Other Native Grasses 15%
Perennial Forbs 10%
Shrubs/Subshrubs 0-5%

Estimated Total Annual Production (lbs/ac)*
Low - 450
Representative Value - 650
High - 800
* Estimated based on current data – subject to revision

Phase 1.2: At-Risk Community Phase
In the At-Risk Community Phase (1.2), rhizomatous wheatgrasses are in decline and only occur at low cover. Inland saltgrass is in nearly equal proportion to shortgrasses. Shortgrasses such as Sandberg bluegrass, and unpalatable forbs such as curlycup gumweed, are increasing. Sodium-tolerant bunchgrasses are rare or absent in this phase.

Community Phase Pathway 1.1a
Drought, improper grazing management, or a combination of these factors can shift the Rhizomatous Wheatgrass-Inland Saltgrass Community Phase (1.1) to the At-Risk Community Phase (1.2). These factors favor a decrease in rhizomatous wheatgrasses and an increase in inland saltgrass and shortgrasses.

Community Phase Pathway 1.2a
Normal or above-normal spring precipitation and proper grazing management can return The At-Risk Community Phase (1.2) to the Rhizomatous Wheatgrass-Inland Saltgrass Community Phase (1.1).

Transition T1A
Prolonged drought (approximately 3 years or more), 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, cool-season grasses become rare and contribute little to production. Shortgrasses, particularly Sandberg bluegrass, and unpalatable forbs dominate the plant community.

Transition T1B
The Reference State (1) transitions to the Invaded State (3) when invasive plant species invade the Reference State (1). These communities are commonly adjacent to seeded pastures. Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced. 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, or barley, transitions the Reference State (1) to the Cropland State (3).

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. The site is dominated by shortgrasses, such as Sandberg bluegrass. Mid-statured grasses, particularly rhizomatous wheatgrasses, have been eliminated or nearly so. Unpalatable forbs are common and may account for as much as 50 percent of the total annual production. Reductions in stocking rates can reduce shortgrass cover and increase the cover of rhizomatous wheatgrasses. This recovery may take decades, especially if soil properties are substantially altered (Dormaar and Willms, 1990).

Phase 2.1: Shortgrass Community Phase
The Shortgrass Community Phase (2.1) is dominated by shortgrasses, such as Sandberg bluegrass. Mid-statured grasses such as western wheatgrass have been eliminated, or nearly so. Unpalatable forbs, such as curlycup gumweed, are common and may account

for as much as 50 percent of the total production.

Transition T2A
The Shortgrass State (2) transitions to the Invaded State (3) when invasive plant species invade the Shortgrass State (2). These communities are commonly adjacent to seeded pastures. Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced. 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
Reduction in livestock grazing pressure alone may not be sufficient to restore the Shortgrass State (2) to the Reference State (1) (Dormaar and Willms, 1990). Practices such as range seeding may be necessary (Hart et al., 1985), but these are management intensive and costly. Therefore, returning the Shortgrass State (2) to the Reference State (1) can 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. Invasive species dynamics are not well understood on this ecological site. Invasive species that have been documented on this site include annual bromes, smooth brome (Bromus inermis), and crested wheatgrass (Agropyron cristatum). Crested wheatgrass, in particular, is very aggressive and can outcompete native species when conditions are favorable. Noxious weeds, such as leafy spurge, have not been documented on this site. Further study is needed to fully access the ecological dynamics of the Invaded State (3).

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. This site is generally not well suited to crops, and cereal grain production is limited.

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 Phase
In the absence of active management, the site can re-vegetate naturally and, over time, potentially return to a perennial grassland community with western wheatgrass and Sandberg bluegrass. Shortly after cropland is abandoned, annual and biennial forbs and annual brome grasses invade the site (Samuel and Hart, 1994). Eventually, these pioneering annual species are replaced by perennial forbs and perennial shortgrasses. Invasion of the site by exotic species, such as crested wheatgrass and annual bromes, will depend upon the site’s proximity to a seed source.

Fifty or more years after cultivation, these sites may have species composition similar to phases in the Reference State (1). However, soil quality is consistently lower than conditions prior to cultivation (Dormaar and Smoliak, 1985), making a shift to the Reference State (1) is unlikely within a reasonable timeframe.

Phase 5.2: Perennial Grass Phase
When the site is seeded to perennial forage species, particularly introduced perennial grasses such as RS wheatgrass (Elymus hoffmannii), also known as hybrid wheatgrass, this community phase can persist for several decades. A mixture of native species may also be seeded to provide species composition and structural complexity similar to those of the contemporary Reference State (1). However, soil quality conditions have been substantially altered and are unlikely to return to pre-cultivation conditions within a reasonable timeframe (Dormaar et al., 1990).

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

Additional community tables

Inventory data references

One low-intensity plot and one medium-intensity plot were available for this provisional ecological site. These plots, in conjunction with a review of the scientific literature and professional experience, were used to approximate the reference plant community for this provisional ecological site. Information for alternate 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.

Other references

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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	09/24/2026
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):**

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:**