USDA Natural Resources Conservation Service

Ecological site FX052X02Y160 Thin Breaks (TB) Moist 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.

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

• Association: *Pascopyrum smithii - Hesperostipa comata* Central Mixedgrass Grassland

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: 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. 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. Thin Breaks Moist Grassland is an ecological site of limited extent occurring on areas of the till plain near the various mountain ranges as well as the Sweetgrass Hills in MLRA 52. This site typically occurs in a badlands landscape on a variety of slope positions and aspects. Due to the complex nature of the landscape, soil texture, soil depth, and slope on this ecological site can be highly variable.

The distinguishing characteristics of this site are lithic or paralithic bedrock within 40 inches of the soil surface and a relatively young, undeveloped soil profile, which lacks features such as a mollic epipedon and an argillic horizon. Soils are very shallow to moderately deep (less than 40 inches) to bedrock and are typically derived from residuum. Soil surface textures are variable, but clay content is less than 35 percent. Slopes vary, but are typically greater than 15 percent. Characteristic vegetation is rhizomatous wheatgrasses, needle and thread (*Hesperostipa comata*), and prairie Junegrass (Koeleria macrantha). Little bluestem (Schizachyrium scoparium) occurs on this site on the north slopes of the Bear's Paw and Highwood Mountains.

Associated sites

FX052X02X131	**Shallow Clay (Swc) Moist Grassland** This site occurs on moderate to steeply sloping hillslopes adjacent to the Thin Breaks Moist Grassland ecological site where soils contain greater than 35 percent clay. It typically occupies a similar slope position to the Thin Breaks Moist Grassland ecological site.
FX052X02X029	**Limy-Steep (Lystp) Moist Grassland** This site occurs on upslope from the Thin Breaks Moist Grassland ecological site It most commonly occupies a shoulder position were the soil depth is greater than 40 inches.

Similar sites

FX052X02X131	**Shallow Clay (Swc) Moist Grassland** This site differs from Thin Breaks Moist Grassland in that the clay content is greater than 35 percent and depth to bedrock is less than 20 inches.
FX052X02X029	**Limy-Steep (Lystp) Moist Grassland** This site differs from the Thin Breaks Moist Grassland ecological site in that the soil depth is greater than 40 inches and soils are typically derived from glacial till rather than residuum. Herbaceus production, particular of mid-statured bunchgrasses, is significantly higher.
FX052X02X040	**Loamy-Steep (Lostp) Moist Grassland** This site differs from Thin Breaks Moist Grassland ecological site in that the soil is typically greater than 40 inches deep and derived from glacial till. When moderately deep (20 to 40 inches) soils are well developed (evidenced by a mollic epipedon and argillic horizon).

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified

Herbaceous	Not specified

Legacy ID

R052XY751MT

Physiographic features

Thin Breaks Moist Grassland is an ecological site of limited extent occurring in the moist areas of MLRA 52. The majority of MLRA 52 is covered by a broad till plain, but this ecological site largely occurs at higher elevations near the various mountain ranges and the Sweetgrass Hills This ecological site largely occurs in areas that have been dissected by streams or rivers and bedrock is exposed. This site occurs on a variety of slope positions including side slopes, nose slopes, and headslopes. Typical landforms are hillslopes, bluffs, and escarpments. Slopes vary from 0 to 60 percent, but are typically greater than 15 percent.

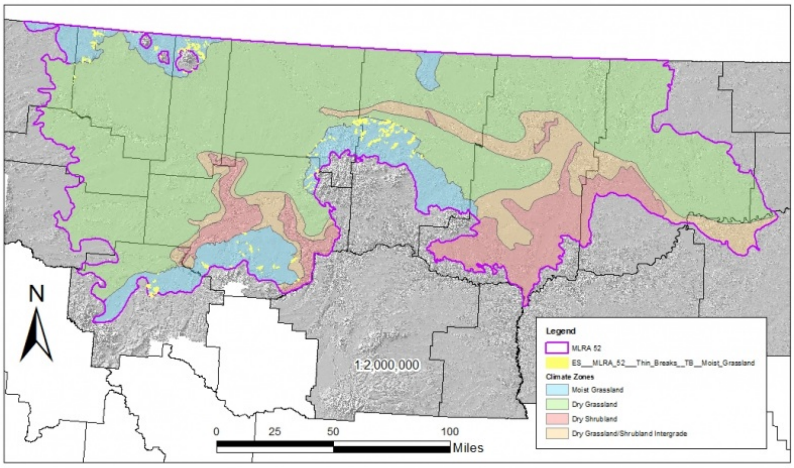

Figure 2.

Table 2. Representative physiographic features

Landforms	(1) Till plain > Hillslope (2) Bluff (3) Escarpment
Elevation	1,097–1,399 m
Slope	0–65%
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. Steep slopes combined with bedrock at relatively shallow depths result in very high runoff potential. Intense precipitation events deliver large amounts of surface runoff downslope. 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. Soil moisture is the primary limiting factor for plant production on this ecological site.

Soil features

The soil series that best represent the central concept of this ecological site are Cabba and Doney. The Cabba soil is in the Ustorthents great group. It is in the loamy family and is shallow (between 10 to 20 inches to bedrock). The Doney soil is in the Haplustepts great group. It is in the fine-loamy family and is moderately deep (between 20 to 40 inches to bedrock). Both of these soils have mixed mineralogy. All soils in this concept are characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon and contact with lithic or paralithic bedrock less than 40 inches below the soil surface. 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 fine sandy loam, loam, or clay loam. The upper 4 inches of soil contains less than 35 percent clay and sand content is typically less than 70 percent. The underlying horizons are typically weakly developed and an argillic horizon is lacking. Subsurface textures are typically similar to the surface horizon. Organic matter content in the surface horizon typically ranges from 1 to 2 percent, and moist colors vary from light olive brown (2.5Y 5/3) to very dark grayish brown (2.5Y 3/2). The upper 5 inches of these soils sometimes, but not always, reacts with hydrochloric acid. Calcium carbonate equivalent varies from 0 to 10 percent, but is typically more than 5 percent. In the upper 20 inches, electrical conductivity is less than 4, and the sodium absorption ratio is less than 13. Soil pH class is slightly acid to strongly alkaline in the surface horizon and neutral to strongly alkaline in the subsurface horizons. The soil depth class for this site can vary from very shallow (less than 10 inches) to moderately deep and typically changes quickly on the landscape. Content of coarse fragments is less than 35 percent in the upper 20 inches of soil (Table 4).

Table 4. Representative soil features

Parent material	(1) Residuum (2) Till
Surface texture	(1) Fine sandy loam (2) Loam (3) Clay loam
Drainage class	Well drained
Soil depth	0–102 cm

Available water capacity (0-101.6cm)	5.08–10.16 cm
Calcium carbonate equivalent (0-12.7cm)	0–9%
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)	6.1–9
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 Thin Breaks Moist Grassland provisional ecological site in MLRA 52 Dry Grassland consists of three states: The Reference State (1), the Altered State (2), and the Invaded State (3). 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). It is not known how significant fire was on the Thin Breaks Moist Grassland ecological site. It is believed that the frequency of fire would be less than that of adjacent sites due to the broken topography and sparser vegetation but further investigation of fire dynamics is needed to better assess this concept.

Improper grazing of this site can result in a reduction in the cover of the mid-statured grasses and an increase in shortgrasses such as prairie Junegrass. 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. Further degradation of the site due to improper grazing can result in a community dominated by shortgrasses such as such as prairie Junegrass and blue grama. Periods of extended drought (approximately 3 years or more) may have similar effects. This site is also susceptible to invasion by non-native species, although invasive species dynamics are not well studied on this ecological site. Potential invasive species are non-native perennial grasses and noxious weeds. Further investigation of invasive species dynamics is needed.

Due to the steep slopes and relatively shallow soils, this ecological site is generally not suitable for cropland. Therefore, this ecological site has largely remained in native vegetation.

The 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 two community phases characterized by a rhizomatous wheatgrasses, mid-statured bunchgrasses, and shortgrasses such as prairie Junegrass. 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.

Phase 1.1: Mixedgrass Community Phase
The Mixedgrass Community Phase (1.1) is characterized by a rhizomatous wheatgrasses, mid-statured bunchgrasses, and shortgrasses. The most abundant species are western wheatgrass (*Pascopyrum smithii*) and needle and thread (*Hesperostipa comata*). Thickspike wheatgrass (*Elymus lanceolatus*) may also be present, becoming more abundant in the northern extent of this ecological site. Little bluestem is a warm-season bunchgrass that appears on this site near Havre and eastward along the north slope of the Bear’s Paw Mountains. When present, it occurs in monoculture patches that encompass approximately 10 percent of the site. The predominant shortgrass species is prairie Junegrass, but blue grama (*Bouteloua gracilis*) and Sandberg bluegrass (*Poa secunda*) may also occur. Other species that may occur on this site are plains muhly (*Muhlenbergia cuspidata*) and threadleaf sedge (*Carex filifolia*). Common forbs are scarlet globemallow (*Sphaeralcea coccinea*), and spiny, or Hood’s, phlox (*Phlox hoodii*). Shrubs and subshrubs are rare on this site, however, prairie, or fringed, sagewort (*Artemisia frigida*) and silver sagebrush (*Artemisia cana*) can occur at low cover. The approximate species composition of the reference plant community is as follows:

Percent composition by weight*
Rhizomatous Wheatgrass 25-35%
Needle and Thread 20-25%
Little Bluestem 0-10%
Prairie Junegrass 10%
Other Native Grasses 15%
Perennial Forbs 10%
Shrubs/Subshrubs 5%

Estimated Total Annual Production (lbs/ac)*
Low - Insufficient Data
Representative Value - 700
High - Insufficient Data
* 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. It is characterized by a decline in rhizomatous wheatgrasses, an increase in shortgrasses such as prairie Junegrass, and eventually a decline in needle and thread (Adams et al., 2013). The cover of shortgrasses equals or exceeds the cover of needle and thread. Rhizomatous wheatgrass are rare and have declining vigor. Threadleaf sedge may also increase in this phase.

Community Phase Pathway 1.1a
Drought, improper grazing management, 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 prairie Junegrass and a decrease in midgrasses (Coupland, 1961, Adams et al., 2013).

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 Altered State (2). The Reference State (1) transitions to the Altered State (2) when cool-season midgrasses become rare and contribute little to production. Shortgrasses such as prairie Junegrass and blue grama dominate the plant community.

Transition T1B
The Reference State (1) transitions to the Invaded State (3) when non-native grasses or noxious weeds invade the Reference State (1). 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 (Henderson and Naeth, 2005) and soil quality (Smoliak and Dormaar, 1985; Dormaar et al., 1995), have been substantially altered from the Reference State (1).

State 2: Altered State
The Altered State (2) consists of two community phases. The dynamics of this state are driven by long-term drought, improper grazing management, or a combination of these factors. Cool-season midgrasses decrease with long-term improper grazing (Coupland, 1961; Biondini and Manske, 1996; Derner and Whitman, 2009). When little bluestem is present, the Shortgrass-Little Bluestem Community Phase (2.2) may develop under certain conditions. Reductions in stocking rates can increase the cover of cool-season midgrasses, although this recovery may take decades (Dormaar and Willms, 1990; Dormaar et al., 1994).

Phase 2.1: Subshrub/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 western wheatgrass and needle and thread have been largely eliminated and replaced by short-statured species, such as prairie Junegrass and blue grama. Threadleaf sedge may persist due to its short stature and extensive root system, however, it may eventually decline due to grazing pressure as well. Prairie sagewort may also increase in this phase. There is typically a high amount of bare ground, and erosional patterns and plant pedestaling are evident.

Phase 2.2: Shortgrass-Little Bluestem Community Phase
In areas where little bluestem is present, the Shortgrass-Little Bluestem Community Phase (2.2) may develop under certain conditions. When actively growing, little bluestem is regarded as desirable forage for cattle; however in MLRA 52, this grass is only palatable for a very short time. When pastures are grazed in late summer or fall, little bluestem is mature and unpalatable and livestock tend to avoid it. This combined with improper grazing management may result in the Shortgrass-Little Bluestem Community Phase (2.2). Dynamics of this phase are not well understood and require further investigation.

Transition T2A
The Altered State (2) transitions to the Invaded State (3) when non-native grasses or noxious weeds invade the Reference State (1). 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 (Henderson and Naeth, 2005) and soil quality (Smoliak and Dormaar, 1985; Dormaar et al., 1995), have been substantially altered from the Reference State (1).

Restoration Pathway R2A
A reduction in livestock grazing pressure alone may not be sufficient to return the Altered State (2) to the Reference State (1) (Dormaar and Willms, 1990). Intensive management treatments may be necessary (Hart et al., 1985), but practices such as grazing land mechanical treatment and range seeding may not be possible on this site due to topography. Therefore, returning the Altered State (2) to the Reference State (1) can require considerable cost,

energy, and may not be feasible within a reasonable amount of time.

State 3: Invaded State
The Invaded State (2) occurs when invasive plant species invade adjacent native grassland communities. Possible invasive species on this ecological site include introduced bluegrasses, crested wheatgrass, and noxious weeds. Introduced bluegrasses, such as Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass (*Poa compressa*), are primarily a concern on sites with slightly more moisture, such as north-facing slopes. 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). Crested wheatgrass can be a concern on drier sites especially when native plant communities are adjacent to seeded pastures. Crested wheatgrass produces abundant seeds that can dominate the seedbank of invaded grasslands (Henderson and Naeth, 2005), although crested wheatgrass cover decreases with increasing distance from seeded areas (Heidinga and Wilson, 2002).

Noxious weeds such as leafy spurge are not widespread in MLRA 52, but may also invade and displace native species. These species are very aggressive perennials. They typically displace native species and dominate ecological function when they invade a site. Sometimes, 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.

State and transition model

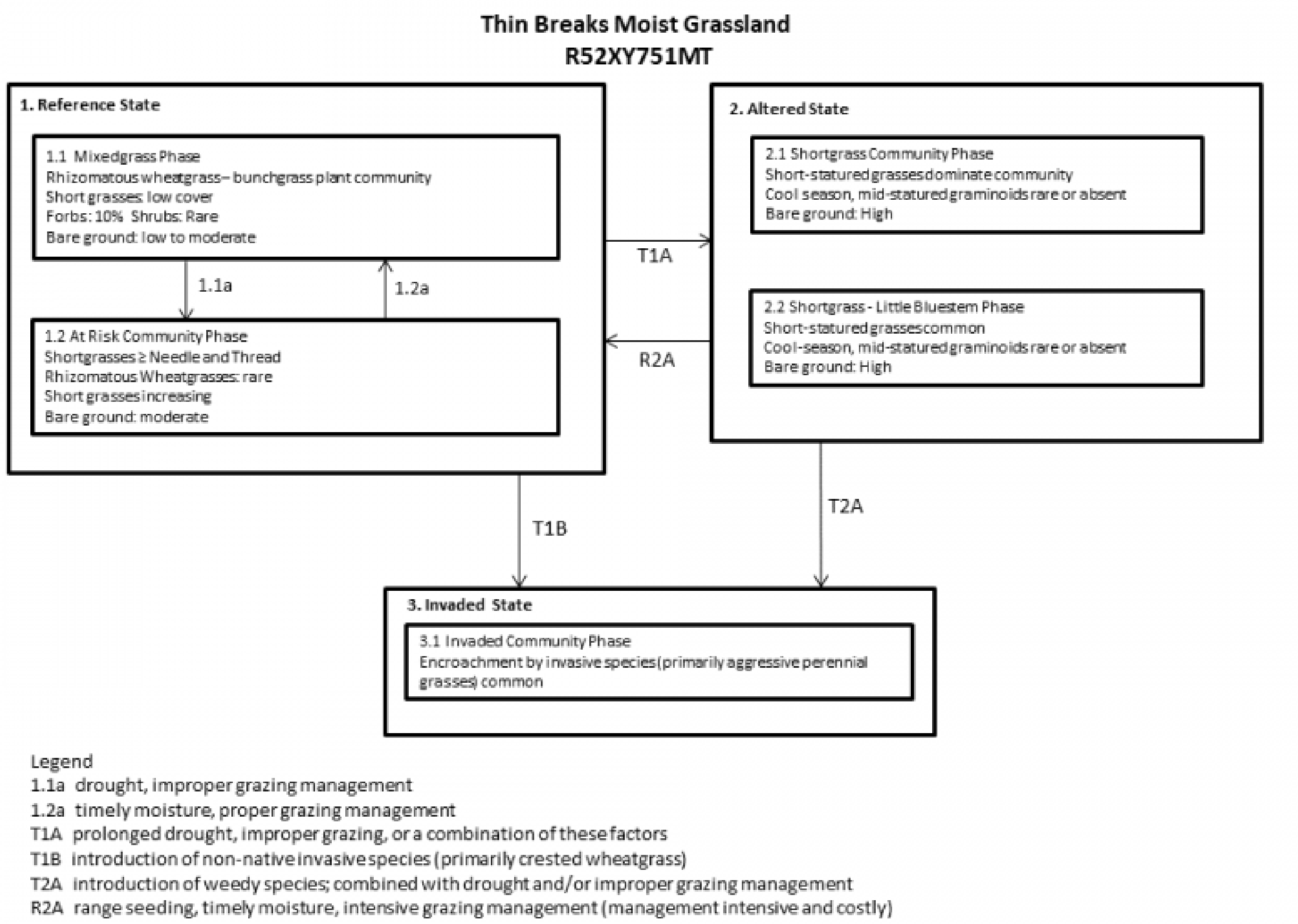

Figure 2. State-and-transition diagram.

Inventory data references

No field data was available for this provisional ecological site. Professional experience and a review of the scientific literature was used to approximate the reference plant community. Information for other states and community phases was obtained from a review of the scientific literature and professional experience. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

Other references

Adams, B.W., et al. 2013. Rangeland plant communities for the mixedgrass natural subregion of Alberta. Second approximation. Rangeland Management Branch, Policy Division, Alberta Environment and Sustainable Resource Development, Lethbridge, Pub. No. T/039.

Anderson, R.C. 2006. Evolution and origin of the central grassland of North America: Climate, fire, and mammalian grazers. Journal of the Torrey Botanical Society 133:626-647.

Baskin, J.M., and C.C. Baskin. 1981. Ecology of germination and flowering in the weedy winter annual grass Bromus japonicus. Journal of Range Management 34:369-372.

Biondini, M.E., and L. Manske. 1996. Grazing frequency and ecosystem processes in a northern mixed prairie, USA. Ecological Applications 6:239-256.

Biondini, M.E., B.D. Patton, and P.E. Nyren. 1998. Grazing intensity and ecosystem processes in a northern mixed-grass prairie, USA. Ecological Applications 8:469-479.

Bloom-Cornelius, I.V. 2011. Vegetation response to fire and domestic and native ungulate herbivory in a Wyoming big sagebrush ecosystem. M.S. thesis, Oklahoma State University. Stillwater, OK.

Bragg, T.B. 1995. The physical environment of the Great Plains grasslands. In: A. Joern and K.H. Keeler (eds.) The Changing Prairie, Oxford University Press, Oxford, pp. 49-81.

Branson, D.H., and G.A. Sword. 2010. An experimental analysis of grasshopper community responses to fire and livestock grazing in a northern mixed-grass prairie. Environmental Entomology 39:1441-1446.

Bylo, L.N., N. Koper, and K.A. Molloy. 2014. Grazing intensity influences ground squirrel and American badger habitat use in mixed-grass prairies. Rangeland Ecology and Management 67:247-254.

Christian, J.M., and S.D. Wilson. 1999. Long-term ecosystem impacts of an introduced grass in the Northern Great Plains. Ecology 80:2397-2407.

Clarke, S.E, E.W. Tisdale, and N.A. Skoglund. 1947. The effects of climate and grazing practices on short-grass prairie vegetation in southern Alberta and southwestern Saskatchewan. Canadian Department of Agriculture Technical Bulletin No. 46.

Cleland, D.T., et al. 1997. National hierarchical framework of ecological units. In: M.S. Boyce and A. Haney (eds.) Ecosystem Management Applications for Sustainable Forest and Wildlife Resources, Yale University Press, New Haven, CT.

Cooper, S.V., C. Jean, and P. Hendricks. 2001. Biological survey of a prairie landscape in Montana’s glaciated plains. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena, MT.

Cooper, S.V., and W.M. Jones. 2003. Site descriptions of high-quality wetlands derived from existing literature sources. Report to the Montana Department of Environmental Quality. Montana Natural Heritage Program, Helena, MT.

Coupland, R.T. 1950. Ecology of the mixed prairie of Canada. Ecological Monographs 20:271-315.

Coupland, R.T. 1958. The effects of fluctuations in weather upon the grasslands of the Great Plains. Botanical Review 24:273-317.

Coupland, R.T. 1961. A reconsideration of grassland classification in the Northern Great Plains of North America. Journal of Ecology 49:135-167.

Coupland, R.T., and R.E. Johnson. 1965. Rooting characteristics of native grassland species in Saskatchewan. Journal of Ecology 53:475-507.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service FWS/OBS, 79(31), 131.

Crowe, E., and G. Kudray. 2003. Wetland Assessment of the Whitewater Watershed. Report to U.S. Bureau of Land Management, Malta Field Office. Montana Natural Heritage Program, Helena, MT

Davis, S.K., R.J. Fisher, S.L. Skinner, T.L. Shaffer, and R.M. Brigham. 2013. Songbird abundance in native and planted grassland varies with type and amount of grassland in the surrounding landscape. Journal of Wildlife Management 77:908-919.

DeKeyser, E.S., M. Meehan, G. Clambey, and K. Krabbenhoft. 2013. Cool season invasive grasses in northern Great Plains natural areas. Natural Areas Journal 33:81-90.

DeKeyser, S., G. Clambey, K. Krabbenhoft, and J. Ostendorf. 2009. Are changes in species composition on central North Dakota rangelands due to non-use management? Rangelands 31:16-19.

Derner, J.D., and R.H. Hart. 2007. Grazing-induced modifications to peak standing crop in northern mixed-grass prairie. Rangeland Ecology and Management 60:270-276.

Derner, J.D., and A.J. Whitman. 2009. Plant interspaces resulting from contrasting grazing management in northern mixed-grass prairie: Implications for ecosystem function. Rangeland Ecology and Management 62:83-88.

Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America. Rangeland Ecology and Management 62:111-118.

Dix, R.L. 1960. The effects of burning on the mulch structure and species composition of grasslands in western North Dakota. Ecology 41:49-56.

Dormaar, J.F., and S. Smoliak. 1985. Recovery of vegetative cover and soil organic matter during revegetation of abandoned farmland in a semiarid climate. Journal of Range Management 38:487-491.

Dormaar, J.F., and W.D. Willms. 1990. Effect of grazing and cultivation on some chemical properties of soils in the mixed prairie. Journal of Range Management 43:456-460.

Dormaar, J.F., B.W. Adams, and W.D. Willms. 1994. Effect of grazing and abandoned cultivation on a Stipa-Bouteloua community. Journal of Range Management 47:28-32.

Dormaar, J.F., M.A. Naeth, W.D. Willms, and D.S. Chanasyk. 1995. Effect of native prairie, crested wheatgrass (Agropyron cristatum) and Russian wildrye (Elymus junceus) on soil chemical properties. Journal of Range Management 48:258-263.

Fansler, V.A., and J.M. Mangold. 2010. Restoring native plants to crested wheatgrass stands. Restoration Ecology 19:16-23.

Federal Geographic Data Committee. 2008. The National Vegetation Classification Standard, Version 2. FGDC Vegetation Subcommittee. FGDC-STD-005-2008 (Version 2). pp. 126.

Fullerton, D.S., and R.B. Colton. 1986. Stratigraphy and correlation of the glacial deposits on the Montana Plains. U.S. Geological Survey.

Fullerton, D.S., R.B. Colton, C.A. Bush, and A.W. Straub. 2004. Map showing spatial and temporal relations of mountain and continental glaciations on the northern plains, primarily in northern Montana and northwestern North Dakota. U.S. Geologic Survey pamphlet accompanying Scientific Investigations Map 2843.

Fullerton, D.S., R.B. Colton, and C.A. Bush. 2013. Quaternary geologic map of the Shelby 1° x 2° quadrangle, Montana: U.S. Geological Survey Open-File Report 2012–1170, scale 1:250,000.

Galatowitsch, S.M., and A.G. Van der Valk. 1996. The vegetation of restored and natural prairie wetlands. Ecological Applications. 6:1 pp.102-112.

Gilbert, M.C., P.M. Whited, E.J. Clairain Jr., and R.D. Smith. 2006. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of prairie potholes. U.S. Army Corps of Engineers Final Report, Washington, DC.

Grant, T.A., B. Flanders-Wanner, T.L. Shaffer, R.K. Murphy, and G.A. Knutsen. 2009. An emerging crisis across northern prairie refuges: Prevalence of invasive plants and a plan for adaptive management. Ecological Restoration 27:58-65.

Haferkamp, M.R., R.K. Heitschmidt, and M.G. Karl. 1997. Influence of Japanese brome on western wheatgrass yield. Journal of Range Management 50:44-50.

Hansen, P.L., et al. 1995. Classification and management of Montana's riparian and wetland sites. University of Montana, Montana Forest and Conservation Experiment Station, Miscellaneous Publication No. 54.

Harmoney, K.R. 2007. Grazing and burning Japanese brome (Bromus japonicus) on mixed grass rangelands. Rangeland Ecology and Management 60:479-486.

Hart, M., S.S. Waller, S.R. Lowry, and R.N. Gates. 1985. Disking and seeding effects on sod bound mixed prairie. Journal of Range Management 38:121-125.

Heidel, B., S.V. Cooper, and C. Jean. 2000. Plant species of special concern and plant associations of Sheridan County, Montana. Report to U.S. Fish and Wildlife Service. Montana Natural Heritage Program, Helena, MT.

Heidinga, L., and S.D. Wilson. 2002. The impact of an invading alien grass (Agropyron cristatum) on species turnover in native prairie. Diversity and Distributions 8:249-258.

Heitschmidt, R.K., and L.T. Vermeire. 2005. An ecological and economic risk avoidance drought management decision support system. In: J.A. Milne (ed.) Pastoral Systems in Marginal Environments, XXth International Grasslands Congress, July 2005, p. 178.

Henderson, A.E., and S.K. Davis. 2014. Rangeland health assessment: A useful tool for linking range management and grassland bird conservation? Rangeland Ecology and Management 67:88-98.

Henderson, D.C., and M.A. Naeth. 2005. Multi-scale impacts of crested wheatgrass invasion in mixed-grass prairie. Biological Invasions 7:639-650.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2009. Monitoring manual for grassland, shrubland and savanna ecosystems. U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, Las Cruces, NM.

Higgins, K.F. 1986. Interpretation and compendium of historical fire accounts in the Northern Great Plains. U.S. Fish and Wildlife Service Resource Publication 161.

Holechek, J.L. 1981. Crested wheatgrass. Rangelands 3:151-153.

Howard, J.L. 1999. Artemisia tridentata subsp. wyomingensis. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service http://www.fs.fed.us/database/feis/plants/shrub/arttriw/all.html accessed (8/11/2016).

Joern, A. 2005. Disturbance by fire frequency and bison grazing modulate grasshopper assemblages in tallgrass prairie. Ecology 86:861-873.

Jones, W.M. 2004. Using vegetation to assess wetland condition: a multimetric approach for temporarily and seasonally flooded depressional wetlands and herbaceous-dominated intermittent and ephemeral riverine wetlands in the northwestern glaciated plains ecoregion, Montana. Report to the Montana Department of Environmental Quality and the U.S. Environmental Protection Agency. Montana Natural Heritage Program, Helena, MT.

Knopf, F.L. 1996. Prairie legacies—birds. In: F.B. Samson and F.L. Knopf (eds.) Prairie Conservation: Preserving North America's Most Endangered Ecosystem, Island Press, Washington, DC, pp. 135-148.

Knopf, F.L., and F.B. Samson. 1997. Conservation of grassland vertebrates. In: F.B. Samson and F.L. Knopf (eds.) Ecology and Conservation of Great Plains Vertebrates: Ecological Studies 125, Springer-Verlag, New York, NY, pp. 273-289.

Krzic, M., K. Broersma, D.J. Thompson, and A.A. Bomke. 2000. Soil properties and species diversity of grazed crested wheatgrass and native rangelands. Journal of Range Management 53:353-358.

Lacey, J., R. Carlstrom, and K. Williams. 1995. Chiseling rangeland in Montana. Rangelands 17:164-166.

Lauenroth, W.K., O.E. Sala, D.P. Coffin, and T.B. Kirchner. 1994. The importance of soil water in recruitment of *Bouteloua gracilis* in the shortgrass steppe. Ecological Applications 4:741-749.

Laycock, W.A. 1988. History of grassland plowing and grass planting on the Great Plains. In: J.E. Mitchell (ed.) Impacts of the Conservation Reserve Program in the Great Plains—Symposium Proceedings, September 16-18, 1987. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Laycock, W.A. 1991. Stable states and thresholds of range condition on North American rangelands. Journal of Range Management 44:427-433.

Lesica, P., and P. Husby. 2006. Field Guide to Montana's Wetland Vascular Plants. Montana Wetlands Trust. Helena, MT.

Lesica, P., and T.H. DeLuca. 1996. Long-term harmful effects of crested wheatgrass on Great Plains grassland ecosystems. Journal of Soil and Water Conservation 51:408-409.

Lockwood, J.A. 2004. Locust: The devastating rise and mysterious disappearance of the insect that shaped the American frontier. Basic Books, New York, NY.

Looman, J., and D.H. Heinrichs. 1973. Stability of crested wheatgrass pastures under long-term pasture use. Canadian Journal of Plant Science 53:501-506.

Madden, E.M., R.K. Murphy, A.J. Hansen, and L. Murray. 2000. Models for guiding management of prairie bird habitat in northwestern North Dakota. American Midland Naturalist 144:377-392.

McNab, W.H., et al. 2007. Description of ecological subregions: Sections of the conterminous United States [CD-ROM]. USDA Forest Service, General Technical Report WO-76B.

McIntyre, C., K. Newlon, L. Vance, and M. Burns. 2011. Milk, Marias, and St. Mary monitoring: developing a long-term rotating basin wetland assessment and monitoring strategy for Montana. Report to the United States Environmental Protection Agency. Montana Natural Heritage Program, Helena, MT.

Miller, J.J., and J.A. Brierley. 2011. Solonetzic soils of Canada: Genesis, distribution, and classification. Canadian Journal of Soil Science 91:889-902.

Montana State College. 1949. Similar vegetative rangeland types in Montana. Montana State College, Agricultural Experiment Station.

Mushet, D.M., N.H. Euliss, Jr., and C.A. Stockwell. 2012. A conceptual model to facilitate amphibian conservation in the Northern Great Plains. Great Plains Research 22:45-58.

Nesser, J.A., G.L. Ford, C.L. Maynard, and D.S. Page-Dumroese. 1997. Ecological units of the Northern Region: Subsections. USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-369.

Oard, M.J. 1993. A method of predicting chinook winds east of the Montana Rockies. Weather and Forecasting 8:166-180.

Ogle, S.M., W.A. Reiners, and K.G. Gerow. 2003. Impacts of exotic annual brome grasses (Bromus spp.) on ecosystem properties of the northern mixed grass prairie. American Midland Naturalist 149:46-58.

Roath, L.R. 1988. Implications of land conversions and management for the future. In: J.E. Mitchell (ed.) Impacts of the Conservation Reserve Program in the Great Plains—Symposium Proceedings, September 16-18, 1987. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Rogler, G.A., and R.J. Lorenz. 1983. Crested wheatgrass: Early history in the United States. Journal of Range Management 36:91-93.

Romo, J.T. 2011. Clubmoss, precipitation, and microsite effects on emergence of graminoid and forb seedlings in the semiarid northern mixed prairie of North America. Journal of Arid Environments 75:98-105.

Rowe, J.S. 1969. Lightning fires in Saskatchewan grassland. Canadian Field Naturalist 83:317-327.

Salo, E.D., et al. 2004. Grazing intensity effects on vegetation, livestock and non-game birds in North Dakota mixed-grass prairie. Proceedings of the 19th North American Prairie Conference, Madison, WI.

Samuel, M.J., and R.H. Hart. 1994. Sixty-one years of secondary succession on rangelands of the Wyoming High Plains. Journal of Range Management 47:184-191.

Semlitsch, R.D. 2000. Principles for management of aquatic-breeding amphibians. Journal of Wildlife Management 64:615-631.

Shay, J., D. Kunec, and B. Dyck. 2001. Short-term effects of fire frequency on vegetation composition and biomass in mixed prairie in south-western Manitoba. Plant Ecology 155:157-167.

Smith, B., and G.J. McDermid. 2014. Examination of fire-related succession within the dry mixed-grass subregion of Alberta with the use of MODIS and Landsat. Rangeland Ecology and Management 67:307-317.

Smith, R.E. 2013. Conserving Montana's sagebrush highway: Long distance migration in sage-grouse. M.S. thesis, University of Montana, Missoula, MT.

Smoliak, S. 1974. Range vegetation and sheep production at three stocking rates on Stipa-Bouteloua prairie. Journal of Range Management 27:23-26.

Smoliak, S., and J.F. Dormaar. 1985. Productivity of Russian wildrye and crested wheatgrass and their effect on prairie soils. Journal of Range Management 38:403-405.

Smoliak, S., J.F. Dormaar, and A. Johnston. 1972. Long-term grazing effects on Stipa-Bouteloua prairie soils. Journal of Range Management 25:246-250.

Soil Survey Staff. 2014. Keys to soil taxonomy, 12th edition. USDA Natural Resources Conservation Service.

Soller, D.R. 2001. Map showing the thickness and character of Quaternary sediments in the glaciated United States east of the Rocky Mountains. U.S. Geological Survey Miscellaneous Investigations Series I-1970-E, scale 1:3,500,000.

Stephens, S.E., J.J. Rotella, M.S. Lindberg, M.L. Taper, and J.K. Ringelman. 2005. Duck nest survival in the

Missouri Coteau of North Dakota: Landscape effects at multiple spatial scales. Ecological Applications 15:2137-2149.

Stewart, R.E., and H.A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. No. 92. US Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

Tiner, R.W. 2003. Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Region 5, Hadley, MA. http://www.fws.gov/northeast/wetlands/pdf/CorrelatingEnhancedNWIDataWetlandFunctions WatershedAssessments[1].pdf.

Toledo, D., M. Sanderson, K. Spaeth, J. Hendrickson, and J. Printz. 2014. Extent of Kentucky bluegrass and its effect on native plant species diversity and ecosystem services in the Northern Great Plains of the United States. Invasive Plant Science and Management 7:543-552.

Umbanhowar, Jr., C.E. 2004. Interactions of climate and fire at two sites in the Northern Great Plains. Palaeogeography, Palaeoclimatology, and Palaeoecology 208:141-152.

U.S. Department of Agriculture, Natural Resources Conservation Service. Glossary of landform and geologic terms. National Soil Survey Handbook, Title 430-VI, Part 629.02c. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242 (Accessed 13 April 2016).

U.S. Fish and Wildlife Service. 2013. Greater sage-grouse (Centrocercus urophasianus) conservation objectives: Final report.

Vance, L., S. Owen, and J. Horton. 2013. Literature review: Hydrology-ecology relationships in Montana prairie wetlands and intermittent/ephemeral streams. Report to the Cadmus Group and the U.S. Environmental Protection Agency. Montana Natural Heritage Program, Helena, MT.

Van Dyne, G.M., and W.G. Vogel. 1967. Relation of Selaginella densa to site, grazing, and climate. Ecology 48:438-444.

Vaness, B.M., and S.D. Wilson. 2007. Impact and management of crested wheatgrass (Agropyron cristatum) in the northern Great Plains. Canadian Journal of Plant Science 87:1023-1028.

Vermeire, L.T., J.L. Crowder, and D.B. Wester. 2011. Plant community and soil environment response to summer fire in the northern Great Plains. Rangeland Ecology & Management 64:37-46.

Vermeire, L.T., J.L. Crowder, and D.B. Wester. 2014. Semiarid rangeland is resilient to summer fire and postfire grazing utilization. Rangeland Ecology & Management 67:52-60.

Vuke, S.M., K.W. Porter, J.D. Lonn, and D.A. Lopez. 2007. Geologic map of Montana - information booklet: Montana Bureau of Mines and Geology Geologic Map 62-D.

Wambolt, C.L., K.S. Walhof, and M.R. Frisina. 2001. Recovery of big sagebrush communities after burning in south-western Montana. Journal of Environmental Management. 61:243-252.

Watts, M.J., and C.L. Wambolt. 1996. Long-term recovery of Wyoming big sagebrush after four treatments. Journal of Environmental Management 46:95-102.

Whisenant, S.G. 1990. Postfire population dynamics of Bromus japonicus. American Midland Naturalist 123:301-308.

Wilson, S.D., and J.M. Shay. 1990. Competition, fire, and nutrients in a mixed-grass prairie. Ecology 71:1959-1967.

With, K.A. 2010. McCown's longspur (Rhynchophanes mccownii). In: A. Poole (ed.) The Birds of North America (online), Cornell Lab of Ornithology, Ithaca. http://bna.birds.cornell.edu/bna/species/09.

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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:**
