Ecological site FX053A99X700
Choppy Sandhills (CS)

Last updated: 11/22/2023
Accessed: 10/12/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 053A–Northern Dark Brown Glaciated Plains

The Northern Dark Brown Glaciated Plains, MLRA 53A, is a large, agriculturally and ecologically significant area. It consists of approximately 6.1 million acres and stretches 140 miles from east to west and 120 miles from north to south, encompassing portions of 8 counties in northeastern Montana and northwestern North Dakota. This region represents part of the southern edge of the Laurentide Ice Sheet during maximum glaciation. It is one of the driest and westernmost areas within the vast network of glacially derived prairie pothole landforms of the Northern Great Plains and falls roughly between the Missouri Coteau to the east and the Brown Glaciated Plains to the west. Elevation ranges from 1,800 feet (550 meters) to 3,300 feet (1,005 meters).

Soils are primarily Mollisols, but Inceptisols and Entisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). The bedrock is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur in glacial outwash channels and along major drainages, including portions of the Missouri, Poplar, and Big Muddy Rivers. Large eolian deposits of sand occur in the vicinity of the ancestral Missouri River channel east of Medicine Lake (Fullerton et al., 2004). The northwestern portion of the MLRA contains a large unglaciated area containing paleoterraces and large deposits of sand and gravel known as the Flaxville gravel.

Much of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton and Colton, 1986; Fullerton et al., 2004). Subsequent erosion from major stream and river systems has created numerous drainageways throughout much of the MLRA. The result is a geologically young landscape that is predominantly a dissected till plain interspersed with alluvial deposits and dominated by soils in the Mollisol and Inceptisol orders. Much of this area is typic ustic, making these soils very productive and generally well suited to production agriculture.

Dryland farming is the predominant land use, and approximately 50 percent of the land area is used for cultivated crops. Winter, spring, and durum varieties of wheat are the major crops, with over 48 million bushels produced annually (USDA-NASS, 2017). Areas of rangeland typically are on steep hillslopes along drainages. The rangeland is mostly native mixed-grass prairie similar to the Stipa-Agropyron, Stipa-Bouteloua-Agropyron, and Stipa-Bouteloua faciations (Coupland, 1950, 1961). Cool-season grasses dominate and include rhizomatous wheatgrasses, needle and thread, western porcupine grass, and green needlegrass. Woody species are generally rare; however, many of the steeper drainages support stands of trees and shrubs such as green ash and chokecherry. Seasonally ponded, prairie pothole wetlands may occur throughout the MLRA, but the greatest concentrations are in the east and northeast where receding glaciers stagnated and formed disintegration moraines with hummocky topography and numerous areas of poorly drained soils.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 053A Northern Dark Brown Glaciated Plains

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)
• Domain: Dry
• Division: Temperate Steppe
• Province: Great Plains-Palouse Dry Steppe Province 331
• Section: Glaciated Northern Grasslands Section 331L
• Subsection: Glaciated Northern Grasslands Subsection 331La
• Landtype association/Landtype phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Mesomorphic Shrub and Herb Vegetation Class (2)
o Subclass: Temperate and Boreal Grassland and Shrubland Subclass (2.B)
 Formation: Temperate Grassland and Shrubland Formation (2.B.2)
• Division: Central North American Grassland and Shrubland Division (2.B.2.Nb)

o Macrogroup: *Andropogon hallii* - *Calamovilfa longifolia* - Artemisia filifolia Great Plains Sand Grassland & Shrubland Macrogroup
 Group: *Andropogon hallii* - *Calamovilfa longifolia* - *Hesperostipa comata* Sand Grassland Group
• Alliance: *Andropogon hallii* Sand Prairie Alliance
• Alliance: *Calamovilfa longifolia* Sand Prairie Alliance

o 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: Prunus virginiana - *Symphoricarpos occidentalis* - Amelanchier alnifolia Great Plains Shrubland Alliance

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: Glaciated Dark Brown Prairie (42i)
Glaciated Northern Grasslands (42j)

Ecological site concept

This provisional ecological site is limited to areas of wind-deposited sediments in MLRA 53A. Choppy Sandhills is an ecological site of limited extent occurring in areas of wind-transported sands, known as eolian sands. This site is characterized by an undulating, dynamic landscape of dunes or dune fields. Soils typically contain more than 70 percent sand and have little or no development. Characteristic vegetation is Indian ricegrass (Achnatherum hymenoides), lemon scurfpea (Psoralidium lanceolatum), various bunchgrasses, chokecherry (Prunus virginiana), and western snowberry (*Symphoricarpos occidentalis*).

Associated sites

FX053A99X110	**Sandy (Sy)** This site occurs on alluvial deposits adjacent to the Choppy Sandhills ecological site. It is generally on outwash fans, alluvial fans, or terraces whereas the Choppy Sandhills ecological site is on eolian sands.

Similar sites

FX053A99X110	**Sandy (Sy)** This site differs from the Choppy Sandhills ecological site in that it is not derived from eolian sands and its soils typically contains less than 70 percent sand.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Calamovilfa longifolia* (2) *Sporobolus cryptandrus*

Legacy ID

R053AY700MT

Physiographic features

The Choppy Sandhills ecological site occurs in areas of eolian sand dunes. Sand dunes, predominantly parabolic forms, are common landforms on the Northern Great Plains. Most areas of these dunes are stable, although small areas of active dunes occur (Muhs and Wolfe, 1999). This ecological site occurs on dunes, interdunes, and sand plains in dune fields. Slopes are highly variable and range from 0 to 60 percent.

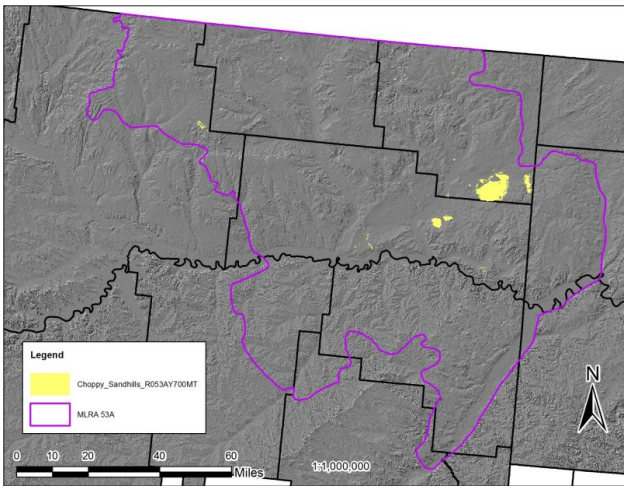


Figure 1. General distribution of the Choppy Sandhills ecological site by map unit extent.

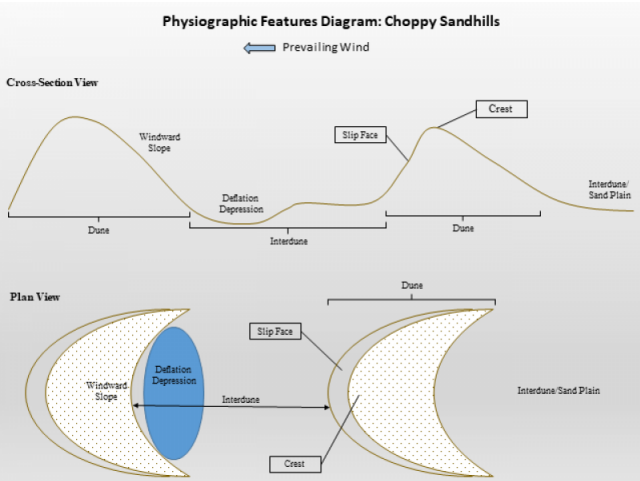


Figure 2. Diagram of physiographic features.

Table 2. Representative physiographic features

Landforms	(1) Dune field > Dune (2) Dune field > Interdune (3) Sand plain
Flooding frequency	None
Ponding frequency	None

Elevation	1,800–3,300 ft
Slope	0–60%
Aspect	Aspect is not a significant factor

Climatic features

The Northern Dark Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Coupland, 1958; Richardson and Hanson, 1977; Heidel et al., 2000). The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Summer rainfall comes mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Approximately 80 percent of the annual precipitation occurs during the growing season. June is the wettest month, followed by July and May (Richardson and Hanson, 1977; Heidel et al., 2000). Average annual precipitation ranges from 11 inches (280 mm) near Richey, Montana, to 15 inches (380 mm) in the Little Muddy drainage near Williston, North Dakota, but precipitation varies greatly from year to year. On average, severe drought and very wet years occur with the same frequency, which is 1 out of 10 years (Coupland, 1958; Heidel et al., 2000). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). The frost-free period for this ecological site ranges from 90 to 130 days, and the freeze-free period ranges from 115 to 155 days.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-130 days
Freeze-free period (characteristic range)	115-155 days
Precipitation total (characteristic range)	11-15 in
Frost-free period (average)	110 days
Freeze-free period (average)	135 days
Precipitation total (average)	13 in

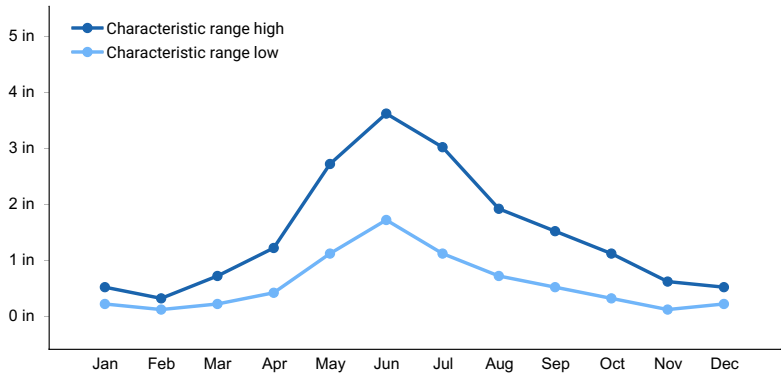


Figure 3. Monthly precipitation range

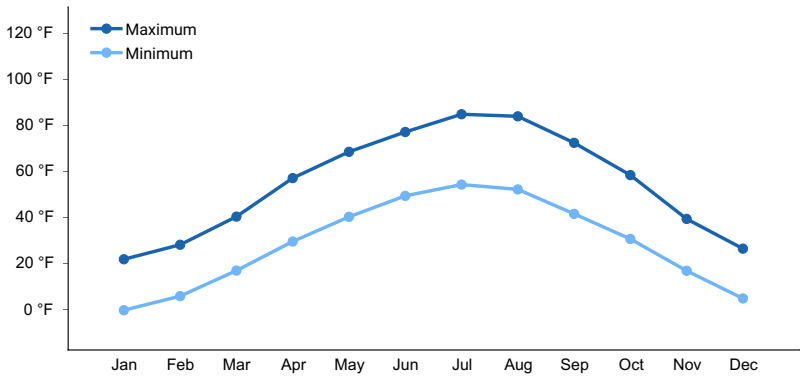


Figure 4. Monthly average minimum and maximum temperature

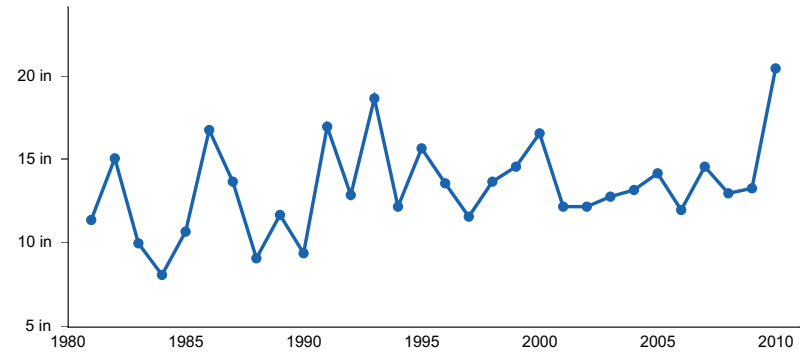


Figure 5. Annual precipitation pattern

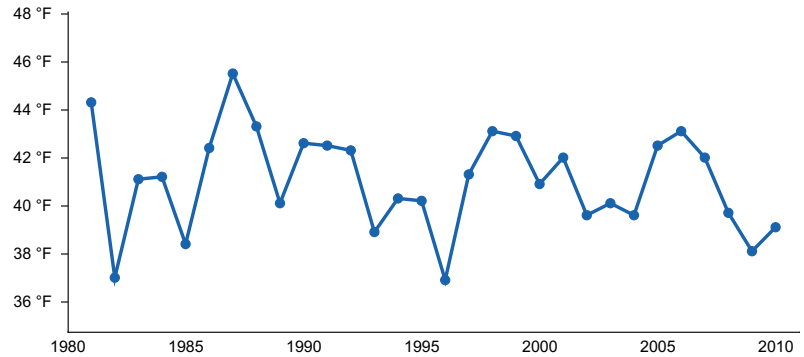


Figure 6. Annual average temperature pattern

Climate stations used

- (1) BREDETTE [USC00241088], Poplar, MT
- (2) CULBERTSON [USC00242122], Culbertson, MT
- (3) OPHEIM 10 N [USC00246236], Opheim, MT
- (4) OPHEIM 12 SSE [USC00246238], Opheim, MT
- (5) PLENTYWOOD [USC00246586], Plentywood, MT
- (6) SCOBEY 4 NW [USC00247425], Scobey, MT
- (7) SIDNEY [USC00247560], Sidney, MT
- (8) VIDA 6 NE [USC00248569], Vida, MT
- (9) WILLISTON SLOULIN INTL AP [USW00094014], Williston, ND

Influencing water features

This is an upland ecological site with soils that have a very high sand content, a low water-holding capacity, and high infiltration rates. Water is able to flow freely through the soil profile to lower areas on the landscape, but typically this does not create a water table. Some portions of this site are considered important recharge areas for local aquifers. These aquifers are too deep to directly influence the ecological site, but they are important water sources for irrigation and livestock water. Moisture loss exceeds precipitation for the majority of the growing season,

and soil moisture is the primary limiting factor for plant production on this ecological site.

Soil features

The soil series that best represents the central concept of this ecological site is Blanchard. This soil is in the Ustipsamments great group and is characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon and by textures of loamy fine sand or coarser in all layers. It is derived from eolian sand parent material, has mixed minerology, and has a sand content of 90 to 100 percent. The soil moisture regime for all soils in this ecological site concept is typic ustic, which means that the soils are moist in some or all parts for either 180 cumulative days or 90 consecutive days during the growing season but are dry in some or all parts for over 90 cumulative days. These soils have a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface horizon textures on this site are typically sand or loamy sand and contain 90 to 100 sand. The underlying horizons typically contain 95 to 100 percent sand and have coarse sand, sand, or fine sand textures. Organic matter content in the surface horizon typically ranges from 0.5 to 1.5 percent, and moist colors vary from dark brown (10YR 3/2) to grayish brown (10YR 5/2). Calcium carbonate equivalent ranges from 0 to 5 percent in the surface horizon and 0 to 15 percent in the underlying horizons. Soil pH classes are neutral to slightly alkaline in the surface horizon and neutral to strongly alkaline in the subsurface horizons. The soil depth class for this site is typically deep or very deep (more than 40 inches to bedrock). Content of coarse fragments in the upper 20 inches of soil is less than 35 percent and typically less than 5 percent.

Table 4. Representative soil features

Parent material	(1) Eolian sands
Surface texture	(1) Sand (2) Loamy sand
Family particle size	(1) Sandy
Drainage class	Excessively drained
Soil depth	40–72 in
Available water capacity (0-40in)	2.8–4 in
Calcium carbonate equivalent (0-5in)	0–5%
Electrical conductivity (0-20in)	0–3 mmhos/cm
Sodium adsorption ratio (0-20in)	0–12
Soil reaction (1:1 water) (0-40in)	6.6–9
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), 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 Choppy Sandhills provisional ecological site in MLRA 53A consists of four states: the Historic Reference State (1), the Contemporary Reference State (2), the Destabilized State (3), and the Invaded State (4). This ecological site occurs in an eolian, sand dune ecosystem and thus is influenced heavily by dune evolution and dune

morphology. Dunes in the Great Plains typically have a parabolic morphology; the dunes are crescent shaped with a steep face (known as the slip face) on the downwind side, a deflation depression on the upwind side, and two wings extending upwind on either end. Because dune evolution is largely driven by climatic factors, this ecological site is inherently sensitive to small shifts in climate (Muhs and Wolfe, 1999; Wolfe and Lemmen, 1999). Drought reduces vegetative cover and can result in localized blowouts, particularly on windward slopes. Severe drought may trigger widespread dune activity at a local or even regional scale, whereas moister climatic cycles result in revegetation and stabilization of dunes (Wolfe et al., 2001). Evidence suggests that periods of widespread dune activity occurred in the 1800s, whereas much of the area has been restabilizing in the 20th century, likely due to climatic variations (Wolfe et al., 2001).

Plant communities are diverse and typically vary depending on dune morphology and the degree of site stability (Heidel et al., 2000; Coenen and Bentz, 2003). Areas of active blowouts will be colonized by pioneering species such as Indian ricegrass, prairie sandreed (*Calamovilfa longifolia*), and lemon scurfpea. When these areas begin to stabilize, bunchgrasses such as sand bluestem (*Andropogon hallii*) and needle and thread (*Hesperostipa comata*) will begin to colonize the site. Shrubs will establish on the most stable sites, but species will depend on the position on the dune and available soil moisture.

The historic ecosystem experienced periodic lightning-caused fires, with estimated fire return intervals of 6 to 25 years (Bragg, 1995). Historically, Native Americans also set periodic fires. The majority of lightning-caused fires occurred in July and August, whereas Native Americans typically set fires during spring and fall to correspond with the movement of bison (Higgins, 1986). The precise effects of fire on this ecological site are not well known. Plant communities associated this ecological site are generally resilient to fire, but it is largely unknown how fire affects the stability of the site. Further study is need to assess the role of fire on this ecological site.

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. Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus) also played an important role in the ecology of these communities (Lockwood, 2004). In general, this ecological site was resilient to light grazing, but localized areas may have experienced destabilization due to heavy grazing.

Following European settlement, fire was largely eliminated, domestic livestock replaced native ungulates as the primary grazers, and non-native species were introduced to the ecosystem. Aside from drought, livestock grazing and mechanized disturbances, such as vehicle traffic, are now the principle disturbances on the landscape.

Improper grazing of this site can result in a reduction in vegetation cover and increased wind erosion in localized areas. 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. Mechanical disturbances, such as heavy vehicle traffic or excavations, may also cause localized blowouts. Further degradation of the site due to improper grazing can result in a destabilized state, where stable vegetation is unable to persist and active soil movement becomes widespread.

Most, if not all, extant examples of this site have some degree of invasion by non-native species. Non-native grasses such as crested wheatgrass (*Agropyron cristatum*) are the most common invasive species. Seeding introduced grasses, particularly crested wheatgrass, was a common practice in eroded and abandoned agricultural areas after the droughts of the 1930s. Crested wheatgrass can invade relatively undisturbed grasslands, reducing cover and production of native cool-season midgrasses (Heidinga and Wilson, 2002; Henderson and Naeth, 2005). In most cases native ecological function is relatively intact, but in some cases non-native grasses will displace native species and dominate the ecological functions of the site.

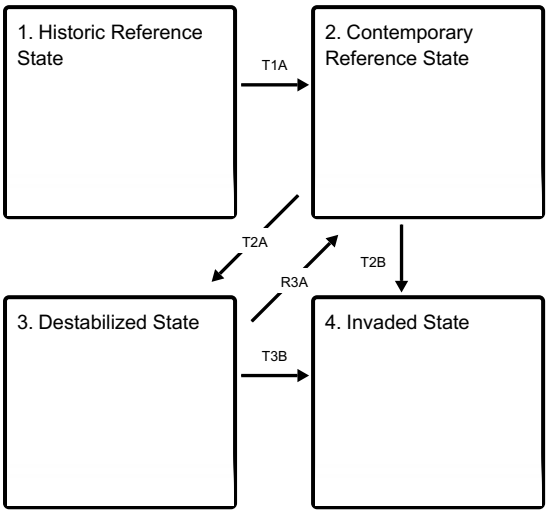
Due to the undulating topography, a very low water-holding capacity, and the extreme sensitivity to disturbance, this ecological site is generally not suitable for cropland. In general, this site has not been converted to cropland and has remained in native vegetation.

The state-and-transition model (STM) suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before

prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State and transition model

Ecosystem states



T1A - Introduction of non-native grass species, such crested wheatgrass.

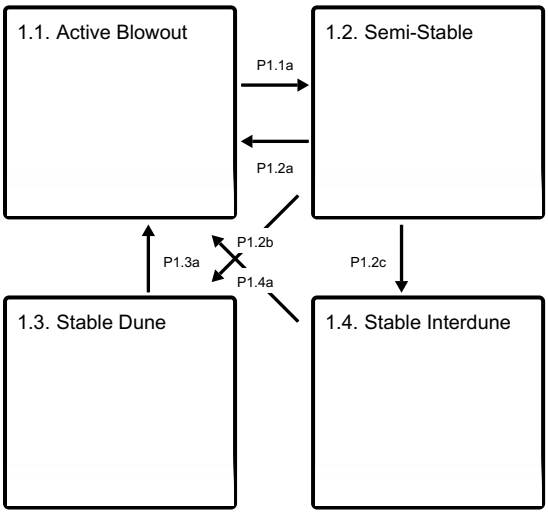
T2A - Improper grazing management, warmer and drier climatic conditions.

T2B - Displacement of native species by non-native invasive species (Crested Wheatgrass, noxious weeds, etc.)

R3A - Critical area seeding, proper grazing management (management intensive and costly); or cooler, moister climatic conditions

T3B - Recolonization of site by non-native species (Crested Wheatgrass, noxious weeds, etc.)

State 1 submodel, plant communities



P1.1a - Recolonization by perennial plants and soil entrapment

P1.2a - Localized disturbance, such as heavy grazing, or short-term drought

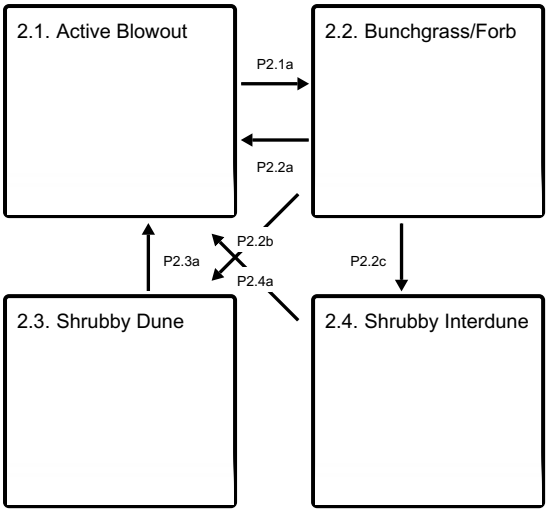
P1.2b - Establishment of stable woody vegetation and site stabilization of dune faces

P1.2c - Establishment of stable woody vegetation and site stabilization of interdunes

P1.3a - Localized disturbance, short term drought

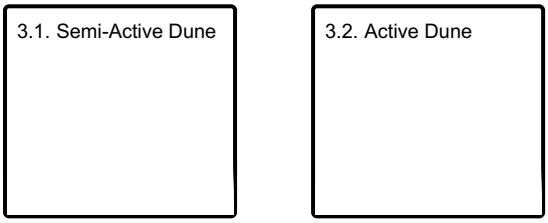
P1.4a - Localized disturbance, short term drought

State 2 submodel, plant communities

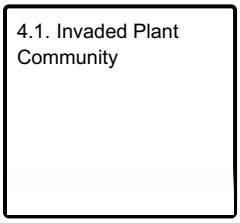


P2.1a - Recolonization by perennial plants and soil entrapment
P2.2a - Localized disturbance (i.e. fire, improper grazing, mechanical disturbance), drought
P2.2b - Establishment of stable woody vegetation and site stabilization of dune faces
P2.2c - Establishment of stable woody vegetation and site stabilization of interdunes
P2.3a - Localized disturbance (i.e. fire, improper grazing, mechanical disturbance), drought
P2.4a - Localized disturbance (i.e. fire, improper grazing, mechanical disturbance), drought

State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Historic Reference State

The Historic Reference State (1) contains four plant communities characterized by predominantly climate-driven eolian processes. This state is considered extinct and is included here for historical reference purposes. It evolved under the combined influences of climate, grazing, and fire (with climatic variation having the greatest influence on site stability, dune evolution, and vegetative cover). It is hypothesized that fire reduced shrub cover in this state. Most community phases in this state were resilient to light grazing, although localized areas may have experienced destabilization due to heavy grazing.

Community 1.1
Active Blowout

The Active Blowout (1.1) was characterized by localized instability and soil movement. This phase typically occurred in small areas on the windward side of otherwise stable dunes. Vegetation cover was sparse and dominantly consisted of pioneering species such as Indian ricegrass, prairie sandreed, and lemon scurfpea. At a localized scale, bare ground and soil movement were common.

Community 1.2
Semi-Stable

The Semi-Stable (1.2) was characterized by the recolonization of the site by bunchgrasses and forbs. This phase occurred in relatively stable areas on sand plains, on the windward side of dunes, or in interdune areas. The site was mostly covered by vegetation and was moderately stable. Grasses were predominantly bunchgrasses such as sand bluestem, sand dropseed (*Sporobolus cryptandrus*), and needle and thread. Forbs such as lemon scurfpea were also common. Shrubs were rare, but some species, particularly rose (Rosa spp.), were beginning to establish.

Community 1.3
Stable Dune

The Stable Dune (1.3) was characterized by high vegetative cover and predominantly stable soils. This phase typically occurred on stabilized slip faces or the leeward edges of the dune crest. Common grasses were sand dropseed and needle and thread. Lemon scurfpea was also common. Deep-rooted shrubs, particularly chokecherry, were common, comprising up to 40 percent of the cover.

Community 1.4
Stable Interdune

The Stable Interdune (1.4) was characterized by high vegetative cover and predominantly stable soils. This phase typically occurred on stabilized interdunes, particularly in deflation depressions, and was typically at the lowest position on the landscape. The predominant grass species was sand dropseed, but numerous other grass species occurred as well. Common forbs were American licorice (*Glycyrrhiza lepidota*) and field sagewort (*Artemisia campestris*). Shrub cover was up to 60 percent and was predominantly western snowberry (*Symphoricarpos occidentalis*) and Wood's rose (*Rosa woodsii*).

Pathway P1.1a
Community 1.1 to 1.2

Recolonization of the site by perennial plants and soil entrapment transitions the Active Blowout (1.1) to the Semi-Stable (1.2).

Pathway P1.2a
Community 1.2 to 1.1

Localized disturbance, such as heavy grazing, or short-term drought transitions the Semi-Stable (1.2) back to the Active Blowout (1.1).

Pathway P1.2b
Community 1.2 to 1.3

Establishment of stable woody vegetation and site stabilization transition the Semi-Stable (1.2) to the Stable Dune (1.3). This transition occurs on dune slopes, particularly leeward slip faces.

Pathway P1.2c
Community 1.2 to 1.4

Establishment of stable woody vegetation and site stabilization transition the Semi-Stable (1.2) to the Stable Interdune (1.4). This transition occurs on interdunes, particularly in deflation depressions.

Pathway P1.3a
Community 1.3 to 1.1

Localized disturbance, such as fire or heavy grazing, or short-term drought transitions the Stable Dune (1.3) back to the Active Blowout (1.1).

Pathway P1.4a
Community 1.4 to 1.1

Localized disturbance, such as fire or heavy grazing, or short-term drought transitions the Stable Interdune (1.4) back to the Active Blowout (1.1).

State 2
Contemporary Reference State

The Contemporary Reference State (2) contains four plant communities characterized by predominantly climate-driven eolian processes. Evidence suggests that climatic variation has the greatest influence on site stability, dune evolution, and vegetative cover and that this site is sensitive to small shifts in climate (Muhs and Wolfe, 1999; Wolfe and Lemmen, 1999). This state is considered representative of dominant climate patterns of the last 100 to 150 years, which generally have induced dune stabilization in the Northern Great Plains throughout the 20th century (Wolfe et al., 2001). This state differs from the Historic Reference State in that it is influenced by introduced plant species and has altered fire and grazing regimes. It is hypothesized that this state may have greater shrub cover due to the elimination of fire. In general, this state is resilient to light grazing, although grazing can influence site stability in localized areas. Non-native species, predominantly crested wheatgrass, typically comprise less than 10 percent of the plant community in this state.

Community 2.1
Active Blowout

The Active Blowout (2.1) is characterized by localized instability and soil movement, which may be induced by drought or management practices. This phase typically occurs in small areas on the windward side of otherwise stable dunes. Bare ground and soil movement are common, as evidenced by wind scouring and the formation of plant pedestals. Vegetation cover is sparse and dominantly pioneering species such as Indian ricegrass, prairie sandreed, and lemon scurfpea.

Community 2.2
Bunchgrass/Forb

The Bunchgrass/Forb (2.2) is characterized by the recolonization of the site by grasses and forbs. This phase occurs on sand plains, on the windward side of dunes, or in interdune areas where vegetative cover is increased and soils are relatively stable. Some soil movement may still occur, but vegetative cover is sufficient to prevent active blowouts. Grasses are predominantly bunchgrasses such as sand bluestem, sand dropseed, and needle and thread, although rhizomatous species such as prairie sandreed may also occur. Forbs such as lemon scurfpea and field sagewort and the cactus fragile prickly pear (*Opuntia fragilis*) are also common. Shrubs are typically rare or absent, but rose and chokecherry may occur on some sites. The following table shows approximate plant community composition by functional group and the predominant species within each group. Percent composition by weight* Bunchgrasses - 45-55% Needle and Thread Sand Dropseed Sand Bluestem Indian Ricegrass Rhizomatous Grasses - 5-15% Prairie Sandreed Native Forbs - 30-35% Lemon Scurfpea Field Sagewort Shrubs/Cactus - 1-5% Rose Chokecherry Fragile Prickly Pear Non-native species 1-10% Estimated Total Annual Production (lbs./ac)* Low - Insufficient Data Representative Value - 850 High - Insufficient Data * Estimated based on current data – subject to revision

Community 2.3
Shrubby Dune

The Shrubby Dune (2.3) is characterized by predominantly stable soils and a high cover of shrubs, particularly chokecherry. This phase typically occurs on stabilized slip faces or the leeward edges of dune crests. Soil movement is minimal due to the robust vegetative cover and the sheltered topographic position. Predominant grasses are sand dropseed and needle and thread, but prairie sandreed and Indian ricegrass may also occur. Common forbs are lemon scurfpea, hairy false goldenaster (*Heterotheca villosa*), and field sagewort. Shrub cover ranges from 20 to 40 percent and includes chokecherry, golden currant (*Ribes aureum*), and western snowberry. The following table shows approximate plant community composition by functional group and the predominant species within each group. Percent composition by weight* Bunchgrasses - 25-35% Sand Dropseed Needle and

Thread Indian Ricegrass Rhizomatous Grasses - 0-10% Prairie Sandreed Forbs - 10-20% Lemon Scurfpea Hairy False Goldenaster Field Sagewort Shrubs - 40-50% Chokecherry Golden Currant Western Snowberry Non-native species - 1-10% Estimated Total Annual Production (lbs./ac)* Low - Insufficient Data Representative Value - 1000 High - Insufficient Data * Estimated based on current data – subject to revision

Community 2.4
Shrubby Interdune

The Shrubby Interdune (2.4) is characterized by predominantly stable soils and a high cover of shrubs, particularly western snowberry. This phase typically occurs in stabilized areas in between dunes, typically at the lowest position on the landscape. Soil movement is minimal due to the robust vegetative cover and the sheltered topographic position. The predominant grass is sand dropseed, but western wheatgrass and sedges may also occur. Common forbs are American licorice and field sagewort. Shrub cover ranges from 30 to 60 percent and includes western snowberry and Woods' rose. The following table shows approximate plant community composition by functional group and the predominant species within each group. Percent composition by weight* Graminoids - 20-30% Sand Dropseed Western Wheatgrass Sedges Forbs - 10-20% American Licorice Field Sagewort Shrubs - 50-60% Western Snowberry Woods' Rose Non-native species - 1-10% Estimated Total Annual Production (lbs./ac)* Low - Insufficient Data Representative Value - 1300 High - Insufficient Data *Estimated based on current data – subject to revision

Pathway P2.1a
Community 2.1 to 2.2

Recolonization of the site by perennial plants and soil entrapment transition the Active Blowout (2.1) to the Bunchgrass/Forb (2.2).

Pathway P2.2a
Community 2.2 to 2.1

Localized disturbance (i.e., fire, improper grazing, or mechanical disturbance) or drought transitions the Bunchgrass/Forb (2.2) back to the Active Blowout (2.1).

Pathway P2.2b
Community 2.2 to 2.3

Establishment of stable woody vegetation and site stabilization transition the Bunchgrass/Forb (2.2) to the Shrubby Dune (2.3). This transition occurs on dune slopes, particularly leeward slip faces.

Pathway P2.2c
Community 2.2 to 2.4

Establishment of stable woody vegetation and site stabilization transition the Bunchgrass/Forb (2.2) to the Shrubby Interdune (2.4). This transition occurs on interdunes, particularly in deflation depressions.

Pathway P2.3a
Community 2.3 to 2.1

Localized disturbance, such as fire or heavy grazing, or short-term drought transitions the Stable Dune (2.3) back to the Active Blowout (2.1).

Pathway P2.4a
Community 2.4 to 2.1

Localized disturbance (i.e., fire, improper grazing, or mechanical disturbance) or drought transitions the Shrubby Interdune (2.4) back to the Active Blowout (2.1).

State 3
Destabilized State

The Destabilized State (3) consists of two plant communities. The dynamics of this state are driven by long-term drought, improper grazing management, or a combination of these factors. Evidence suggests that landscape-scale destabilization and reactivation of dunes are largely due to warmer and drier climatic conditions (Muhs and Wolfe, 1999; Wolfe et al., 2001). Removal of vegetation due to improper grazing, particularly when it occurs over multiple years and on a widespread scale, may also destabilize the site.

Community 3.1
Semi-Active Dune

The Semi-Active Dune (3.1) occurs when site conditions decline due to drought, improper grazing, or a combination of these factors. Vegetative cover is reduced, exposing soil to wind erosion and resulting in site instability. Blowouts are common, and the site becomes of mosaic of areas of moving sand and pockets of vegetation. Vegetation is predominantly pioneering species such as prairie sandreed and lemon scurfpea.

Community 3.2
Active Dune

The Active Dune (3.2) occurs when site conditions destabilize due to long-term climatic shifts. Extended periods of warmer, drier climate trigger reactivation of dunes on a landscape or even regional scale, and dune activity may persist for many decades. The most recent known occurrence of this phenomenon took place approximately 220 years ago. Below average precipitation for much of the 1700s triggered reactivation of dunes in the northern Great Plains that persisted for approximately 80 years (Wolfe et al., 2001).

State 4
Invaded State

The Invaded State (4) occurs when invasive plant species invade adjacent native grassland communities and displace the native species. Data suggest that the diversity of native species declines significantly when invasive species exceed 30 percent of the plant community. Crested wheatgrass has been planted on an estimated 20 million acres in the western U.S. since the 1930s (Holechek, 1981) and is the greatest concern on this ecological site. It is extremely drought tolerant, establishes readily on a variety of soil types, has high seedling vigor, and can dominate the seedbank of invaded grasslands (Rogler and Lorenz, 1983; Henderson and Naeth, 2005). Invasive grass species can invade relatively undisturbed grasslands, but it is not clear precisely what triggers them to displace native species. Reduced plant species diversity, simplified structural complexity, and altered biologic processes result in a state that is substantially departed from both the Reference State (1) and the Contemporary Reference State (2). Noxious weeds such as leafy spurge are not widespread in MLRA 53A, but they can be a concern on this ecological 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 Contemporary Reference State (2). However, cessation of control methods will most likely result in recolonization of the site by the noxious species.

Community 4.1
Invaded Plant Community

Encroachment by introduced grasses, noxious weeds, and other invasive species is common. Rangeland health attributes have departed substantially from both the Reference State (1) and the Contemporary Reference State (2).

Transition T1A
State 1 to 2

Introduction of non-native grass species occurred in the early 20th century. The naturalization of these species in relatively undisturbed grasslands, coupled with changes in fire and grazing regimes, transitions the Reference State

(1) to the Contemporary Reference State (2).

Transition T2A
State 2 to 3

Improper grazing management can weaken the resilience of the Contemporary Reference State (2) and drive its transition to the Destabilized State (3). A shift to warmer, drier climatic conditions will also trigger the transition to the Destabilized State (3). The Contemporary Reference State (2) transitions to the Destabilized State (3) when soil loss exceeds vegetative recovery and dune activity reactivates on a larger scale.

Transition T2B
State 2 to 4

The Contemporary Reference State (2) transitions to the Invaded State (4) when aggressive perennial grasses or noxious weeds displace native species and dominate the site. The most common concern is crested wheatgrass, which is a widespread invasive species in the Northern Great Plains (Heidinga and Wilson, 2002; Henderson and Naeth, 2005). The precise triggers of this transition are not clear, and further investigation is required. In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered.

Restoration pathway R3A
State 3 to 2

A reduction in livestock grazing pressure alone may not be sufficient to reestablish stable vegetative cover in the Destabilized State (3). Intensive management such as critical area seedings may be necessary, but these practices are labor intensive and costly. In some cases, a shift to cooler, drier climate conditions may be required to facilitate a return the Contemporary Reference State (2). Returning the Destabilized State (3) may require considerable energy and cost and may not be feasible within a reasonable amount of time.

Conservation practices

Critical Area Planting
Prescribed Grazing

Transition T3B
State 3 to 4

The Destabilized State (3) transitions to the Invaded State (4) when aggressive perennial grasses or noxious weeds displace native species and dominate the site. The most common concern is crested wheatgrass, which is a widespread invasive species in the Northern Great Plains (Heidinga and Wilson, 2002; Henderson and Naeth, 2005). The precise triggers of this transition are not clear, and further investigation is required. In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered.

Additional community tables

Inventory data references

Data for this provisional ecological site was obtained from three low-intensity plots. These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for the Contemporary Reference State (2). 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.

Other references

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.

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.

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.

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.

Coenen, V., and J. Bentz. 2003. Plant community classification of the Pakowki Sandhills and Sandplains. Report to the Resource Data Division of Alberta Sustainable Resource Development. Geowest Environmental Consultants Ltd., Edmonton, Alberta, Canada.

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.

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.

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., S. Smoliak, and W.D. Willms. 1990. Soil chemical properties during succession from abandoned cropland to native range. Journal of Range Management 43:260-265.

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.

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

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.

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.

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

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

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.

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

Muhs, D.R., and S.A. Wolfe. 1999. Sand dunes of the northern Great Plains of Canada and the United States. In: D.S. Lemmen and R.E. Vance (eds.) Holocene Climate and Environmental Change in the Palliser Triangle: A Geoscientific Context for Evaluating the Impacts of Climate Change on the Southern Canadian Prairies. Geological Survey of Canada Bulletin 534, pp. 183-197.

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.

Richardson, R.E., and L.T. Hanson. 1977. Soil survey of Sheridan County, Montana. USDA Soil Conservation Service, Bozeman, MT.

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., and Y. Bai. 2004. Seedbank and plant community composition, Mixed Prairie of Saskatchewan. Journal of Range Management 57:300-304.

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.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils. Version 3.0. USDA Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

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.

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.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2017. Montana Annual Bulletin, Volume LIV, Issue 1095-7278. https://www.nass.usda.gov/Statistics_by_State/Montana/Publications/Annual_Statistical_Bulletin/2017/Montana_Annual_Bulletin_2017.pdf (Accessed 14 February 2017).

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).

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 and 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 and 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.

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

Wolfe, S.A., and D.S. Lemmen. 1999. Monitoring of dune activity in the Great Sand Hills region, Saskatchewan. In: D.S. Lemmen and R.E. Vance (eds.) Holocene Climate and Environmental Change in the Palliser Triangle: A Geoscientific Context for Evaluating the Impacts of Climate Change on the Southern Canadian Prairies. Geological Survey of Canada, Bulletin 534, pp. 199-210.

Wolfe, S.A., et al. 2001. Late 18th century drought-induced sand dune activity, Great Sand Hills, Saskatchewan. Canadian Journal of Earth Sciences 38:105-117.

Contributors

Scott Brady
Stuart Veith

Approval

Kirt Walstad, 11/22/2023

Acknowledgments

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

Soil Concepts, Soils Information, and Field Descriptions
Charlie French, USDA-NRCS (retired)
Steve Sieler, USDA-NRCS

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

Peer Review
Kirt Walstad, USDA-NRCS
Mark Hayek, USDA-NRCS
Kami Kilwine, USDA-NRCS
Robert Mitchell, USDA-NRCS

Editing
Jenny Sutherland, USDA-NRCS

Quality Control
Kirt Walstad, USDA-NRCS

Quality Assurance
Stacey Clark, USDA-NRCS

Preceding Version: U.S. Department of Agriculture, Soil Conservation Service - Montana. 1981. Technical Range Site Description. Sands 10 to 14 inch p.z. Eastern Glaciated Plains. Field Office Technical Guide Section II-E-8

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	10/12/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

   _____

2. **Presence of water flow patterns:**

   _____

3. **Number and height of erosional pedestals or terracettes:**

   _____

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

   _____

5. **Number of gullies and erosion associated with gullies:**

   _____

6. **Extent of wind scoured, blowouts and/or depositional areas:**

   _____

7. **Amount of litter movement (describe size and distance expected to travel):**

   _____

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

   _____

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

   _____

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

    _____

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

    _____

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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

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

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

17. **Perennial plant reproductive capability:**