

Ecological site FX052X03X131 Shallow Clay (Swc) Dry Shrubland

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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.

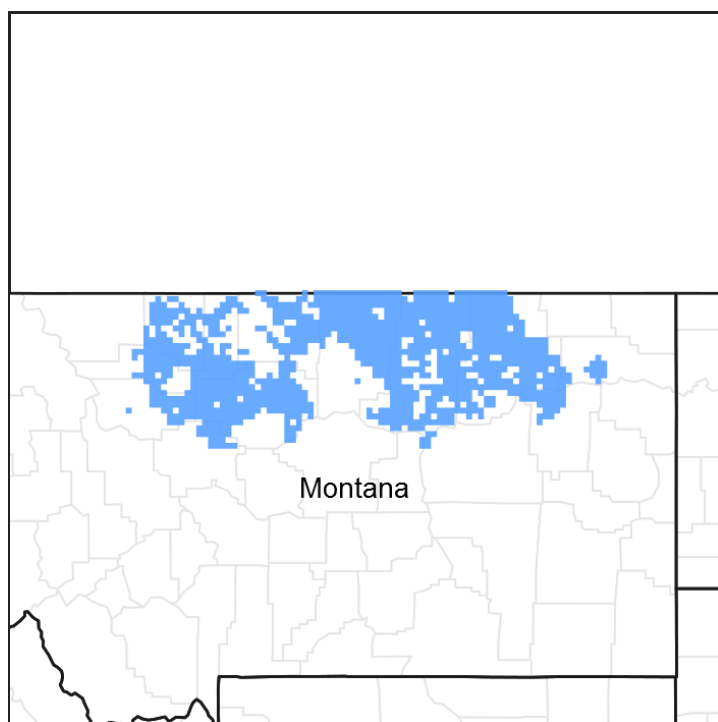


Figure 1. Mapped extent

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 sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007) is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, with the maximum glacial extent occurring 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 the 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 Illinoian age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic-ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The dry shrubland zone represents the northernmost extent of the big sagebrush (*Artemisia tridentata*) steppe on the Great Plains. 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 yet fully understood.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and

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

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

Classification relationships

NRCS Soil Geography Hierarchy

- Land Resource Region: Northern Great Plains
- Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
- Climate Zone: Dry Shrubland

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: Xeromorphic Woodland, Scrub and Herb Vegetation Class (3)
- Subclass: Cool Semi-Desert Scrub and Grassland Subclass (3.B)
- Formation: Cool Semi-Desert Scrub and Grassland Formation (3.B.1)
- Division: Cool Semi-Desert Scrub and Grassland Division (3.B.1.Ne)
- Macrogroup: *Artemisia tridentata* - *Artemisia tripartita* ssp. *tripartita* - *Purshia tridentata* Steppe and Shrubland Macrogroup (3.B.1.Ne.3)
- Group: *Artemisia tridentata* - *Artemisia tripartita* - *Purshia tridentata* Big Sagebrush Steppe and Shrubland Group (3.B.1.Ne.3.b)
- Alliance: *Artemisia tridentata* ssp. *wyomingensis* Mesic Steppe and Shrubland Alliance
- Association: *Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii* Shrub Grassland or *Artemisia tridentata* ssp. *wyomingensis* / *Pseudoroegneria spicata* Shrub

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) and Glaciated Northern Grasslands (42j)

Ecological site concept

This provisional ecological site occurs in the Dry Shrubland 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. Shallow Clay Dry Shrubland is a moderately extensive ecological site occurring on most landscapes in MLRA 52. This ecological site occurs on hillslopes, badlands, and bluffs where soils are less than 20 inches deep and have a clay content greater than 35 percent. Slopes vary from 0 to 60 percent, but are typically greater than 15 percent.

The distinguishing characteristics of this site are lithic or paralithic bedrock less than 20 inches from the soil surface and a clay content of greater than 35 percent. Soils are derived from clayey residuum, or clayey alluvium over shale. Soil surface textures (upper 4 inches) contain more than 35 percent clay. Underlying horizons are typically weakly developed and commonly contain shale fragments. Calcium carbonate equivalent is typically less than 5 percent, but may be up to 15 percent in some cases. This site is nonacid, with pH values greater than 5.6 throughout the soil profile. Vegetation is typically sparse and soil exposure relatively high. Characteristic vegetation is western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), and Wyoming big sagebrush (*Artemisia tridentata* subsp. *wyomingensis*).

Preliminary studies indicate that there may also be an acid variant of this site. This variant appears to exhibit retarded shrub growth, reduced cover of cool season bunchgrasses, and increased cover of creeping juniper and prairie sandreed. At this time, this variant cannot be consistently identified as a separate ecological site concept and further investigation is required.

Associated sites

FX052X03X001	<p>Clayey (Cy) Dry Shrubland</p> <p>This site is generally upslope from the Shallow Clay Dry Shrubland site. It is most common on summits where the slope is less than 15 percent and soil depth is 20 inches deep or greater.</p>
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FX052X03X005	Clayey-Steep (Cystp) Dry Shrubland This site is adjacent to the Shallow Clay Dry Shrubland ecological site where bedrock occurs at a depth greater than 20 inches. It typically occupies a backslope position similar to the Shallow Clay Dry Shrubland ecological site.
FX052X03X007	Coarse Clay (Coc) Dry Shrubland This site occurs on moderate to steeply sloping hillslopes adjacent to the Shallow Clay Dry Shrubland ecological site. It is commonly in the same landscape positions but has different soil structure.

Similar sites

FX052X01X131	Shallow Clay (Swc) Dry Grassland This site differs from the Shallow Clay Dry Shrubland ecological site in that it has slightly cooler annual temperatures and supports silver sagebrush rather than big sagebrush.
FX052X03X005	Clayey-Steep (Cystp) Dry Shrubland This site differs from the Shallow Clay Dry Shrubland ecological site in that depth to bedrock is greater than 20 inches.
FX052X03X007	Coarse Clay (Coc) Dry Shrubland This site differs from the Shallow Clay Dry Shrubland ecological site in that the soil structure in the surface horizon is coarse granular rather than blocky. Prairie sandreed is a dominant plant species.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY724MT

Physiographic features

Shallow Clay Dry Shrubland ecological site is moderately extensive, occurring primarily in the southern portions of MLRA 52. The majority of MLRA 52 is covered by a broad till plain and this ecological site largely occurs where the till plain has been dissected by streams or rivers and underlying bedrock has been exposed. This site is typically in backslope positions on hillslopes, badlands, and bluffs. Slopes vary but are typically 15 to 60 percent.

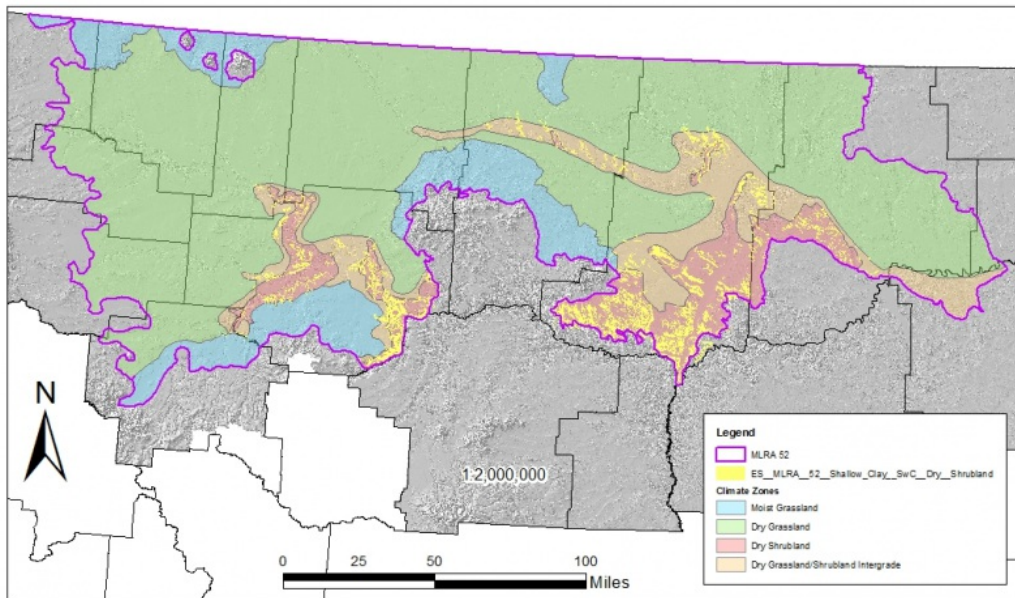


Figure 2. Figure 1. General distribution of the Shallow Clay Dry Shrubland ecological site by map unit extent.

Table 2. Representative physiographic features

Landforms	(1) Till plain > Hillslope (2) Till plain > Bluff (3) Badlands
Elevation	2,000–3,870 ft
Slope	0–60%
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 125 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 10 to 14 inches, and 70 to 80 percent of this occurs during the growing season (Cooper et al., 2001). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

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

damaging winds, prolonged chinook episodes can result in drought or vegetation kills due to a reaction of plants to a “false spring” (Oard, 1993).

Table 3. Representative climatic features

Frost-free period (average)	125 days
Freeze-free period (average)	145 days
Precipitation total (average)	13 in

Climate stations used

- (1) CONTENT 3 SSE [USC00241984], Zortman, MT
- (2) FT BENTON [USC00243113], Fort Benton, MT
- (3) FT PECK PWR PLT [USC00243176], Fort Peck, MT
- (4) LOMA 1 WNW [USC00245153], Loma, MT
- (5) MALTA 7 E [USC00245338], Malta, MT
- (6) MALTA 35 S [USC00245340], Zortman, 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 high clay content 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 in the upper 40 inches. Soil moisture is the primary limiting factor for plant production on this ecological site.

Soil features

Soils that best represent the central concept of this ecological site are the Yawdim and Neldore series. These soils are in the Ustorthents great group. They are characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon and by contact with paralithic bedrock within 20 inches of the soil surface. Both are clayey and have smectitic minerology. The soil moisture regime for these and all soils in this ecological site concept is ustic bordering on aridic, which means that the soils are moist in some or all parts for either 180 cumulative days or 90 consecutive days during the growing season 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 textures found in this site are typically clay, silty clay, clay loam, or silty clay loam and contain greater than 35 percent clay. Underlying horizons are weakly developed and frequently contain soft shale chips. Organic matter in the surface horizon typically ranges from 1 to 2 percent, and moist colors vary from grayish brown (2.5Y 4/2) to very dark

grayish brown (2.5Y 3/2). Darker colors are typically inherited from the parent material and are not a result of an accumulation of organic matter. Soil pH class is moderately acid to slightly alkaline in the surface horizon and moderately acid to strongly alkaline in the subsurface horizons. The soil depth class for this site is shallow or very shallow (bedrock is less than 20 inches below the soil surface). Content of coarse fragments is typically between 15 and 60 percent by volume in the subsurface horizons. These fragments are typically soft parafragments that are weakly cemented and can be crushed between the fingers.

Table 4. Representative soil features

Parent material	(1) Residuum (2) Till
Surface texture	(1) Clay (2) Silty clay (3) Silty clay loam
Drainage class	Well drained
Soil depth	0–20 in
Available water capacity (0-40in)	1.9–2.8 in
Calcium carbonate equivalent (0-5in)	0–10%
Electrical conductivity (0-20in)	0–3 mmhos/cm
Sodium adsorption ratio (0-20in)	0–12
Soil reaction (1:1 water) (0-40in)	5.6–9
Subsurface fragment volume ≤3" (0-20in)	0–34%
Subsurface fragment volume >3" (0-20in)	0–34%

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM), 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 Shallow Clay Dry Shrubland ecological site in MLRA 52 consists of three states: The

Reference State (1), the Shortgrass State (2), and the Invaded State (3). Plant communities associated with the Shallow Clay Dry Shrubland ecological site evolved under the combined influences of climate, grazing, and fire. Extreme climatic variability results in frequent droughts, which can have the greatest influence on the relative contribution of species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). Due to the dominance of cool-season graminoids, annual production is highly dependent upon mid to late-spring precipitation (Heitschmidt and Vermeire, 2005; Anderson, 2006).

Native grazers also shaped these plant communities. American bison (*Bison bison*) were the dominant historic grazer, but pronghorn (*Antilocapra americana*), elk (*Cervus canadensis*), and deer (*Odocoileus* spp.) were also common. Small mammals such as prairie dogs (*Cynomys* spp.) and ground squirrels (*Urocitellus* spp.) also 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).

Fire is a critical dynamic on the Shallow Clay Dry Shrubland ecological site. The historic ecosystem experienced relatively frequent lightning-caused fires. Historically, Native Americans also set frequent 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). It is difficult to precisely determine the fire return interval in the Dry Shrubland climate zone, but estimates range from 6 to 25 years (Bragg, 1995) to 10 to 70 years (Howard, 1999). It is believed that the frequency and intensity of fire would be less on the Shallow Clay Dry Shrubland ecological site than on adjacent sites due to the broken topography and sparser vegetation. Generally, the herbaceous vegetation is resilient to fire and the primary effects of fire are reduction of litter and short term fluctuations in production (Vermeire et al., 2011, 2014). However, studies have shown that very short fire return intervals (less than 5 years) can have a negative effect, shifting species composition toward warm-season, short-statured grasses (Shay et al., 2001; Smith and McDermid, 2014). Conversely, fire has a significant effect on Wyoming big sagebrush cover. Wyoming big sagebrush is a non-sprouting shrub and is most often killed by fire (Howard, 1999). Often, it may take 30 years or more for a stand to recover following fire (Watts and Wambolt, 1996; Wambolt et al., 2001). It is likely that fire return intervals shorter than 30 years will result in a reduction in Wyoming big sagebrush cover over the long term. Long-term fire suppression in the 20th century removed periodic fire from the ecosystem altogether. Very little is known how this has affected the Dry Shrubland ecosystem. Some studies suggest an increase in Wyoming big sagebrush cover, presumably due to fire suppression (Bloom-Cornelius, 2011). Increased decadence in Wyoming big sagebrush may also occur (Howard, 1999), but these results are inconclusive.

Lack of periodic fires can also result in an increase in litter accumulation and, in some cases, provide ideal conditions for seed germination and seedling establishment of non-native annual brome species, such as field or Japanese brome (*Bromus arvensis*) (Whisenant, 1990). These species have become naturalized in relatively undisturbed

grasslands (Ogle et al., 2003; Harmoney, 2007) and can be present in any state within the scope of this ecological site. They typically do not have a significant ecological impact; however, their presence can reduce the production of cool-season perennial grasses in some cases (Haferkamp et al., 1997). Their abundance varies depending on precipitation and germination conditions. The fire-recovery cycle is a critical element in managing the Dry Shrubland ecosystem. Further study is needed in this area to determine a balanced and sustainable fire cycle.

Improper grazing of this site can result in a reduction in the cover of the cool-season midgrasses and an increase in blue grama (Smoliak et al., 1972; Smoliak, 1974). Unpalatable forbs such as curlycup gumweed (*Grindelia squarrosa*) also increase. 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 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 inadequate seasonal rotation moves over multiple years. Periods of extended drought (approximately 3 years or greater) can reduce mid-statured, cool-season grasses and shift the species composition of this community to one dominated by blue grama (Coupland, 1958, 1961). Long-term improper grazing can shift the species composition of this community to one dominated by shortgrasses, such as blue grama and Sandberg bluegrass, and unpalatable forbs.

Because of the shallow soil and generally steep slopes, this ecological site is unsuitable for cropland. Therefore, this ecological site has remained in native vegetation.

The State-and-Transition Model (STM) diagram (Figure 2) suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State 1: Reference State

The Reference State (1) contains three community phases characterized by rhizomatous grasses, mid-statured cool-season bunchgrasses, and Wyoming big sagebrush, a perennial, evergreen, non-sprouting shrub. 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, although heavy grazing could influence species composition in localized areas.

Phase 1.1: Shrubland Community Phase

The Shrubland Community Phase (1.1) is dominated by rhizomatous wheatgrasses, mid-statured bunchgrasses, and Wyoming big sagebrush. Typically, the most abundant herbaceous species are western wheatgrass and green needlegrass. Thickspike wheatgrass may also be present, becoming more abundant in the northern extent of this ecological site. Bluebunch wheatgrass (*Pseudoroegneria spicata*) may occur on this site, but is typically limited to the southern portions of Phillips and Valley Counties where soils are underlain by the Bear Paw Shale Formation. Plains muhly (*Muhlenbergia cuspidata*) may also be common. Short-statured grasses, such as blue grama (*Bouteloua gracilis*), prairie Junegrass (*Koeleria macrantha*), and Sandberg bluegrass (*Poa secunda*), are common although cover and production are low. Common forbs are prairie clover (*Dalea* spp.), American vetch (*Vicia americana*), and fewflower buckwheat (*Eriogonum pauciflorum*). The principle shrub on this site is Wyoming big sagebrush, canopy cover is typically 5 to 15 percent. Subshrubs are rare and may include prairie sagewort (*Artemisia frigida*), rubber rabbitbrush (*Ericameria nauseosa*), and broom snakeweed (*Gutierrezia sarothrae*). The approximate species composition of the reference plant community is as follows:

Percent composition by weight*

Rhizomatous wheatgrass 20-40%

Bluebunch wheatgrass 0-20%

Green needlegrass 15%

Plains muhly 10%

Blue grama 5%

Other native grasses 5%

Perennial forbs 5%

Wyoming big sagebrush 15% (canopy cover 5-15%)

Other shrubs/subshrubs 5%

Estimated Total Annual Production (lbs./ac)*

Low - 200

Representative Value - 350

High - 500

*Estimated based on current data – subject to revision

Phase 1.2: Post-Fire Community Phase

The Post-Fire Community Phase occurs when the plant community is burned either by wildfire or prescribed fire and may persist for as long as 30 years after burning. It is characterized by a wheatgrass-bunchgrass plant community. The most abundant mid-statured species are western wheatgrass and green needlegrass. Bluebunch wheatgrass may also occur, but it is typically limited to the southern portions of Phillips and Valley Counties where soils are underlain by the Bear Paw Shale Formation. Blue grama, prairie Junegrass, and Sandberg bluegrass are common short-statured grasses. Total cover of shortgrasses is similar to Shrubland Community Phase (1.1). Wyoming big sagebrush will be eliminated or nearly so immediately following fire. Recovery of Wyoming big sagebrush

depends on many factors including climate, proximity to a seed source, and fire intensity. Typically, there is little or no regeneration for 5 to 10 years post-fire, then cover begins to increase gradually until an equilibrium level is reached (Watts and Wambolt, 1996). Generally recovery is prolonged, sometimes taking as long as 30 years (Wambolt et al., 2001).

Phase 1.3: At-Risk Community Phase

The At-Risk Community Phase occurs when the site condition declines due to drought or improper grazing management. Multiple fires in close succession can also transition the site to this phase. This community phase is characterized by an increase in shortgrasses, particularly blue grama, and a decline in mid-statured grasses. The cover of shortgrasses equals or exceeds cover of rhizomatous wheatgrasses. Cool-season bunchgrasses such as green needlegrass will become rare or disappear from the site. Prairie Junegrass, Sandberg bluegrass and unpalatable forbs such as curlycup gumweed (*Grindelia squarrosa*) also increase in this phase. Cover of Wyoming big sagebrush will vary depending on the length of time since the last burn. If less than 30 years have passed since the last fire big sagebrush cover will be similar to Post-Fire Community Phase (1.2), but 30 years or more post-fire cover will be similar to Shrubland Community Phase (1.1).

Community Phase Pathway 1.1a

Fire will transition the Shrubland Community Phase (1.1) to the Post-Fire Community Phase (1.2). Wyoming big sagebrush is killed and perennial grasses will dominate the site.

Community Phase Pathway 1.1b

Drought, improper grazing management, or a combination of these factors can shift the Shrubland Community Phase (1.1) to the At Risk Community Phase (1.3). These factors favor an increase in blue grama and a decrease in cool-season midgrasses (Coupland, 1961; Shay et al., 2001). Wyoming big sagebrush cover will be similar to the Shrubland Community Phase (1.1).

Community Phase Pathway 1.2a

30 years or more of natural vegetative regrowth will transition the Post-Fire Community Phase (1.2) to the Shrubland Community Phase (1.1). 30 years or more without fire permits Wyoming big sagebrush to recolonize the site.

Community Phase Pathway 1.2b

Drought, improper grazing management, multiple fires in close succession, or a combination of these factors can shift the Post-Fire Community Phase (1.2) to the At Risk Community Phase (1.3). These factors favor an increase in blue grama and a decrease in cool-season midgrasses (Coupland, 1961; Shay et al., 2001). Wyoming big sagebrush cover will be similar to the Post-Fire Community Phase (1.2).

Community Phase Pathway 1.3a

Less than 30 years post-fire; normal or above-average precipitation and proper grazing management transitions the At Risk Community Phase (1.3) to the Post-Fire Community

Phase (1.2).

Community Phase Pathway 1.3b

30 years or more post-fire; normal or above-average precipitation and proper grazing management transitions the At Risk Community Phase (1.3) to the Shrubland Community Phase (1.1).

Transition T1A

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

The Shortgrass State 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. Blue grama increases with long-term improper grazing at the expense of cool-season midgrasses (Coupland, 1961; Biondini and Manske, 1996; Derner and Whitman, 2009). Once established, blue grama-dominated communities can alter soil properties, creating conditions that resist establishment of other grass species (Dormaar and Willms, 1990; Dormaar et al., 1994). Reductions in stocking rates can reduce blue grama cover and increase the cover of cool-season midgrasses, although this recovery may take decades (Dormaar and Willms, 1990; Dormaar et al., 1994). Cover of Wyoming big sagebrush varies depending on fire frequency, with dynamics similar to the Reference State (1).

Phase 2.1: Shrub/Shortgrass Community Phase

The Shrub/Shortgrass Community Phase (2.1) occurs when site conditions decline due to long-term drought or improper grazing, and a fire has not occurred on the site for at least 30 years. In this phase, mid-statured grasses such as green needlegrass and rhizomatous wheatgrasses have been largely eliminated and replaced by short-statured species such as blue grama and prairie Junegrass. Blue grama resists grazing due to its low stature and extensive root system. Unpalatable forbs such as curlycup gumweed are also common in this phase. Cover of Wyoming big sagebrush is 5 to 15 percent.

Phase 2.2: Shortgrass/Forb Community Phase

The Shortgrass/Forb Community Phase occurs when site conditions decline due to long-term drought or improper grazing, and a fire has occurred on the site less than 30 years prior. In this phase, mid-statured grasses such as green needlegrass and rhizomatous wheatgrasses have been largely eliminated and replaced by short-statured species such as blue grama and prairie Junegrass. Blue grama resists grazing due to its low stature and extensive root system. Unpalatable forbs, such as curlycup gumweed, are also common in this phase. Wyoming big sagebrush is rare.

Transition T2A

The Shortgrass State (2) transitions to the Invaded State (3) when non-native grasses, noxious weeds, and other invasive plants invade the Shortgrass State (2). Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced.

Restoration Pathway R2A

Blue grama can resist displacement by other species (Dormaar and Willms, 1990; Laycock, 1991; Dormaar et al., 1994; Lacey et al., 1995). A reduction in livestock grazing pressure alone may not be sufficient to reduce the cover of blue grama in the Shortgrass State (2) (Dormaar and Willms, 1990). Intensive restoration methods may be necessary to reestablish desirable species. Reseeding via conventional methods may not be possible due to the steep topography of this site. Specialized reseeding techniques (hydroseeding, straw wattles, etc.) may be necessary. These restoration methods are labor intensive, costly, and may not be practical in all situations. Therefore, returning the Shortgrass State (2) to the Reference State (1) can require considerable cost, energy, and may not be feasible within a reasonable amount of time.

Community Phase Pathway 2.1a

Fire will transition the Shrub/Shortgrass Community Phase (2.1) to the Shortgrass/Forb Community phase (2.2). Wyoming big sagebrush is killed and perennial grasses will dominate the site.

Community Phase Pathway 2.2a

Thirty years or more of natural vegetative regrowth will transition the Post-Fire Community Phase (1.2) to the Shrubland Community Phase (1.1). It is believed that 30 years or more without fire will permit Wyoming big sagebrush to recolonize the site, however, conclusive documentation has not yet been obtained. Therefore, this pathway is considered hypothetical until further investigation can be completed.

State 3: Invaded State

The Invaded State (3) occurs when invasive plant species invade adjacent native grassland communities. Invasive species that could be a concern are annual bromes, saltlover (*Halogeton glomeratus*), and noxious weeds. Annual bromes are generally not a significant concern in MLRA 52, however, in the Shallow Clay Dry Shrubland ecological site, there could be instances where they do significantly affect the site. More information is needed to assess this condition. Noxious weeds such as leafy spurge are uncommon on

this site, but they may also invade and displace native species. Although very aggressive, these species can sometimes 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, structural complexity, and soil quality 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

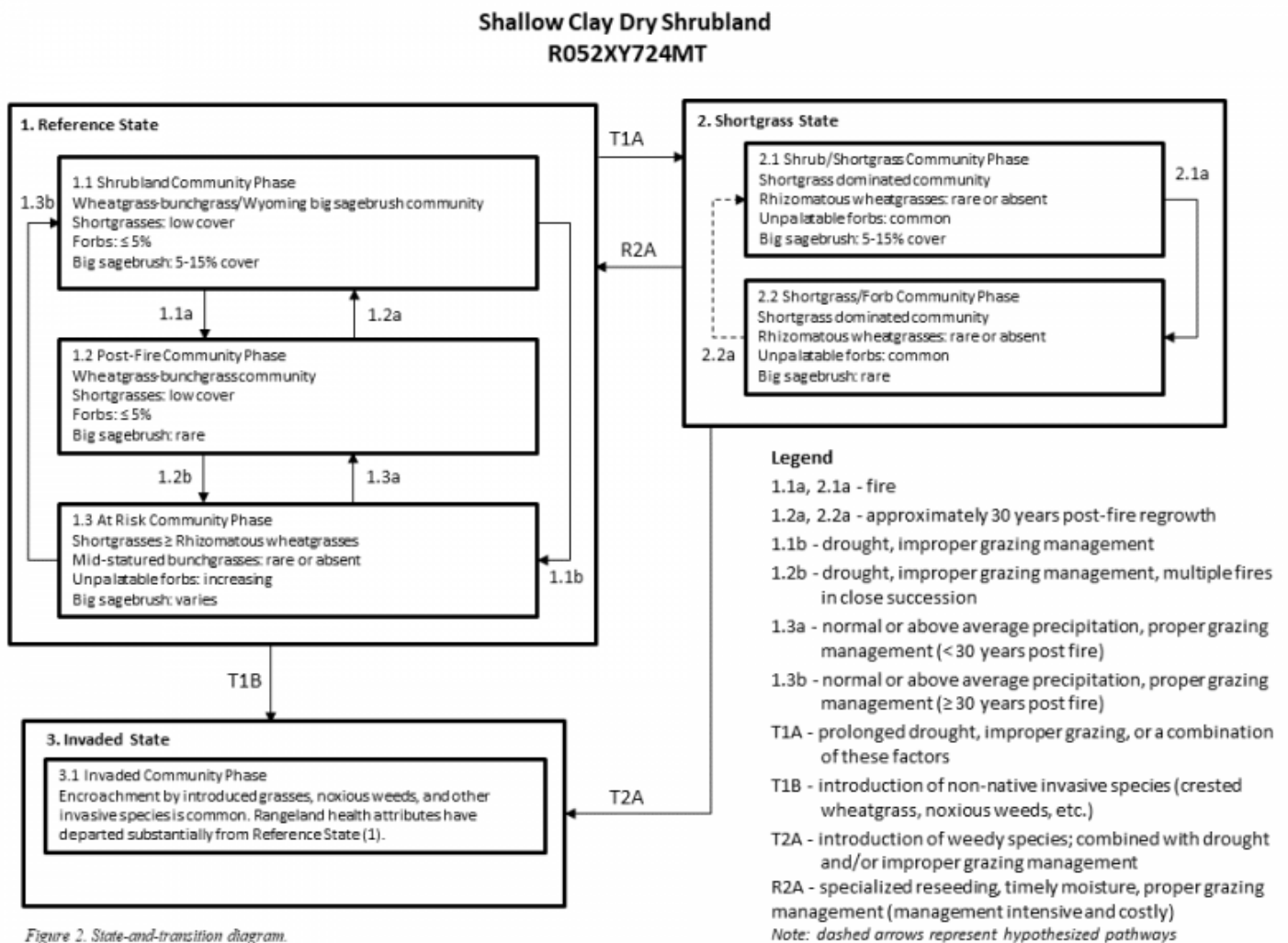


Figure 2. State-and-transition diagram.

Inventory data references

Data for this provisional ecological site was obtained from four low intensity plots. These plots, in combination with professional experience and a review of the scientific literature, were 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.

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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):**

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:**
