Ecological site R055CY024SD
Shallow Limy

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General information

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

MLRA notes

Major Land Resource Area (MLRA): 055C–Southern Black Glaciated Plains

The Southern Black Glaciated Plains (55C) is located within the Northern Great Plains Region. It is entirely within South Dakota encompassing about 10,835 square miles (Figure 1). The elevation ranges from 1,310 to 1,970 square feet. The MLRA is on nearly level to undulating glacial till plains interrupted by steeper slopes adjacent to streams and moraines. The James River is an under-fit stream. Its valley was carved by floodwaters draining glacial Lake Dakota and is filled with glacial outwash and alluvial deposits. (USDA-NRCS, 2006).

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to very poorly drained, and clayey or loamy. This area supports natural prairie vegetation characterized by western wheatgrass (Pascopyrum smithii), green needlegrass (Nassella viridula), needle and thread (Hesperostipa comata), and porcupinegrass (Hesperostipa spartea) with Prairie cordgrass (Spartina pectinata), and reed canarygrass (Phalaris arundinacea) as the dominant vegetation on the poorly drained soils. (USDA-NRCS, 2006).

Classification relationships

Major Land Resource Area (MLRA): Southern Black Glaciated Plains (55C) (USDA-NRCS, 2006)

USFS Subregions: North Central Glaciated Plains Section (251B); Yankton Hills and Valleys Subsection (251Bf); Western Glaciated Plains Section (332B); James River Lowland Subsection (332Bb); North Central Great Plains Section (332D); Southern Missouri Coteau Slope Subsection (332Dd); Southern Missouri Coteau Subsection (332De) - (Cleland et al., 2007).

US EPA Level IV Ecoregion: Southern Missouri Coteau (42e); Southern Missouri Coteau Slope (42f); James River Lowland (46n) - (USEPA, 2013)

Ecological site concept

The Shallow Limy ecological site occurs on the shoulder slopes in the upland areas. Soils are well drained, will effervesce with acid at or near the surface and have bedrock 10 to 20 inches from the soil surface. Precipitation tends to runoff, leaving less soil moisture for plant growth, production is lower, and species composition will tend towards more shallow-rooted and drought tolerant. In some areas the surface layer may consist of stony to extremely stony. Slopes can range from 0 to 40 percent. Vegetation in the Reference State is dominated by warm-season grasses including big bluestem, little bluestem, and sideoats grama. Non-native grasses such as smooth bromegrass, Kentucky bluegrass, and quackgrass or native conifers such as eastern redcedar may invade due to shifts in disturbance regime.

Associated sites

R055CY010SD	**Loamy** These sites occur on upland areas. The soils are well drained and have less than 40 percent clay in the surface and subsoil. The central concept soil series are Clarno, Hand, and Houdek, but other series are included.
R055CY012SD	**Thin Upland** These sites occur on uplands. Soils are well drained that do not have bedrock between 10 to 20 inches form soil surface and will effervesce with acid at or near the surface. The central concept soil series are Ethan and Betts, but other series are included.
R055CY020SD	**Loamy Overflow** These sites occur in upland swales. The Soils are moderately well drained, and have water flow into and over and through the site. The central concept soil series are Bonilla and Prosper but other series are included.

Similar sites

R055CY012SD	**Thin Upland** The Thin Upland site occurs in a similar landscape position, but does not have bedrock 10 to 20 inches from the soil surface. The Thin Upland site will have more little bluestem and more green needlegrass than the Shallow Limy site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Bouteloua curtipendula*

Physiographic features

The Shallow Limy ecological site occurs on the shoulder slopes in the upland areas.

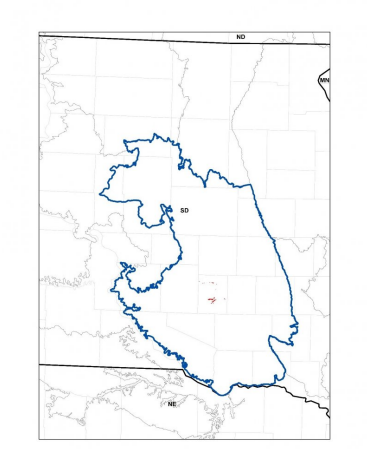


Figure 1. Site Distribution Map of the Shallow Limy Site in MLRA 55C.

Table 2. Representative physiographic features

Landforms	(1) Valley side (2) Hill
Runoff class	High
Flooding frequency	None
Ponding frequency	None
Elevation	1,200–2,000 ft

Slope	9–40%

Climatic features

MLRA 55C is considered to have a continental climate: Cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature may also abound. The climate is the result of this MLRA's location near the geographic center of North America. There are few natural barriers on the Northern Great Plains, and air masses move freely across the plains and account for rapid changes in temperature.

Annual precipitation typically ranges from 19 to 25 inches per year. The average annual temperature is about 47°F. January is the coldest month with average temperatures ranging from about 15°F (Howard, South Dakota [SD]), to about 20°F (Wagner, SD). July is the warmest month with temperatures averaging from about 73°F (Howard, SD), to about 77°F (Wagner, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 58°F. This large annual range attests to the continental nature of this area's climate. Hourly winds are estimated to average about 12 miles per hour (mph) annually, ranging from about 13 mph during the spring to about 11 mph during the summer. Daytime winds are generally stronger than nighttime, and occasional strong storms may bring brief periods of high winds with gusts to more than 50 mph.

Growth of cool-season plants begins in early to mid-March, slowing or ceasing in late June. Warm-season plants begin growth about mid-May and continue to early or mid-September. Green-up of cool-season plants may occur in September and October when adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (characteristic range)	122-129 days
Freeze-free period (characteristic range)	137-151 days
Precipitation total (characteristic range)	22-26 in
Frost-free period (actual range)	114-131 days
Freeze-free period (actual range)	133-155 days
Precipitation total (actual range)	21-27 in
Frost-free period (average)	125 days
Freeze-free period (average)	144 days
Precipitation total (average)	24 in

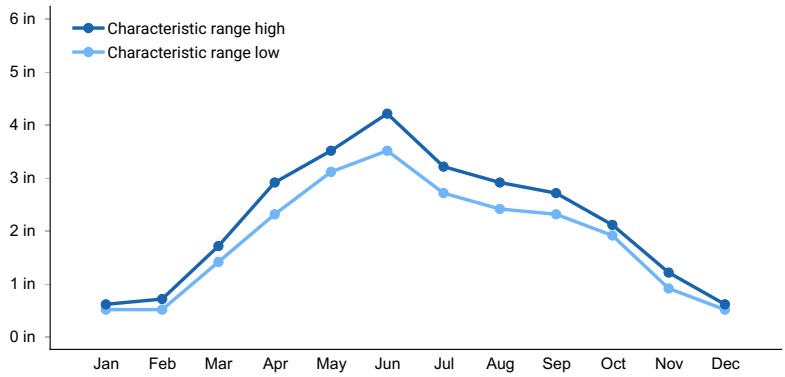


Figure 2. Monthly precipitation range

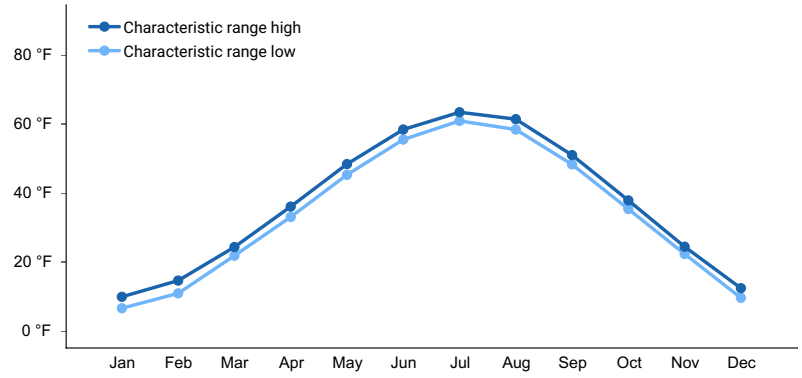


Figure 3. Monthly minimum temperature range

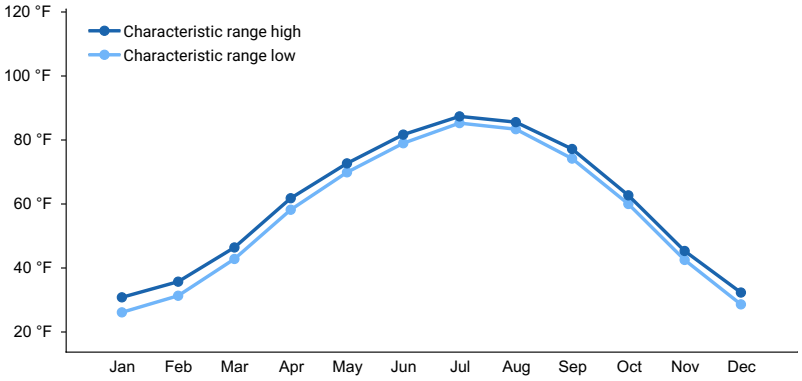


Figure 4. Monthly maximum temperature range

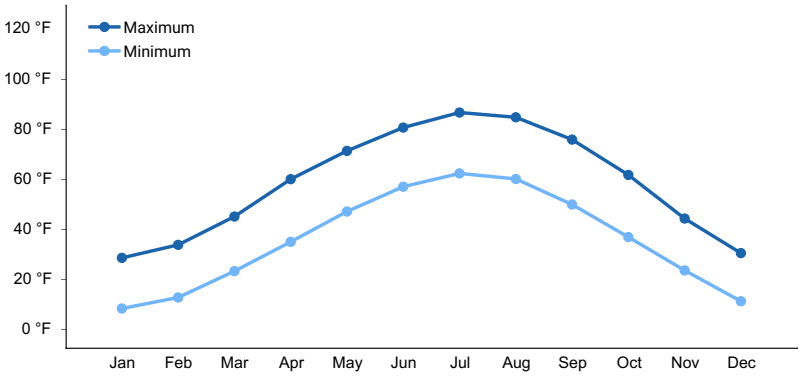


Figure 5. Monthly average minimum and maximum temperature

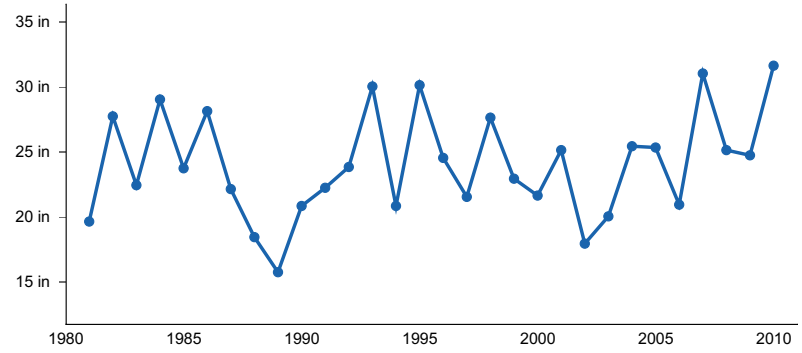


Figure 6. Annual precipitation pattern

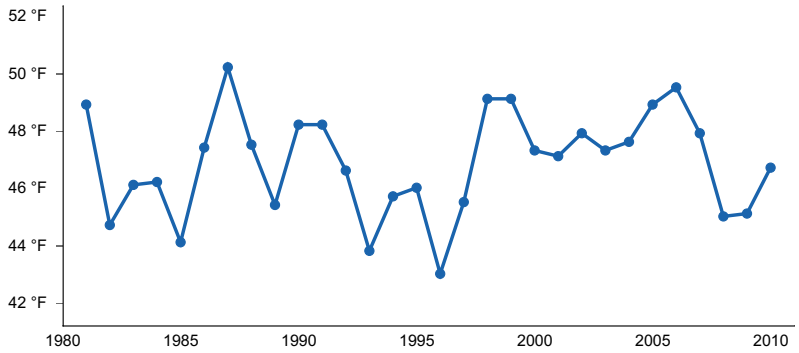


Figure 7. Annual average temperature pattern

Climate stations used

- (1) FAULKTON 1 NW [USC00392927], Faulkton, SD
- (2) REDFIELD [USC00397052], Redfield, SD
- (3) MILLER [USC00395561], Miller, SD
- (4) HURON RGNL AP [USW00014936], Huron, SD
- (5) DE SMET [USC00392302], De Smet, SD
- (6) HOWARD [USC00394037], Howard, SD
- (7) FORESTBURG 4 NNE [USC00393029], Artesian, SD
- (8) CHAMBERLAIN MUNI AP [USW00094943], Chamberlain, SD
- (9) CHAMBERLAIN 5 S [USC00391621], Chamberlain, SD
- (10) MITCHELL [USC00395669], Mitchell, SD
- (11) MITCHELL 2 N [USC00395671], Mitchell, SD
- (12) MITCHELL MUNI AP [USW00094950], Mitchell, SD
- (13) ALEXANDRIA [USC00390128], Alexandria, SD
- (14) SALEM 5NE [USC00395360], Salem, SD
- (15) MARION [USC00395228], Marion, SD
- (16) MENNO [USC00395481], Menno, SD
- (17) TYNDALL [USC00398472], Tyndall, SD
- (18) WAGNER [USC00398767], Wagner, SD
- (19) ARMOUR [USC00390296], Armour, SD
- (20) ACADEMY 2NE [USC00390043], Platte, SD

Influencing water features

This site does not have a water table.

Soil features

Soils are well drained, will effervesce with acid at or near the surface and have bedrock 10 to 20 inches from the soil surface.

Soil series is Gavin.

Table 4. Representative soil features

Parent material	(1) Residuum–calcareous siltstone
Surface texture	(1) Loam (2) Silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate
Soil depth	10–20 in

Surface fragment cover <=3"	0–4%
Surface fragment cover >3"	0–2%
Available water capacity (Depth not specified)	2.2–2.8 in
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	1–8%
Subsurface fragment volume >3" (Depth not specified)	0–4%

Ecological dynamics

State and Community Phases
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 site which is located in the Southern Black Glaciated Plains Region developed under Northern Great Plains climatic conditions and included natural influence of large herding herbivores and occasional fire. Changes will occur in the plant communities due to weather fluctuations and management actions. Under adverse impacts, a relatively rapid decline in vegetative vigor and composition can occur. Under favorable conditions, the site has the potential to resemble the Reference State. Interpretations for this site are based primarily on the 1.1 Big Bluestem-Little Bluestem-Sidoats Grama Plant Community Phase. This community phase and the Reference State have been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes. Trends in plant community dynamics ranging from heavily to lightly grazed areas, seasonal use pastures, and historical accounts also have been considered.

The foremost diagnostic feature of this site is the shallow depth to bedrock (10 to 20 inches). The site does not receive additional moisture from higher adjacent areas and is subject to significant runoff. Relatively minor changes in local elevation can affect the plant community since the bedrock can fluctuate in depth. This site often occurs in complex with the Thin Upland sites.

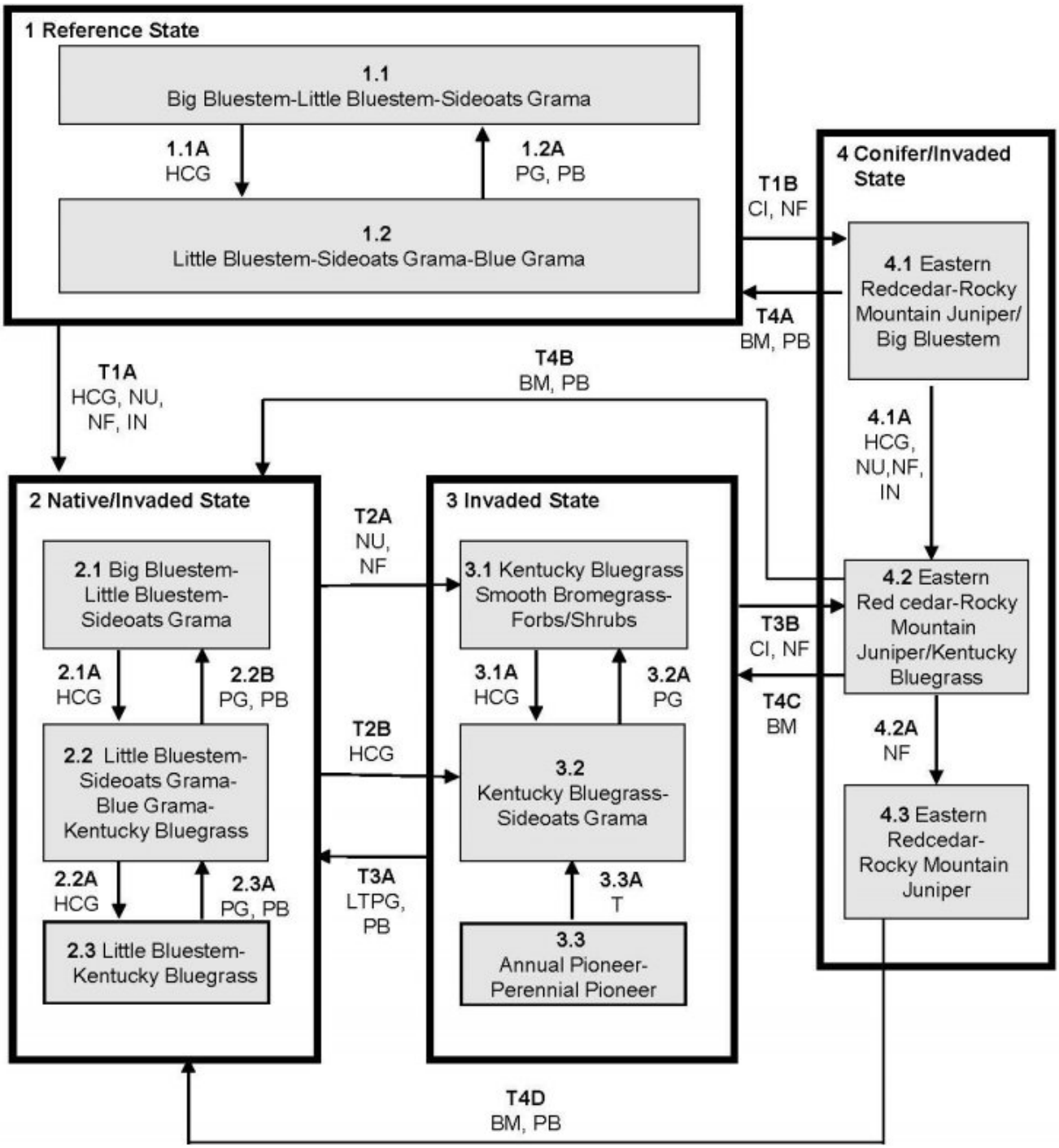
This ecological site (ES) has been grazed by domestic livestock since they wereintroduced into the area. The introduction of domestic livestock and the use of fencing and reliable water sources have changed the ecological dynamics of this site. Continuous season-long grazing (during the typical growing season of May through October) or repeated seasonal grazing (e.g., every spring, every summer) without adequate recovery periods following grazing events causes departure from the 2.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase. Blue grama (*Bouteloua gracilis*) will eventually develop into a sod. Western wheatgrass will increase initially and then begin to decrease. Green needlegrass, needle and thread, porcupinegrass, sideoats grama, big bluestem and little bluestem will decrease in frequency and production. Extended periods of nonuse and/or lack of fire will result in excessive litter and a plant community dominated by cool-season grasses such as Kentucky bluegrass (*Poa pratensis*), smooth bromegrass (*Bromus inermis*), and cheatgrass (*Bromus tectorum*). Extended periods of no surface fire could result in the invasion of conifers in which eastern redcedar (*Juniperus virginiana*) and Rocky Mountain juniper (*Juniperus scopulorum*) will increase and could eventually dominate the site.

Following the state-and-transition diagram are narratives for each of the described states and community phases. These may not represent every possibility, but they are the most prevalent and repeatable states and community phases. The associated plant composition tables have been developed from the best available knowledge at the time of this revision. As more data are collected, some of these community phases and states may be revised or

removed, and new ones may be added. The main purpose for including the descriptions here is to capture the current knowledge and experience at the time of this revision.

State and transition model

Shallow Limy – R055CY024SD



LEGEND
Shallow Limy – R055CY024SD

BM – Brush management
CI – Conifer invasion
HCG – Heavy, continuous grazing
IN – Invasion
LTPG – Long-term prescribed grazing
NU – Non-use
NF – No fire
PB – Prescribed burning
PG – Prescribed grazing
T – Time w/wo disturbances

Figure 8. State-and-Transition Model and Legend for the Shallow Limy Site in MLRA 55C.

Code	Process
T1A	Heavy, continuous grazing, non-use, no fire, invasion
T1B	Conifer invasion, no fire
T2A	Non-use, no fire
T2B	Heavy, continuous grazing
T3A	Long term prescribed grazing, prescribed burning
T3B	Conifer invasion, no fire
T4A	Brush management, prescribed burning
T4B	Brush management, prescribed burning
T4C	Brush management
T4D	Brush management, prescribed burning
1.1A	Heavy, continuous grazing
1.2A	Prescribed grazing with recovery periods, prescribed burning
2.1A	Heavy, continuous grazing
2.2A	Heavy, continuous grazing
2.2B	Prescribed grazing with recovery periods, prescribed burning
2.3A	Prescribed grazing with recovery periods, prescribed burning
3.1A	Heavy, continuous grazing
3.2A	Prescribed grazing with recovery periods
3.3A	Time w/wo disturbances
4.1A	Heavy, continuous grazing, non-use, no fire, invasion
4.2A	No fire

Figure 9. Matrix for the Shallow Limy Site in MLRA 55C.

State 1
Reference State

The Reference State represents the natural range of variability that dominated the dynamics of this ecological site (ES). This state was dominated by warm-season grasses, with cool-season grasses being subdominant. Prior to European settlement in North America, the primary disturbance mechanisms for this site in the Reference condition included periods of below and above average precipitation, periodic fire, and herbivory by insects and large ungulates. Timing of fires and herbivory coupled with weather events dictated the dynamics that occurred within the natural range of variability. In some locations, this site likely received relatively heavy grazing pressure. Cool-season and Tall warm-season grasses would have declined and corresponding increase in short warm-season grasses would have occured. Today, a similar state, the Native/Invaded State (State 2) can be found on areas that are properly managed with grazing and/or prescribed burning, and sometimes on areas receiving occasional short periods of rest.

Community 1.1
Big Bluestem-Little Bluestem-Sideoats Grama

Interpretations are based primarily on the 1.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase (this is also considered to be climax). The potential vegetation was about 80 percent grasses or grass-like plants, 10 percent forbs, and 10 percent shrubs. The community was dominated by warm-season grasses, with cool-season grasses being subdominant. The major grasses included big bluestem, little bluestem, sideoats grama, porcupine grass, and green needlegrass. Other grass or grass-like species included prairie dropseed (*Sporobolus heterolepis*), needleandthread, western wheatgrass, plains muhly (*Muhlenbergia cuspidata*), Canada wildrye (Elymus Canadensis), prairie sandreed (*Calamovilfa longifolia*), switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*), slender wheatgrass (*Elymus trachycaulus*), blue grama, and sedges (Cyperaceae). This plant community was resilient and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allowed for high drought tolerance. This was a sustainable plant community in regards to site/soil stability, watershed function, and biologic integrity.

Community 1.2
Little Bluestem-Sideoats Grama-Blue Grama

This plant community evolved under heavy continuous grazing or from over utilization during extended drought periods. The potential plant community was made up of approximately 85 percent grasses and grass-like species, 10 percent forbs, and 5 percent shrubs. Dominant grasses included little bluestem, sideoats grama, blue grama, green needlegrass, and needleandthread. Grasses of secondary importance included western wheatgrass, porcupine grass, big bluestem, and sedge (Cyperaceae). Forbs commonly found in this plant community included cudweed sagewort (*Artemisia ludoviciana*), prairie coneflower (Ratibida), and western yarrow (*Achillea millefolium*). This plant community had similar plant composition to the 2.2 Little Bluestem-Sideoats Grama-Blue Gama-Kentucky Bluegrass Plant Community Phase. The main difference is that this plant community phase did not have the presence of nonnative invasive species such as Kentucky bluegrass and smooth bromegrass. When compared to the 1.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase, western wheatgrass, blue grama, and sedges increased. Big bluestem, porcupine grass, green needlegrass, and sideoats grama decreased, and production of mid- and tall warm-season grasses was also reduced. This plant community was moderately resistant to change. The herbaceous species present were well adapted to grazing; however, species composition could be altered through long-term overgrazing. If the herbaceous component was intact, it tended to be resilient if the disturbance was not long-term. Most of the components of the ecological processes would have been functioning at optimum levels. However, the vigor and reproductive capability of the tall warm-season grasses would have been reduced due to grazing pressure or a combination of stressors. A reduction of this dominant functional group allowed for an increase in shorter-statured (and shallower rooted) species.

Pathway 1.1A
Community 1.1 to 1.2

Heavy continuous grazing which includes herbivory at moderate to heavy levels at the same time of year each year without adequate recovery periods, or during periods of below normal precipitation when grazing frequency and intensity increases on these sites due to limited forage availability on adjacent upland sites will shift this community to the 1.2 Little Bluestem-Sideoats Grama-Blue Grama Plant Community Phase.

Pathway 1.2A
Community 1.2 to 1.1

Prescribed grazing (alternating season of use and providing adequate recovery periods) or periodic light to moderate grazing possibly including periodic rest and/or prescribed burning occurring at relatively frequent intervals (3 to 5 years) and a return to normal disturbance regime levels and frequencies will convert this plant community to the 1.2 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase.

State 2
Native/Invaded State

The Native/Invaded State represents the more common range of variability that exists with higher levels of grazing management, but in the absence of periodic fire due to fire suppression. This state is dominated by cool- and warm-season grasses. It can be found on areas that are properly managed with grazing and/or prescribed burning and sometimes on areas receiving occasional short periods of rest. Taller warm-season species can decline and a corresponding increase in short-statured grass will occur.

Community 2.1
Big Bluestem-Little Bluestem-Sideoats Grama

This plant community phase is similar to the 1.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase but it also contains minor amounts of non-native invasive grass species such as Kentucky bluegrass and smooth bromegrass (up to about 15 percent by air-dry weight). The potential vegetation is about 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent shrubs. This community is dominated by warm-season grasses, with cool-season grasses being subdominant. The major grasses include big bluestem, little bluestem, sideoats grama, green needlegrass, and porcupinegrass. Other grass or grass-like species include prairie dropseed, needle and thread, western wheatgrass, plains muhly, Canada wildrye, prairie sandreed, switchgrass, Indiangrass, slender wheatgrass, blue grama, Kentucky bluegrass, and threadleaf sedge (*Carex filifolia*). This plant community is resilient and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high tolerance to drought. This is a sustainable plant community in regards to site and soil stability, watershed function, and biologic integrity.

Community 2.2
Little Bluestem-Sideoats Grama-Blue Grama-Kentucky Bluegrass

This plant community is a result of heavy, continuous grazing or from over utilization during extended drought periods. The potential plant community is made up of approximately 80 percent grasses and grass-like species, 15 percent forbs, and 5 percent shrubs. Dominant grasses include little bluestem, sideoats grama, blue grama, Kentucky Bluegrass. Grasses of secondary importance include western wheatgrass green needlegrass, needle and thread, porcupinegrass, big bluestem, buffalograss (*Bouteloua dactyloides*), smooth bromegrass, and threadleaf sedge. Forbs commonly found in this plant community include cudweed sagewort, prairie coneflower, and western yarrow. When compared to the 1.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase, western wheatgrass, blue grama, and sedges have increased. Big bluestem, porcupinegrass, green needlegrass, and sideoats grama decreased. Production of mid- and tall warm-season grasses is also reduced. This plant community is moderately resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. If the herbaceous component is intact, it tends to be resilient if the disturbance is not long-term. Most of the components of the ecological processes are functioning at optimum levels. However, the vigor and reproductive capability of the tall warm-season grasses are reduced due to grazing pressure or a combination of stressors. A reduction of this dominant functional group allows for an increase in shorter-statured (and shallower rooted) species. The introduction of non-native invasive species such as Kentucky bluegrass and smooth bromegrass results in alterations to the soil profile. Organic matter levels tend to decrease and begin to be concentrated more in the surface layers, and the structure will begin to be modified. These changes favor the shallow-rooted species and hasten their eventual dominance if steps are not taken to reduce these species.

Community 2.3
Little Bluestem-Kentucky Bluegrass

This plant community is a result of heavy, continuous grazing or from over utilization during extended drought periods. The potential plant community is made up of approximately 75 percent grasses and grass-like species, 15 percent forbs, and 10 percent shrubs. Dominant grasses include little bluestem and Kentucky bluegrass. Grass and grass-like species of secondary importance include sideoats grama, blue grama, western wheatgrass, threadleaf sedge, green needlegrass, big bluestem, and quackgrass (*Elymus repens*). Forbs commonly found in this plant community include goldenrod (Oligoneuron), cudweed sagewort, heath aster (Symphyotrichum), scurfpea (Psoralidium), Cuman ragweed (*Ambrosia psilostachya*), and western yarrow. When compared to the 1.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase, little bluestem and Kentucky bluegrass have increased. Production of mid- and tall warm- and cool-season grasses is reduced. This plant community is moderately resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. If the herbaceous component is intact, it tends to be resilient if the disturbance is not long-term. A reduction of the dominant functional groups as found in the interpretive plant community phase allows for an increase in shorter-statured (and shallower rooted) species. The introduction of non-native invasive species such as Kentucky bluegrass and smooth bromegrass results in alterations to the soil profile. Organic matter levels tend to decrease and begin to be concentrated more in the surface layers and the structure will begin to be modified. These changes favor the shallow-rooted species and hasten their eventual dominance if steps are not taken to reduce these species.

Pathway 2.1A
Community 2.1 to 2.2

Heavy, continuous grazing which includes herbivory at moderate to heavy levels at the same time of year each year without adequate recovery periods, or during periods of below normal precipitation when grazing frequency and intensity increases on these sites due to limited forage availability on adjacent upland sites will shift this community to the 2.2 Little Bluestem-Sideoats Grama-Blue Grama-Kentucky Bluegrass Plant Community Phase.

Pathway 2.2B
Community 2.2 to 2.1

Prescribed grazing (alternating season of use and providing adequate recovery periods), periodic light to moderate grazing (possibly including periodic rest), prescribed burning occurring every 3 to 5 years, and a return to normal disturbance regime levels and frequencies will convert this plant community to the 2.1 Big Bluestem-Little Bluestem-Sideoats Grama Plant Community Phase.

Pathway 2.2A
Community 2.2 to 2.3

Heavy, continuous grazing which includes herbivory at moderate to heavy levels at the same time of year each year without adequate recovery periods, or during periods of below normal precipitation when grazing frequency and intensity increases on these sites due to limited forage availability on adjacent upland sites will shift this community to the 2.3 Little Bluestem-Kentucky Bluegrass Plant Community Phase.

Pathway 2.3A
Community 2.3 to 2.2

Prescribed grazing (alternating season of use and providing adequate recovery periods), periodic light to moderate grazing (possibly including periodic rest), prescribed burning occurring every 3 to 5 year, and a return to normal disturbance regime levels and frequencies will convert this plant community to the 2.2 Little Bluestem-Sideoats Grama-Blue Grama-Kentucky Bluegrass Plant Community Phase.

State 3
Invaded State

The Invaded State is a result of encroachment mainly by invasive introduced cool-season grasses. The ecological processes are not functioning, especially the biotic processes and the hydrologic functions. The introduced cool-season grasses cause reduced infiltration and increased runoff. Preliminary studies would tend to indicate this threshold may exist when Kentucky bluegrass exceeds 30 percent of the plant community and native grasses

represent less than 40 percent of the plant community composition. The opportunity for high intensity spring burns is severely reduced by early green-up, and increased moisture and humidity at the soil surface and grazing pressure cannot cause a reduction in sod-grass dominance. Production is limited to the sod-forming species. Infiltration continues to decrease, runoff increases, and energy capture into the system is restricted to early season low producing species. Nutrient cycling is limited by root depth of the dominant species.

Community 3.1
Kentucky Bluegrass-Smooth Bromegrass-Forbs/Shrubs

This plant community phase is a result of extended periods of non-use and no fire or occasionally light levels of grazing over several years. It is characterized by dominance of Kentucky bluegrass and smooth bromegrass. Forbs commonly found in this plant community include cudweed sagewort, goldenrod, and scurfpea. Shrubs commonly found in this plant community include western snowberry (*Symphoricarpos occidentalis*) and wild plum (*Prunus americana*). The dominance of Kentucky bluegrass and smooth bromegrass is at times so complete that other species are difficult to find on the site. A thick duff layer also accumulates at or above the soil surface and eventually a thatch-mat layer may develop. Nutrient cycling is greatly reduced and native plants have great difficulty becoming established. When dominated by smooth bromegrass, infiltration is moderately reduced and runoff is moderate. Production can be equal to or higher than the interpretive plant community. However, when dominated by Kentucky bluegrass, infiltration is greatly reduced and runoff is high. Production in this case will likely be significantly less. In either case, the period that palatability is high is relatively short as these cool-season species mature rapidly. Energy capture is also reduced. The dominance of these introduced species has been shown to alter the biotic component of the soil, as well as, organic matter levels and eventually the soil structure. These alterations perpetuate the dominance of Kentucky bluegrass and smooth bromegrass and tend to make establishment of native species extremely difficult.

Community 3.2
Kentucky Bluegrass-Sideoats Grama

This plant community phase is a result of heavy, continuous grazing or a combination of disturbances such as extended periods of below-average precipitation combined with heavy, continuous grazing. It is characterized by a dominance of Kentucky bluegrass and sideoats grama. The dominance is at times so complete that other species are difficult to find on the site. A relatively thick duff layer can sometimes accumulate at or above the soil surface and eventually a thatch-mat layer may develop at the surface as well. Nutrient cycling is greatly reduced and native plants have great difficulty becoming established. Infiltration is greatly reduced and runoff is high. Production will be significantly reduced when compared to the interpretive plant community. The period that palatability is high is relatively short, as Kentucky bluegrass matures rapidly. Energy capture is also reduced. Biological activity in the soil is likely reduced significantly in this phase.

Community 3.3
Annual Pioneer-Perennial Pioneer

This plant community developed under continuous, heavy grazing or other excessive disturbances. The potential plant community is made up of approximately 40 to 80 percent grasses and grass-like species, 20 to 60 percent forbs, and 0 to 5 percent shrubs. The species present in this phase are highly variable, but often include non-native invasive and early seral species. Plant diversity is low (plant richness may be high but areas are often dominated by a few species). The ecological processes are difficult to restore because of the loss of plant diversity and overall soil disturbance. Soil erosion is potentially very high because of the bare ground and shallow-rooted herbaceous plant community. Water runoff will increase and infiltration will decrease due to animal related soil compaction and loss of root mass due to low plant diversity and vigor. This plant community will require significant economic inputs and time to move towards another plant community. This movement is highly variable in its succession. This is due to the loss of diversity (including the loss of the seed bank), within the existing plant community, and the plant communities on adjacent sites.

Pathway 3.1A
Community 3.1 to 3.2

Heavy continuous grazing which includes herbivory at moderate to heavy levels at the same time of year each year

without adequate recovery periods, or during periods of below normal precipitation when grazing frequency and intensity increases on these sites due to limited forage availability on adjacent upland sites will shift this community to the 3.2 Kentucky Bluegrass-Sideoats Grama Plant Community Phase.

Pathway 3.2A
Community 3.2 to 3.1

Prescribed grazing (alternating season of use and providing adequate recovery periods) or periodic light to moderate grazing possibly including periodic rest will convert this plant community to the 3.1 Kentucky Bluegrass-Smooth Bromegrass-Forbs/Shrubs Plant Community Phase.

Pathway 3.3A
Community 3.3 to 3.2

This community pathway occurs with the passage of time as successional processes take place and perennial plants gradually begin to establish on the site again. This pathway will lead to the 3.2 Kentucky Bluegrass-Sideoats Grama Plant Community Phase.

State 4
Conifer/Invaded State

The Conifer/Invaded State is dominated (canopy exceeds 20 percent of total surface area) by areas where trees have become established or have encroached onto the site due to the absence of periodic fire. This state is dominated by eastern redcedar and/or Rocky Mountain juniper with cool-season grasses being subdominant. The plant community can develop into a closed canopy that impedes the reproductive capability of the major native perennial grass species. A single eastern redcedar tree with a 7 foot crown diameter eliminates the equivalent of 3 pounds of forage. Further, the forage potential of a pasture with 250 mature eastern redcedar trees per acre (or one tree every thirteen feet) is reduced by 50 percent. It is suggested that reducing stocking rates by 10 percent for every 50 trees per acre. The increase in tree canopy which is a result of a disruption of the natural, and human related fire regimes that occurred prior to European settlement in North America, which kept trees from encroaching much of the grasslands.

Community 4.1
Eastern Redcedar-Rocky Mountain Juniper/Big Bluestem

This plant community evolved due to the invasion of conifers, such as eastern redcedar and Rocky Mountain juniper. This phase was a result of the absence of periodic fire. These events may cause a reduction in warm-season grasses and an increase in cool-season grasses and allow for the encroachment of conifers. The potential plant community is made up of approximately 50 percent grasses and grass-like species, 10 percent forbs, 10 percent shrubs, and 30 percent trees. Dominant grasses and grass-likes include big bluestem, little bluestem, sideoats grama, porcupinegrass, western wheatgrass, and blue grama. As the canopy increases, warm-season grasses tend to decrease as the cool-season grasses increase. Forbs will be diverse. Trees species will include eastern redcedar and Rocky Mountain juniper. When compared to the 1.1 Big Bluestem-Little Bluestem-Sideoats Grams Plant Community, coniferous trees have increased significantly and herbaceous component has decreased. This plant community is susceptible to the encroachment of eastern redcedar and Rocky Mountain juniper.

Community 4.2
Eastern Redcedar-Rocky Mountain Juniper/Kentucky Bluegrass

This plant community phase is a result of heavy, continuous seasonal grazing or heavy, continuous season-long grazing or non-use and/or no surface fire for extended periods of time (typically for 10 or more years). When compared to the 4.1 Eastern Redcedar-Rocky Mountain Juniper/Big Bluestem Plant Community, the amount of non-native invasive cool-season grasses such as Kentucky bluegrass and smooth bromegrass have increased significantly. It is characterized by a dominance of Kentucky bluegrass, smooth bromegrass, and blue grama. The dominance of Kentucky bluegrass is at times so complete that other species are difficult to find on the site. A relatively thick duff layer can sometimes accumulate at or above the soil surface and eventually a thatch-mat layer may develop at the surface as well. Production is limited to the sod-forming species. The period that palatability is

high is relatively short, as Kentucky bluegrass matures rapidly. Infiltration continues to decrease and runoff increases, energy capture into the system is restricted to early season low producing species. Nutrient cycling is limited by root depth of the dominate species. Biological activity in the soil is likely reduced significantly in this phase.

Community 4.3
Eastern Redcedar-Rocky Mountain Juniper

This plant community phase is a result of no surface fire for extended periods of time (typically for 10 or more years). Coniferous trees have increased significantly, and the herbaceous component has decreased. With the dominance of the coniferous trees such as eastern redcedar and Rocky Mountain juniper, the canopy covers the area and grass species are unable to survive. Grass production for livestock is severely limited. Prescribed burning before the juniper species reach maturity and are still susceptible to fire (< 5 foot in height), or mechanical brush management can be used to maintain or recover 4.3 Eastern Redcedar-Rocky Mountain Juniper Plant Community Phase.

Pathway 4.1A
Community 4.1 to 4.2

Non-use, no surface fire for 10 or more years (causing litter levels to become high enough to reduce native grass vigor, diversity, and density), heavy, continuous grazing, or invasion of non-native plant species will shift this plant community to the 4.2 Eastern Redcedar-Rocky Mountain Juniper/Kentucky Bluegrass Plant Community Phase.

Pathway 4.2A
Community 4.2 to 4.3

No surface fire for extended periods of time (typically for 10 or more years) causing litter levels to become high enough to reduce native grass vigor, diversity, and density, will shift this plant community to the 4.3 Eastern Redcedar-Rocky Mountain Juniper Plant Community Phase.

Transition T1A
State 1 to 2

Non-use, no surface fire for 10 or more years (causing litter levels to become high enough to reduce native grass vigor, diversity, and density), heavy, continuous grazing, or invasion of non-native plant species will likely lead this state over a threshold resulting in the Native/Invaded State (State 2).

Transition T1B
State 1 to 4

No surface fire for extended periods of time (typically for 10 or more years) causing litter levels to become high enough to reduce native grass vigor, diversity, and density, and invasion of conifer will likely lead this state over a threshold leading to the 4.1 Eastern Redcedar-Rocky Mountain Juniper/Big Bluestem Plant Community Phase within the Conifer/Invaded State (State 4).

Transition T2A & T2B
State 2 to 3

Non-use and/or no surface fire for extended periods of time (typically for 10 or more years) causing litter levels to become high enough to reduce native grass vigor, diversity, and density, will likely lead this state over a threshold leading to the 3.1 Kentucky Bluegrass-Smooth Bromegrass-Forbs/Shrubs Plant Community Phase within the Invaded State (State 3). Heavy continuous grazing (stocking levels well above carrying capacity for extended portions of the growing season and often at the same time of year each year), will likely lead this state over a threshold leading to the 3.2 Kentucky Bluegrass-Sideoats Grama Plant Community Phase within the Invaded State (State 3). Grazing repeatedly in the early growing season can expedite this shift by causing mechanical disturbance due to trampling.

Restoration pathway T3A
State 3 to 2

Long-term prescribed grazing (moderate stocking levels coupled with adequate recovery periods, or other grazing systems such as high-density, low-frequency intended to treat specific species dominance, or periodic light to moderate stocking levels possibly including periodic rest), prescribed burning occurring every 3 to 5 years, and a return to normal disturbance regime levels and frequencies may lead this Invaded State (State 3) over a threshold to the Native/Invaded State (State 2).

Transition T3B
State 3 to 4

No surface fire for extended periods of time (typically for 10 or more years) causing litter levels to become high enough to reduce native grass vigor, diversity, and density, and invasion of conifer will likely lead this state over a threshold leading to the 4.2 Eastern Redcedar-Rocky Mountain Juniper/Kentucky Bluegrass Plant Community Phase within the Conifer/Invaded State (State 4).

Restoration pathway T4A
State 4 to 1

Brush management (which would include the mechanical removal of the conifers), coupled with prescribed burning every 3 to 5 years, and a return to normal disturbance regime levels and frequencies may lead this 4.1 Eastern Redcedar-Rocky Mountain Juniper/Big Bluestem Plant Community Phase within the Conifer/Invaded State (State 4) over a threshold to the Reference State (State 1).

Restoration pathway T4B & T4D
State 4 to 2

Brush management (which would include the mechanical removal of the conifers), coupled with prescribed burning every 3 to 5 years, and a return to normal disturbance regime levels and frequencies may lead this 4.2 Eastern Redcedar-Rocky Mountain Juniper/Kentucky Bluegrass Plant Community Phase within the Conifer/Invaded State (State 4) over a threshold to the Native/Invaded State (State 2). Brush management (which would include the mechanical removal of the conifers), coupled with prescribed burning every 3 to 5 years, and a return to normal disturbance regime levels and frequencies may lead this 4.3 Eastern Redcedar-Rocky Mountain Juniper Plant Community Phase within the Conifer/Invaded State (State 4) over a threshold to the Native/Invaded State (State 2).

Restoration pathway T4C
State 4 to 3

Brush management, which would include the mechanical removal of the conifers, may lead this 4.2 Eastern Redcedar-Rocky Mountain Juniper/Kentucky Bluegrass Plant Community Phase within the Conifer/Invaded State (State 4) over a threshold to the Invaded State (State 3).

Additional community tables

Other information

Ecological Site Correlation Issues and Questions:

• Reference and alternative states within the state and transition model are may not be fully documented and may require additional field sampling for refinement.

Inventory data references

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range-trained personnel were also used. Those involved in developing this site include: Stan Boltz, Range Management Specialist, NRCS; and Bruce Kunze, Soil Scientist, NRCS.

Data Source Sample Period State County
None

Other references

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Approval

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This Provisional Ecological Site concept has passed both Quality Control and Quality Assurance processes. Officially approved for publication by David Kraft as of 11/12/2020.

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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	02/01/2024
Approved by	Suzanne Mayne-Kinney
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):**

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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

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

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

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:**