USDA Natural Resources Conservation Service

Ecological site R063BY017SD
Shallow Clay

Accessed: 05/11/2025

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.

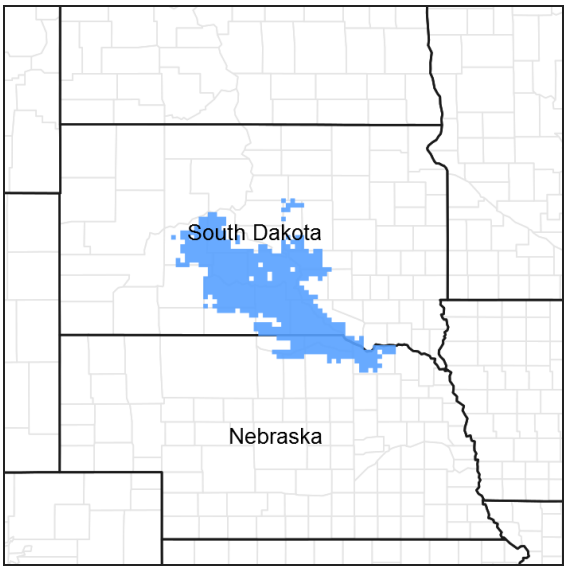


Figure 1. Mapped extent

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): 063B–Southern Rolling Pierre Shale Plains

MLRA Notes:
The Southern Rolling Pierre Shale Plains (MLRA 63B) is approximately 4,460 square miles in size. The majority of the MLRA is located in South Dakota (82 percent), and the remaining 18 percent is located in Nebraska. Interstate 90 crosses the northern portion through Chamberlin, SD. There are several American Indian Reservations, including the Lower Brule, Crow Creek, Santee, and Yankton Reservations.
This MLRA is an area of old plateaus and terraces that have been deeply eroded, with nearly level to rolling long slopes and well-defined dendritic drainage systems. The rivers and creek valleys have smooth floors and steep walls. The majority of the MLRA is located in the unglaciated section of the Missouri Plateau, Great Plains Province. The northeast corner of the MLRA, east of the Missouri River, is located in the glaciated section with higher areas with deposits of glacial drift. The southwestern tip is located in the High Plains Section.
Elevations range from 1,310 feet to 1,640 feet on the bottom lands along the Missouri River, and from 1,310 feet to 1,970 feet on the shale plains uplands.
The Missouri and Niobrara Rivers, and the confluence of the White and Missouri Rivers, occur within this MLRA. Lake Francis Case, Fort Randall Dam, and Lewis and Clark Lake are also within this MLRA's borders.
Cretaceous Pierre Shale underlies most of the area. This is a marine sediment with layers of volcanic ash that has been altered to smectitic clays. These clays shrink as they dry and swell as they become wet, causing significant problems for road and structural foundations.
Younger Niobrara chalk occurs in the southern part of the MLRA. Alluvial sand and gravel underlie the valley floors

along major streams.

Soils are shallow to very deep, generally well drained, and with loamy or clayey textures. Annual precipitation is 19 to 26 inches, mostly falling during the growing season, as frontal storms during the spring and convective thunderstorms in summer. The average annual temperature is 45°-50°F. The freeze-free period averages 165 days, and ranges from 145 to 185 days.

Vegetation is a transition between tall prairie grasses and mixed prairie grasses. Green needlegrass, porcupinegrass, western wheatgrass, and big bluestem are the major species. Little bluestem, buffalograss, sideoats grama, and sedges are dominant on the shallow soils. Buffaloberry, skunkbush sumac, and prairie rose are common on steep slopes along the major streams. Prairie cottonwood and a variety of willow species are common on flood plains along the major streams. Green ash, boxelder, chokecherry, bur oak, and buffaloberry occur in draws and narrow valleys. Encroachment of Rocky Mountain juniper and eastern redcedar onto the river breaks is becoming a concern.
The majority of the land is utilized for ranching (60 percent) and farming (27 percent). Major resource concerns for the area are wind erosion, water erosion, maintenance of the content of organic matter and soil productivity, and management of soil moisture.

Classification relationships

USDA - Land Resource Region G – Western Great Plains Range and Irrigated Region, Major Land Resource Area (MLRA) 63B – Southern Rolling Pierre Shale Plains (USDA-NRCS, Ag Handbook 296).

EPA - Level IV Ecoregions of the Continental United States:

Northwestern Glaciated Plains - 42f – Southern Missouri Coteau Slopes, 42g – Ponca Plains, 42h – Southern River Breaks, 42p – Holt Tablelands

North Western Great Plains - 43C – River Breaks, 43f – Subhumid Pierre Shale Plains, 43r – Niobrara River Breaks.

Ecological site concept

The Shallow Clay ecological site occurs throughout the MLRA 63B. It is located on upland landscapes and does not receive additional moisture from run off or overflow. Typical slopes range from 9 to 45 percent. Soils are shallow, between 10 and 20 inches deep with clay, silty clay, or silty clay loam surface textures 2 to 8 inches thick. Soils are typically calcareous above the bedrock. Fine to very fine soft weathered shale fragment are common (up to 50 percent by volume) below 4 inches. The shale bedrock is often fractured in the upper part, and some fine roots can be found extending up to 30 inches below the surface. The vegetation in Reference consists of a mix of cool- and warm-season grasses. Major grasses include western wheatgrass, big bluestem, needlegrasses, little bluestem, and sideoats grama. Forbs are common and diverse, shrubs include leadplant, rose, skunkbush sumac, western snowberry, and yucca. Deciduous trees can become established in swales and slump areas on north- and east-facing slopes. This site is susceptible to encroachment by juniper species.

Associated sites

R063BY010SD	**Loamy** The Loamy site can be located adjacent to or downslope of the Shallow Clay site.
R063BY011SD	**Clayey** The Clayey site can be located adjacent to or downslope of the Shallow Clay site.
R063BY012SD	**Thin Upland** The Thin Upland site can be found adjacent to the Shallow Clay site.

Similar sites

R063BY012SD	**Thin Upland** The Thin Upland site will have a loamy soil surface texture and carbonates at or near the surface. It will also tend to have more little bluestem, needle and thread, and porcupinegrass than the Shallow Clay site.
R063BY011SD	**Clayey** The Clayey site will tend to have less big bluestem and higher forage production.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Nassella viridula* (2) *Andropogon gerardii*

Physiographic features

This site occurs on moderately to steeply sloping uplands.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge (3) Plain
Elevation	1,300–2,000 ft
Slope	9–45%
Aspect	Aspect is not a significant factor

Climatic features

MLRA 63B is considered to have a continental climate, with cold winters and hot summers, low humidity, light rainfall, and ample 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 18 to 25 inches per year. The average annual temperature is about 48°F. January is the coldest month with average temperatures ranging from about 15°F (Stephan, SD), to about 22°F (Winner, SD). July is the warmest month with temperatures averaging from about 73°F (Stephan, SD), to about 76°F (Winner, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 56°F. This large annual range attests to the continental nature of this area's climate. Hourly winds are estimated to average about 11 miles per hour (mph) annually, ranging from about 13 mph during the spring to about 10 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 (average)	133 days
Freeze-free period (average)	150 days
Precipitation total (average)	24 in

Climate stations used

- (1) STEPHAN 2 NW [USC00397992], Highmore, SD
- (2) WINNER [USC00399367], Winner, SD
- (3) LYNCH [USC00255040], Lynch, NE
- (4) PICKSTOWN [USC00396574], Lake Andes, SD
- (5) NIOBRARA [USC00255960], Niobrara, NE
- (6) GANN VALLEY 4NW [USC00393217], Gann Valley, SD
- (7) WOOD [USC00399442], Wood, SD

Influencing water features

No riparian areas or wetland features are directly associated with this site.

Soil features

The common features of soils in this site are the silty clay or clay textured surface soils with slopes of 0 to 40 percent. The soils in this site are shallow to soft shale bedrock, well-drained, and formed in residuum weathered from clayey shale. The surface layer is 2 to 6 inches thick and has slow to very slow permeability and low to moderately low saturated hydraulic conductivity. The subsoil is typically silty clay or clay. Carbonates, gypsum, or other salts are found in the subsoil of some soils but not others. The subsoil is characterized by a high clay content resulting in very slow permeability and very low or low saturated hydraulic conductivity. The subsoil also contains 15 to 65 percent of soft shale chips or parachanners. Subsurface soil layers are non-restrictive to water movement and root penetration. The upper part of the bedrock, which starts at 12 to 20 inches below the surface, is highly degraded, soft shale that some plant roots can penetrate. Typically around 30 to 35 inches below the surface, the bedrock becomes more consolidated and this harder, impervious shale is virtually impenetrable to plant roots.

When dry these soils crack due to the high shrink-swell potential of smectitic clays. When the soils are wet, surface compaction can occur with heavy traffic. This site is not flooded or ponded and there is no zone of water saturation within a depth of 72 inches. The soils have a slow to very slow infiltration rate.

This site should show slight to no evidence of rills, wind scoured areas, or pedestalled plants. Water flow paths are broken, irregular in appearance, or discontinuous with numerous debris dams or vegetative barriers.

Major soils correlated to the Shallow Clay ecological site include: Okaton, Orella, Samsil, and Sansarc.

These soils are mainly susceptible to water erosion. The hazard of water erosion increases on slopes greater than about 15 percent. Low available water capacity and very slow permeability strongly influences the soil-water-plant relationship.

Access Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) for specific local soils information.

Table 4. Representative soil features

Parent material	(1) Residuum–clayey shale
Surface texture	(1) Clay (2) Silty clay loam (3) Silty clay
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Very slow to slow
Soil depth	12–18 in
Surface fragment cover <=3"	1–2%
Surface fragment cover >3"	0–23%
Available water capacity (0-40in)	1–2 in

Calcium carbonate equivalent (0-40in)	0–25%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–1
Soil reaction (1:1 water) (0-40in)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	1–4%
Subsurface fragment volume >3" (Depth not specified)	0–21%

Ecological dynamics

This site developed under Northern Great Plains climatic conditions, natural influences of large herbivores, occasional fire, and other biotic and abiotic factors that typically influence soil/site development. Changes will occur in the plant communities due to short-term weather variations, impacts of native and/or exotic plant and animal species, and management actions. While the following plant community descriptions specify more typical transitions between communities that will occur, severe disturbances, such as periods of well below-average precipitation, can cause significant shifts in plant communities and/or species composition.

Continuous season-long grazing (during the typical growing season of May through October) and/or repeated seasonal grazing (e.g., every spring, every summer) without adequate recovery periods following each grazing occurrence causes this site to depart from the Needlegrass- Bluestem-Western Wheatgrass Plant Community (1.1). Sedge and other shortgrasses will increase and eventually develop into a sod. Little bluestem will increase initially and then begin to decrease. Green needlegrass, needle and thread, porcupinegrass, sideoats grama, big bluestem, and western wheatgrass will decrease in frequency and production. Extended periods of non-use and/or lack of fire will result in excessive litter and a plant community dominated by cool-season grasses such as western wheatgrass, bluegrass, smooth brome, and cheatgrass.

Natural soil slumping of north- and east-facing slopes due to increased hydrology can often develop into a diverse hardwood tree and shrub plant community, given adequate time and the absence of fire. All slopes are susceptible to the encroachment of eastern redcedar and Rocky Mountain juniper in the absence of fire.

Interpretations are primarily based on the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1). This was 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 grazed to lightly grazed areas, seasonal use pastures, and historical accounts also have been used. Plant community phases, states, transitional pathways, and thresholds have been determined through similar studies and experience.

The following is a diagram that illustrates the common plant community phases that can occur on the site and the transition pathways between communities. These are the most common plant community phases based on current knowledge and experience, and changes may be made as more data is collected. Narratives following the diagram contain more detail pertaining to the ecological processes.

State and transition model

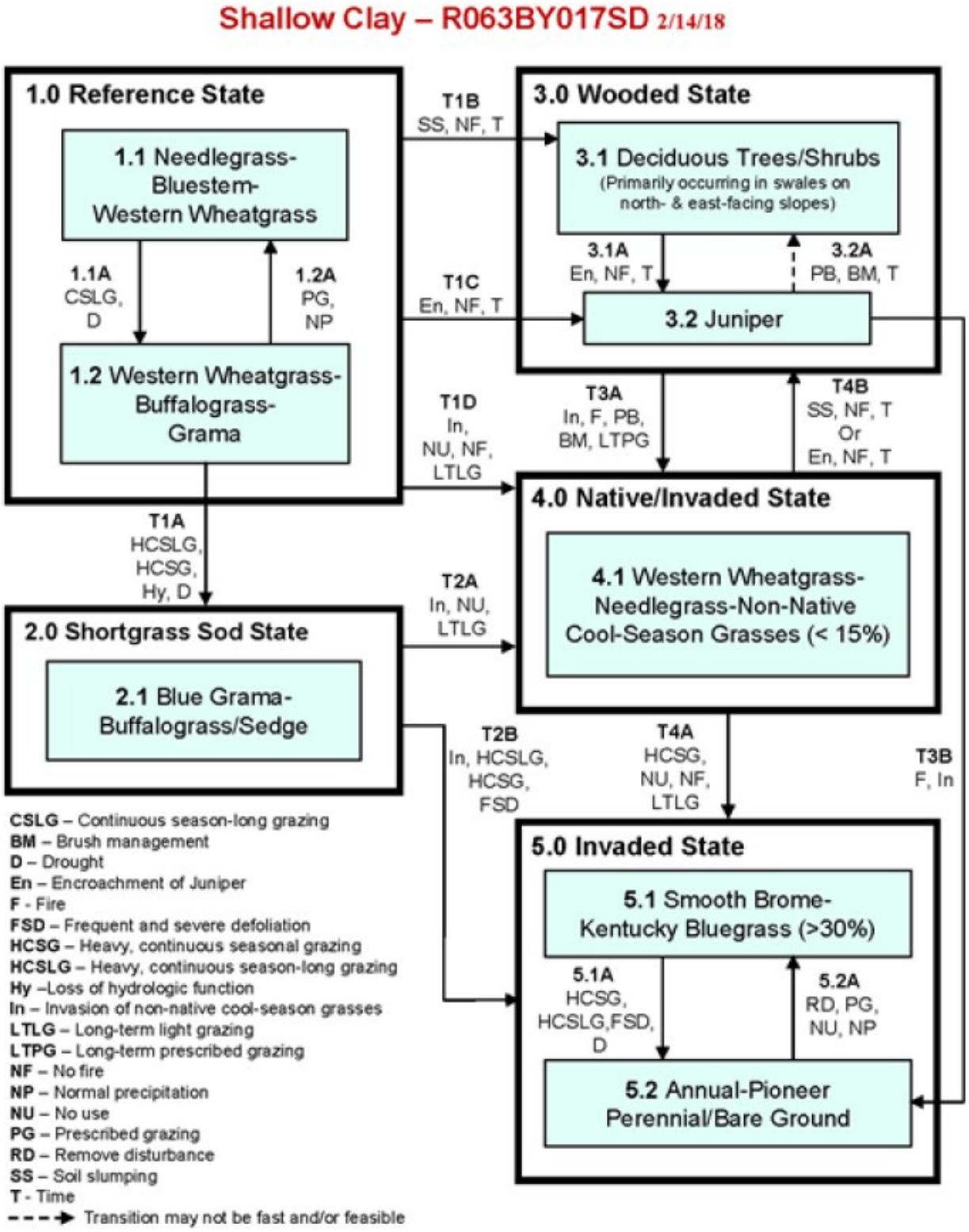


Figure 6. Shallow Clay - R063BY017SD.

State 1
Reference State

This State represents the natural range of variability that dominates the dynamics of this ecological site. This State is codominant by cool- and warm-season grasses. In pre-European times, the primary disturbance mechanisms for this site in the reference condition included frequent fire and grazing by large herding ungulates. Timing of fires and grazing coupled with weather events dictated the dynamics that occurred within the natural range of variability. Today, this State 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. The dominant cool- and warm-season species can decline and a corresponding increase in short statured species will occur with continuous seasonal grazing.

Community 1.1
Needlegrass-Bluestem-Western Wheatgrass

Figure 7. Shallow Clay - PCP 1.1.

Figure 8. Shallow Clay - PCP 1.1.

Interpretations are based primarily on the Needlegrass-Bluestem-Western Wheatgrass Plant Community (this is also considered to be Reference Plant Community). The potential vegetation is about 80 percent grasses or grass-like plants, 10 percent forbs, 8 percent shrubs, and 2 percent trees. The community is dominated by both cool- and warm-season grasses. The major grasses include western wheatgrass, big bluestem, green needlegrass, sideoats grama, and little bluestem. Other grass and grass-like species include needle and thread, porcupinegrass, blue grama, buffalograss, and sedges. This plant community is resilient and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high tolerance for drought. This is a sustainable plant community in regard to site/soil stability, watershed function, and biologic integrity.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1260	1903	2505
Forb	100	165	250
Shrub/Vine	40	110	200
Tree	0	22	45
Total	**1400**	**2200**	**3000**

Figure 10. Plant community growth curve (percent production by month). SD6303, Pierre Shale Plains, cool/warm-season codominant.. Cool-season,

warm-season codominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	20	28	21	10	5	3	0	0

Community 1.2
Western Wheatgrass-Buffalograss-Grama

This plant community developed under continuous seasonal grazing or from over-utilization during extended drought periods. The potential plant community is made up of approximately 83 percent grasses and grass-like species, 10 percent forbs, 5 percent shrubs, and 2 percent trees. Dominant grasses include western wheatgrass, buffalograss, blue grama, and sideoats grama. Grasses of secondary importance include sedge, green needlegrass, Kentucky bluegrass, and tall dropseed. Forbs commonly found in this plant community include white sagebrush (cudweed sagewort), goldenrod, and Cuman rageweed (western ragweed). When compared to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1), blue grama and buffalograss have increased. Needlegrasses and tall warm-season grasses have decreased, and production has also been 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.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	705	1320	1820
Forb	70	113	165
Shrub/Vine	25	53	80
Tree	0	14	35
Total	**800**	**1500**	**2100**

Figure 12. Plant community growth curve (percent production by month). SD6303, Pierre Shale Plains, cool/warm-season codominant.. Cool-season, warm-season codominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	20	28	21	10	5	3	0	0

Pathway 1.1A
Community 1.1 to 1.2

Continuous seasonal grazing which includes grazing at moderate to heavy stocking levels at the same time of year each year, or a combination of disturbances such as extended periods of below-average precipitation coupled with periodic heavy grazing will shift this community to the Western Wheatgrass-Buffalograss-Grama Plant Community (1.2).

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 a return to normal precipitation patterns, will convert this plant community to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1).

Conservation practices

Prescribed Grazing

State 2
Shortgrass Sod State

This State is dominated by warm-season shortgrass species and upland sedges. It is the result of grazing practices that remove the mid-statured cool- and warm-season grasses, and provide a competitive advantage to shortgrasses and grass-like species that are grazing-resistant. Water infiltration has decreased and runoff has increased in this State. This State is very resilient and resistant to change through grazing management alone. Because of the prevalence of non-native cool-season grasses in this MLRA, a restoration pathway back to the Reference State (1.0) is unlikely.

Community 2.1
Blue Grama-Buffalograss/Sedge

This plant community evolved under heavy, continuous season-long grazing or from over-utilization during extended drought periods. The potential plant community is made up of approximately 85 percent grasses and grass-like species, 10 percent forbs, 6 percent shrubs, and 2 percent trees. Dominant grass and grass-like species include sedge, buffalograss, blue grama, and sideoats grama. Grasses of secondary importance include needle and thread, bluegrass, annual brome, and smooth brome. Forbs commonly found in this plant community include white sagebrush (cudweed sagewort), goldenrod, and sweetclover. When compared to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1), short-statured species are dominant on this plant community. Tall/mid cool- and warm-season grasses have decreased significantly. This plant community is very resistant to change. The herbaceous species present are well adapted to grazing; however, composition can be altered through long-term prescribed grazing. This plant community is less productive than most other phases. The thick sod prevents other species from becoming established. Lack of litter and reduced plant vigor causes higher soil temperatures, poor water infiltration rates, and high evapotranspiration, which gives the short- statured species a competitive advantage. Soil erosion will be minimal due to the sod-forming habit of dominant species in this phase.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	445	788	1230
Forb	40	68	95
Shrub/Vine	15	36	55
Tree	0	8	20
Total	**500**	**900**	**1400**

Figure 14. Plant community growth curve (percent production by month). SD6303, Pierre Shale Plains, cool/warm-season codominant.. Cool-season, warm-season codominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	20	28	21	10	5	3	0	0

State 3
Wooded State

This State consists of areas where trees have become established or have encroached onto the site. There are at least two distinct plant communities in this State. One is the establishment of deciduous trees and shrubs in swales and/or areas where soil slumping has occurred. The second plant community is the establishment and expansion of eastern redcedar and/or Rocky Mountain juniper. The latter plant community can develop into a closed canopy that impedes the reproductive capability of the major native perennial grass species. In either case, the increase in tree canopy is a result of a disruption of the natural, and human related fire regimes that occurred prior to European settlement, which kept trees at an immature stage.

Community 3.1

Deciduous Trees/Shrubs

Figure 15. Shallow Clay - PCP 3.1.

Figure 16. Shallow Clay - PCP 3.1.

This plant community can develop in swales and areas where slopes have slumped due to increased hydrology beyond the point where the slope remains stable. These areas typically occur in north- or east-facing slopes that tend to be cooler and wetter. The tree canopy can exceed 20 percent when mature. 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 western wheatgrass, green needlegrass, Canada wildrye, sideoats grama, little bluestem, and sedges. As the canopy increases, warm-season grasses tend to decrease as the cool- season grasses increase. Forbs will be diverse. Shrubs will include western snowberry, sumac, currant, and rose. Trees species can include, green ash, bur oak, American elm, hackberry and juniper. Compared to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1), deciduous trees have increased significantly and herbaceous component has decreased. This plant community is susceptible to the encroachment of eastern redcedar and Rocky Mountain juniper.

Figure 17. Plant community growth curve (percent production by month). SD6304, Pierre Shale Plains, warm-season dominant, cool-season subdominant. Warm-season dominant, cool-season subdominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	7	17	25	25	15	7	1	0	0

Community 3.2
Juniper

Figure 18. Shallow Clay - PCP 3.2.

The Juniper plant community develops under non-use, no fire, and encroachment by eastern redcedar, Rocky Mountain juniper, and/or by deciduous trees occasionally, such as bur oak. These species expand on this site due to suppression of fire. The tree canopy is 15 percent or greater. The potential plant community is made up of approximately 48 percent grasses and grass-like species, 10 percent forbs, 7 percent shrubs, and 35 percent trees. Dominant grasses and grass-likes include western wheatgrass, green needlegrass, Canada wildrye, sideoats grama, little bluestem, and sedges. As the canopy increases, warm-season grasses tend to decrease as the cool-season grasses initially increase. Forbs commonly found in this community include white sagebrush (cudweed sagewort), goldenrod, and sweetclover. Non-native species such as annual brome grasses and bluegrass will tend to invade. Compared to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1), juniper increases significantly. The grass component decreases dramatically as the buildup of juniper needles increases. Annual herbaceous production also decreases significantly. While the juniper canopy provides excellent protection from the weather for both livestock and wildlife, it is not capable of supporting large numbers of wildlife and livestock due to decreased production. The type of wildlife utilizing this site will change as the juniper canopy increases. This is especially evident in avian species, where grassland birds will eventually be replaced by generalist or woodland birds. A significant reduction of juniper can be accomplished through brush management or fire, however, eastern redcedar mortality decreases as tree size increases. This is due to relatively thicker bark, sparse fine fuels beneath the canopy, and greater vertical distance of the upper foliage from lethal temperatures. Prescribed burning can result in an 88 percent mortality when juniper are less than 4 feet in height but only a 35 percent mortality when trees exceed 7 feet in height (Owensby et.al., 1973; Ortmann et.al., 1988). Because eastern redcedar and Rocky Mountain juniper are non-sprouting species, mechanical removal is 100 percent effective if the stem is cut at ground level.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	525	882	955
Tree	185	350	585
Forb	65	105	155
Shrub/Vine	25	63	105
Total	**800**	**1400**	**1800**

Figure 20. Plant community growth curve (percent production by month). SD6311, Pierre Shale Plains, heavy conifer canopy.. Mature eastern redcedar overstory..

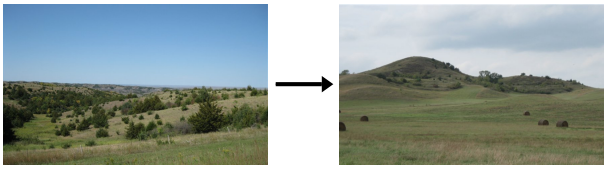
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	7	11	24	27	12	5	4	3	2	1

Pathway 3.1A
Community 3.1 to 3.2

Deciduous Trees/Shrubs Juniper

Encroachment of eastern redcedar and/or Rocky Mountain juniper, no fire, and time can convert this plant community to a juniper-dominated plant community (3.2).

Pathway 3.2A
Community 3.2 to 3.1



Juniper Deciduous Trees/Shrubs

Prescribed burning while deciduous trees are in dormancy and 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 the Deciduous Trees/Shrub Plant Community (3.1).

Conservation practices

Brush Management
Prescribed Burning

State 4
Native/Invaded State

This State has been invaded by smooth brome and/or Kentucky bluegrass but not at the levels where the plant community is dominated by these species. This State is ‘At Risk’ of transitioning to the Invaded State (5.0) which is dominated by smooth brome and/or Kentucky bluegrass. Prescribed burning and/or chemical herbicides, along with targeted grazing, can be used to reduce the amount of smooth brome and Kentucky bluegrass in the plant community, but it will not be completely removed. At this point a restoration pathway to the Reference State (1.0) does not exist.

Community 4.1
Western Wheatgrass-Needlegrass-Non-Native Cool-Season Grasses (< 15%)

This plant community develops when smooth brome or Kentucky bluegrass become established on the site This may occur due to the close proximity to seed sources or expansion from road ditches, improved pastures, or other invaded sites. No use and no fire or very light stocking rates for long periods of time will allow these non-native cool-season grasses to increase in the plant community. These two species will not exceed 15 percent of the total annual production. Plant litter accumulates in large amounts when this community first develops. Litter buildup reduces mature native plant vigor and density, and seedling recruitment declines. Eventually litter levels become high enough that plant density decreases. Typically, rhizomatous grasses form small colonies because of a lack of tiller stimulation. The potential vegetation is made up of 80 to 85 percent grass or grass-like plants, 5 to 10 percent forbs, 5 percent shrubs, and 2 percent trees. The dominant grasses will be western wheatgrass, needlegrasses, and non-native cool-season grasses, primarily smooth brome and/or Kentucky bluegrass. Warm-season grasses will include patches of big bluestem, little bluestem, and sideoats grama. Forbs will be diverse. Shrubs will include leadplant, rose, and western snowberry. Total annual production will be somewhat less than the Reference Plant Community (1.1).

Table 9. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1180	1557	1800
Forb	85	135	200
Shrub/Vine	35	90	160
Tree	0	18	40
Total	**1300**	**1800**	**2200**

Figure 22. Plant community growth curve (percent production by month). SD6303, Pierre Shale Plains, cool/warm-season codominant.. Cool-season, warm-season codominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	20	28	21	10	5	3	0	0

State 5
Invaded State

This State is the result of invasion and dominance of introduced species. This State is characterized by the dominance of smooth brome and/or Kentucky bluegrass, and an increasing thatch layer that effectively blocks introduction of other plants into the system. Plant litter accumulation tends to favor the more shade-tolerant, introduced grass species. The nutrient cycle is also impaired, and the result is typically a higher level of nitrogen, which also favors the introduced species. Increased plant litter decreases the amount of sunlight reaching plant crowns, thereby shifting competitive advantage to shade-tolerant, introduced grass species. Studies indicate that soil biological activity is altered, and this shift apparently exploits the soil microclimate and encourages growth of the introduced grass species. Once the threshold is crossed, a change in grazing management alone cannot cause a reduction in the invasive grass dominance. 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. Plant communities dominated by Kentucky bluegrass have significantly less cover and diversity of native grasses and forb species (Toledo, D. et al., 2014). Smooth brome is assumed to follow a similar ecological threshold, but that is not documented scientifically.

Community 5.1
Smooth Brome-Kentucky Bluegrass (> 30%)

This plant community can be the result of extended periods of non-use and no fire, or heavy, continuous seasonal grazing (stocking levels well above carrying capacity for extended portions of the growing season, and at the same time of year each year), or long-term light grazing. It is characterized by a dominance of smooth brome and/or Kentucky bluegrass. The dominance is at times so complete that other species are difficult to find on the site. A thick duff layer may also accumulate at or above the soil surface. Nutrient cycling is greatly reduced, and native plants have great difficulty becoming established. When dominated by smooth brome, 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 during which palatability is high is relatively short, as these cool-season species mature rapidly. Photosynthetic energy capture is also reduced.

Figure 23. Plant community growth curve (percent production by month). SD6301, Pierre Shale Plains, cool-season dominant.. Cool-season dominant on uplands..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	4	12	25	36	10	5	4	4	0	0

Community 5.2
Annual-Pioneer Perennial/Bare Ground

This plant community evolved under heavy, continuous grazing or from overutilization during extended drought periods. The potential plant community is made up of approximately 50 to 80 percent grasses and grass-like species, 10 to 25 percent forbs, and 5 to 25 percent shrubs and trees. The dominant species are highly variable in this phase, often consisting of invasive species such as annual brome, smooth brome, Kentucky bluegrass, and invasive forbs. Other plant species, from adjacent ecological sites, can become minor components of this plant community. This plant community is susceptible to invasion of Canada thistle and other non-native species because of the relatively high percentage of bare ground. Compared to the Needlegrass-Bluestem-Western Wheatgrass Plant Community (1.1), annual brome, invasive forbs, and percentage of bare ground have increased. Western wheatgrass, needlegrasses, and other cool-season grasses and grass-like species have decreased as have the warm-season species including big bluestem, sideoats grama, little bluestem, plains muhly, and prairie dropseed. 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.

Figure 24. Plant community growth curve (percent production by month). SD6301, Pierre Shale Plains, cool-season dominant.. Cool-season dominant on uplands..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	4	12	25	36	10	5	4	4	0	0

Pathway 5.1A
Community 5.1 to 5.2

Heavy, continuous seasonal or season-long grazing, or frequent and severe defoliation, and extended periods of drought, will convert this plant community to the Annual-Pioneer Perennial/Bare Ground Plant Community (5.2).

Pathway 5.2A
Community 5.2 to 5.1

Removal of management-induced disturbance, followed by prescribed grazing (alternating season of use and providing adequate recovery periods), or periodic light to moderate grazing, possibly including periodic rest, and a return to normal precipitation patterns will convert this plant community to the Smooth Brome-Kentucky Bluegrass greater than 30%) Plant Community (5.1).

Conservation practices

Prescribed Grazing

Transition T1A
State 1 to 2

Heavy, continuous seasonal grazing (stocking levels well above carrying capacity for extended portions of the growing season, and at the same time of year each year, typically beginning early in the season) or heavy, continuous season-long grazing will convert this plant community to the Shortgrass Sod State (2.0).

Transition T1B
State 1 to 3

A diverse hardwood tree and shrub plant community (3.1) can develop with an increase in hydrology, typically occurring on north- and east- facing slopes, causing the soils to slump or slide. This disturbance provides the opportunity for hardwood trees to establish in the absence of fire.

Transition T1C
State 1 to 3

No fire for extended periods of time and the encroachment of juniper species will lead the Reference State (1.0) across a threshold to a Juniper Plant Community (3.2). This is a result of a disruption of the natural and human related fire regimes that occurred prior to European settlement. This transition can occur in combination with heavy grazing, long-term light grazing, or no grazing.

Transition T1D
State 1 to 4

Invasion of non-native cool-season grasses, no use and no fire for extended periods of time (typically for 10 or more years), or long-term light grazing will likely lead this State over a threshold. This will result in transition to the Native/Invaded State (4.0), which can contain up to 15 percent non-native cool-season grasses in the plant community.

Transition T2A
State 2 to 4

Non-use or long-term light grazing and invasion of non-native cool-season grasses will transition the Shortgrass Sod State (2.0) to the Native/Invaded State (4.0).

Transition T2B
State 2 to 5

Invasion of non-native cool-season grasses, in combination with heavy, continuous seasonal grazing (stocking levels well above carrying capacity for extended portions of the growing season, and at the same time of year each year, typically beginning early in the season) or heavy, continuous season-long grazing, or frequent and severe defoliation will convert this plant community to the Invaded State (5.0).

Transition T3A
State 3 to 4

Invasion of non-native, cool-season grasses, fire, prescribed burning, or brush management, in conjunction with long-term prescribed grazing may lead this plant community across a threshold to the Native/Invaded State (1.0). This would have to take place before the trees reach maturity and are still susceptible to fire and reproductive propagules of the perennial grasses are still present.

Transition T3B
State 3 to 5

Wildfire intense enough to kill mature trees, and the invasion of non-native cool-season grasses, will cause this plant community to cross a threshold and lead to the Invaded State (5.0) and specifically to the Annual-Pioneer Perennial/Bare Ground Plant Community (5.2).

Transition T4B
State 4 to 3

A diverse hardwood tree and shrub plant community (3.1) can develop with an increase in hydrology, typically occurring on north- and east-facing slopes, causing the soils to slump or slide. This disturbance provides the opportunity for hardwood trees to establish in the absence of fire. Another possibility is caused by no fire for extended periods of time and the encroachment of juniper species. This will lead the Native/Invaded State (4.0) across a threshold to a Juniper Plant Community (3.2). This is a result of a disruption of the natural, and human related fire regimes, which occurred prior to European settlement, allowing juniper to establish and persist on the site.

Transition T4A
State 4 to 5

Heavy, continuous seasonal grazing, or no use and no fire, or long-term light grazing will cause a transition from this State to the Invaded State (5.0). The ecological threshold can be identified by the percentage of non-native cool-season species in the Plant Community. 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 (Toledo, D. et al., 2014). Smooth brome is assumed to follow a similar ecological threshold, but that is not documented scientifically.

Additional community tables

Table 10. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool-Season Bunchgrasses**			330–550	
	green needlegrass	NAVI4	*Nassella viridula*	220–440	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	44–220	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	44–220	–
	Canada wildrye	ELCA4	*Elymus canadensis*	0–110	–
2	**Tall Warm-Season Grasses**			220–550	
	big bluestem	ANGE	*Andropogon gerardii*	220–550	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–176	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–110	–
3	**Wheatgrass**			220–550	
	western wheatgrass	PASM	*Pascopyrum smithii*	220–550	–
4	**Mid Warm-Season Grasses**			220–440	
	sideoats grama	BOCU	*Bouteloua curtipendula*	110–330	–
	little bluestem	SCSC	*Schizachyrium scoparium*	110–330	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	0–110	–
5	**Short Warm-Season Grasses**			22–110	
	buffalograss	BODA2	*Bouteloua dactyloides*	22–110	–
	blue grama	BOGR2	*Bouteloua gracilis*	22–110	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–66	–
6	**Other Native Grasses**			22–110	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	0–110	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	22–66	–
7	**Grass-likes**			22–110	
	sedge	CAREX	*Carex*	22–110	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–66	–
8	**Non-Native Grasses**			0	
Forb					
9	**Forbs**			110–220	
	Forb, native	2FN	*Forb, native*	22–88	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	22–66	–

	false boneset	BREU	*Brickellia eupatorioides*	0–44	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	22–44	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	22–44	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	22–44	–
	dotted blazing star	LIPU	*Liatris punctata*	22–44	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	0–44	–
	beardtongue	PENST	*Penstemon*	0–44	–
	scurfpea	PSORA2	*Psoralidium*	22–44	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	22–44	–
	goldenrod	SOLID	*Solidago*	22–44	–
	white heath aster	SYER	*Symphyotrichum ericoides*	22–44	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–22	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–22	–
	milkweed	ASCLE	*Asclepias*	0–22	–
	textile onion	ALTE	*Allium textile*	0–22	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–22	–
	alpine golden buckwheat	ERFLF	*Eriogonum flavum var. flavum*	0–22	–
Shrub/Vine					
10	**Shrubs**			44–176	
	leadplant	AMCA6	*Amorpha canescens*	22–88	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–66	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–44	–
	rose	ROSA5	*Rosa*	22–44	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	22–44	–
	soapweed yucca	YUGL	*Yucca glauca*	22–44	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	–
Tree					
11	**Trees**			0–44	
	Tree	2TREE	*Tree*	0–44	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–44	–
	eastern redcedar	JUVI	*Juniperus virginiana*	0–44	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–44	–

Table 11. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool-Season Bunchgrasses**			30–150	
	green needlegrass	NAVI4	*Nassella viridula*	0–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–45	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–45	–
2	**Tall Warm-Season Grasses**			0–150	
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–150	–

			compositae		
	big bluestem	ANGE	*Andropogon gerardii*	0–75	–
3	**Wheatgrass**			225–450	
	western wheatgrass	PASM	*Pascopyrum smithii*	225–450	–
4	**Mid Warm-Season Grasses**			30–150	
	sideoats grama	BOCU	*Bouteloua curtipendula*	30–150	–
	little bluestem	SCSC	*Schizachyrium scoparium*	0–75	–
5	**Short Warm-Season Grasses**			75–300	
	buffalograss	BODA2	*Bouteloua dactyloides*	30–225	–
	blue grama	BOGR2	*Bouteloua gracilis*	15–120	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	15–120	–
6	**Other Native Grasses**			15–75	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	0–75	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	15–45	–
7	**Grass-likes**			30–150	
	sedge	CAREX	*Carex*	30–150	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–75	–
8	**Non-Native Grasses**			0–150	
	smooth brome	BRIN2	*Bromus inermis*	0–150	–
	bluegrass	POA	*Poa*	0–75	–
	brome	BROMU	*Bromus*	0–30	–
Forb					
9	**Forbs**			75–150	
	sweetclover	MELIL	*Melilotus*	0–150	–
	Forb, introduced	2FI	*Forb, introduced*	0–75	–
	Forb, native	2FN	*Forb, native*	0–45	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	15–45	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	15–45	–
	goldenrod	SOLID	*Solidago*	15–45	–
	white heath aster	SYER	*Symphyotrichum ericoides*	15–30	–
	field pennycress	THAR5	*Thlaspi arvense*	0–30	–
	scurfpea	PSORA2	*Psoralidium*	0–30	–
	common pepperweed	LEDE	*Lepidium densiflorum*	0–30	–
	dotted blazing star	LIPU	*Liatris punctata*	0–15	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–15	–
	milkweed	ASCLE	*Asclepias*	0–15	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	0–15	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–15	–
Shrub/Vine					
10	**Shrubs**			30–75	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–45	–
	soapweed yucca	YUGL	*Yucca glauca*	15–45	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–30	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–30	–

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	western snowberry	SYOC	*Symphoricarpos occidentalis*	15–30	–
	rose	ROSA5	*Rosa*	0–15	–
	leadplant	AMCA6	*Amorpha canescens*	0–15	–
Tree					
11	**Trees**			0–30	
	Tree	2TREE	*Tree*	0–30	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–30	–
	eastern redcedar	JUVI	*Juniperus virginiana*	0–30	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–30	–

Table 12. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool-Season Bunchgrasses**			9–63	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–54	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–27	–
	green needlegrass	NAVI4	*Nassella viridula*	0–27	–
2	**Tall Warm-Season Grasses**			0	
3	**Wheatgrass**			0–45	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–45	–
4	**Mid Warm-Season Grasses**			0–45	
	sideoats grama	BOCU	*Bouteloua curtipendula*	0–45	–
5	**Short Warm-Season Grasses**			9–90	
	buffalograss	BODA2	*Bouteloua dactyloides*	0–63	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–45	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–45	–
6	**Other Native Grasses**			9–45	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	0–45	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	9–27	–
7	**Grass-likes**			135–360	
	sedge	CAREX	*Carex*	135–360	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–72	–
8	**Non-Native Grasses**			90–270	
	smooth brome	BRIN2	*Bromus inermis*	45–225	–
	brome	BROMU	*Bromus*	9–90	–
	bluegrass	POA	*Poa*	45–90	–
Forb					
9	**Forbs**			45–90	
	sweetclover	MELIL	*Melilotus*	0–72	–
	Forb, introduced	2FI	*Forb, introduced*	0–45	–
	Forb, native	2FN	*Forb, native*	0–27	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	9–27	–

	common pepperweed	LEDE	*Lepidium densiflorum*	0–27	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	9–18	–
	goldenrod	SOLID	*Solidago*	9–18	–
	white heath aster	SYER	*Symphyotrichum ericoides*	9–18	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–9	–
	scurfpea	PSORA2	*Psoralidium*	0–9	–
Shrub/Vine					
10	**Shrubs**			18–54	
	western snowberry	SYOC	*Symphoricarpos occidentalis*	9–36	–
	soapweed yucca	YUGL	*Yucca glauca*	9–36	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–27	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–27	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–9	–
	rose	ROSA5	*Rosa*	0–9	–
Tree					
11	**Trees**			0–18	
	Tree	2TREE	*Tree*	0–18	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–18	–
	eastern redcedar	JUVI	*Juniperus virginiana*	0–18	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–18	–

Table 13. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool-Season Bunchgrasses**			28–210	
	green needlegrass	NAVI4	*Nassella viridula*	14–210	–
	Canada wildrye	ELCA4	*Elymus canadensis*	14–140	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–70	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–70	–
2	**Tall Warm-Season Grasses**			0	
3	**Wheatgrass**			28–280	
	western wheatgrass	PASM	*Pascopyrum smithii*	28–280	–
4	**Mid Warm-Season Grasses**			28–140	
	sideoats grama	BOCU	*Bouteloua curtipendula*	14–112	–
	little bluestem	SCSC	*Schizachyrium scoparium*	14–112	–
5	**Short Warm-Season Grasses**			0–70	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–70	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–56	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–42	–
6	**Other Native Grasses**			14–70	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	0–70	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	14–42	–

7	**Grass-likes**			14–70	
	sedge	CAREX	*Carex*	14–70	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–42	–
8	**Non-Native Grasses**			0–70	
	smooth brome	BRIN2	*Bromus inermis*	0–70	–
	brome	BROMU	*Bromus*	0–70	–
	bluegrass	POA	*Poa*	0–42	–
Forb					
9	**Forbs**			70–140	
	sweetclover	MELIL	*Melilotus*	0–70	–
	white heath aster	SYER	*Symphyotrichum ericoides*	14–42	–
	Forb, introduced	2FI	*Forb, introduced*	0–42	–
	Forb, native	2FN	*Forb, native*	0–42	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	14–42	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	14–28	–
	common pepperweed	LEDE	*Lepidium densiflorum*	0–28	–
	field pennycress	THAR5	*Thlaspi arvense*	0–28	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	0–28	–
	scurfpea	PSORA2	*Psoralidium*	14–28	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–28	–
	goldenrod	SOLID	*Solidago*	0–28	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–14	–
	alpine golden buckwheat	ERFLF	*Eriogonum flavum var. flavum*	0–14	–
	dotted blazing star	LIPU	*Liatris punctata*	0–14	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–14	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–14	–
	milkweed	ASCLE	*Asclepias*	0–14	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–14	–
Shrub/Vine					
10	**Shrubs**			28–98	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–42	–
	rose	ROSA5	*Rosa*	14–42	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	14–42	–
	soapweed yucca	YUGL	*Yucca glauca*	0–28	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–28	–
	leadplant	AMCA6	*Amorpha canescens*	0–14	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–14	–
Tree					
11	**Trees**			210–490	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–490	–
	eastern redcedar	JUVI	*Juniperus virginiana*	0–490	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–280	–
	Tree	2TREE	*Tree*	0–140	–

Table 14. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Cool-Season Bunchgrasses**			270–450	
	green needlegrass	NAVI4	*Nassella viridula*	180–270	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	90–180	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	90–180	–
	Canada wildrye	ELCA4	*Elymus canadensis*	0–90	–
2	**Tall Warm-Season Grasses**			90–270	
	big bluestem	ANGE	*Andropogon gerardii*	90–270	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	18–144	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–90	–
3	**Wheatgrass**			270–450	
	western wheatgrass	PASM	*Pascopyrum smithii*	270–450	–
4	**Mid Warm-Season Grasses**			90–270	
	sideoats grama	BOCU	*Bouteloua curtipendula*	36–180	–
	little bluestem	SCSC	*Schizachyrium scoparium*	36–180	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	0	–
5	**Short Warm-Season Grasses**			18–90	
	buffalograss	BODA2	*Bouteloua dactyloides*	18–90	–
	blue grama	BOGR2	*Bouteloua gracilis*	18–90	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–45	–
6	**Other Native Grasses**			18–90	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	0–90	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	18–54	–
7	**Grass-likes**			18–90	
	sedge	CAREX	*Carex*	18–90	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–54	–
8	**Non-Native Grasses**			90–270	
	smooth brome	BRIN2	*Bromus inermis*	36–270	–
	bluegrass	POA	*Poa*	36–90	–
	brome	BROMU	*Bromus*	2–54	–
Forb					
9	**Forbs**			90–180	
	Forb, native	2FN	*Forb, native*	22–88	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	22–66	–
	false boneset	BREU	*Brickellia eupatorioides*	0–44	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	22–44	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	22–44	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	22–44	–
	dotted blazing star	LIPU	*Liatris punctata*	22–44	–

	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	0–44	–
	beardtongue	PENST	*Penstemon*	0–44	–
	scurfpea	PSORA2	*Psoralidium*	22–44	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	22–44	–
	goldenrod	SOLID	*Solidago*	22–44	–
	white heath aster	SYER	*Symphyotrichum ericoides*	22–44	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–22	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–22	–
	milkweed	ASCLE	*Asclepias*	0–22	–
	textile onion	ALTE	*Allium textile*	0–22	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–22	–
	alpine golden buckwheat	ERFLF	*Eriogonum flavum var. flavum*	0–22	–
Shrub/Vine					
10	**Shrubs**			36–144	
	leadplant	AMCA6	*Amorpha canescens*	22–88	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–66	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–44	–
	rose	ROSA5	*Rosa*	22–44	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	22–44	–
	soapweed yucca	YUGL	*Yucca glauca*	22–44	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–22	–
Tree					
11	**Trees**			0–40	
	Tree	2TREE	*Tree*	0–40	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–40	–
	eastern redcedar	JUVI	*Juniperus virginiana*	0–40	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–40	–

Animal community

Grazing Interpretations
The following table lists annual suggested initial stocking rates with average growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of conservation planning. Often, the current plant composition does not entirely match any particular plant community (as described in this Ecological Site Description). Therefore, a resource inventory is necessary to document plant composition and production. More accurate carrying capacity estimates should eventually be calculated using the following stocking rate information along with animal preference data and actual stocking records, particularly when grazers other than cattle are involved. With consultation of the land manager, more intensive grazing management may result in improved harvest efficiencies and increased carrying capacity.

Plant Community: Needlegrass-Bluestem-Western Wheatgrass (1.1)
Average Annual Production (lbs./acre, air-dry): 2,200
Stocking Rate (AUM/acre): 0.60

Plant Community: Western Wheatgrass-Buffalograss-Grama (1.2)
Average Annual Production (lbs./acre, air-dry): 1,500
Stocking Rate (AUM/acre): 0.41

Plant Community: Sedge/Grama/Buffalograss Sod (2.1)
Average Annual Production (lbs./acre, air-dry): 900
Stocking Rate* (AUM/acre): 0.25

Plant Community: Western Wheatgrass-Needlegrass-Non-Native Cool-Season Grasses (< 15%) (4.1)
Average Annual Production (lbs./acre, air-dry): 1,800
Stocking Rate (AUM/acre): 0.49

Plant Community: All other Plant Communities identified in this document will have variable annual production values and will require on-site sampling to determine suggested initial stocking rates.

Based on 912 lbs./acre (air-dry weight) per Animal Unit Month (AUM), and on 25 percent harvest efficiency of preferred and desirable forage species (refer to USDA NRCS, National Range and Pasture Handbook).

Total annual production on-site may contain vegetation deemed undesirable or untargeted by the grazing animal. Therefore, AUM values may have been reduced to reflect only preferred or desirable forage species.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage. During the dormant period, the forage for livestock will likely be lacking protein to meet livestock requirements, and added protein will allow ruminants to better utilize the energy stored in grazed plant materials. A forage quality test (either directly or through fecal sampling) should be used to determine the level of supplementation needed.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group D. Infiltration is slow and runoff potential for this site is very high. In many cases, areas with greater than 75 percent ground cover have the greatest potential for higher infiltration and lower runoff. An example of an exception would be where shortgrasses form a strong sod and dominate the site. Dominance by blue grama, buffalograss, bluegrass, and/or smooth bromegrass will result in reduced infiltration and increased runoff. Areas where ground cover is less than 50 percent have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, USDA, NRCS. National Engineering Handbook for hydrologic soil groups, runoff quantities, and hydrologic curves).

Recreational uses

This site provides hunting, hiking, photography, bird watching, and other opportunities. The wide varieties of plants that bloom from spring until fall have an aesthetic value that appeals to visitors.

Wood products

No appreciable wood products are typically present on this site.

Other products

Seed harvest of native plant species can provide additional income on this site.

Other information

Revision Notes: “Previously Approved” Provisional
This Provisional ecological site concept has passed Quality Control (QC) and Quality Assurance (QA) to ensure that the site meets the 2014 NESH standards for a Provisional ecological site. This is an updated “Previously Approved” ESD which represents a first-generation tier of documentation that, prior to the release of the 2014 National Ecological Site Handbook (NESH), met all requirements as an “Approved” ESD as laid out in the 1997, rev.1, 2003 National Range and Pasture Handbook (NRPH). The document fully described the Reference State and Community Phase in the State-and-Transition model. All other alternative states are at least described in narrative form. The

“Previously Approved” ESD has been field-tested for a minimum of five years and is a proven functional document for conservation planning. The “Previously Approved” ESD does not contain all tabular and narrative entries as required in the current “Approved” level of documentation, but it is expected that the “Previously Approved” ESD will continue refinement toward an “Approved” status.

Site Development and Testing Plan:
Future work, as described in a Project Plan, is necessary to validate the information in this Provisional Ecological Site Description. This will include field activities to collect low-, medium-, and high-intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. The final field review, peer review, quality control, and quality assurance reviews of the ESD will be required to produce the final document.

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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: April Boltjes, Range Management Specialist (RMS), NRCS; Stan Boltz, RMS, NRCS; and Dana Larsen, RMS, NRCS.

There are 18 SCS-RANGE-417s collected from 1980-2006 from, Brule, Buffalo, Gregory, and Lyman Counties in South Dakota, and from Boyd County Nebraska.

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Contributors

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ESD updated by Rick L. Peterson on 12/12/17.

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)	Stan Boltz
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Date	02/20/2009
Approved by	Stan Boltz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Slight to none, typically on steeper slopes and discontinuous.

2. **Presence of water flow patterns:** None, or barely visible and discontinuous with numerous debris dams when present.

3. **Number and height of erosional pedestals or terracettes:** Few pedastalled plants typically on steeper slopes.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground roughly 5 to 15 percent, and patches less than 2 inches in diameter.

5. **Number of gullies and erosion associated with gullies:** None should be present.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None.

7. **Amount of litter movement (describe size and distance expected to travel):** Small size litter classes will generally move short distances, some medium size class litter will move very short distances. Litter debris dams are occasionally present.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil aggregate stability ratings typically 4 to 6. Surface organic matter adheres to the soil surface.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A-horizon should be 2 to 4 inches thick with light to dark brownish gray colors. Structure should typically be fine granular at least in the upper A-horizon.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Combination of shallow and deep rooted species (mid & tall rhizomatous and tufted perennial cool- and warm-season grasses) with fine and coarse roots positively influences infiltration.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None – when dry, B horizons can be hard and appear to be compacted, but no platy structure will be present.

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: Tall and mid, cool-season bunchgrasses = tall, warm-season grasses = wheatgrasses (mid, cool-season) >

    Sub-dominant: Mid, warm-season grasses >

    Other: Forbs > shrubs > short, warm-season grasses = grass-likes species > short, cool-season bunchgrasses > trees

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Very little evidence of decadence or mortality. Bunch grasses have strong, healthy centers and shrubs are vigorous.

14. **Average percent litter cover (%) and depth (in):** Litter cover 40 to 60 percent, and litter in contact with soil surface. Litter depth about 0.25 to 0.5 inches.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Total annual production ranges from 1,400 to 3,000 pounds/acre, with the reference value being 2,200 pounds/acre (air-dry basis).

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:** State and local noxious weeds; also Kentucky bluegrass.

17. **Perennial plant reproductive capability:** Perennial grasses should have vigorous rhizomes or tillers.